

Issued February 12, 1912.

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.

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SOIL SURVEY OF WAUKESHA COUNTY,  
WISCONSIN.

BY W. J. GEIB, PERCY O. WOOD, AND GROVE B. JONES, OF THE UNITED STATES DEPARTMENT OF AGRICULTURE; AND A. H. MEYER, OF THE WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY.

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J. E. LAPHAM, INSPECTOR IN CHARGE.

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[Advance Sheets—Field Operations of the Bureau of Soils, 1910.]



WASHINGTON:  
GOVERNMENT PRINTING OFFICE.  
1912.

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## LETTER OF TRANSMITTAL.

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U. S. DEPARTMENT OF AGRICULTURE,  
BUREAU OF SOILS,  
*Washington, D. C., August 9, 1911.*

SIR: In continuance of the cooperative agreement with the State of Wisconsin, one of the soil-survey projects completed in Wisconsin during the field season of 1910 was the survey of Waukesha County.

The soils are varied and of glacial origin. Among them are types excellently adapted to grasses, and dairying is one of the main branches of farming. Many creameries and cheese factories are found in the county and milk is shipped to Milwaukee and Chicago. Sugar beets form an important special crop and there are wide areas of soil that might be used in extending this industry.

The accompanying report and map should be of service to those interested in improving their agriculture, especially as regards the adaptation of crops to soils and the maintenance of soil productivity by diversification, green manuring, rotation, etc.

I have the honor to recommend that the accompanying manuscript report and map be published as advance sheets of Field Operations of the Bureau of Soils for 1910, as authorized by law.

Respectfully,

MILTON WHITNEY,  
*Chief of Bureau.*

HON. JAMES WILSON,  
*Secretary of Agriculture.*

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MAP.

Soil map, Waukesha County sheet, Wisconsin.



# SOIL SURVEY OF WAUKESHA COUNTY, WISCONSIN.

By W. J. GEIB, PERCY O. WOOD, and GROVE B. JONES, of the United States Department of Agriculture, and A. H. MEYER, of the Wisconsin Geological and Natural History Survey.

## DESCRIPTION OF THE AREA.

Waukesha County is located in the southeastern part of Wisconsin. It is bounded on the north by Dodge and Washington Counties, on the east by Milwaukee County, on the south by Racine and Walworth Counties, and on the west by Jefferson County. The parallel  $43^{\circ}$  north latitude and meridian  $88^{\circ}$  west longitude cross near the city of Waukesha. The eastern limit of the county is but 10 miles from Lake Michigan; the southern boundary is 24 miles from the Illinois State line. The county has the form of a square, each side measuring 24 miles; it is composed of 16 townships and comprises an area of 560 square miles, or 358,400 acres.

The surface features of the area are characteristic of a glacial region, and the topography varies from level to rolling and hilly. The most pronounced topographic feature is the Kettle Moraine, which traverses the county in a general direction about  $15^{\circ}$  west of south, passing through the townships of Merton, Delafield, Genesee, the southeast part of Ottawa, and Eagle. This ridge varies in width from 1 to 4 or 5 miles and

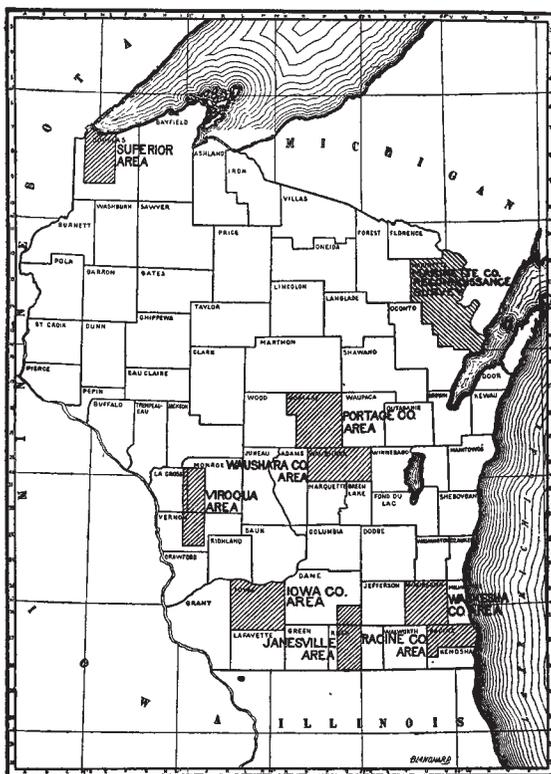


FIG. 1.—Sketch map showing location of the Waukesha County area, Wisconsin.

includes the roughest part of the area. In the southwestern part of Delafield Township, on Government Hill, it attains an elevation of 1,233 feet above sea level, which is the highest point in the county, and 350 feet above the level of Summit Prairie. The average elevation of the area is between 900 and 1,000 feet. The topography in the immediate vicinity of Government Hill is extremely rough and broken.

Another moraine belt extends to the northeast from the village of Mukwonago, passing through the township of Vernon and into the southwest corner of New Berlin. Throughout a large part of Oconomowoc and Summit Townships the surface is level to undulating.

Extending to the east and northeast of Eagle is a level tract of considerable size commonly spoken of as prairie. Another similar occurrence, though of much smaller extent, is found immediately south of Waukesha. Other level to undulating areas are found in the eastern part of Merton, the eastern and northern parts of Lisbon, the northwestern part of Delafield, and the southern and eastern parts of Muskego Townships.

There are a number of marshes in the area, the largest occupying a portion of Eagle and Ottawa Townships; another of considerable size extends north from Mukwonago along Fox River. Other smaller swamps are found in all parts of the survey. The remainder of the county is rolling to hilly. In general, it may be said that the southern half of the county is rougher than the northern.

The Fox River is the largest drainage course in the county. It heads in the northeastern part of the area, meanders in a southwesterly direction to near Mukwonago, thence, turning sharply eastward to Big Bend, it flows south and leaves the county. It empties into the Illinois River and eventually into the Mississippi. The Fox River receives practically all the drainage from the north-central, central, southern, and southeastern parts of the county. The western and northwestern parts are drained by the Scuppernong, Bark, and Oconomowoc Rivers, the waters of which find their way to the Mississippi through Rock River. The extreme northeastern corner is traversed by the Menominee River, and Root River passes through the eastern border of New Berlin Township. Both of these streams flow into Lake Michigan. A few of the streams afford a small amount of water power, which is utilized chiefly for running grist-mills.

The first settlement in Waukesha County was made in 1834, at Prairie Village, on the present site of Waukesha. Wisconsin Territory was organized in 1836. The county of Waukesha was established from a part of Milwaukee County in 1846.

The first settlers came chiefly from New England, New York, Pennsylvania, Ohio, and Illinois. Later a number of foreign settlements were established within the county. The names directly trace-

able to English settlement and influence are Sussex, Merton, Hartland, Brookfield, and Colgate. The Welsh found the hilly region of Delafield and Genesee Townships to their liking. The settlements of Irish and Scotch were largely in the same townships as the English. The Germans exhibited their characteristic caution by settling first in the eastern part of the county near the center of supplies. Those who went farther inland established themselves along the old roads which formed the main lines of travel. At the present time persons of German descent are the most numerous within the area, while the English are probably second in numbers. All parts of the county are now thickly settled, well developed, and supplied with telephone and rural free delivery.

Waukesha, an up-to-date city of about 8,000, is situated in the east-central part of the area, in the midst of a good agricultural district. It is the county seat, a thriving business center and a distributing point for farm implements, seeds, and general supplies. It has long been famous for its mineral springs. Oconomowoc, in the northwestern part of the area, is the second town of importance. It has a population of about 3,000, is built between two beautiful lakes, contains many fine summer homes, and is surrounded by a good farming country. Okauchee, Nashotah, Delafield, Pewaukee, Menomonee Falls, Eagle, Mukwonago, North Lake, Muskego, Wales, and Elm Grove are smaller towns and villages scattered throughout the county.

The county is well supplied with steam and electric roads. The La Crosse division of the Chicago, Milwaukee & St. Paul Railroad traverses the area from east to west, passing through Oconomowoc and Pewaukee and on to Chicago via Milwaukee. The Prairie du Chien division crosses the area from northeast to southwest, passing through Eagle, Waukesha, and Brookfield. From Eagle a branch extends south to Elkhorn, in Walworth County. Another branch extends into the northern part of the survey from Menomonee Falls through Lannon, Templeton, and Sussex to North Lake. The Milwaukee and Madison branch of the Chicago & North Western Railway crosses the center of the county from east to west, through Waukesha and Wales. A direct line of this road from Milwaukee to St. Paul is now being completed through the northern part of the area. The Soo line traverses the survey from north to south through Waukesha and Mukwonago, giving a direct route to Chicago.

The Milwaukee Electric Light & Railway Co. has three electric lines traversing this area. One extends from Milwaukee to Watertown, touching Waukesha, Delafield, and Oconomowoc. Another crosses the southern portion through Muskego and Mukwonago. The third crosses the extreme southeast corner of the area, joins the Mukwonago line, and extends to Milwaukee. There are no steam roads in the southeast part of the county, and, as the electric lines are not

permitted to carry freight or express, the farmers of this region haul most of their produce to Milwaukee by team. All other parts of the area are within easy reach of shipping points.

The dirt roads throughout the county are kept in very good condition. They are piked by the use of large road-grading machines and crowned with gravel or crushed rock. There is an abundance of good road-building material in nearly all parts of the area. The mileage of improved highway is increasing each year. There are no toll roads in Waukesha County.

The towns and cities within the county afford a limited market for the products of the farm and dairy. The chief markets are Milwaukee and Chicago, both of which are within easy reach. From Waukesha to Milwaukee it is but 20 miles via the Chicago & North Western and but 100 miles to Chicago via the Soo line.

#### CLIMATE.

The following table gives the records of the Weather Bureau station at Harvey, in Jefferson County, which joins Waukesha on the west. The station being so near and in the same latitude, the records may be applied to the area surveyed with but slight chance of error.

*Normal monthly, seasonal, and annual temperature and precipitation at Harvey, Jefferson County.*

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
December.....	22	55	-19	1.4	1.2	1.0	5.9
January.....	19	57	-21	1.3	1.1	.4	6.8
February.....	17	59	-24	1.5	.9	1.2	6.0
Winter.....	19			4.2	3.2	2.6	18.7
March.....	32	78	- 4	2.1	2.8	2.6	5.9
April.....	47	87	14	2.6	.8	2.2	1.0
May.....	59	90	29	4.2	3.0	4.5	T.
Spring.....	46			8.9	6.6	9.3	6.9
June.....	68	99	32	3.6	1.8	3.8	.0
July.....	72	107	41	3.8	1.4	9.4	.0
August.....	70	98	41	3.5	1.0	7.7	.0
Summer.....	70			10.9	4.2	20.9	.0
September.....	62	96	24	3.4	3.5	4.9	.0
October.....	50	90	10	2.5	2.8	1.7	.3
November.....	34	69	17	2.0	.8	1.0	7.0
Fall.....	49			7.9	7.1	7.6	7.3
Year.....	46	107	-24	31.9	21.1	40.4	32.9

It will be seen that the mean annual precipitation is 31.9 inches and that the greater proportion of this is normally distributed throughout the growing season, when it is most needed. The period of greatest variation in the rainfall is during the three summer months, June, July, and August. The normal precipitation for this time is 10.9 inches, but the record shows a range of from 4.2 inches to 20.9 inches. Such extremes seldom occur, but it is quite common to have a dry spell in July or August, or for a part of both months, during which crops suffer from lack of moisture. On account of the uneven topography over a portion of the county and the large amount of gravel in the subsoil, some of the types are naturally droughty, and during dry seasons crops on such soils suffer considerably.

The average snowfall is 32.9 inches, and under normal conditions crops of winter wheat, rye, clover, and alfalfa are well protected by a covering of snow. When the snowfall is light such crops are frequently damaged to considerable extent by freezing and thawing.

The lowest temperature recorded is  $-27^{\circ}$  and the highest  $107^{\circ}$ , with a mean annual temperature of  $46^{\circ}$ . Such extremes are infrequent and of short duration, however, and it is very seldom that zero weather continues for a week at a time or that the temperature reaches  $100^{\circ}$  F. during the hottest season. The summer nights are usually cool, though the effect of Lake Michigan is seldom felt unless the wind is from the east or northeast. The winters are long and severe, but the cold is rendered less noticeable because of the comparatively uniform conditions which prevail during the winter months.

