

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS—MILTON WHITNEY, Chief.

SOIL SURVEY OF PORTAGE COUNTY, WISCONSIN.

BY

F. N. MEEKER AND R. T. AVON BURKE.

[Advance Sheets—Field Operations of the Bureau of Soils, 1905.]



WASHINGTON:
GOVERNMENT PRINTING OFFICE.

1906.

[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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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,

Washington, D. C., April 23, 1906.

SIR: Petitions from the owners of over 50,000 acres of swamp lands in Portage, Adams, and Wood counties, Wis., were transmitted to this Bureau in 1904 by Senator J. V. Quarles and Representative J. H. Davidson. These petitions state in substance that:

There are in Portage, Adams, and adjoining counties several hundred square miles of marsh land covered with turf, muck, and peat soils varying in depth from 6 inches to 10 or 12 feet, which are the product of decayed vegetation, mainly sphagnum moss. The undersigned are owners of these marsh lands and are anxious to know if they can be made productive for general and special agricultural purposes when drained. Some drainage districts have already been formed and others are likely to be formed in the near future, and it is possible to invest hundreds of thousands of dollars for the purpose of draining these lands. We would respectfully ask that you give this problem some of your valuable time and attention, for the purpose of investigating these soils to arrive at a conclusion as to what is best to do with them and to determine what they are capable of producing when drained.

In accordance with these petitions a soil survey of Portage County was undertaken in the summer of 1905. Herewith I transmit a report upon this work, which I recommend be published as advance sheets of the Field Operations of the Bureau of Soils for 1905, as authorized by law.

Very respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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MAP.

Soil map, Portage County sheet, Wisconsin.

SOIL SURVEY OF PORTAGE COUNTY, WISCONSIN.

By F. N. MEEKER and R. T. AVON BURKE.

LOCATION AND BOUNDARIES OF THE AREA.

Portage County is situated very nearly in the central part of the State of Wisconsin, and comprises about 797 square miles. It is bounded on the north by Marathon County, on the east by Waupaca County, on the south by Waushara and Adams counties, and on the west by Wood County. It is regular in its outline and would be a square of five townships on each side but for the lack of the three townships, 21, 22, and 23 N., R. 6 E., which are a part of Wood County.

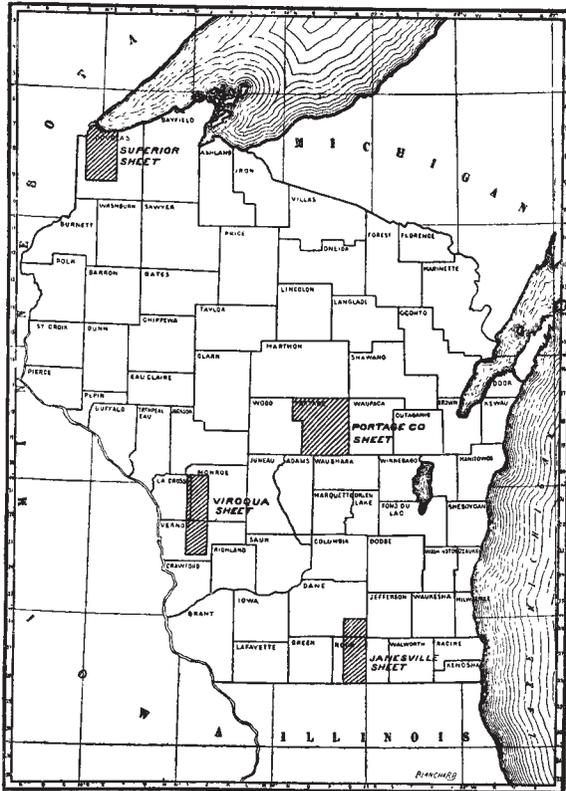


FIG. 1.—Sketch map showing location of the Portage County area, Wisconsin.

The Wisconsin River, on which is located Stevens Point, the county seat, traverses the northwestern part of the county. Stevens Point is 108 miles by rail from Madison and 252 miles from Chicago. The base map used in the soil survey was taken from a county map.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Portage County was organized in January, 1844, and at that time embraced a large part of the territory of northern Wisconsin. By later acts of the legislature several other counties were formed from what was originally Portage County. The last to be set off was Wood County, in 1856, leaving the area of Portage County within the constitutional limit.

In 1820 the area of the county, together with the whole of upper Wisconsin, was an unbroken wilderness. It, like several of the surrounding counties, was first visited by white man for its pine timber. The Indians became alarmed at the rapid increase of lumbermen, and complained to the Government agents. In 1836 a treaty was made with the Menominee Indians for the cession of a strip of land 3 miles in width on each side of the Wisconsin River, from Point Bas, 40 miles up the river, to permit the operations of the lumbermen. This was offered for public sale in 1840, which opened the country, to the extent of this strip, to occupation and settlement. Early records show that the first settlers came principally from Illinois, Ohio, Pennsylvania, New York, and Maine, and a few from Canada. At present quite a large proportion of the population of Portage County is made up of Poles, Germans, Norwegians, and Swedes, who moved here mostly between the years 1850 and 1870. Many of them emigrated directly from Europe, while others came from the Eastern and Central States.

As the lumbering industry increased a demand arose for some means of obtaining supplies at less cost than wagoning them from southern Wisconsin and northern Illinois. Early experiments in agriculture proved so successful that many men who came for the purpose of lumbering turned their attention to farming, selling their farm produce to the lumbermen.

In 1848 a treaty was concluded with the Menominee Indians by which the United States Government acquired all the land in the State belonging to this tribe. This opened the remaining part of Portage County to settlement. New settlers came in from States to the south and east, and immense tracts of pine and other lands were entered, which quickened the lumbering industry, as well as the farming industry, of this county. The principal crops grown by the early farmers were potatoes, corn, oats, rye, and wheat.

CLIMATE.

In general the climate of Portage County is very healthful, though subject to great extremes of temperature. The winters are usually long and severe, the temperature sometimes falling as low as -35° F. The soil freezes to a depth of from 1 to 3 feet. The snowfall is heavy and usually covers the ground from the 1st of December

to the middle of March. It is necessary to make careful preparation for the housing of stock during the winter months. The summers are rather short, but very pleasant. Occasionally the temperature reaches 100° F., thus giving an extreme range of about 135° F.

The following table, compiled from the records of the Weather Bureau stations at Stevens Point and Amherst, shows the normal monthly and annual temperature and precipitation in this area. The data here given are computed from records covering a period of eleven years at Stevens Point and twelve years at Amherst:

Normal monthly and annual temperature and precipitation.

Month.	Stevens Point.		Amherst.		Month.	Stevens Point.		Amherst.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	° F.	Inches.	° F.	Inches.		° F.	Inches.	° F.	Inches.
January	15.9	0.77	13.9	1.12	August	67.5	2.55	67.2	2.96
February	14.1	.75	14.4	1.73	September	59.0	3.55	59.3	3.21
March	28.3	1.26	27.7	1.75	October	48.3	2.68	47.5	2.78
April	47.0	2.50	44.5	2.74	November	31.5	1.48	31.1	1.52
May	57.6	4.13	55.5	4.23	December	18.4	1.04	17.9	1.39
June	66.2	3.70	65.4	4.24	Year	43.6	27.83	42.8	31.43
July	69.6	3.42	70.8	3.76					

It will be noted from the table that the rainfall is very well distributed, about 70 per cent of the rain falling from April 1 to September 30, the period of the year when vegetation is in greatest need of it. From the 1st of January until the end of April the prevailing winds are from the west and northwest. The winds during May and June generally blow from the south or southeast. During July and August they usually blow from the southwest, while during the last four months of the year the prevailing direction is from the northwest. During the months of July and August heavy thunderstorms are frequent, with occasionally a severe hailstorm. Tornadoes and heavy hailstorms occur at rare intervals. The first killing frost in the fall usually occurs about September 24, and the last in the spring about May 25. This gives a growing season of approximately 122 days.