The average date of the first killing frost in the fall is October 1, and of the last in the spring May 4, with the earliest and latest record September 20 and June 6, respectively. During normal seasons, therefore, it will be seen that there is a growing season of 149 days for the most tender vegetation.

The prevailing winds during winter are from the west and north and during summer from the west and southwest. This region is seldom visited by storms of cyclonic nature, though high winds are quite common during March. The climate is healthful, and especially delightful during the summer months. The water supply is abundant and of very good quality. On account of the mineral springs and the many beautiful lakes large numbers of people are attracted to Waukesha County each year to spend the summer months.

#### AGRICULTURE.

The early history of agriculture in Waukesha County dates back to 1834, when the first settlement was made on the present site of the city of Waukesha. The Indians who inhabited this region had scratched the soil and grown some corn prior to this time, but their efforts are scarcely worthy of consideration.

The raising of grain early became the leading industry and for about 15 years winter wheat was grown. What spring wheat was sown at first did not yield satisfactorily, except on the "openings" and prairies where the winter wheat killed out. Spring wheat came gradually into favor, however, and for a period of about 25 years, or up to 1880, it was grown almost exclusively. About this time, owing to small yields from continued cropping on the same fields, drought, the chinch bug, weevil, and the decline in prices, the acreage of spring wheat was greatly reduced and winter wheat was again tried. Up to 1878 and 1880 the raising of wheat gradually increased. In 1880 there were 42,038 acres in the area which gave a yield of 711,839 bushels. Since that time there has been a rapid falling off in the wheat production, and in 1900 there were only 2,315 acres in this crop, which produced 39,410 bushels. The amount grown at present is still smaller, and only a few fields were seen in each community throughout the county.

The growing of hops was at one time an important industry in the area. Up to 1860 only a few were grown, but by 1867 and 1868 the "hop fever" had reached its height. Nearly every farmer went into the business and some on quite an extensive scale. The hop louse in the East and the increased demand of brewers made hops a very profitable crop. In 1857 the price was from 40 to 50 cents a pound, and in many cases a single crop paid for the land and all improvements. So many went into hop raising that overproduction resulted. In 1869 the price was 10 to 15 cents a pound, while hops of poor quality brought only 3 cents a pound. The prices went even lower than this. The hop louse also invaded the region, and this, in connection with low prices, aided in bringing failure upon many farmers. By 1880 hop growing was almost entirely abandoned.

During the decline of the hop industry the production of barley gradually increased. In 1890 the crop of the county from 32,880 acres amounted to 1,174,100 bushels, an average of 37 bushels per acre. By 1900 the acreage had fallen to 19,524, and at present there is less than one-fourth as much grown as there was 20 years ago.

While wheat was grown more extensively than any other grain in the early history of the county, it was not grown to the exclusion of other crops, and as early as 1839 the yield of corn in what is now Waukesha County amounted to 23,063 bushels, that of oats 18,202 bushels, buckwheat 29,008 bushels, and potatoes 36,634 bushels.

The early methods of farming were crude and wasteful. Fields were poorly cultivated; often planted to the same crop year after year. No thought was given to the question of maintaining or improving the productiveness of the soil, and as a result the yields decreased. When the reduction in yields and the cause thereof became apparent the system was gradually improved until at the

present time a large number of farmers follow a system of crop rotation, exercise considerable care in the selection of seed, return large amounts of organic matter to the soil in the form of barnyard manure or green crops, and the most up-to-date farmers are constantly on the lookout for methods by which conditions may be still further improved.

The early pioneers had the usual difficulties to contend with in clearing the land, breaking up new fields and getting the product to market. Practically all surplus grain and other produce was hauled to Milwaukee by team. The coming of the railroads greatly reduced the hauling and opened up new markets. They brought in more settlers and assisted in the development of the region. The Prairie du Chien division of the Chicago, Milwaukee & St. Paul, which was the first road in the State, was completed through the county in 1851, and the La Crosse division in 1855.

About the time of the failure of the hop industry (1879) the growth of the factory system of butter and cheese making began, and the type of agriculture now practiced throughout the area consists chiefly of dairying in conjunction with general farming and stock raising. Dairying is the most important branch of farming in Waukesha County and the magnitude of this industry can be appreciated when it is known that in 1905 the production of milk was 115,184,390 pounds, having a value of \$1,211,216. A large proportion of this was made into butter, some into cheese, and a large amount was shipped to Milwaukee and some to Chicago. The State census of 1905 states that at that time there were within the area 37 creameries and 3 cheese factories, which received 52,803,337 pounds of milk that year. Since that time the number of creameries and cheese factories has increased with the more extensive development of the dairy industry generally. Practically all of the creameries and cheese factories are owned by individuals or companies and only a few are managed on the cooperative plan. Where creameries are patronized the farmers usually separate their own cream and haul it to the creamery, where it is tested and paid for according to the butter-fat content. The price varies somewhat, but is usually about 2 cents above Elgin quotation, the creamery keeping the overrun. When the cream is collected by the creamery the price is somewhat lower. Those who patronize cheese factories haul their own milk and sell it by the hundredweight, without its being tested in any way. The price varies from \$1 per hundredweight in the summer to \$1.70 in the winter. Brick and American cheeses are the kinds most commonly made. The whey is returned to the farmers, who feed it to hogs.

In Waukesha County there is a milk producers' association to which many of those who ship to Milwaukee belong. A representa-

tive of the association at each station attends to the shipping, transacts the business with the distributing companies, and in general looks after the interest of the producers. The milk is shipped chiefly in 8-gallon cans and the price received in Milwaukee varies from 75 cents to \$1.25 per can, and sometimes a little more. The farmers are obliged to pay the freight, which amounts to 13½ cents a can from points in the eastern part of the county. The freight on a can of cream of the same size and from the same points is 19 cents. From the southeastern part of the area considerable quantities of milk and cream are hauled to Milwaukee by team.

The census of 1905 states that at that time there were 27,648 milch cows in the county. The number is larger at present. While the greater proportion of the dairy herds are grade stock there are many pure-bred herds and the number of these is increasing gradually. Where the object is the production of a large quantity without regard to the butter-fat content, pure-bred or grade Holsteins are the most desirable, and those who ship to the regular trade in Milwaukee or to cheese factories usually prefer this breed. Many of those who patronize a creamery or ship the milk to consumers who wish a rich, well-colored product prefer the Guernsey or Jersey; the latter, however, are not held in very high favor in this region and there are comparatively few in the county.

There are more Holsteins in the county than pure breeds of any other class. They are noted especially for the quantity of milk they produce. Their calves are large and if desired for veal they will bring in more money than calves of smaller breeds. There are several dairies in the area which produce certified milk. This is shipped to Milwaukee and Chicago, where it brings respectively 14 and 15 cents a quart.

Conditions in the county are very favorable for dairying, the average farmer keeping from 10 to 15 milch cows, though there are many farms making a specialty of dairying and keeping a much larger number of cows. Milwaukee and Chicago furnish good markets for the dairy products. Much of the butter and cheese is marketed in the cities of the East. The silo is in very common use, the number increasing rapidly. Stave silos are the most common, though brick, stone, and cement are sometimes used in their construction.

Hog raising is carried on in conjunction with dairying, and the present high prices of pork are stimulating a greater development of the industry. The chief breeds are the Chester White, Poland China, Berkshire, and Duroc Jersey, though a large proportion of the stock is of mixed blood.

Comparatively few beef cattle are raised, though a few head are fed on a number of farms each winter. There are some pure-bred

herds representing practically all the leading beef, dairy, and dual-purpose breeds, but most of the stock placed on the market is sold for breeding purposes. The raising of sheep is confined largely to the rougher portions of the area mapped as Miami gravel and Miami gravelly sandy loam, though small flocks are found in nearly all parts of the county. The rough areas are better adapted to grazing than to anything else, and as there is usually a good supply of water available this class of land is well adapted to sheep raising. There are several breeders of pure-bred sheep within the area who have attained a wide reputation.

Practically all of the teaming and farm work is done with horses, there being only a few mules in this region. Many farmers raise one or two colts each year, thus supplying their own work stock and occasionally having a team to sell. One of the leading horse farms in the country, having an international reputation and doing considerable importing each year, is located in the county near Oconomowoc. The management extends the use of pure-bred sires to the people of the vicinity for a nominal sum in order that the stock of the locality may be improved. Another horse farm is located at Menomonee Falls.

The principal farm crops now grown in this region are, in the order of acreage, hay, oats, corn, barley, rye, peas, wheat, potatoes, buckwheat, sugar beets, and truck crops. The hay consists of clover, timothy, marsh grass, alfalfa, and an occasional cutting of oats and peas. Brookfield, Genesee, and New Berlin Townships lead in the production of hay. Seeding may be done with wheat, oats, or rye. On account of an acid condition in some soils it is sometimes difficult to get a stand of clover. When the usual hay crop fails or is short, a field of oats and peas may be depended upon to furnish a good substitute.

The growing of alfalfa in this region has passed from the experimental stage. It has been demonstrated by many farmers that it can be grown successfully, and the acreage is gradually increasing. Three cuttings and sometimes four can be obtained each year, the total yield ranging from 3 to 5 tons per acre. Alfalfa contains a high percentage of protein, has a feeding value nearly equal to wheat bran, and is especially valuable on the dairy farm. For its production the soil should be well drained, richly manured, limed, and in good physical condition. Inoculation is advisable, though not always necessary, especially where sweet clover grows. A very satisfactory method of inoculation is to sow about 3 pounds of alfalfa seed in with clover, and when that field is later sown to alfalfa it will be thoroughly inoculated. Soil from an old alfalfa field may be used, or nitroculture may be applied to the seed. Alfalfa may be seeded in the spring with oats and peas as a nurse crop, and these cut for

hay, or it may be sown without a nurse crop in August. Both methods have given satisfactory results in the county. Twenty pounds of seed per acre is considered sufficient to insure a good stand.

Oats are grown more extensively than any other grain, though the acreage now devoted to the crop is not so great as it was 10 years ago. The average yield for the entire county is over 40 bushels per acre. Oats form the chief grain ration for horses, some is ground and mixed with other feeds for cattle, and varying amounts are sold. While Pewaukee, Oconomowoc, and Genesee Townships lead in the production of oats, this crop is grown extensively in all parts of the area.

Corn is the most important crop grown, and its cash value frequently exceeds that of oats. As the dairy industry develops the acreage of corn gradually increases. Large amounts are cut for ensilage when in the glazed stage. Considerable corn is husked and fed to hogs, while some is ground and forms a part of the grain ration of the dairy cows and fattening steers. Ordinary early yellow dent is the variety most largely grown, as it is always certain to mature in this latitude. White No. 7 and Yellow No. 8 have given good results, though the white requires a longer season, and there is some danger of frost damaging this variety. The townships of Vernon, Mukwonago, and Oconomowoc exceed in the production of corn, though it is grown extensively in all parts of the survey.

The growing of barley is gradually decreasing, though it is still an important factor in the agriculture of the county. From 1900 to 1905 the acreage was more than half that of corn. A large percentage of the crop is sold, though considerable is fed on the farms. More barley is raised in Lisbon, Oconomowoc, Menomonee, and Merton Townships than elsewhere.

Rye is grown to a limited extent and is confined chiefly to the lighter soils of the area. A small amount is fed, some is ground and used in making bread, and the remainder is sold. Ottawa, Mukwonago, Summit, and Vernon Townships produce the most rye.

As stated before, only a very small amount of wheat is now grown in the area, and on account of the high price of land and the extensive development of the dairy industry, it is not at all probable that the acreage will ever be increased. In 1905 there were only 2,028 acres of wheat in Waukesha County.

In Mukwonago Township and in a few other parts of the area a small amount of buckwheat is annually produced.

Within the last few years the growing of peas for canning has developed quite extensively in the vicinity of Waukesha and north along the Soo Line. The canning factory is located at Waukesha and thrashing stations are scattered about through the pea-growing section. The crop is planted at intervals so that the peas will be

ready to harvest at different times during the summer. It is necessary that the vines should be cut when the peas have reached a certain stage of development. If left a few days they deteriorate rapidly. But few farmers raise more than 10 acres. The vines are cut with a mowing machine and hauled to the thrasher at once. There they are graded and run through the machine, which breaks the pods and separates the peas. The peas which are sweet and tender and in the best possible condition bring the highest price. For the season of 1910 this was  $2\frac{1}{2}$  cents a pound. The other grades brought 2 and  $1\frac{1}{2}$  cents a pound, respectively. Thirty dollars per acre net is considered a good average return from this crop, though as high as \$80 net has been secured under the most favorable conditions. Frequently the crop is a complete failure and will not pay for the labor expended. Farmers report better crops after land has grown peas for a season or two. As soon as the vines are cut some of the farmers plow the land and the same field is plowed again in the fall. This extra cultivation may account in part for the increase in subsequent yields.

Beans have never been grown to any extent and only small patches were seen during the progress of the soil survey.

The growing of potatoes has never been developed on an extensive commercial scale. Every farmer plants a few acres and sells the surplus.

In the northeastern part of the county sugar beets are grown and nearly every farmer in that section has from 2 to 10 acres in this crop. Beets grown on the Miami clay loam produce a heavier growth and higher test than those grown on the silt loam. On well-drained areas of Clyde silty clay loam the tonnage and net returns are greater than on any of the upland soils, though the test is usually about 2 per cent lower. The average yield of beets is 12 tons per acre and the average test 16 per cent sugar. The factory guarantees to supply labor for thinning and weeding the beets and advises the farmers as to the best methods of fertilization and culture. Besides stable manure, commercial fertilizers are sometimes used. A special brand put up by one of the packing plants, together with refuse lime, is used. The sugar factory is located at Menomonee Falls and receives beets from various parts of the State.

The trucking industry has not been extensively developed at any point in the county, though small patches of strawberries, tomatoes, onions, celery, melons, cabbage, and the like are grown in various parts of the survey. In the southern and southeastern parts of the area a number of farmers grow considerable sweet corn. In the vicinity of New Berlin cabbage and cauliflower are raised quite extensively. There is a pickle factory at Eagle and one at Duplainville, and cucumbers are grown in the vicinity of these places. Two hun-

dred dollars is the maximum amount received from an acre. More strawberries are grown in the vicinity of Dousman than elsewhere.

The fruit-growing industry is not developed on a commercial scale in any part of the county, though on most of the farms there is a small apple orchard and occasionally a few peach, pear, cherry, and plum trees, and some small fruits. During the more favorable seasons a small amount of fruit is sold, but ordinarily the most of it is required for home use. The climatic conditions in this part of the State are not so favorable for fruit growing as in sections which receive the modifying influence of large bodies of water, and it is not at all probable that this industry will ever be developed on a large commercial scale.

The type of agriculture practiced at the present time in Waukesha County and the crops which are being grown are well adapted to the soils and the general conditions prevailing throughout this region. Considerable land has been improved and its productiveness increased by tile drains. In several places marsh land has been, or is being, reclaimed by open ditches. There is considerable variation as to crop rotation, as will be seen from the discussions on the various soil types, but the rotation most common consists of corn, barley, oats, or only one of the last two—hay one or two years, and pasture one year. Grass seeding is sometimes done with the oats or barley, though when wheat or rye follow oats, as is sometimes the case, it is customary to seed with one of these crops.

As a rule the farm buildings are substantial, well painted, and kept in good repair, and while there are always some unkempt places a large number of comfortable farm homes, with neatly kept lawns, well-cultivated fields, and good fences are evidences of thrift and prosperity to be seen throughout the county.

The labor problem is one which causes some concern, and it frequently determines the type of farming to be followed. The usual wage for eight months is \$25 to \$35 a month, with board. There is an industrial school at Waukesha, and on being released or paroled employment is found for some of the boys on farms. Their wage depends upon their ability and previous experience, ranging upward from \$16 a month. It is especially difficult to get competent help on the dairy farms.

The average size of farms is gradually decreasing, and, as given in the census of 1900, was 93.6 acres. As the average size decreases the methods followed become more intensive and greater returns per acre are received.

Many of the small towns and villages in the area are made up largely of retired farmers. The census of 1900 states that 73.2 per cent of the farms are operated by the owners. The share system prevails in renting. When the tenant furnishes everything, one-third

of the crop is given as rent. When the landowner furnishes stock, tools, and seed, the crops are equally divided. The canning factory at Waukesha sometimes rents land on which to grow peas and pays \$5 an acre for it. Comparatively little cash renting is done. In one case a tract of 120 acres, half under cultivation and the remainder about equally divided between woodlot, rough pasture land, and marsh, from which hay could be cut, rents for \$350 a year.

The value of farm lands in the county depends upon the character of the soil, topography, location, and improvements. The lowest in value consists of Miami gravel, Miami gravelly sandy loam, and unreclaimed marshes, prices for which range from \$10 to \$50 an acre. On the Miami clay loam, silt loam, and loam types, which are highly developed, land values range from \$75 to \$150 an acre.

While the agriculture of the area is highly developed and in a prosperous condition, there are, nevertheless, some changes and additions which might be made advantageously. A few general suggestions are given here, but the more specific recommendations are reserved for the separate soil types to which they refer. Since the area surveyed is favorably located in regard to markets, well supplied with railroads, and admirably adapted to dairying, it is recommended that this already important industry be still further developed. Catering to special classes of trade in milk production is proving profitable. Sanitary methods of handling the milk and in caring for stock should be followed.

The number of silos should be increased and the acreage devoted to corn for ensilage extended. Alfalfa is an excellent feed for dairy cows and, as it can be successfully grown here, its production should be greatly extended. Where the soils are found to be acid, a more liberal use of lime is recommended. This may be applied directly to the cultivated fields or may first be sprinkled in the stables to improve their sanitary condition and reach the land when the manure is applied, thus serving a double purpose. Whenever it is possible to do so, manure should be spread upon the fields as rapidly as made. When this can not be done it should be stored in a shed to prevent loss.

While this region is not adapted to commercial fruit growing, it is suggested that more attention be given to putting out small orchards for home use. On every farm there should be a few trees of the different kinds of fruit, so there would always be enough for home consumption.

On many of the soils trucking could be profitably developed. This industry could be extended, especially on the lighter types, which are not so well adapted to general farming and dairying. Strawberries, melons, cucumbers, tomatoes, and a few other truck crops are being successfully grown on small acreages on the light soils, and cabbage

does well on the Clyde loam and silty clay loam. Where a water supply is convenient small irrigation systems could be established and water applied to these special crops during the dry months.

The marshes, of which there are many, should be reclaimed, thus adding thousands of acres of valuable land to the resources of the county. This matter should be given careful attention by the land owners, because when improved these areas will produce very profitable yields.

#### SOILS.

Waukesha County, in common with all northern and eastern Wisconsin, owes the general character of its surface to glacial action. Three more or less distinct periods of glaciation have influenced the geology and topography of the State. The products of these several invasions of the ice are known as the Older or Pre-Wisconsin Drift, the Early Wisconsin Drift, and the Late Wisconsin Drift. It is with the most recent period of glaciation that we are concerned in the present survey, since it alone brought down and deposited the material which covers the surface of this region. The Late Wisconsin Drift was formed by the advance and retreat of four contemporaneous ice lobes known as the Superior, Chippewa, Green Bay, and Lake Michigan Glaciers. The two last named were confined to the eastern part of the State and combined to mold the surface features of a large area, including Waukesha County.

The direction of the main body of the Green Bay Glacier was to the southwest, though the portion reaching into Waukesha, Jefferson, and Walworth Counties had a direction varying from south to southeast. The Lake Michigan Glacier advanced southward along the lake basin, and on the west developed laterally what is called the Delavan Lobe. Where the Green Bay Glacier came into contact with the Delavan Lobe what is known as the Kettle Moraine or Medial Moraine was formed. This consists of a very conspicuous range of hills extending to the northeast from a point near Delavan, in Walworth County, to about the center of Kewaunee County. It crosses Waukesha County and forms the most noticeable feature of the area. Outside of the Kettle Moraine, till deposited by the ice sheets is known as the ground moraine. The topography here varies from level to rolling and hilly. There are a number of "prairies" in the county, which represent glacial outwash plains. Rough gravelly areas are found in various parts of the survey, frequently having the form of drumloidal hills or elongated ridges. There are also large areas where the surface of the drift is gently rolling.

On the retreat of the great ice sheets the melting of massive blocks which had broken off, the issuing of water from under the glaciers, and the dumping of glacial debris across drainage channels resulted in the formation of numerous kettlelike depressions or holes from

a few rods to several miles in extent. Many of these filled with water and formed the beautiful lake region of Waukesha County. Many of the smaller depressions contain no water and are spoken of as "pot holes" or "kettle holes."

The glacial drift over Waukesha County varies in depth from a few feet to over 300 feet. There appear to be several preglacial valleys in the area, and one of these is traversed by the Fox River between Waukesha and Big Bend. At some points here the drift is known to be at least 300 feet deep. The rock encountered in wells in the floor of these valleys is in one case Cincinnati shale; in another Potsdam sandstone. The rock upon which the glacial drift throughout the greater part of the county rests is the Niagara limestone, which overlies the Cincinnati shale. This outcrops extensively at Waukesha and Lannon, where large quarries have long been in operation, and also at numerous other places throughout the county. In Lisbon and the western part of Menominee Townships the rock is frequently encountered at from 2 to 3 feet below the surface.

Twenty soil types, including Peat and Meadow, have been recognized and mapped in Waukesha County. The material of which they are composed has all been derived from glacial till, though some of it has been reworked and redeposited by water and modified by the incorporation of organic matter since its first deposition. The glacial drift consists of a heterogeneous mixture of sand, gravel, clay, and boulders. The greater proportion of this material consists of ground-up limestone and the resulting soils are naturally more productive than where no limestone is found.

The Miami series of soils is the most extensively developed. It comprises light-colored soils originally covered by a forest growth. It is found covering large tracts throughout eastern Wisconsin, in Minnesota, Michigan, Ohio, Indiana, and Illinois. The types in this series mapped in Waukesha County are the silt loam, clay loam, loam, fine sandy loam, sand, gravelly sandy loam, and gravel.

The Plainfield series consists of light-colored soils composed of assorted glacial material, which occurs in the form of outwash plains and filled-in valleys. The types belonging to this series recognized in Waukesha County are the silt loam, loam, fine sandy loam, and sand.

The Waukesha series includes the dark-brown to black soils occupying outwash plains and glacial terraces. These areas are commonly spoken of as prairies, though portions of them were originally wooded. Two types of this series, the loam and gravelly loam, were encountered in the survey of Waukesha County.

The Carrington series, which is developed over a very small area, includes dark-colored soils of glacial origin. Two types, Carrington loam and clay loam, were mapped.

The Clyde series includes dark-colored soils occupying low, poorly drained depressions, marshes, and old lake beds. They contain a high percentage of organic matter, but much more mineral matter than Peat (with included areas of Muck). The types recognized as belonging to this series are Clyde silty clay loam, loam, and sandy loam.

The material mapped as Peat (with included areas of Muck) occupies swamps, marshes, and old lake beds. Where the vegetable matter has reached an advanced stage of decomposition and where there is considerable mineral matter incorporated with it, it is true Muck, but those areas in which the material is still fibrous or lacks mineral components is Peat. On account of the lack of uniformity and the constant gradation of one phase of material into the other, it was not feasible to separate the two.

Meadow includes narrow, low-lying strips of land along streams which overflow their banks annually. The soil is variable and can not be classed with any of the other established types. It would be difficult to drain the tracts of soil mapped as Meadow.

The names of the different types, together with their actual and relative extent, are given in the following table:

*Areas of different soils.*

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Miami silt loam.....	82,176	22.9	Plainfield loam.....	4,160	1.2
Peat (with included areas of Muck).....	57,600	16.1	Plainfield sand.....	2,752	.8
Miami gravelly sandy loam...	51,520	14.4	Miami fine sandy loam.....	2,624	.7
Miami clay loam.....	30,848	8.6	Miami sand.....	1,920	.5
Plainfield silt loam.....	24,064	6.7	Meadow.....	1,728	.5
Miami loam.....	22,592	6.3	Clyde sandy loam.....	1,088	.3
Miami gravel.....	20,672	5.8	Waukesha gravelly loam.....	704	.2
Clyde silty clay loam.....	16,960	4.7	Carrington loam.....	640	.2
Clyde loam.....	14,464	4.0	Carrington clay loam.....	256	.1
Waukesha loam.....	13,440	3.7	Total.....	358,400	.....
Plainfield fine sandy loam....	8,192	2.3			

MIAMI CLAY LOAM.