PHYSIOGRAPHY AND GEOLOGY.^a

Portage County is from 1,200 to 1,300 feet above sea level in its northern part, slopes gently toward the south, and has an elevation of from 900 to 1,100 feet at the southern boundary. The country is from 500 to 600 feet above Lake Michigan. North and south through the central part of Portage County the surface is quite level or plain-

^a Matters pertaining to the geology of the area are taken mainly from the Geology of Wisconsin, by T. C. Chamberlain.

like. In the southern part of the county this level area is approximately 18 miles in width and extends northward along the western border of the county about as far north as the Wisconsin River. As it extends northward it becomes narrower, and on the northern boundary line is about 12 miles wide.

All of that portion of the country east of the plainlike area is part of a terminal moraine, and includes fully one-third of the county. Here the surface is for the most part very uneven, rounded or hummocky hills and boulder ridges being prominent features of the topography, though in the eastern part of the country, in the vicinity of Alban, Newhope, and Garfield, are some level or slightly rolling areas. The boundary between the moraine and the more level area to the west of it is very distinct. The difference in elevation between these two areas is from 50 to 100 feet. The northwest part of Portage County has a level to rolling topography.

The principal river of the county is the Wisconsin, which flows from the north through the more level area of the central part of the county. On this river are located Stevens Point, Conant Rapids, and Plover. Both Little Eau Pleine and Plover rivers empty into the Wisconsin in this county. In the southwestern part of the county three creeks, Buena Vista, Duck, and Ten Mile, flow to the westward and empty into the Wisconsin River in Wood County. These drain the large swampy area in the southwestern part of the county. Mill Creek, another small stream tributary to the Wisconsin, drains the northwestern part of the area. The water of all of these eventually reaches the Mississippi River. East of the divide, passing north and south through the eastern part of the county, the Waupaca River and the Little Wolf River, with their many smaller tributaries reaching throughout almost the entire eastern part of the county, flow to the southeast and finally reach Lake Michigan.

Throughout the area of the moraine are to be found numerous small lakes, where water has accumulated in the depressions of the uneven surface. Some of these lakes have no surface outlet, while others have. Still other depressions which were originally lakes are now marshy or swampy areas. In some of the depressions the accumulated organic matter has so far decayed as to form a soil of the nature of peat or muck, or some intermediate stage between the two. The forest growth is mainly tamarack, with some cedar. These swampy areas among the moraine hills are all comparatively small. In the southwestern part of the county is a marshy area covering about 55,000 acres. Other small marshy areas are found scattered throughout the entire northwestern part of the county.

The eastern part of the county is a typical glacial area, its surface for the most part being made up of rounded drift hills and ridges. The area shows comparatively little evidence of erosion, which fact

would indicate that it originated through the deposition of material from the later ice sheets which passed over this part of the State. Many kettle-hole depressions occur in the hilly sections. The eastern portion of this county forms a part of what is known as the Kettle Range, a range of moraine hills which extends for a considerable distance to the north and south of Portage County. The materials forming these drift deposits are boulders, gravel, sand, and clay, sand being the most prominent material. Boulders are to be seen in large numbers in some parts of this district, while in other parts they are very few in number.

In the northwestern part of the county is to be found glacial drift material deposited by an ice flow much earlier than that of the eastern part of the county. Boulders are to be seen here also, but not in such large numbers as in the eastern part. The surface is very much more eroded, and the resulting soils are for the most part heavier than those of the eastern part of the county.

The next older geological formation to be found in the county is the Potsdam sandstone of the Cambrian period. The rock of this formation outcrops in a number of places in the western and southwestern parts of the county, and is seen to lie in horizontal layers over the older rocks beneath. In T. 21 N., R. 8 E., are to be seen ledges or peaks of this sandstone extending from about 50 to 100 feet above the level of the surrounding country. Beneath the sandstone are found the crystalline rocks of Archean time. The layer of sandstone in Portage County is comparatively thin. In the river bed at Stevens Point the crystalline rocks are to be seen. Very near the river at this point is also to be seen the outcropping overlying sandstone. The Archean rocks can be traced for some distance to the south in the river bed until at Nekoosa, in Wood County, they become entirely covered by the sandstone. North of Stevens Point very little of the sandstone is seen, while the Archean rocks are found at the surface in several places, and probably underlie the greater proportion of the northwestern part of the county at a comparatively short distance below the surface. They are made up principally of gneisses and granites. The heavier soils of this part of the county seem to have originated both from the decomposition of the underlying crystalline rocks and the overlying glacial drift.

During the closing stages of the last glacial period, when the ice was gradually melting, the streams issuing from the glaciers were very much swollen, and were thus able to carry and deposit large quantities of materials along their courses. In this manner a large part of the more level area of the central and southwestern parts of Portage County has been formed. Along certain parts of the terminal moraines is an "outwash" plain formed by the water issuing from the melting glacier. Over these areas the soils contain considerable

quite coarse gravel, and are usually heavier than the alluvial soils farther west. The soils of the glacial outwash plain and those of the river flood plain merge into each other so imperceptibly that it is impossible to note any sharp dividing line between the two.^a

SOILS.

Twelve soil types have been recognized in this area, including Muck and the bottom-land soil along the streams. In many places the types pass so gradually one into another that it is difficult to define their boundaries, while in other parts of the area the boundaries are sharply marked. The map accompanying this report represents the types in color, while the extent of each is shown by the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Miami sand.....	146,624	28.7	Miami stony sand.....	17,536	3.4
Muck.....	128,640	25.2	Portage stony sandy loam.....	11,362	2.2
Miami sandy loam.....	65,536	12.8	Portage sandy loam.....	9,792	2.0
Miami loam.....	44,544	8.8	Miami stony loam.....	5,632	1.1
Marshall sand.....	31,040	6.1	Wabash loam.....	2,944	.6
Marshall gravelly loam.....	24,064	4.7	Total.....	510,400	-----
Portage silt loam.....	22,656	4.4			

MIAMI SAND.

The Miami sand occupies 28.7 per cent of the area of the county, and is one of the most extensive soil types of the area. The surface material, to a depth of 7 to 9 inches, is a brown medium sand, composed mainly of somewhat rounded particles. The sand often has a loamy appearance, especially in cultivated areas, owing to the presence of more silt, clay, and organic material. In local areas the first 1 or 2 inches of the soil may be somewhat darker than the type in general, this being due to the increased amount of organic material near the surface. The subsoil is almost invariably a yellowish-brown medium sand, becoming somewhat lighter in color and coarser in texture as the depth increases. Fine gravel is sometimes found in the subsoil, usually at a depth of from 25 to 36 inches. Where the Miami sand occurs in the area of the moraine in the eastern part of the county, it is not uncommon to find gravel in the subsoil and sometimes in the soil.

This type of soil occurs most largely in the southern part although it is also found in separate areas in nearly all parts of the county. Its surface in the moraine district is rolling and hilly. In the southwestern part of the area, where the type occurs on the Wis-

^a Soils and agricultural conditions of north-central Wisconsin, by Doctor Samuel Weidmann, p. 6.

consin River plain, it is quite level. West of Stevens Point it is generally quite level, and along the course of the Wisconsin, in the northern part of the county, it is somewhat more rolling. Owing to the texture of both the soil and subsoil, the type is well drained, and is somewhat inclined to be droughty. Rain generally sinks into the soil very readily. Crops do best on this soil during wet seasons.