The surface soil of the Miami clay loam consists of a brownish-gray silt loam or silty clay loam, 8 to 10 inches deep, underlain by a yellowish-brown clay, which at 24 inches grades into a stiff, tenacious, chocolate-brown or dull-red clay. The depth of the surface soil is variable, as erosion has removed from some of the higher elevations the silty covering, which has accumulated on the lower slopes to considerable depth. The subsoil of the Miami clay loam closely resembles the subsoil of the Superior clay loam in a number of places, and as work progresses eastward toward Lake Michigan it is prob-

able that an arbitrary line will be established between the Miami and the Superior clay loams.

In the vicinity of Fussville the type is somewhat lighter than typical. The surface consists of a brown heavy loam or light clay loam, underlain by a yellowish clay in which seams of quicksand are found in the lower subsoil. Along the edge of the main body of the Miami clay loam and in the broken areas in the southeastern part of the county the surface is more silty than elsewhere. The boundary line between the Miami clay loam and the Miami silt loam is more or less arbitrary. Scattered over the type are to be found small pebbles and in some places a few larger stones, mostly of limestone material. There are also a few gravel beds, but these are never as numerous as is the case throughout the slit loam and the loam types.

Checks and cracks one-half inch in width are commonly found on this soil. The occurrence of these fissures means a great loss of soil moisture which could be utilized by the growing crop if properly conserved. A soil mulch created by continuous cultivation is a good way of retaining the moisture. With proper cultivation crops on this type will withstand drought for a long period, but if no mulch is provided they will suffer sooner than on some of the lighter soils of the series.

The Miami clay loam can be cultivated only under a limited range of moisture conditions. If worked when the moisture conditions are the most favorable the soil breaks up into granules, but if cultivated when too wet the granules coalesce and form lumps which are very difficult to pulverize. When dry, the soil becomes very hard and often almost impossible to cultivate. This type is the most difficult to handle of all the soils of the county.

The main body of the Miami clay loam extends across the county in a north and south direction in a strip about  $4\frac{1}{2}$  miles wide from the north county line to near New Berlin. Thence southward it is developed only in small, separate areas.

Except along streams, where the surface becomes somewhat broken and hilly, this type is gently rolling to rolling. The surface drainage is fairly good. In depressions and draws tile drains would be very beneficial. Even over much of the gently rolling land tiles could be installed to good advantage. The reclamation of small potholes and wet swales will mean large regular fields instead of small, obstructed, irregular ones. Tile drainage also means earlier cultivation in the spring and a warmer soil, conditions which are especially necessary for the successful growing of corn.

The Miami clay loam is derived largely from the weathering of the glacial till which covers this region, but it is probable that the heavy red clay forming the subsoil is related to the soils of the Superior series and may therefore be partly of lacustrine origin.

The original timber growth consisted of red, white, and bur oak, hickory, maple, ash, elm, and other hardwoods. At present only small areas are forested, and these are woodlots.

General farming, with a few special crops, is practiced on the Miami clay loam. The chief cereal crops are corn, oats, and rye. The growing of barley has declined on account of the low yields obtained in recent years, but with proper rotation and better seed selection this crop could be grown successfully again. Barley gives an average yield of 25 to 30 bushels per acre.

If the season is not too late and wet, corn does very well on this type, giving an average yield of 35 to 50 bushels per acre. At present most of the corn is cut in the glazed stage for silage. Fodder corn yields from 12 to 20 tons per acre, with an average of 15 tons.

This type is well adapted to oats and a large acreage is sown. The average yield is 40 bushels per acre, but as high as 65 bushels is often obtained. A limited acreage is devoted to the growing of rye, which yields 15 to 25 bushels per acre, with an average of about 20 bushels. This soil is well adapted to grasses, clover, and alfalfa. Clover and timothy are grown more extensively than other hay crops, but the acreage of alfalfa is gradually increasing. Clover yields  $1\frac{1}{2}$  to  $2\frac{1}{2}$  tons; when mixed with timothy 1 ton to  $1\frac{1}{2}$  tons. Alfalfa thrives on the more rolling areas and yields from 2 to 3 tons per acre, with a maximum yield of 4 to 5 tons. The abundant growth of sweet clover along the roadsides is an indication that most of the soils are well inoculated with the alfalfa bacteria. Some alsike clover is grown, chiefly for seed. It is a very uncertain crop, yielding from 2 to 8 bushels per acre, with an average of 3 to 4 bushels.

Sugar beets are grown quite extensively on the area north of Brookfield P. O. Nearly every farmer plants the crop, the acreages ranging from 2 to 10 acres. Scarcity of labor has retarded the industry considerably, with the result that the beet-sugar factory has engaged a crew of men who go from farm to farm to weed and block the beets. The cost of weeding and blocking is deducted from the farmer's gross receipts. This method of handling the labor has made it possible for farmers without family help to grow this crop. Beets are grown more extensively on this type than on any other in the area. The average yield is from 12 to 15 tons per acre, although as much as 18 to 20 tons has been obtained. Beets grown on this soil have a higher sugar content, from 14 to 16 per cent, than beets grown on any of the other types in the area. The average price paid by the factory is \$6 a ton. A heavy application of manure and thorough tillage are necessary for the successful growing of sugar beets.

Around Elm Grove some of this type is devoted to the production of cabbage and cauliflower. Cabbage yields from 10 to 18 tons per acre, with an average of about 13 tons. The average gross return

from cauliflower is about \$150 per acre. These products are marketed in Milwaukee. Potatoes are grown on a commercial scale by a few farmers, but in most cases they are grown only for home consumption, the soil being too hard and compact for good results. The ordinary yields per acre range from 75 to 150 bushels.

Up to the present time only barnyard manure has been used on the Miami clay loam in growing the general farm crops. Green manuring crops would loosen the soil and make it more friable and they should be more extensively used. No set rotation is followed by the majority of farmers, but the following one is suggested as being well suited to the needs of the soil: Corn, barley or oats, clover or clover and timothy, with one year of pasture. The pasture should be plowed in the fall, to conserve the soil moisture and improve the physical condition, with a top dressing of manure applied the following winter. In spring the land should be thoroughly disked and harrowed before planting to corn.

Farms on this type range in value from \$100 to \$150 an acre, depending on location, improvements, and condition of the soil.

#### MIAMI SILT LOAM.

As found in Waukesha County the surface soil of the Miami silt loam, to a depth of 10 to 14 inches, consists of a grayish to yellowish brown silt loam. This is underlain by a yellowish silty clay loam to a depth of 18 to 20 inches, where a yellowish-brown gritty clay loam is encountered. On the rolling areas of the type, in particular, there is present upon the surface a small quantity of gravel and some larger stones and bowlders. Most of these have been removed from the cultivated fields. A large percentage of the rock fragments are limestone. On knolls and hills the surface soil has often been eroded, leaving exposed the brownish clayey material. In depressions and draws the surface soil has accumulated to considerable depth and is usually of a darker color.

While the greater part of the type in this area answers the description given above, there are some variations worthy of notice. In the vicinity of Lannon the soil is very shallow, the underlying limestone being encountered at from 12 to 18 inches. The rock is exposed in a few places and a number of quarries are in operation in that region. In the southeastern part of the county the soil is not quite as silty as elsewhere; the subsoil is somewhat heavier, and contains less gravel than the type as a whole. In the areas southeast of New Berlin the soil is very floury in appearance, being very silty and of a whitish color. These areas are rather low in organic matter and less productive than the typical soil. The areas northeast of Waukesha approach the Miami loam and the boundary lines here are somewhat arbitrary. In the depressions the soil is a silty loam, while on the higher land it

is more like a loam. Around the edge of kettle holes the soil is often quite gravelly at the surface and is droughty.

The Miami silt loam is an easier soil to cultivate than the clay loam and can be worked under a wider range of moisture conditions. Cultivation when wet causes some baking and clodding and of course this should be avoided as much as possible. The physical character of this soil is such that a good mulch can be kept on the surface by judicious cultivation and a very loose and mellow seed bed secured.

The Miami silt loam is one of the most extensive and important types in the county. It is confined chiefly to the northern half, giving way to the Miami clay loam along the eastern border, grading into the Miami loam toward the south, and merging into the Plainfield silt loam of the outwash plains to the west. The type is interspersed with areas of gravel and gravelly loam, especially in the northwestern part of the county.

The topography varies from undulating to rolling. In the vicinity of Pewaukee the surface is rolling, approaching a hilly topography. The same is also true of some of the areas northeast and southeast of Waukesha. In a number of places where the surface is the most broken, erosion has become a factor in farm management. The surface soil of some of the steeper slopes has been washed away and gullies formed. Many of the eroded fields are kept constantly in grass and it is advisable that such places should always be protected by a cover crop of some kind.

Owing to the topography and also, over a greater part of the type, to the gravel in the subsoil the natural drainage is good. Narrow draws and depressions are an exception, but these can usually be drained by a single line of tile. Along the margin of kettle holes, where the gravel appears at or comes close to the surface, the type is inclined to be droughty. For a short time in early spring frozen ground in kettle holes and small depressions will not permit the escape of water and some damage is occasionally done to clover or alfalfa in such places.

The original timber growth on this type consisted of white, red, and bur oak, hickory, ironwood, ash, and basswood, with some maple, butternut, walnut, elm, and beech. By far the greater part of the Miami silt loam is now cleared and in a high state of cultivation.

This type of soil is derived from the ground moraine, here deposited chiefly by the Lake Michigan Glacier, though a portion of it was left by the Green Bay Glacier.

The greater proportion of the type is devoted to general farming and dairying. It is considered a good soil for this type of agriculture. Fodder corn yields from 8 to 15 tons per acre, and field corn from 35 to 70 bushels per acre. In many sections oats are grown

more extensively than other crops. The soil is well adapted to the production of this crop. Yields range from 35 to 75 bushels, with an average of 45 bushels per acre. Barley is grown to some extent, but owing to improper rotations and too little attention to the selection of seed, the yields have depreciated and the tendency is to reduce the acreage. The average yield is about 30 bushels per acre, with yields considerably lower where the crop has been grown continuously. Small tracts are devoted to rye, with yields of from 20 to 25 bushels per acre. The acreage devoted to wheat is very small. The yields during the season of 1910 were between 20 and 30 bushels per acre, which is somewhat above the average for a series of years. Clover does very well and yields of  $2\frac{1}{2}$  tons per acre are not uncommon. Alfalfa is coming into favor in the crop rotations because of its large yields and high feeding value. Three cuttings are secured and the average yield for the season is 3 tons per acre, though as high as 4 and 5 tons per acre have been obtained. The acreage is limited at present, but it is being gradually extended.

Peas, sugar beets, and potatoes are the leading special crops on this type. The growing of peas is largely confined to a strip of land embracing an area of about 50 square miles on both sides of the Soo Line north of Waukesha. A canning factory located at Waukesha takes most of the crop. The gross returns per acre range from \$30 to \$45. When cured or put in the silo the vines make a good feed for stock. Sugar-beet culture is chiefly followed in the northeastern part of the silt loam area in the northern part of the county. On account of the physical character of the type beets are more easily raised and at a lower cost than on the Miami clay loam. Yields range from 10 to 13 tons per acre, though larger yields are frequently obtained. Potatoes are grown successfully on this soil, but not on a commercial scale.

The most common rotation practiced consists of corn one year, oats or barley one year, or one year for each of these crops, clover for hay one or two years, and pasture one year. On a number of farms systematic crop rotation is not followed.

No commercial fertilizers are used, but stable manure is applied every three or four years at the rate of 6 to 8 tons per acre. The application of stable manure, combined with some system of green manuring, is doubtless the best method of keeping up the productivity of the soil. As many clover and other leguminous crops as possible should be grown to assist in keeping up the nitrogen content. Where there is an indication of acidity about 20 bushels of lime per acre should be applied.

Farm values on this type range from \$90 to \$150 an acre, depending upon location, improvements, and the condition of the land.