Through the central part of Portage County the Miami sand is very largely alluvial in its origin, having been deposited by the swollen streams issuing from the glaciers. In the eastern part of the county it is of glacial origin, occurring as drift material. Here the sand is undoubtedly formed of ground-up and disintegrated sandstone of the underlying Potsdam formation. Some areas in the western part of the county may also be glacial in origin.

Notwithstanding the loose texture of this soil, potatoes can be grown with profit in seasons of sufficient rain, while corn does fairly well under like conditions. Potatoes generally yield from 75 to 100 bushels per acre; corn yields from 15 to 25 bushels per acre; rye about 10 bushels, and oats about 20 bushels. Hay yields one-half to 1 ton per acre. The timber growth is mostly jack pine.

As a whole the type is not naturally productive, but the crop yields may be increased considerably by careful attention to manuring and crop rotation. On account of its porous texture it requires very frequent fertilizing. This drawback, however, is offset in a measure by the ease with which the land can be worked. The fertilizer is generally barnyard manure, very little commercial fertilizer being used. Some few instances have been noted where the application of land plaster seemed to increase crop yields on this soil. The Miami sand has a value of from \$25 to \$30 an acre.

The following table gives the average results of mechanical analyses of this type of soil:

Mechanical analyses of Miami sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
13273, 13922, 13924.	Soil	1.5	21.9	36.2	27.9	2.8	4.4	4.8
13274, 13923, 13925.	Subsoil .....	.8	19.5	33.0	34.5	3.4	2.4	2.8

In order to obtain an idea of the principal manurial requirements of this soil, a large sample was collected about $1\frac{1}{2}$ miles west of Stevens Point. The field from which the sample was taken had been in cultivation to small grain and potatoes for a period of five years. Small quantities of stable manure had been used, but no other fertilizers. Potatoes are the chief crop, giving medium yields of fine quality tubers.

The results of the determinations made on this soil by the wire-basket method indicate that stable manure produces large increases in the productiveness of the soil; that nitrate of soda exerts a beneficial effect, which is further augmented by the addition of acid phosphate, sulphate of potash, and lime, although no two of these substances in combination have any advantages over nitrate of soda alone. The results agree with field practice and experience in regard to stable manure, and suggest that nitrate of soda and complete fertilizers with lime might prove of decided benefit.

In these tests wheat plants were used as an indicator, and the results are held to be applicable only to the field from which the sample was taken and to related crops. To what extent they are applicable to potatoes or other unrelated crops is a matter for further investigation.

MIAMI SANDY LOAM.

The Miami sandy loam is composed of a brown, somewhat loose medium sandy loam, about 8 inches deep, underlain by a yellowish-brown light sandy loam, which may become a sticky sandy loam as depth increases, and sometimes contains a sufficient amount of stone and gravel to make borings difficult. At a depth of about 27 inches the subsoil generally grades into a mixture of sand and gravel which continues to a depth of 36 inches or more. A yellowish sandy clay frequently occurs at a depth of from 20 to 25 inches. This may grade into a mixture of sand and gravel or into sandy clay which contains gravel. Over the small areas of the type in the moraine district stone and boulders occur quite plentifully on the surface, but the extent of such occurrences is not sufficient to warrant the establishment of a distinct type. This stony phase is indicated on the map by symbol.

This type occurs in irregular shaped areas in the eastern, north-western, and south-central parts of the county. In the latter section the topography is quite level or gently rolling. North of Almond some quite level areas occur. In the region of the moraine, as well as in the northwestern part of the county, the topography is rolling and hilly. Owing to the surface configuration of the type and to its texture it is usually very well drained, while at the same time it retains sufficient moisture to prevent injury to crops during ordinary dry spells.

In the eastern part of the county the Miami sandy loam is made up of drift material deposited by the later glaciers, while in the north-western part of the county it is probably very largely derived from material laid down by an earlier ice sheet. The parts of the type occurring on the more level areas in the south-central part of the

county undoubtedly have originated from the morainic material to the east, transported by the waters issuing from the melting glaciers.

The potato is the crop to which this type seems best adapted. Corn, oats, rye, and hay are also grown. Potatoes yield from 75 to 125 bushels per acre, corn from 25 to 35 bushels, oats from 25 to 40 bushels, rye from 15 to 20 bushels, and hay from 1 to 1½ tons per acre. This type as a whole is not considered a strong soil, but when careful attention is given to fertilizing and crop rotation fairly good yields may be counted upon. Oak is the principal forest growth upon the type.

The Miami sandy loam has a value of about \$35 an acre.

The following table shows the average results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Miami sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
13275, 13888, 13892.	Soil	0.8	12.6	20.0	32.5	10.1	16.4	7.1
13276, 13889, 13893.	Subsoil	1.5	9.3	15.4	24.5	11.2	24.7	13.1

A large sample of this type was collected with the object of obtaining an idea of its principal manurial requirements. The field was situated about 1 mile northeast of Junction. The soil here consists of brown sandy loam about 9 inches deep and contains some rock fragments. The surface is gently rolling and the soil well drained. The land from which the sample was taken has been cultivated for twenty-three years, cropped to grass, corn, oats, and barley in more or less regular rotation. Medium yields of grass and small grains and good yields of corn and potatoes are secured. The field has received light applications of stable manure, but no other fertilizers.

The results obtained by the wire-basket method indicate that a fair increase in productiveness may be secured by the use of manure; that a complete fertilizer with lime gives a relatively small increase. When lime alone was used it seemed of little if any value, but in connection with some other fertilizer it apparently increased the beneficial effects to some extent. When either nitrate of soda, sulphate of potash, or acid phosphate was used alone, little if any increase was observed, but when any two of the salts were used in combination a slight increase in yield occurred.

These results were obtained by the use of wheat plants as an indicator. To what extent they are applicable to other crops or to other fields than that from which the sample was taken has not been determined.

MIAMI STONY SAND.

The upper 7 or 8 inches of the Miami stony sand consist of a rather light-brown fine to medium sand, containing varying amounts of small stone and gravel. The surface is usually quite thickly strewn with bowlders. The subsoil is a yellowish-brown fine to medium sand, which becomes somewhat lighter in color as the depth increases. It also contains varying amounts of small stone and gravel.

The type is located in the eastern part of the county, the largest areas being found in the south-central part, a little to the east of a line drawn north and south through the center of the county. It occupies only a small part of the area surveyed and occurs in quite widely separated, long, narrow areas, often forming ridges which have in general a north and south direction. On these ridges bowlders of all sizes are often found, and the proportion of stones is in general greater than in other parts of the type. The topography of the Miami stony sand is the most rolling and uneven of any type of the area, the hills and ridges usually being from 50 to 100 feet above the lower lying areas to the west. Owing to its surface configuration and to the texture of both the soil and subsoil the type is always well drained. Wherever small areas of the type are cultivated they are inclined to be droughty.

The origin of this type is very similar to that of the Miami sand found in the eastern part of the county, the sand being derived largely from the grinding up of Potsdam formation. The crystalline bowlders scattered through the soil have been carried here by the glacier from the region farther to the north and northeast.

The Miami stony sand is used almost entirely for grazing, for which purpose it is best adapted. Wherever any of this type is cultivated, the crops grown and the yields obtained are similar to those on the Miami sand. In most cases the bowlders are so large that it is impracticable to attempt to remove them from the fields. A large part of the type is covered with forest growth, mainly red and white oak. The Miami stony sand has a value of from \$20 to \$25 an acre.

The following table gives the average results of mechanical analyses of typical samples of this type of soil:

Mechanical analyses of Miami stony sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
13610, 13918	Soil	1.7	11.6	19.1	43.1	8.1	10.1	5.8
13611, 13919	Subsoil	1.7	11.8	19.2	44.4	7.9	9.2	5.4

For the purpose of making a wire-basket test of the manurial requirements of this type of soil a large sample was collected about 9

miles east of Stevens Point. The soil here to a depth of 8 inches is a brown light sandy loam, containing very little stone in the surface soil, but large quantities of bowlders and gravel in the subsoil. This open structure tends to make the land droughty and leachy, and as a result depressions receiving wash and seepage are generally more productive than the higher lying land.

The field from which the sample was taken is situated on a typical moraine and has been in cultivation from ten to fifteen years, corn, potatoes, oats, and grass forming the chief crops. The yields of the last two are very light. No definite information concerning the production of the others could be obtained.

The results of the determinations made in the test indicates that this soil is benefited to a marked degree by applications of stable manure; that nitrate of soda and sulphate of potash alone give slight increases, which are more marked when the two are used together, and that acid phosphate, lime, and green manuring have little effect in increasing the productiveness.

In these tests wheat was used as the indicating plant, and favorable conditions of climate and moisture maintained throughout its growth. These results are held to be applicable only to the field from which the sample was taken, but the treatments might prove beneficial over a considerable part of the type as it occurs in this area.

MARSHALL SAND.

The Marshall sand is quite distinct from the Miami sand. The upper 9 to 11 inches consist of a dark-brown or black loamy sand, containing a small percentage of silt and clay. The dark color is due to the organic matter contained. This, together with the small content of silt and clay, gives the soil its loamy appearance, which is especially noticeable in slight depressions. Under the microscope the sand grains are seen to be considerably rounded. The subsoil is a very loose yellowish-brown sand, medium in texture, becoming somewhat lighter in color and coarser in texture as the depth increases. A small amount of fine gravel is common at a depth of from 30 to 36 inches. The subsoil of this type is probably the most uniform of any occurring in the area. The yellowish-brown coloring is due to the very small amount of iron present. Practically no stones are to be found on the surface of the type.

Almost the entire area of this type is on the eastern side of the Wisconsin River, occurring on the broad valley floor of this river. The southern boundary of the type is in the vicinity of the town of Plover, from which point it extends north in a gradually narrowing but almost unbroken area to the county line. From Stevens Point the area reaches about 5 miles to the east. There are a few small, isolated areas of the type in other parts of the county, mostly in the southwestern part, around the edge of the large marsh.

One of the very noticeable features of this type is its level topography. Although level it is well drained, owing to the loose and porous nature of both the soil and subsoil. During wet seasons crops do fairly well, but during seasons of average rain or during dry seasons crops are very likely to suffer for lack of moisture.

The material composing this type of soil was undoubtedly deposited during the later stage of the glacial period, when the streams issuing from the glaciers were very much swollen and were able to carry large amounts of material. About 2 miles east of Stevens Point, where the Plover River has cut its channel through this type, the deep subsoil is seen to be very sandy. The principal constituent of both the soil and subsoil is quartz sand. Owing to the nature of the soil, the roads passing over the type are usually very sandy. This has occasioned so much difficulty in traveling that parts of three of the main roads leading from Stevens Point have been covered with crushed rock, thus making a very firm roadbed.

The potato is the crop which seems best adapted to this soil. Corn grows fairly well. Clover catches and grows quite well during seasons of sufficient rain. Rye and oats are also grown on the type. Potatoes commonly yield from 75 to 125 bushels per acre, corn from 20 to 25 bushels, rye from 10 to 12 bushels, and oats about 25 bushels to the acre. Hay produces from one-half to 1 ton per acre. From about 1860 to 1880 large quantities of hops were produced on this type of soil, but at present very few are grown.

Under improved conditions farms on the Marshall sand are worth about \$40 an acre, while in its wild state the type is worth from \$10 to \$20 an acre. The principal forest growth over the type is oak and jack pine.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of the Marshall sand:

Mechanical analyses of Marshall sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
13271, 13912	Soil	0.8	17.1	25.7	37.2	4.5	6.1	8.3
13272, 13913	Subsoil	1.4	18.0	30.9	38.6	4.1	3.2	3.7

With a view of determining its principal manurial requirements, a large sample of this type was collected about 1 mile southeast of Stevens Point. The field from which the sample was taken had been in cultivation for more than twenty-five years, during which time no fertilizers and only moderate quantities of stable manure had been used. The soil is used mainly in the production of potatoes, yielding 100 to 150 bushels per acre. Barley, oats, rye, and grass are grown. Poor crops of grass, mainly red-top, are secured.

The results obtained on this soil by the wire-basket method indicate that stable manure produces a fair increase in productiveness, that nitrate of soda is also quite beneficial, and that acid phosphate, sulphate of potash, lime, and green manure produce slight increases. In these tests wheat plants were used as an indicator, and to what extent these results would apply to the potato has not yet been determined.

The indications as to the use of stable manure by this method are in agreement with field practice and experience, and nitrate of soda would doubtless be of value, particularly to the grass and grain crops. The results are held to be applicable only to the field from which the sample was taken, but will doubtless prove of value over large areas of the type in similar condition.

MIAMI LOAM.

The surface soil of the Miami loam consists of about 8 inches of a dark-brown, rather compact loam composed mainly of silt and quartz sand, the sand being mostly fine to medium in texture. There is also some clay in the soil, which, together with the silt and sand, gives it quite a mellow texture. The subsoil, to a depth of about 18 inches, is a yellowish-brown loam somewhat heavier than the soil, composed mainly of silt and fine sand. Underlying this to a depth of about 25 inches usually occurs a quite compact yellowish sandy clay, often containing small stones and gravel, and beneath this is generally to be found a mixture of sand, gravel, and small stones. Boulders are found here and there over the surface, but not in sufficient numbers to interfere seriously with cultivation. The stones and boulders have in some cases been removed from the fields.

This type is located in the eastern part of the county, the largest areas lying in T. 23 and 24 N., R. 10 E. Nearly all of the type is on the eastern side of the drainage divide, which passes nearly north and south through the eastern part of the county.

The topography of the type is both rolling and level. In T. 24 N. and in the northern part of T. 23 N., R. 10 E., many areas have a nearly level or only slightly rolling surface. In sections 5 and 6 of T. 22 N., R. 10 E., is another noticeably level area. The remaining areas of the type are generally quite rolling.

The Miami loam is well drained, but at the same time it retains ample moisture for the growing of good crops, and yields are seldom affected either by prolonged dry weather or by unusual periods of wet weather. All of this type is found within the glacial region and is undoubtedly of glacial origin. The clay has probably been derived from the Archean crystalline rocks which underlie this section.

The Miami loam is one of the best types of soil in the area and is well adapted to general farming purposes. Small fruits, such as

strawberries and raspberries, do well on the type. Apple trees as a usual thing do not thrive in this county, although on some parts of this type they seem to grow and produce well. The crab apple seems to grow better than other varieties. On this soil potatoes produce from 100 to 150 bushels per acre, corn from 30 to 40 bushels, and hay from 1½ to 2 tons per acre. Oats yield from 40 to 50 bushels and rye about 20 bushels per acre. The soil has a value of from \$30 to \$50 an acre.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of the Miami loam:

Mechanical analyses of Miami loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
13235, 13898, 13900.	Soil	1.8	12.7	13.3	14.2	6.9	38.4	12.7
13286, 13899, 13901	Subsoil	2.7	15.4	13.8	17.1	7.2	26.6	17.0

MARSHALL GRAVELLY LOAM.

The upper 9 to 11 inches of Marshall gravelly loam consist of a dark-brown to black medium sandy loam. Gravel and small stones may occur on the surface and disseminated through the soil, but this is not always the case. Over a good part of the type as it occurs in this county this feature is absent, and in parts of the type the soil is quite silty. The immediate subsoil varies from a sand to a yellowish-brown or dark-brown sandy loam. At a depth of from 20 to 24 inches is generally a sticky sand or sandy clay of a yellowish-brown color, containing varying proportions of small stones and gravel. This gravel content of the subsoil is practically a constant feature of the type. Below a depth of about 30 inches the subsoil is generally lighter, usually being made up of a mixture of rather coarse yellowish-brown sticky sand and gravel.