## MIAMI LOAM.

The Miami loam consists of a yellowish to brownish-gray medium loam, 8 to 12 inches deep, underlain by a brownish clay loam becoming rather compact at a depth of 2 feet and grading into a gritty clay loam at 24 to 30 inches. The lower subsoil frequently becomes very gravelly and a gravel bed is sometimes encountered at 3 feet. On some of the knolls a sprinkling of gravel is sometimes found upon the surface, and over the rougher portion of the type bowlders were originally found. Most of these have been removed from the cultivated fields.

The type is somewhat variable, though the areas departing from type are too limited in extent to be classed as separate soils. There are a number of patches, especially in the southern and southeastern parts of the county, where the soil contains considerable sand and the subsoil more gritty material than is typical. Along the contact with the clay loam the subsoil, especially, becomes quite heavy, and where it joins the Miami silt loam the boundary is often arbitrary. Around the margin of kettle holes gravel frequently comes very near the surface.

The Miami loam is comparatively easy to cultivate and can be worked under quite a range of moisture conditions. When cultivated too wet it may clod a little, but not so much as the clay loam and silt loam types. The surface is somewhat deficient in organic matter.

The type is confined chiefly to the southern and eastern parts of the county. The largest areas are found southwest of Waukesha and in the townships of Vernon and Muskego. Besides these there are a number of smaller patches scattered throughout the southern and eastern parts of the survey.

The Miami loam occupies a gently rolling to rolling topography, and in a few places becomes quite hilly. The natural drainage is good, except in draws and small depressions, but such places can be readily reclaimed by the use of tiles. In many cases a single line of tile would be sufficient to remove the excess water.

The Miami loam is derived from the glacial material which covers this entire region and forms a part of the ground moraine.

The natural growth on the Miami loam consisted of red, white, and bur oak and a few other hardwoods. Most of the type has been cleared and brought under cultivation.

At present the Miami loam is chiefly devoted to general farming. Corn does well and gives a yield of 30 to 50 bushels per acre. Oats are well adapted to this type, and a large acreage is devoted to this crop each year, yielding on an average 35 to 40 bushels per acre. Rye yields 15 to 25 bushels per acre. Clover and timothy are the

important hay crops and do well on the Miami loam. Clover alone yields  $1\frac{1}{2}$  to  $2\frac{1}{2}$  tons per acre, and when mixed with timothy  $1\frac{1}{2}$  to 2 tons. Alfalfa is being grown successfully, but the acreage devoted to it is still small. It ordinarily gives a yield of 2 or 3 tons per acre, and often as high as 4 or 5 tons.

No definite rotation is followed by the majority of farmers, but the following 5 or 6 year rotation was found to be practiced by a number: Corn, 1 year; oats, 2 years, or oats 1 year and rye 1 year; clover, 1 year, followed by clover and timothy 1 year; and pasture, 1 year.

No commercial fertilizer is used, but moderate quantities of barnyard manure are applied. As the type is rather low in organic matter, a judicious application of manure combined with green manuring would increase and tend to maintain the productivity of the land. Liming at the rate of 20 bushels per acre will correct any acid condition, and, in addition improve, the physical condition of the soil.

Farms on this type of soil range in value from \$70 to \$100 an acre.

#### MIAMI FINE SANDY LOAM.

The Miami fine sandy loam consists of a brown fine sandy loam to light loam, 8 to 10 inches deep, underlain by a yellowish, slightly sticky fine sandy loam which contains varying amounts of fine gravel. The areas associated with the Kettle Moraine are light in texture, approaching a fine sand in places. Some areas of loamy fine sand were found, but these variations were not of sufficient importance to be separated.

This type is very easy to cultivate and can be worked under a wide range of moisture conditions. The soil is deficient in organic matter and is slightly acid, as indicated by the litmus test and growth of sorrel.

The Miami fine sandy loam is of limited extent, occupying only a few square miles. The largest area lies  $2\frac{1}{2}$  miles northwest of Mukwonago, while a few small patches are scattered about over the southern part of the county. A gently rolling to rolling topography gives good natural drainage. The crops seldom suffer from drought. The material composing the soil is largely glacial debris from the ground moraine, though a few areas occur within the Kettle Moraine.

Originally the natural vegetation consisted chiefly of bur and white oak, with a scattering of other hardwoods. At present hazel brush is quite abundant on uncleared areas. The greater proportion of this soil is under cultivation.

The Miami fine sandy loam is devoted chiefly to general farming, though a small amount of trucking is also done. Corn is grown extensively. It yields from 25 to 40 bushels per acre. Rye gives fair

returns, even under adverse conditions, yielding from 15 to 25 bushels per acre. Oats will average 30 bushels per acre. Clover and timothy do fairly well, averaging  $1\frac{1}{2}$  tons of hay per acre, though some difficulty is experienced in getting a good stand of clover. Potatoes could be grown more extensively. At present only a few are grown, mainly for home use. They yield from 75 to 125 bushels per acre. These yields could be greatly increased by following proper methods of cultivation and fertilization. Barley does not do well, but winter wheat gives fair returns, yielding during the season of 1910 an average of 25 bushels per acre. This, however, is above the yield obtained in most years.

A rotation commonly followed is corn, oats, rye, clover, and pasture, though no definite system is practiced by the majority of farmers. There is less dairying on this soil than on some of the other types in the county, and as a result it receives less manure. For this reason green manuring should be practiced to a greater extent.

Farms on this soil range in value from \$50 to \$75 an acre.

#### MIAMI SAND.

Miami sand consists of a yellowish to brownish-gray medium to fine sand 6 to 8 inches deep, underlain by a loose, incoherent yellow sand of the same texture. The soil is very low in organic matter. Because of its loose, open structure it is easy to cultivate and can be worked under almost all moisture conditions. When the surface is not covered by a crop the sand is sometimes blown by the wind, though not to any marked extent.

Areas of the Miami sand are confined to the southwest part of the county, where they are associated with the Kettle Moraine. The type is of small extent and not highly improved.

The surface is gently rolling to rolling, which, with the loose, open character of the soil and subsoil, makes the drainage too thorough, the crops suffering from drought, except when the rainfall is unusually well distributed.

Practically all of the Miami sand is derived from glacial moraine material. Bur oak, red oak, and white oak, of rather scrubby growth, were the original timber growth. At present hazel bushes cover a part of the type. The greater part of it is under cultivation, the chief crops being corn, oats, rye, and clover. When the rainfall is well distributed fair yields are obtained, but there is usually a dry period of considerable length during each season, and all crops on this soil suffer. The land is not highly developed.

Soils of the Miami sand type are better adapted to early truck crops than to general farming. For whatever crop intended, the organic matter content of the soil should be increased. Green manuring

crops should be turned under frequently and all available stable manure saved and applied to the fields. Peat may be used also, but should be supplemented with commercial fertilizers containing potash and phosphoric acid.

#### MIAMI GRAVELLY SANDY LOAM.

The Miami gravelly sandy loam, as found in Waukesha County, is subject to considerable variation. The greater part of it occurs in two distinct phases. The most extensive and important of these has a light-brown sandy loam to loam, 8 to 10 inches deep, underlain by a reddish-brown gravelly sandy loam, containing enough clay to produce coherence in the soil particles. At 18 inches the gravel content increases and a considerable quantity of cobblestones and bowlders, mostly of limestone material, are found. Very often the subsoil consists of a gravel bed. Throughout the type occur patches of sand and gravel too small to be shown on the soil map.

A heavier phase consists of an ashen-gray to brown silty loam 6 to 10 inches deep, underlain by a yellowish-brown gritty clay loam to a depth of 18 inches, where gravelly clay loam containing a quantity of cobblestones is encountered. Much of this phase is also underlain by gravel beds. A number of small patches of silt loam are found, but these were too small to be mapped. In both phases a sprinkling of gravel and some bowlders are found upon the surface, especially on knolls, ridges, and around the edges of kettle holes.

This type can be cultivated under a wide range of moisture conditions and it is very easy to obtain a loose, mellow seed bed. Some difficulty is experienced in cultivating where the gravel is too close to the surface or where bowlders interfere and the topography is too rough and broken. The gravelly nature of the subsoil makes this type somewhat unretentive of moisture, but in a normal season fair crops are raised, especially on the heavier phase.

The Miami gravelly sandy loam is found in practically all parts of the county outside of a narrow strip along the eastern side of the area. The heavier phase occurs in the northern half of the county, closely associated with the Miami silt loam, and the lighter phase in the southern half, closely associated with the other types of the Miami series. The best developed areas are found in the southern half and western part of the county. In the vicinity of Waukesha Beach and Lakeside Station numerous small areas occupying tops of hills occur.

The Miami gravelly sandy loam has a rolling, hummocky topography. It occurs on the tops of hills and knolls and as narrow ridges. Kettle holes abound throughout this type. Drainage is rapid and thorough. From 10 to 15 per cent of the area is subject to erosion,

though it is severe in only a few places. On steep hillsides cover crops should be grown as much as possible. The silty phase is more subject to erosion than the lighter phase.

This type is derived from glacial drift, much of it morainic material. The original timber growth consisted of white and red oak, hickory, and other hardwoods.

The Miami gravelly sandy loam is devoted to general farming. It is fairly well adapted to corn, of which yields of 25 to 40 bushels per acre are secured. Oats and rye are the predominating small-grain crops. A large acreage is devoted to oats, yielding on the average 30 to 40 bushels per acre. Rye averages 15 to 25 bushels per acre. Considerable quantities of corn are grown for ensilage, yielding 8 to 12 tons per acre. Good drainage and the high lime content make it a very favorable soil for clover and alfalfa. Clover is usually seeded with a nurse crop and, as a rule, alfalfa also. The former gives a yield of 1½ to 2 tons per acre and alfalfa 3 to 4 tons per acre. A larger acreage of alfalfa was found upon the Miami gravelly sandy loam than upon any of the other soils of the county. On the more gravelly phases the crop yields are less than those stated above.

Up to the present time no commercial fertilizers have been used on this soil, but where best developed manure has been applied at the rate of 6 tons per acre about every four years. The application of barnyard manure combined with green manuring is a good way to increase and maintain the productiveness of this soil. The rotation most commonly followed is corn, oats, and rye for one year each, clover for two years, followed by one year of pasture.

The price of land of the Miami gravelly sandy loam type ranges from \$30 to \$70 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

*Mechanical analyses of Miami gravelly sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
25041.....	Soil.....	0.9	13.5	18.4	25.4	5.5	25.9	9.9
25042.....	Subsoil.....	4.1	14.8	18.3	23.6	6.4	13.4	19.0

MIAMI GRAVEL.

The surface soil of the Miami gravel consists of a dark-gray to dark-brown sandy loam 6 to 8 inches deep, carrying high percentages of gravel, cobblestones, and bowlders on the surface and mixed with

the finer soil material. The underlying material consists of a heterogeneous mixture of sand, gravel, and bowlders, consisting chiefly of limestone. Most of the gravel is waterworn to some extent and in a few cuts the material showed stratification. The surface soil in the northern part of the county contains a higher percentage of silt than that found in the southern part.

The Miami gravel is confined almost entirely to the western half of the county and is closely associated with the Kettle Moraine. It occurs as well rounded hills and knolls and as small, narrow, choppy ridges. Kettle holes from 50 to 100 feet deep are abundant. On the tops of hills, knolls, and ridges the surface soil has been removed, leaving large bodies of gravel and stone exposed, while in the depressions a good covering of soil is found. The Miami gravel is of glacial origin and consists almost entirely of morainic material.

The nature of the material and its topographic position render the Miami gravel practically nonagricultural. Most of the type is still in timber, which consists chiefly of scrubby oak. The land is used largely for pasture, and in the early summer supports a good growth of June grass, but later this fails on account of drought. Most of the Miami gravel should be left in forest and the cleared portions reforested. Land of the Miami gravel type varies in price from \$10 to \$20 an acre.

#### PLAINFIELD SILT LOAM.

As found in Waukesha County the surface soil of Plainfield silt loam consists of an ashen-gray to light-brown silt loam, having an extremely smooth and velvety feel and extending to a depth of 8 to 14 inches. This is underlain by a yellowish-brown silty clay loam, becoming rather compact in the second foot. At from 2 to 3 feet gravel in a clay loam matrix or a gravel bed is encountered. In a number of places this comes to within 12 or 18 inches of the surface, and especially along the edge of kettle holes the soil is shallow and very gravelly.