The largest area of this type occurs northeast of the central part of the county, most of it between Ellis and Stockton. Another area occurs in the northeastern part of the county in the vicinity of Rosholt and Alban, and a third area is found near Almond. That part of the type around Rosholt is within the limits of the terminal moraine, but has a level to gently rolling topography. The remainder of the type occupies parts of the more level area passing nearly north and south through the county, and locally known as "the prairie."

The type is well drained and is a good farming soil. It retains moisture much better than the lighter soils of the area, and thus the crop yields are much more certain. The greater part of the type is under cultivation. Many well-kept farms are to be seen on it, and nearly all the houses and barns are well built and in good repair.

That part of the type occurring around Rosholt is glacial in its origin. The remaining areas of the type are undoubtedly parts of the outwash plain formed by water issuing from the edge of the melting glacier. In some parts of the type the color of the soil is considerably darker than that of the type as a whole, owing to a larger amount of organic material.

More hops are produced at present on this type of soil than on any other in the county. For some years prices for the hops of this section have been so low that it has not been profitable to grow them. At present, however, there seems to be a more active demand for them, so that the chances for profitable returns from the crop are considerably better. The soil of this type seems to be well adapted to this crop. Some of the hops produced on this soil type in 1902 are said to be equal to the best European hops. About 700 pounds can be grown to the acre, although under favorable conditions this yield may be very much increased. Potatoes and hay are also important crops on the type. Potatoes yield from 100 to 150 bushels per acre, and hay about 1½ tons to the acre. Corn, oats, and rye are also grown successfully, corn producing about 35 bushels to the acre, oats 35 to 45 bushels, and rye about 18 bushels. The type has a valuation of from \$30 to \$50 an acre.

The following table gives the average results of mechanical analyses of typical samples of the Marshall gravelly loam:

Mechanical analyses of Marshall gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
13269, 13902	Soil	2.6	18.8	21.7	30.6	7.1	10.9	7.5
13270, 13903	Subsoil	2.2	16.1	19.9	31.9	7.2	12.1	10.2

In order to obtain an idea of the manurial requirements of this type, a large sample was collected from a field about 2½ miles south of Ellis. This field had been in cultivation over twenty years, the crops grown being potatoes, oats, rye, and grass. Fair yields of grass and grain are secured. Potatoes yield from 100 to 200 bushels per acre. Little corn is grown on this farm. Light dressings of stable manure are used on potatoes, but no other fertilizers are used on any crop.

The manurial requirements of this soil, as determined by the wire-basket method, are as follows: Stable manure gives a fair increase in productiveness; nitrate of soda is slightly beneficial; green manure and lime, also acid phosphate, sulphate of potash, and lime alone or in combination, produce no improvement in the soil.

These results are obtained with wheat as an indicator, and are held to be applicable strictly only to the field from which the sample was

taken and are not to be considered as final for all crops even there. They are, however, in agreement with general farm practice on this type, and may prove of value over considerable areas of this soil in the county.

MIAMI STONY LOAM.

The surface soil of the Miami stony loam consists of a dark-brown to rather black loam 4 to 6 inches deep, composed mainly of silt and fine sand. It contains considerable quantities of stones and gravel, and over the surface are usually strewn large numbers of bowlders. The subsoil is generally a yellowish loam, composed mainly of silt and fine sand, which at about 18 inches grades into a sandy clay, continuing to a depth of about 25 inches. Below this is usually found a mixture of sand and gravel, the sand sometimes being sticky. The making of borings is often rendered difficult by the stones in the subsoil. This type of soil is quite similar to the Miami loam, except that it has a great many more bowlders strewn over its surface. The soil of the Miami stony loam is also shallower and is somewhat darker in color than that of the Miami loam, on account of the larger proportion of organic material which it contains.

The Miami stony loam is located entirely within the limits of the terminal moraine in the eastern and northeastern parts of the county. It covers only a small proportion of the survey and occurs in comparatively small isolated areas. The topography is usually quite rough and rolling, and the type sometimes occurs on ridges. Owing to its surface configuration the soil is well drained. The nature of the soil, however, is such that it retains moisture well.

Its origin is very similar to that of the Miami loam. The large bowlders, for the most part granite, found on this type were originally a part of the Archean rocks which underlie this section of the State. The soil is composed mainly of fine-grained quartz sand, together with considerable silt and clay.

The Miami stony loam is used almost entirely for grazing purposes, to which it is adapted. The bowlders are usually so large that it is impracticable to remove them from the fields. The greater part of the type is covered with a forest growth, principally of oak. Its value varies from \$15 to \$25 an acre.

The following table gives the average results of mechanical analyses of typical samples of fine earth of the soil and subsoil of the stony loam:

Mechanical analyses of Miami stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
13283, 13908.....	Soil.....	1.8	12.1	14.1	15.5	6.6	39.3	10.3
13284, 13909.....	Subsoil....	2.4	13.7	15.8	23.3	7.6	21.7	15.3

PORTAGE SILT LOAM.

The upper 8 or 10 inches of the Portage silt loam consist of a grayish colored silty loam, usually underlain by a mottled-gray and yellow heavy loam composed mainly of silt and clay. At a depth of about 25 inches a thin layer of sand, sandy loam, or sandy clay frequently occurs, grading quite abruptly into a heavy dark-red clay, which continues to a depth of 6 feet or more. In the northwestern part of T. 24 N., R. 6 E., and in the southwestern part of T. 25 N., R. 6 E., is a phase of this soil in which both the soil and the subsoil contain somewhat less clay. Here the heavy red clay frequently occurs at a depth of about 3 feet or even lower. A small area of this phase is also to be found in the western part of T. 23 N., R. 7 E. In this particular area the lower subsoil is quite sandy.

The Portage silt loam is found in the western part of the county, west and northwest from Stevens Point. For the most part the type is quite level, but some of the areas in the neighborhood of Junction are slightly rolling. Much of the Portage silt loam is rather poorly drained, and several marshy areas occur through the type. Considerable improvement could be made in this type by the digging of open ditches to connect with natural drainage ways. The more rolling phases of the type are, of course, better drained.

The materials composing this soil type are probably derived from three different sources. The red clay subsoil is derived from the underlying crystalline rocks; the sandy layer is glacial, and the surface covering of silty material is probably loessial.

The type is naturally productive, but for its highest efficiency requires deep and thorough cultivation. Green crops should be turned under not only for the purpose of increasing the organic matter content, but also to improve the physical condition of the soil. The Portage silt loam is well adapted to the growing of grass crops and small fruits, such as strawberries and raspberries. Vegetables also do well. Both corn and potatoes do better on the more rolling phases of the type. Hay produces from 2 to 2½ tons, corn about 20 bushels, oats from 40 to 50 bushels, rye about 25 bushels, and potatoes about 125 bushels to the acre. During favorable seasons wheat does fairly well and produces about 25 bushels to the acre. Peas produce from 20 to 30 bushels per acre.

The principal forest growth on the type is oak, maple, basswood, and elm. Land of this type has a value ranging from \$25 to \$50 an acre, depending upon improvements.

The following table gives the average results of mechanical analyses of samples of the Portage silt loam:

Mechanical analyses of Portage silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
13981, 13990, 13994.	Soil	1.0	4.9	3.5	4.1	5.5	57.8	23.0
13996.....	Subsoil .....	.9	16.9	20.1	28.4	5.4	11.6	16.4
13997.....	do .....	.6	6.5	7.5	14.1	5.6	25.0	40.4

In order to obtain an idea of the manurial requirements of this soil a large sample was collected about 1 mile southwest of Junction. In the field from which the sample was taken the soil has a depth of about 8 inches, and consists of a heavy brown silt loam containing some shale fragments. The subsoil is a silty clay, but considering its heavy texture the type has fair drainage. The field has been in cultivation over twenty years, cropped to grass, corn, oats, and barley. The yield of grain ranges medium to good, and of grass from 2 to 3 tons per acre of fine quality hay. Some stable manure is used, but no other fertilizer.

The wire-basket tests indicate that stable manure produces a fair increase in productiveness, and that lime has a slightly beneficial effect, while nitrate of soda, sulphate of potash, and acid phosphate, alone or in combination, have little or no effect. These results are held to be applicable only to the field from which the sample was taken. They are, however, in accord with the experience and practice of the community, and show the slight value of mineral fertilizers for general farm crops on a soil already in a high state of productiveness. Doubtless these indications will hold for considerable areas of this type in the vicinity, as the conditions of soil drainage and cultivation are apparently quite uniform.

PORTAGE SANDY LOAM.

The upper 8 or 9 inches of Portage sandy loam consist of a grayish-brown sandy loam of medium texture. Over the surface and through the soil are found varying quantities of small stones from 1 to 4 inches in diameter. The subsoil is generally a brownish-yellow sandy loam, which at a depth of from 20 to 25 inches usually grades into a sandy clay of mottled gray and yellow color. At a lower depth the sandy clay becomes redder in color and more compact.

This type occupies only 2 per cent of the area surveyed, and occurs in a number of small, irregular-shaped areas in the northwestern part of the county. The topography varies from gently rolling to nearly level. On the level areas the drainage is not good and considerable

improvement could be made by the digging of open ditches to connect with the natural drainage channels. Lower lying marshy or muck areas are often to be found near this type.

The lower subsoil of the Portage sandy loam is derived from the underlying crystalline rocks, principally granite of Archean age. The surface soil has its origin in the older glacial drift. The main constituent of the type is quartz sand. Only a short distance north of Stevens Point the sandy clay subsoil of this type is utilized for the manufacture of brick.

This soil is quite well adapted to the growing of general farm crops. Hay is the most important crop. Small fruits and vegetables do quite well. A large part of the type is not under cultivation. The yield of hay is from 1 to 1½ tons per acre, potatoes about 100 bushels, corn about 30 bushels, oats about 40 bushels, and rye from 10 to 15 bushels. Field peas are also grown with a yield of about 25 bushels to the acre.

The principal forest growth is oak, maple, basswood, and birch, with some elm and ash. The type has a valuation of about \$30 an acre.

The following table gives the average results of mechanical analyses of samples of the Portage sandy loam:

PORTAGE STONY SANDY LOAM.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
13279, 13942, 13944.	Soil	2.1	17.1	21.4	22.7	7.2	18.1	11.2
13280, 13943, 13945.	Subsoil	1.6	13.4	18.3	22.4	7.0	18.5	18.5

PORTAGE STONY SANDY LOAM.

The soil of the Portage stony sandy loam is a rather loose dark grayish-brown medium sandy loam, with a depth of from 8 to 10 inches. The underlying material is a yellowish-brown or gray sand of fine to medium texture. At a depth of from 30 to 36 inches a mottled yellow and gray sandy clay sometimes occurs. Borings in the type to a depth of 6 feet show that this sandy clay sometimes continues to a depth of 5½ feet, below which may be found a yellowish-brown sand. The sandy clay is sometimes of a bluish-gray color. Over the surface of this type are to be seen rather extensive outcrops of the underlying crystalline rocks, and a considerable number of boulders, principally of granite, occur throughout the soil and subsoil.

The type lies entirely in the northern part of the county, the largest area occurring between Wisconsin and Plover rivers. Its topography varies from generally level to gently rolling, the larger part of it being quite level. As a result of the level topography many wet and

swampy depressions occur over the type. These would seem to be very difficult of drainage.

The origin of this type of soil is probably both glacial and residual, principally the former. It is composed principally of quartz sand. The boulders and rock exposures are mostly granite.

Owing to the drainage conditions and to the quantity of stone, the Portage stony sandy loam is used for little else than pasturage. A large proportion of it supports a thick growth of oak, maple, and white birch, with a few scattering pines. The undergrowth in the poorly drained areas is mainly alder and willow. The valuation of the land of this type ranges from \$15 to \$25 per acre.

The following table gives the average results of mechanical analyses of samples of the fine earth of Portage stony sandy loam:

Mechanical analyses of Portage stony sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
13277, 13938.....	Soil.....	1.5	11.2	21.9	35.6	9.2	12.1	8.3
13278, 13939.....	Subsoil....	1.4	9.7	21.1	41.3	9.7	8.5	7.9

WABASH LOAM.

The Wabash loam is a stream-bottom type. The soil is a dark-brown somewhat heavy silty to sandy loam extending to a depth of about 10 inches. The subsoil is a dark yellowish-brown compact loam composed mainly of silt and fine sand. A dark yellowish-brown fine sand frequently occurs at a depth of about 25 inches, and fine gravel is sometimes found at a depth of about 3 feet. The type occurs only along the Wisconsin River and occupies a comparatively small area. It is quite level, in some places rather poorly drained, and is subject to overflow at least once in five years. But for this fact the Wabash loam would be a more desirable soil than it is at present. When the river is at its normal stage a large proportion of it is sufficiently well drained to produce good crops.

The soil type owes its origin to the recent deposition of material by the Wisconsin River during times of flood. It is naturally a very productive soil. While the occasional floods do great damage, at the same time they add fertilizing material to the soil and increase its crop-producing power. The Wabash loam seems to be best adapted to the growing of onions. Vegetables and small fruits also do well. Hay, corn, potatoes, oats, and rye are also grown. Hay is a good crop to grow on this soil, since it is not so likely to be injured by floods. Rye and oats, though grown to some extent, do not seem to be especially adapted to it, the straw being very rank and the grain

not maturing well. Under average conditions onions produce about 400 bushels to the acre. Hay produces from 1 to 1½ tons to the acre, corn about 35 bushels, and potatoes from 125 to 175 bushels. Oats produce about 40 bushels to the acre and rye about 18 bushels. This soil type has an average value of about \$30 an acre.

The following table gives the average results of mechanical analyses of samples of the Wabash loam:

Mechanical analyses of Wabash loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
13267, 13884, 13886.	Soil	0.3	2.9	8.7	18.7	14.6	32.4	22.1
13268, 13885, 13887.	Subsoil ....	.3	3.1	11.4	42.2	14.8	17.2	10.9

MUCK.

The organic matter, in varying stages of decomposition, accumulated in the lower lying areas constitutes the material which has been mapped as Muck in this area. For the most part the soil is a black Muck, composed of finely divided and quite thoroughly decomposed vegetable matter, varying in depth from 1 to 6 feet or more. Sometimes the decomposition has not progressed far enough to produce a true Muck, thus giving rise to a soil more of the nature of Peat. This, however, seems to be the exception. The subsoil is usually a dark-gray sand of medium texture, but may also be a dark-gray sandy clay.

Some areas of the Muck are to be found in the eastern part of the county within the limits of the terminal moraine. These areas are insignificant when compared with the areas found in the western half of the county. In the southwestern part of the county are swampy or marshy areas which in the aggregate cover very nearly 100 square miles. In the northwestern and northern parts of the county are extensive Muck areas. In many cases, as will be seen by reference to the soil map, this type of soil lies along stream courses.

The areas of Muck are uniformly level and consequently poorly drained. Both soil and subsoil are usually saturated with water or have water standing on the surface. Only a few instances have been noted in this county this season where it has been possible to walk over the Muck areas without encountering water. Owing to its undrained condition these areas are locally spoken of as "swamps" or "marshes." Artificial drainage is necessary before this type of soil can be utilized for general farming purposes. Drainage work is at present being carried on in the southwestern part of the county.