In Summit Township an area of the type varying somewhat from the above description is found. The surface consists of a yellowish-gray or ashen-gray silty loam, containing a high percentage of fine and very fine sand and extending to a depth of 8 to 12 inches. It is underlain by a yellowish-brown silty loam or light clay loam which contains a high percentage of sand and gravel and which grades into gravel at about 18 inches. The gravel under the entire type consists largely of limestone material and the beds are a heterogeneous mixture of gravel, sand, cobblestones, and bowlders, which in many places show stratification.

Cultivation of this soil is easy, and owing to the underlying gravel it can be worked under a wide range of moisture conditions. The

color of the soil indicates a low organic matter content and the growth of sorrel and the litmus test indicate slight acidity.

The Plainfield silt loam is confined to the northwestern part of the county in Oconomowoc and Summit Townships. It resembles the Miami silt loam in having a silty surface soil and some gravel in the subsoil. It differs, however, in topography and the method of deposition.

This type has a level to slightly undulating surface. It is composed of glacial material, the greater part of which has been reworked by streams issuing from beneath glaciers and deposited as outwash plains. The underlying gravel shows stratification in many localities and this is an indication of the method of deposition. Owing to the gravelly nature of the subsoil the natural drainage is good. Where the gravel comes close to the surface, as is the case along the margin of the pot holes, which are numerous, and in a few other places, the type is inclined to be droughty. Crops on the light phase in Summit Township are apt to suffer somewhat during the longest dry spells.

The native vegetation on this soil consisted chiefly of oak. Where this growth was scrubby and scattered the term "oak openings" was applied. While a large part of the Summit Township area is included in what is called Summit Prairie, it was not originally entirely treeless.

The Plainfield silt loam is considered a good general farming soil and nearly all the type is under cultivation. Corn yields from 30 to 70 bushels per acre; oats from 35 to 75, with an average of 45 bushels per acre. Oats is grown more extensively in Oconomowoc Township on this soil than in any other part of the county. The average yield is about 35 bushels per acre. Rye is grown to some extent and yields about 24 bushels per acre on the average. Wheat is grown only to a very limited extent. Clover yields from  $1\frac{1}{2}$  to 3 tons per acre and clover and timothy from 1 ton to 2 tons per acre. Alfalfa is grown successfully and yields from 2 to 4 tons per acre. The acreage is being increased gradually. No special crops are grown upon this soil, except in the home gardens, the entire area being devoted to general farming and dairying.

A common rotation consists of corn, oats, or barley, followed by clover and then by pasture one year, and back to corn. While the agriculture is in general highly developed, there are nevertheless a number of farms on which no systematic crop rotation is practiced.

No commercial fertilizers are used, but liberal applications of stable manure are given every three or four years. The use of stable manure, in combination with some system of green manuring, is doubtless the best method of increasing and maintaining the produc-

tiveness of the soil. Where there is an indication of acidity, as is frequently the case, lime should be applied at the rate of about 20 bushels per acre.

The value of farm lands on this type of soil ranges from \$100 to \$150 an acre, depending on location and improvements.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

*Mechanical analyses of Plainfield silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
25033.....	Soil.....	0.6	2.6	3.1	4.1	2.8	76.2	10.8
25034.....	Subsoil.....	.7	2.9	3.9	4.9	3.7	66.9	16.6

PLAINFIELD LOAM.

The soil of the Plainfield loam consists of a light-brown, medium loam, frequently containing considerable sand and extending to a depth of 8 or 10 inches. The subsoil is a brownish or yellowish clay loam containing enough sand and fine gravel to give a gritty feel to the material. The content of sand and gravel usually increases below 20 inches and frequently a gravel bed is encountered at 2 to 3 feet. This gravel shows stratification in places. Most of the pebbles and stones are limestone. Cultivation of this soil is easy and a loose mellow seed bed can be readily secured.

Though widely distributed the total area of Plainfield loam is small. Several patches are found in the vicinity of Waterville. One small area occurs in the extreme southwest corner of the county, another southwest from Mukwonago, one at Chamberlain, and several northeast of Vernon Station.

A level or slightly undulating surface characterizes the soil. Drainage is naturally good. Where gravel comes close to the surface crops suffer from drought. The material composing the soil consists of glacial debris which has been largely reworked by streams issuing from glaciers and then deposited as outwash plains.

Practically all the Plainfield loam is under cultivation. It is devoted chiefly to general farming, and is fairly well suited to this type of agriculture. In crop adaptation, methods of cultivation followed, rotations practiced, and yields obtained it compares very favorably with the Miami loam, differing from that type chiefly in its topography, method of deposition, and in the somewhat higher percentage of sand.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

*Mechanical analyses of Plainfield loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
25456.....	Soil.....	0.1	2.3	8.2	22.9	12.7	37.6	16.1
25457.....	Subsoil.....	.6	4.9	10.3	15.7	9.9	29.7	28.7

PLAINFIELD FINE SANDY LOAM.

The surface soil of the Plainfield fine sandy loam consists of a yellowish or brownish fine sandy loam, 8 to 10 inches deep, underlain by a light-colored subsoil of the same texture. In places the material approaches a fine sand, but such variations were too inextensive to be indicated on the map. Because of its sandy nature the type is very easy to cultivate. The surface soil is very low in organic matter and in a number of places slightly acid.

Most of the Plainfield fine sandy loam occurs in the western part of the area, the greater part west of the Kettle Moraine in Summit and Ottawa Townships. There is one small area near Chamberlain and two others north of Vernon.

In topography the soil is level to gently undulating and the natural drainage is good. The material composing the type consists of glacial débris, which has been reworked and deposited as outwash plains by streams issuing from the glaciers.

The Plainfield fine sandy loam is devoted largely to general farming, though some trucking is also carried on. The ordinary farm crops yield practically the same as on the Miami fine sandy loam. In addition to these sorghum is sometimes grown, yielding about 50 gallons of sirup per acre. An excellent quality of potatoes can also be produced, but at present only a few are grown. In the vicinity of Dousman strawberries of fine quality are being grown. The ordinary gross returns from this crop average from \$250 to \$300 an acre. Often as much as \$500 an acre is obtained. Most of the berries are shipped to Milwaukee, where they bring the same prices as Michigan berries.

Since this type is located in a section where there is but little dairying it does not receive as much stable manure as some of the other soils. Liberal applications of such manure combined with green crops turned under or with Peat with the addition of potash and phosphate fertilizers would assist in increasing the productiveness of the type. For correcting acidity 20 to 25 bushels of lime should be applied per acre in the fall before seeding to clover the following spring.

## PLAINFIELD SAND.

The Plainfield sand consists of a brown medium to fine sand, extending to a depth of 6 to 8 inches, underlain by loose, incoherent, yellow to reddish-brown sand of medium texture. In the areas associated with the large marsh west of Eagle the soil contains considerable organic matter, which gives the loamy character. In some of these areas the deep subsoil grades into a sticky sand. Such spots approach a sandy loam, but on account of their limited extent they were not mapped separately.

On account of the loose, open structure of the Plainfield sand it is easy to cultivate and can be worked under a wide range of moisture conditions. According to the litmus test, the soil is slightly acid. The condition was further indicated by a growth of sorrel.

The Plainfield sand is confined chiefly to the southwestern part of the county west of the Kettle Moraine, though there are a few patches east of the moraine in the southern part of the survey. Much of the type consists of islands in the large marshes and in places it forms a border along the swampy areas.

The surface of the type is level, but owing to its sandy open nature the drainage is good. It does not suffer from drought as much as some of the heavier soils, as the water table is nearer the surface.

The Plainfield sand consists of glacial material which has been largely reworked and deposited as outwash plains by glacial streams.

The original timber growth consisted chiefly of scrubby bur, red, and white oak. Hazel bushes are quite plentiful at the present time.

Areas of the Plainfield sand are devoted to general farming and trucking, and as a rule fair crops are produced. Corn yields from 15 to 35 bushels per acre. The oat crop is not very satisfactory. Only enough for feeding the work stock are produced. From 20 to 25 bushels per acre is the usual yield. Quite a large acreage is given to rye, the average production being 20 bushels per acre. The growing of barley is not a success and the acreage is small. It is sometimes difficult to get a stand of clover, especially in dry seasons, unless the soil has been carefully farmed. A small amount of sorghum is grown for making sirup. Cucumbers and potatoes are grown with success, as are also melons and strawberries. The type is best adapted to truck crops and should be devoted entirely to the development of the trucking industry.

In order to increase the organic matter content stable manure should be liberally applied and green manuring practiced to a greater extent. Peat or muck may be used for the same purpose. It should be supplemented with commercial fertilizers containing potash and phosphoric acid. Lime should be applied where the soil gives indications of being acid. In planning any rotation for this type as much vegetable matter as possible should be returned to the soil.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

*Mechanical analyses of Plainfield sand.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
25039.....	Soil.....	0.5	13.3	41.6	31.5	2.1	7.2	3.5
25040.....	Subsoil.....	.1	14.3	39.9	29.3	2.3	9.0	4.0

WAUKESHA LOAM.

The Waukesha loam consists of a dark-brown to black loam or silty loam, 8 to 14 inches deep, underlain by a brownish clay loam. Gravel beds are encountered at a depth of 18 to 24 inches. A quantity of limestone material is present in these beds, which often show stratification. The relatively high percentage of organic matter gives the soil the dark color so characteristic of this type. Most of the soil is acid, according to the litmus test and the abundant growth of sorrel. The phase of Waukesha loam in the vicinity of Mukwonago is rather light in color and texture. The surface soil contains quite a quantity of medium sand, giving it the appearance of a sandy loam. Gravel is usually encountered at 18 inches. One mile south of Eagle the soil is a medium loam and gravel is not encountered nearer than 2 to 3 feet of the surface. On the remainder of the outwash terrace the soil contains more sand and the gravel is closer to the surface, cropping out in many places. In section 1, Township of Eagle, the Waukesha loam is very light in color, the area being a gradation zone lying next to the Miami loam. In the vicinity of Waukesha this type is a true loam. The gravel is here ordinarily encountered at depths of 12 to 24 inches, and often comes as close to the surface as 8 inches. The same may be said of the area south of Oconomowoc, except that the gravel is not encountered above 18 inches. In the vicinity of Beaver Lake, in the southwestern part of the county, the Waukesha loam is light in texture.

This soil is not difficult to till, but the plow has to be kept well cleaned and polished, otherwise it will not scour readily. On the heavier phase small cracks and checks are frequently seen. The proximity of gravel to the surface makes the soil rather droughty, but in an average season good crop returns are obtained.

This type occupies a flat to gently undulating topography. The drainage is thorough. The Waukesha loam occurs as terraces and outwash plains. It is derived from glacial material which has been reworked by waters issuing from beneath the ice sheet.

Portions of the type were originally wooded, chiefly with oak and hickory, though quite a large part was prairie.

The Waukesha loam is devoted to general farming, corn, oats, and rye being the chief grain crops. The soil is well adapted to corn and a large acreage is devoted to it each year, yielding on the average 45 bushels per acre, though as much as 65 bushels has been obtained in wet seasons. Oats yield 35 to 40 bushels per acre. Rye is chiefly grown on the lighter phase and is a rather important crop on this part of the type. It yields 15 to 25 bushels per acre. On account, it is believed, of an acid condition of the soil some difficulty has been experienced in getting a good stand of clover. The average yield is 1 ton to 2 tons per acre. When mixed with timothy the yield is somewhat less. Experimental plot tests carried on by the State experiment station show that the application of manure and lime are essential to secure a good stand of clover or alfalfa. Clover should occur more often in the rotation in order to keep up the fertility of the soil.

In the vicinity of Waukesha some cabbage, onions, and carrots are grown, but trucking has not been developed to any great extent.

The rotation most commonly followed on this soil consists of two years corn, two years oats or one year oats and one year rye, one year clover, followed by one year pasture, returning to corn. Manure is applied liberally on the farms of this type of soil.

Farms of this soil range in value from \$65 to \$100 an acre, depending on the location with respect to towns and shipping points and upon the nearness of the gravel stratum to the surface.

#### WAUKESHA GRAVELLY LOAM.

The Waukesha gravelly loam consists of a reddish-brown or black loam, 8 to 10 inches deep, resting upon a reddish brown, sticky gravelly sandy loam. Enough clay is present in this material to make the particles cohere. At 22 inches a light-yellow sandy gravel, including a quantity of large cobblestones, is encountered. Stratified beds contain a quantity of limestone material. The dark color is due to the large percentage of iron and organic matter present. On knolls the soil is very shallow and gravelly; in depressions and on small flats it is deeper and the gravel not so close to the surface. Many small patches of this type, too small to map, were found in the Waukesha loam areas, especially in the vicinity of North Prairie.

The Waukesha gravelly loam is limited in extent, occupying chiefly the upper terraces of the Eagle Prairie northeast of Eagle.

As a whole this soil is very easily tilled, except on the knolls, where the presence of gravel interferes with cultivation. The open and porous subsoil makes the type rather droughty, and crops suffer during dry periods of long duration.

The Waukesha gravelly loam occupies a gently rolling to rolling topography. Drainage is excessive. The material composing this

type consists of glacial and morainic débris, some of which has doubtless been assorted by the action of water.

A portion of the type is still in woodlots, the natural growth consisting chiefly of bur and white oak.

The Waukesha gravelly loam is devoted to general farm crops. Corn yields 15 to 35 bushels per acre, with an average of 20 bushels. Rye and oats are the most important small-grain crops. Oats yield 25 to 35 bushels and rye 15 to 25 bushels per acre. In dry seasons difficulty is experienced in getting a good stand of clover, but in wet seasons a good catch is usually obtained. A dressing of manure and probably some lime applied before seeding would assist in securing good stands of the legumes. Clover yields  $1\frac{1}{2}$  tons, and when mixed with timothy three-fourths ton to  $1\frac{1}{4}$  tons per acre. Manure has been used liberally on this type but no commercial fertilizer. The general rotation practiced is as follows: Corn, oats, rye, clover, followed by one year pasture, after which the land is plowed again for corn. As a rule the land receives an application of manure before being planted to corn.

Farms on this type of soil range in value from \$40 to \$60 an acre.

#### CARRINGTON CLAY LOAM.

The Carrington clay loam consists of a dark-brown or black clay loam, 8 to 12 inches deep, underlain by a light-brown clay loam or clay extending to a depth of 18 to 24 inches, where a compact brownish clay is encountered. In depressions and swales the subsoil becomes more or less mottled and impervious to water. There is little or no coarse material in either soil or subsoil. When properly handled the soil has a friable structure, but if cultivated when too wet it clods and bakes. It contains a relatively high percentage of organic matter which gives the characteristic black color. On the knolls the soil is rather light in color and possesses more of the characteristics of soils of the Miami series.

The Carrington clay loam occupies only a small tract in the extreme southeastern corner of the county, extending into Racine County, where it is the predominating soil type. It occupies a gently rolling to rolling topography and is rather poorly drained. Depressions and swales would be greatly benefited by tiling and even the rolling lands would be improved. Statements of farmers of Racine County show that tile drainage on such land is a profitable investment.

The soil is derived from glacial material which many centuries ago was subjected to wet conditions, favoring the growth and decay of water-loving vegetation. The type was originally timbered with oak and some other hardwoods. Practically all of it is cleared and under cultivation at the present time.

General farming is practiced. The type is adapted to a variety of crops. The chief crops grown are corn, oats, timothy, and clover. Corn does well, giving an average yield of 40 bushels per acre. Oats are grown quite extensively, the yields ranging from 25 to 60 bushels per acre, with an average of 40 bushels. Timothy and clover also do well, as is shown by the average yield of 1½ tons per acre. In Racine County this type has been extensively used for growing cabbage and sugar beets. Cabbage yields 12 to 15 tons and beets 8 to 12 tons per acre. Both of these crops could be grown successfully in Waukesha County, but the distance to shipping stations has retarded development along these lines.

Manure is applied liberally every 4 or 5 years, but no commercial fertilizers have been used. Farms on this soil range in value from \$80 to \$110 an acre.

#### CARRINGTON LOAM.

The surface soil of the Carrington loam consists of a dark-brown or black loam or heavy sandy loam, 8 to 14 inches deep. This rests on a light-brown sandy loam, containing a small quantity of fine gravel. On knolls the soil is only 6 to 8 inches deep, and gravel is encountered at 18 inches or 2 feet. In depressions the soil is darker in color, on account of the higher organic matter content, the subsoil is heavier and gravel content lower. This type differs from the Waukesha loam in having a somewhat lighter texture and in not being underlain by a continuous gravel bed. Litmus tests show the soil to be acid and an abundant growth of sorrel also indicates this condition.

The Carrington loam can be cultivated under a wide range of moisture conditions, being very loose and easy to handle. In dry seasons it is not retentive enough of moisture to withstand the drought as long as the heavier soils of the same series.

This type occupies a single small tract in the extreme southern part of the county, about 1½ miles southwest of Big Bend. It also occurs in the western part of Racine County, where it occupies three limited areas.

The surface is gently rolling to rolling and has good natural drainage. It is derived from glacial material, but is not an outwash plain formation as is the case with the Waukesha loam, which it somewhat resembles.

The original timber growth consisted chiefly of oak and hickory with a small proportion of other hardwoods.

The Carrington loam is devoted to general farming and trucking. Considerable sweet corn is grown, the average yield being about 8,000 ears per acre. It is planted at different times in the spring in order to lengthen the marketing season. Most of it is hauled by wagon to

Milwaukee, bringing an average gross return of \$60 per acre, though in wet seasons higher returns have been obtained. Melons are also grown to some extent and do fairly well, the gross returns amounting to \$200 or \$300 per acre. The Carrington loam is also a desirable soil for general farming. Corn does well. Wisconsin No. 7 yields on the average 45 to 50 bushels per acre. At present very little oats or barley is grown. Mammoth clover, which is a very hardy and a coarse grower, yields 2 to 3 tons per acre. Alfalfa seems to do well with proper culture, yielding about  $3\frac{1}{2}$  tons per acre.

At present a three-year rotation is practiced to some extent on the Carrington loam, consisting of two years of sweet corn and one year of clover cut for hay. Field corn often takes the place of sweet corn in the rotation. Manure is applied liberally to this soil about every three years, but no commercial fertilizers have been used. The indications are that lime should be applied to many fields.

The price of farms on this soil range in value from \$90 to \$110 an acre.

#### CLYDE SILTY CLAY LOAM.

The Clyde silty clay loam consists of a dark-brown or black silty clay loam, 6 to 10 inches deep, underlain by a drab or bluish clay to a depth of 24 inches, where a bluish or sometimes mottled, plastic, silty clay is encountered. The mottled subsoil is very impervious and puttylike and contains iron stains and some calcareous material. Along streams and small depressions the soil is from 10 to 12 inches deep, lighter in texture, and usually modified by some coarse sand and gravel in the lower subsoil. A high percentage of organic matter gives this soil its characteristic dark color. According to the litmus test the Clyde silty clay loam is neutral.

The chief occurrence of this type is in the eastern tier of townships. Numerous other areas are found around Muskego, Big Bend, Elm Grove, Brookfield, and Menomonee Falls. Besides these there are other areas distributed throughout the county. Many patches too small to map occur in the Miami clay loam, silt loam, and loam types. The heavier phase of this soil is closely associated with the Miami clay loam.

The Clyde silty clay loam occupies level areas. The drainage is poor. Variations are due largely to the different degrees of drainage possessed by this soil. In the better drained areas, and also where there has been a large accumulation of organic matter, the soil becomes loamy and very friable, while in the poorly drained areas the surface soil has the appearance of a clay. A single open ditch extending across an area with tiles leading into it at intervals of 4 rods would in nearly all cases give adequate drainage. The size of ditch should vary with the size of the area to be drained, amount of upland drain-

ing into the basin, and the fall. Narrow strips along streams, subject to overflow, will be rather difficult and expensive to reclaim.

This soil has been derived from glacial material occupying old lake beds, the lowland along streams, and small depressions. In such places a large quantity of organic matter has accumulated and become mixed with the mineral constituents of the soil.

Up to the present time very few areas of Clyde silty clay loam have been reclaimed. Part of the tract immediately north of New Berlin and a few small patches around Muskego Lake have been put under cultivation. A tile factory about 2 miles north of Denoon has made it very easy to obtain tile for that district. Where the type is not drained some of it is used for hay and pasture. When the Clyde silty clay loam is drained it becomes very loamy and mellow under cultivation. It can not be worked under as wide a range of moisture conditions as the Clyde loam, but it is not very difficult to handle. If cultivated too wet the soil is apt to puddle and large clods, which are difficult to pulverize, are sometimes formed. Checks and cracks an inch in width are commonly found, but by proper cultivation these can be prevented in fields occupied by intertilled crops. This type has never been known to suffer from drought. During dry seasons crops do well on undrained land. In wet seasons conditions are not favorable for the growth of crops, except where artificial drainage has been established.

On the drained areas of the Clyde silty clay loam general farming and some trucking are carried on. The soil is well adapted to corn and most of the reclaimed land is devoted to this crop. It gives an average yield of 40 bushels per acre, with a maximum yield of 70 bushels. Oats do fairly well, but as a rule lodge before ripening. Heavy crops of potatoes are obtained, yields of 300 bushels per acre being common. The average is about 150 bushels per acre. As on the Clyde loam, the tubers are inferior in quality, often being too large and hollow. Most of the crop is consumed at home. Some are marketed in Milwaukee. This type is well adapted to the wild grasses and when drained to timothy and redtop. The grasses ordinarily yield  $1\frac{1}{2}$  to  $2\frac{1}{2}$  tons of hay per acre.

In the vicinity of Menomonee Falls, a few small, drained areas are devoted to the cultivation of sugar beets. Beets grow luxuriantly on this type, yielding from 15 to 18 tons per acre. The sugar content is lower than in case of beets grown on the Miami clay loam, but the tonnage is enough greater to make the gross receipts somewhat higher.

In the vicinity of Elm Grove cabbage and cauliflower are grown on a few drained tracts. Cabbage yields 10 to 18 tons per acre, and the average returns from cauliflower are \$150 to \$180 an acre.

In Racine County, in the vicinity of Racine, this type has become a great trucking soil. Cabbage produces 10 to 15 tons per acre;

onions 400 to 700 bushels, and potatoes 150 to 250 bushels per acre. Celery also does fairly well. When thoroughly drained there is no question that the Clyde silty clay loam will be one of the best soils in the county from the standpoint of production. No commercial fertilizers have been used, and manure has been applied sparingly. After a few years' cropping the yields decline, unless manures are used. Tests carried on by the State experiment station near Brookfield show that the crops respond well to sulphate of potash. Corn was the crop grown. An application of 150 to 200 pounds per acre of sulphate of potash would be sufficient.

A few tracts of this type are maintained as woodlots. Elm and oak constitute the natural growth. Along streams, on the lighter phase, wild grasses and willows are seen.

The price of land ranges from \$30 to \$50 an acre. Eighty dollars an acre has been asked for some drained tracts.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

*Mechanical analyses of Clyde silty clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
25025.....	Soil.....	0.0	0.2	0.3	1.1	1.0	67.1	30.3
25026.....	Subsoil.....	.0	.3	.4	1.7	2.3	65.8	29.2

CLYDE LOAM.

The surface soil of the Clyde loam consists of a dark-brown to black loam, 10 to 14 inches deep. This is underlain by a drab-colored clay loam which grades into a yellowish or bluish clay at 24 to 30 inches. In the subsoil seams of sand 3 to 4 inches in thickness are very common. The subsoil is mottled and usually streaked with iron stains. It also contains some calcareous material, and gravel is frequently encountered in the third foot. A high percentage of organic matter gives the soil a dark color and makes it very loamy and mellow. In the area east of Mukwonago, the surface soil contains a quantity of medium sand and approaches a sandy loam in texture. The areas northwest of Eagle and south of Dousman also belong to this phase. The subsoil is a mottled, sticky, clayey sand. Another phase is found closely associated with the Miami silt loam, usually occupying narrow draws and depressions. It is a dark-brown or black loam, approaching a silt loam in texture, 10 to 14 inches and sometimes 18 inches deep. The subsoil consists of a mottled, yellowish-blue clay rather impervious to water. The Clyde loam is often the gradation type

between the Peat and upland soils. Such areas occur as bands, and in some instances these were so narrow that it was not found practicable to map them.

When reclaimed this type is very easy to handle and can be cultivated under a rather wide range of moisture conditions. On the heavier phases some checking and cracking occurs, but not enough materially to affect the supply of soil moisture. On such land cultivation should be avoided when the soil is moist.