The greater part of these areas is covered with a thick growth of coarse grasses, while in some areas a coarse moss is found. Many parts of the areas are treeless, supporting no other vegetation than

the grasses, and still other areas are covered with a thick growth of poplar, willow, or tamarack. The latter is especially characteristic of the Muck areas in the northern part of the county, which are locally known as "tamarack swamps."

When thoroughly drained and brought under cultivation this soil should produce good crops of corn and potatoes. It is especially adapted to the growing of celery, onions, and cabbage. In other localities onions have been made to produce from 500 to 800 bushels to the acre on Muck soil. In both Michigan and Indiana peppermint is also a very successful crop for Muck. Even after drainage and cultivation the danger from frosts is considerably greater than on the upland soils. For this reason the Muck is better adapted to the growing of grass crops, since they require a great deal of water and are not affected by frost. Among the grasses which have been found to do well are timothy, redtop, and brome grass; alsike clover also thrives.

At present the Muck is utilized for little else than wild hay. In the spring of the year the areas are usually very wet, but during a part of July and August they are dry enough to allow the hay to be cut, though it can not be hauled away until late in the fall or early in winter, after the soil is frozen. The average yield is from 1 to 1½ tons to the acre. At present this type of soil is worth from \$3 to \$8 an acre.

In order to study the manurial requirements of this soil a sample was collected from the Portage County drainage district tract and an examination made by the wire-basket method. The results obtained indicate that this soil responds favorably to all the fertilizers which were tried. Manure or acid phosphate alone or in combination with sulphate of potash resulted in a marked improvement in productiveness. Sulphate of potash alone or in combination with nitrate of soda or with lime gave a fair increase, while an increase equally good was secured by mixing equal parts of the marsh soil and poor Cecil clay. Lime alone or nitrate of soda alone gave a small increase.

In these tests wheat plants were used as an indicator, and the results are not held to be applicable to other and unrelated crops.

RECLAMATION OF SWAMP LANDS.

In the southeastern part of the county is an extensive marshy muck area, occurring, as will be seen by reference to the soil map, in one large area and locally known as "Buena Vista Marsh." Through it are some smaller higher-lying areas of Miami sand.

Arrangements have been made, and are now being carried out, to drain the main part of this marsh. A district known as the "Portage County Drainage District," including about 55,000 acres, has

been established within the area. The plan at present is to drain the area by the digging of six main ditches and three laterals, which are to carry the water westward into Ten Mile and Buena Vista creeks. Each of these creeks flows from the swampy area westward into the Wisconsin River. Five of the main ditches are planned to run almost parallel with each other east and west, and are to be from $1\frac{1}{2}$ to 2 miles apart. The two main ditches to the south, with two laterals, are to empty into Ten Mile Creek, while the four main ditches to the north, with one lateral, are to empty into Buena Vista Creek. The average fall is about 3 feet to the mile. Each ditch is to be about 30 feet wide and about $6\frac{1}{2}$ feet deep, with a slope of the sides of 1 to 1.

The landowners within the district are taxed to meet the expense of drainage. In order to determine the taxable valuation of each piece of land, a very careful survey of the area was necessary. In this survey three classes of land were established within the district, called "low marsh," "high marsh," and "hard land." The amount of water is greater over the "low marsh" than over the "high marsh" lands. Otherwise there seems to be little difference in the character of the soil and subsoil. "Hard land" includes areas of other types occurring within or around the edge of the Muck area where it comes in contact with other soil types, principally the Miami sand. The "low marsh" has been taken as a basis for taxation. It was assumed that "high marsh" would be benefited less by drainage than "low marsh," and "hard land" less than "high marsh." Accordingly 100 acres of "high marsh" was counted equivalent to 75 acres of "low marsh," and 100 acres of "hard land" equal to 25 acres of "low marsh." In this manner it was possible to determine readily the amount of taxes due from each landowner. The work of draining will probably be completed in about two years. The lands will be improved as rapidly as possible after the work of draining has been completed.

West of the town of Plover, close to the Wisconsin River, is a comparatively small Muck area known as the "Crooked Rift Marsh." Drainage work is also being done in this area. Only one ditch is being dug.

In the extreme northwestern corner of Portage County, bordering and to the south of Eau Pleine River, is still another mucky area, a part of what is locally spoken of as the "Dancy District." Plans have been made to carry out drainage work on this area, but up to the present time very little has been accomplished, and no actual drainage work has been done.

AGRICULTURAL METHODS.

The potato is the principal money crop of the area, and in a large measure crop methods are adapted to its production. For this crop

the land is plowed about June 1 to a depth of about 7 inches. It is then dragged and marked in check rows about 3 feet apart. Planting is done either with a hand or a horse planter. By the use of the hand planter from 2 to 3 acres can be planted in a day. On some of the larger farms where a planter operated by horsepower is used from 7 to 8 acres can be planted in a day. It is a difficult matter, however, to plant in check rows with this implement. As soon as the potato plants begin to show above the ground the field is harrowed thoroughly, which serves to rid it of small weeds and at the same time loosens the soil. As soon as it is possible to follow the rows cultivation is begun, for which purpose the sulky cultivator is generally used. The crop is cultivated from 3 to 4 times during the season, and little or no hoeing is done. For ridding the vines of potato bugs both large sprayers, operated by horsepower, and small hand sprayers are used. In some cases the larger implements work very successfully, but in general the hand sprayers seem to give the most satisfactory results. The potatoes are mostly dug during September. For this purpose a potato digger, of which there are several kinds, is generally used. With one of these implements from 3 to 5 acres can be dug in a day. The principal varieties raised are Burbank, Hebron, Rural New Yorker, Peerless, Early Ohio, and Triumph, the last named being sold mostly for southern seed. In many cases the crop is hauled directly from the field to the local market, where it is either stored or sold. Arrangements are usually made for storing at a certain rate per pushel, depending somewhat on the length of time of storage. Farmers living at a distance from local markets store their potatoes at home, either in pits in the field or in storehouses constructed for the purpose. At every railroad station are to be found one or more potato buyers. Most of the potatoes produced in this area are shipped to the Central and Eastern States.

Corn is generally planted during the latter part of the month of May. The rows are placed about $3\frac{1}{2}$ feet apart. Some farmers plant in drills, but the majority plant in check rows, so that the corn can be cultivated both ways. In planting, either a hand planter or a horse planter is used. With the former about 6 acres can be planted in a day, and with the latter from 12 to 15 acres in a day. Just before the corn comes up it is a common practice to harrow the field at least twice for the purpose of getting rid of the weeds and loosening the soil. The best farmers consider the work of harrowing at this time very important. From this time on the field is usually cultivated four times, and little or no hoeing is done. The corn is cut during the latter part of August or the fore part of September. A great many farmers use corn binders for doing this work, with which from 7 to 10 acres can be cut in a day. Many, however, still use the old-fashioned corn knife, while a few use what is locally called a "stone-boat" corneutter. This is a low wooden frame, on each side of

which is attached a long, sharp blade, so placed as to strike the stalk at an angle. The frame is drawn by a horse between two rows, each knife cutting one row of corn. With it two men can cut about 4 acres of corn in a day. Quite a number of farmers throughout the area own corn huskers or shredders.

For oats the plowing is done in the fall. The seed is generally sown during the latter part of April, the earlier the better, since the early oats seem less likely to be affected by rust. The crop is harvested in the early part of August.

On both the Marshall sand and the Miami sand considerable care must be exercised in preparing the soil for the sowing of small grains, not to work it into such a fine condition that it will be easily blown about by the wind. Where care is not taken in this regard the surface soil is often so shifted as to uncover a large part of the seed sown.