The Clyde loam occurs chiefly in the townships of Mukwonago, Vernon, Waukesha, Genesee, and Pewaukee. Other small tracts occur throughout the county. This type occupies a level topography and is poorly drained. The Clyde loam can be readily reclaimed by ditching and tiling, as suggested for the drainage of the silty clay loam type. Since the subsoil is not so impervious as that of the other type, sufficient drainage may be secured by placing the tile drains 6 rods apart.

Areas of the Clyde loam occur along streams, in glacial lake beds, and in depressions. It has originated from reworked glacial till in which large amounts of organic matter have accumulated. Wild grasses, reeds, and willow and elm constitute the natural growth on this type.

At present very little of the Clyde loam has been reclaimed, though most of it is used for pasturage and hay. When drained it is adapted to trucking and fairly well suited to general farming. No trucking is carried on at present, but this industry should be developed on tracts conveniently located. Corn does well, and most of the reclaimed areas are devoted to its cultivation, giving ordinary yields of 35 to 60 bushels per acre. Very little oats or rye was seen. These crops grow luxuriantly, but often lodge before the grain is mature. Heavy yields of potatoes have been obtained ranging from 120 to 150 bushels, with a maximum of 250 bushels per acre. Irish potatoes grown on the Clyde loam are inferior in quality, usually larger than the market demands, and consequently bring a price below the standard market quotations. Wild grasses and bluejoint do well on this type. When thoroughly drained, timothy can be grown successfully. The grasses yield  $1\frac{1}{2}$  to 2 tons of hay per acre.

Liberal applications of manure are the only fertilizer used on the Clyde loam. It has been found that without manuring the yields decrease after a few years of continuous cropping. The addition of potash and phosphorus, in connection with stable manure, will be found beneficial. When drained and properly fertilized the Clyde loam will become a very valuable soil.

Land values range in price from \$20 to \$40 an acre, while reclaimed land is held at \$50 to \$60 an acre.

## CLYDE SANDY LOAM.

The Clyde sandy loam consists of a dark-brown to black sandy loam, 8 to 10 inches deep, resting upon a brownish-yellow sand or sandy clay. Near Vernon Station the type has a mottled silty clay subsoil at a depth of 3 feet. West of Mukwonago a mucky phase is found. The soil here consists of a black mucky sand 6 to 8 inches deep, resting on a mottled-yellow sand. At 30 inches a grayish sand is encountered.

The loose loamy character of the soil makes it easy to handle. Its sandy subsoil makes it somewhat droughty during long periods of dry weather. This is especially true of the areas lying adjacent to lowlands which have been thoroughly drained.

The Clyde sandy loam occurs chiefly in the southern half of the county in small scattered areas, the largest of which are found east of Saylesville, in the vicinity of Vernon, and west of Mukwonago. Besides these there are other occurrences of small extent distributed over the southern part of the survey.

This type occupies a physiographic position intermediate between the Peat and the upland soils; it has a flat to gently undulating topography, and the drainage is fairly good, except on the mucky phase where the water level is too close to the surface. On the more undulating land the physical character of the soil insures good drainage, whereas on the level tracts ditching and tiling will have to be resorted to in order to make the land tillable. In most cases the large areas of Peat will have to be drained before the mucky phase of this type can be reclaimed.

The Clyde sandy loam is derived from sandy material deposited in ancient lakes, and, as it has been subjected to a swampy condition for a long period, large amounts of organic matter have accumulated and become incorporated in the soil.

When reclaimed this type is a fairly good soil. At present it is mostly devoted to general farm crops. Corn yields 30 to 50 bushels per acre. Rye and oats give fair yields, but since so little of the type has been reclaimed very little can be said concerning crop adaptation and productivity. When heavily fertilized, it is well adapted to small fruits and truck crops.

All of the mucky phase and some of the sandy soil is still unreclaimed, wild grasses and willows being the chief natural growth on the former. On the latter some hardwoods are found.

The better drained land receives a liberal dressing of manure. No commercial fertilizers have been used. No definite crop rotation is followed. The price of this land varies from \$5 to \$40 an acre, depending upon drainage conditions.

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

*Mechanical analyses of Clyde sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
25029.....	Soil.....	0.0	12.7	26.3	29.2	3.3	20.7	7.3
25030.....	Subsoil.....	.5	15.1	31.5	38.1	4.5	6.1	4.1

PEAT (WITH INCLUDED AREAS OF MUCK).

A large number of marshy areas ranging in size from a few acres to several square miles in extent are scattered throughout the county. These form a characteristic feature of this portion of the State. The material composing such areas consists of vegetable matter in varying stages of decomposition, to which has been added, in some instances, varying amounts of mineral matter by the wash from the adjoining higher lands. In the ordinary use of the term, Peat refers to the decaying vegetable matter, chiefly sphagnum moss, which is still fibrous and but partially decomposed, while the term Muck is applied to material which has decayed to such an extent that the fibers are no longer readily distinguishable. In the true Muck some mineral matter has been incorporated. These definitions, however, are somewhat confusing. In the soil survey, when the mineral matter content was found to be high so as to impart to the material a loamy or clayey characteristic it was classed with the Clyde series. On the soil map one color was used for showing the location of highly organic soils, whether Peat or Muck.

In small marshes and in narrow strips along streams there is usually considerably more mineral matter and the Muck is from 1 to 4 feet deep, while in the large marshes the material is often more peaty and from 5 to 15 feet deep. In some localities the surface is quite thoroughly decomposed while the underlying material is fibrous. Throughout most of the area, a bluish or mottled, stiff, plastic clay is found beneath the marshes, except in the western part of the county in the vicinity of sand and sandy loam areas, where a sand or sandy clay is encountered. Marl deposits are found under some of the marshes.

Large and small marshy areas are scattered throughout the county and associated with practically all of the soil types. Many of the small patches were too small to be indicated on the soil map. The largest area occurs in the southwestern part of the county, extending north from a point 3 miles west of Eagle for nearly 10 miles. Some portions of this tract are peaty, but much of it is partially decom-

posed, forming a mucky Peat. The material varies in depth from 2 to 8 feet and is underlain by sand or sandy clay, except in sections 3 and 4, Eagle Township, where a marl bed over 50 feet thick is found. A factory has been established on the edge of the marsh to develop this deposit. Other small occurrences of marl are found throughout this large marsh. The fall is considerable, and practically all of this tract could be drained, but no effort has been made to reclaim the whole area, though a project for draining the northern portion is being considered. The second area in size begins 1 mile north of Mukwonago and extends north for about 6 miles along the Fox River. It has a width of  $1\frac{1}{4}$  miles at one point. The material consists of a mucky Peat extending to a depth of 5 to 15 feet, underlain by a blue clay. It would be practically impossible to drain this tract, as the Fox River is sluggish and the fall slight. If the dams which obstruct the river in Racine County ever are removed this marsh may also be reclaimed. Other marshes of over 2 square miles in extent occur in Menominee, Brookfield, and Muskego Townships, while smaller patches are found in all parts of the survey.

The topography of all these areas of course is flat and the natural drainage poor. During the spring and in wet seasons water stands over much of the surface. Considering the large number of marshy areas in the survey only a very small proportion have been reclaimed, though nearly all of these tracts could be successfully drained and several projects are now being developed. As land values advance, the interest taken in these marshes becomes keener and the time will doubtless come when the reclaimed Peat will be among the most productive soils in the county.

The natural growth on the marshes consists of wild grasses, willows, and tamarack. Many of the marshes are entirely open, supporting only a growth of wild grass, and during dry seasons taking on the appearance of prairies. Others have a growth of tamarack in the center of the swamp, with wild grass and willows around the margin, while a few are entirely covered with tamaracks. It is probable that where the tamaracks exist the swamps are older than those upon which only wild grasses occur.

During dry seasons nearly all of the marsh grass is cut for hay, but if the ground is saturated with water it will not support the weight of a team. Many of the marshes are divided into small tracts and owned by farmers in the vicinity, who depend upon the marsh for hay when the usual supply from the upland fails or is short.

A few reclaimed tracts were seen where corn, timothy, and cabbage were being grown successfully. As a rule, the more thoroughly decomposed areas can be readily developed into good productive land after drainage is established, though in some localities undecomposed peat has been made to produce good crops by proper treatment.

Some of the mucky and peaty material is found to be acid, in which case lime should be applied. There is also a deficiency in potash, which must be supplied, and it is often advisable to apply some form of phosphorus in addition. When reclaimed and properly treated the marsh areas will be well adapted to corn, timothy, and peppermint, while some tracts will grow celery, onions, and cabbage, and doubtless a variety of other crops.

The value of unreclaimed areas of this class of land ranges from \$5 to \$15 an acre.

#### MEADOW.

The type Meadow includes narrow strips of low-lying land along streams, where the soil is subject to overflow and quite variable in texture, so that it can not be classified with any of the other established types. Where found along the Menominee River in the eastern part of the county the soil consists chiefly of a dark-brown clay loam underlain by a heavy, compact, yellowish-brown clay more or less mottled. A lighter phase occurs along the Fox River, north of Waukesha and along the streams northeast of Merton, south of Mukwonago Lake, and north of Eagle Lake. It consists of a dark-brown to black loam, 8 to 16 inches deep, underlain by a heterogeneous mixture of mottled clay, sand, and gravel. In the latter phase the soil contains a high percentage of organic matter. Shells and iron stains are very common in the subsoil. The type is subject to overflow and draining it would be difficult and expensive. Meadow makes good pasture and hay land. The native growth consists of wild grasses, reeds, and willows.

The price for Meadow lands ranges from \$5 to \$15 an acre.

#### SUMMARY.

Waukesha County lies in the southeastern part of Wisconsin and comprises an area of 560 square miles or 358,400 acres. The surface varies from level to rough and hilly.

The drainage is into Lake Michigan from the eastern side of the county, and into tributaries of the Mississippi from other portions.

The first settlement was made in 1834, and the county was established in 1846. The early settlers were chiefly English, Germans, and Irish, coming from the Old World and from the older States. Waukesha, the county seat, is 20 miles from Milwaukee and 100 miles from Chicago.

The county is well supplied with steam, electric, and wagon roads, and all parts of the survey are provided with telephone and rural free-delivery service.

The mean annual precipitation is 31.9 inches. There is an average growing season of 149 days.

The type of agriculture followed consists chiefly of general farming in conjunction with dairying. About one-half of the milk pro-

duced goes to the creameries and cheese factories. Large quantities are shipped to Milwaukee and Chicago.

Numbers of hogs are raised on the dairy farms, and many farms make a specialty of raising pure-bred cattle, horses, sheep, or swine.

Hay (clover and timothy), oats, corn, barley, rye, and peas are the principal crops. The growing of alfalfa has just emerged from the experimental stage. It does well on a variety of soils. Much of the corn is grown for ensilage. Peas are grown for the canning factory at Waukesha and sugar beets for the sugar factory at Menomonee Falls. Some truck crops are produced.

The soils of Waukesha County have all been derived from the mantle of glacial drift which covers the surface of the entire region to a depth of from a few feet to over 300 feet. Twenty types, including Peat (with included areas of Muck) and Meadow, were mapped.

The Miami series, covering over half the county, consists of the light-colored glacial material. Seven types were found belonging to this series. These soils are fair to good general farming soils.

The Plainfield series consists of the light-colored soils of the outwash plains and filled-in valleys and is represented in the present survey by four types. The silt loam and loam are good general farming soils. The fine sandy loam and sand are not extensive types.

The Waukesha series includes the dark-colored soils of the outwash plains, and is represented here by the loam and gravelly loam types. It is largely prairie, level to undulating, and a good general farming soil, though somewhat droughty. The Waukesha gravelly loam is of limited extent, occupying chiefly terraces bordering the Eagle Prairie.

Two Carrington soils, the loam and clay loam, are found. The Carrington clay loam is an extensive type and a good soil in Racine County, but occupies only one small tract in the southeastern part of Waukesha County.

Soils of the Clyde series occupy old lake beds. They contain a high percentage of organic matter. Three types are represented in this survey: The silty clay loam, loam, and sandy loam. The soils need drainage. When reclaimed they are very productive.

Peat (with included areas of Muck) occupies the numerous marshy and swampy areas throughout the county. Few areas have been drained, though most of them could be reclaimed and made highly productive.

Meadow consists of low-lying strips of land adjacent to streams and subject to frequent overflow. Crops on such areas are uncertain.

[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.]

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