While no well-defined system of crop rotation seems to be generally practiced throughout the area, the methods of handling the soil are fairly good. The crops grown on a given field are alternated and from time to time the field is seeded to grass. Among the better class of farmers, however, some definite rotation system is generally used. Quite commonly it is as follows: (1) Corn or potatoes; (2) small grain (wheat, oats, or rye); (3) timothy and clover; (4) pasture. For the following year's crop the sod is top dressed with barnyard manure and plowed under for corn or potatoes. Very little commercial fertilizer is used. A considerable quantity of hay, grown in the western part of the county, is sold at Stevens Point. Some is baled and shipped out of the country. The grain produced throughout the county is, for the most part, fed to stock.

AGRICULTURAL CONDITIONS.

Taken as a whole, the farmers of the county are in a fairly prosperous condition. In many parts of the area the farmhouses are well built and well cared for. The same is true of the barns, which are often large enough to afford room both for storing the crops and housing the stock during the winter months. Within recent years the county has developed rapidly and property has increased considerably in value. In the year 1890 the total assessed value of all real estate and personal property was \$3,039,362, as shown by the county records. For the year of 1904 it was \$11,759,221. In this year property was assessed for its full value, while in 1890 it was assessed for only one-third of its value. Thus the increase in the total value of real estate and personal property within the period of fourteen years was \$2,641,135. According to the census of 1900 the number of acres in farms in this county was 393,857, of which 189,396 acres were improved. The average valuation per farm, including

land, buildings, live stock, and domestic animals, was about \$3,000. The price of land, with the exception of marsh or muck, generally varies from \$20 to \$50 an acre, and in some cases is said to be as high as \$75 an acre. The Muck areas are at present worth from about \$3 to \$8 an acre. The average value of upland still covered with forest growth is probably about \$20 an acre.

About 15 per cent of the farms are worked by tenants, the greater part of whom rent on a share basis. If the tenant furnishes team, seed, and tools he usually has two-thirds of the crop, but if the owner furnishes team, seed, and tools, each has one-half the crop. Land rents on a cash basis for from \$1.50 to \$3 an acre. The average sized farm is about 124 acres, but the farms vary in size from 40 to 400 acres. About nine out of ten farms are operated by the owners.

The farm laborers are all white, and, as a rule, can be had in sufficient numbers at a monthly wage of \$18 to \$25. In the northeastern part of the county the only laborers to be had are Poles, many of whom are not skilled in farm work. The amount which the average farmer pays out annually for hired help is comparatively small. The use of improved machinery has in many cases made it possible for the farmer to do without other help than that of his own family, except during the busiest season of the year. During the thrashing season or potato-digging time all the help needed can generally be had at \$1.50 a day.

The potato is the principal product of the area. The industry of growing this crop for shipping purposes has developed almost entirely within the last two decades. Formerly wheat and hops, especially the latter, were much more important crops than they are at the present time. In the year 1885 the production of potatoes was 382,091 bushels, wheat 175,744 bushels, and hops 155,367 pounds. During the season of 1904 the production of potatoes was 2,993,885 bushels, wheat 11,568 bushels, and hops 12,100 pounds. Portage County leads all the other counties in the State in the production of potatoes.

The greater part of the farms are devoted to general farming, and comparatively little trucking or market gardening is done. The principal crops other than potatoes are hay, corn, rye, and oats. Some wheat, barley, and hops, with some cabbage, turnips, and onions, are also grown. Small fruits, such as raspberries and blackberries, grow very well in many parts of the county. The apple is about the only tree fruit which is grown in the area, and it does not thrive on most of the soils, as they are too sandy. Hay is an important crop. During most seasons a great many tons are cut from the marshes, besides that produced on the upland soils.

Another important agricultural industry in the county is dairying. Nearly every farm has a small herd of dairy cattle. There are about twenty creameries in the county and one or two cheese factories, most

of them having been established within the last ten or twelve years. As a rule the farmers who patronize them are well pleased with the returns. In many cases the farmer separates the cream from the milk at home by use of a hand separator. According to the dairy statistics submitted to the county board in December, 1904, the number of cows contributory to the creameries was 8,285, and the amount of money received from the sale of creamery products during the year was \$276,571.61, or \$38.38 to the cow.

Of the twelve types of soil found in Portage County the Miami sand is probably the least productive, owing to its droughty nature. The potato is the crop to which the type is best adapted, and when careful attention is given to manuring and rotation, fair yields may be obtained. In order to prevent a decline in productivity in this soil, it is necessary to pay special attention to the sowing of such crops as clover or peas, and to manuring.

The Miami sandy loam is only a fairly productive soil. A large proportion of this type also requires careful attention as regards fertilizing and crop rotation. Where the subsoil is a sandy clay the yields are usually good. The crop to which the type is best adapted is the potato.

The Miami stony sand, owing to the large number of bowlders found over the surface and through the soil and to its rough topography, is used for little else than pasture, for which purpose it is well suited. Where cultivated the yields are about equal to those of the Miami sand.

The Marshall sand is one of the most level types occurring in the area. The ease with which it can be worked is one of its good features. It is not considered a strong type, yet it often produces good yields of potatoes. The texture of this type is quite similar to that of the Miami sand, and like the Miami sand its productiveness is maintained by the sowing of such crops as clover and by the application of stable manure.

The Miami loam is one of the best soils in the area for general farming purposes, and some of the best farms of the county occur on it. Apple trees grown on this type seem to do better than on any other type in the county. Small fruits, such as strawberries and raspberries also do well.

The Marshall gravelly loam is usually quite level in its topography, is a productive soil, and one well adapted to general farming. This is the type of soil on which the greater proportion of the hops now produced in the county are planted, and it would seem to be well adapted to the growing of a fine quality of this crop.

The Miami stony loam, like the Miami stony sand, is used mostly for pasturage, because of the bowlders strewn over the surface. If it

were possible to remove the bowlders from the surface some parts of this type would make valuable farming land.

The Portage silt loam is the heaviest soil type occurring in the area. It is especially adapted to the growing of grass crops and for this reason is an important dairy soil. The more rolling areas of the type are well adapted to general farming, and good yields of corn, potatoes, and oats are reported. Small fruits, such as strawberries and raspberries, grow well. Apples do fairly well.

Hay, corn, potatoes, and oats are the principal crops grown on the Portage sandy loam. Of these the hay crop is the most important. Careful attention should be given to drainage and thorough cultivation on this type.

Owing to the amount of stone found on the surface and to the wet or swampy depressions occurring over it, the Portage stony sandy loam is best used for pasturage.

The Wabash loam is mellow and easily worked, and is well adapted to gardening or light farming. It is best adapted to the growing of onions. Hay, potatoes, corn, and cabbage also grow well on the type.

The Muck is at present used for little else than for the hay taken from it during the driest part of the summer. When drained it will be a valuable soil for onions, celery, cabbage, peppermint, and many other crops.

The transportation facilities of the area are very good. Four important railway lines pass through the county and give quick communication with all the large city markets. In only a few parts of the county is the distance to a railroad station over 10 miles.

Some of the wagon roads in the area are very sandy, but taken as a whole the roads are fairly good. The only roads built of crushed rock are those leading out a short distance from Stevens Point. There is abundant material to be had very cheaply for the building of gravel roads. Through the muck areas the roads are generally quite poor.

The most important market for this section is Chicago. Stevens Point, a city of about 9,000 inhabitants, is the chief local market of the area. At several different points along the railroads are stations from all of which a great deal of farm produce is shipped. At nearly every one of these are to be seen warehouses for the storing of produce, principally potatoes.

The county is well supplied with schools. The small country schoolhouses are substantially built of wood or stone. Each of the smaller places throughout the area is supplied with good schools. At Stevens Point are located a State normal school and a high school.

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