

Issued October 20, 1909.

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

SOIL SURVEY OF WEXFORD COUNTY, MICHIGAN.

BY

W. J. GEIB.

[Advance Sheets—Field Operations of the Bureau of Soils, 1908.]



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1909.

[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., May 27, 1909.

SIR: One of the projects undertaken by the Soil Survey in the field season of 1908 was the survey of Wexford County, Mich. This county lies in the northwestern part of the southern peninsula in the region which was formerly covered with forests of pine and hardwood. Almost all of the pine and much of the hardwood forests have been removed and agriculture is being extended over these areas. It is believed that a classification of the soils will be of assistance in enabling their proper utilization by intended settlers as well as by the farmers who are already residents of the county and of contiguous regions which have the same general character of soil. The soils are for the most part light in texture and probably better adapted to some form of special farming than to the extensive growing of grain, although a part of the soil has been used with fair success in general farming. The attention of the Bureau was called to the need for work in this part of Michigan by President Snyder, of the Michigan College of Agriculture, and the request for the work bore the indorsement of the Hon. James C. McLaughlin, Representative in Congress for the district within which Wexford County is included.

I have the honor to transmit herewith the report and map covering this work and to recommend that they be published as advance sheets of Field Operations of the Bureau of Soils for 1908, as authorized by law.

Very respectfully,

MILTON WHITNEY,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

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MAP.

Soil map, Wexford County sheet, Michigan.

SOIL SURVEY OF WEXFORD COUNTY, MICHIGAN.

By W. J. GEIB.

DESCRIPTION OF THE AREA.

Wexford County lies in the northwestern part of the southern peninsula of Michigan and is bounded on the north by Grand Traverse County, on the east by Missaukee, on the south by Lake and

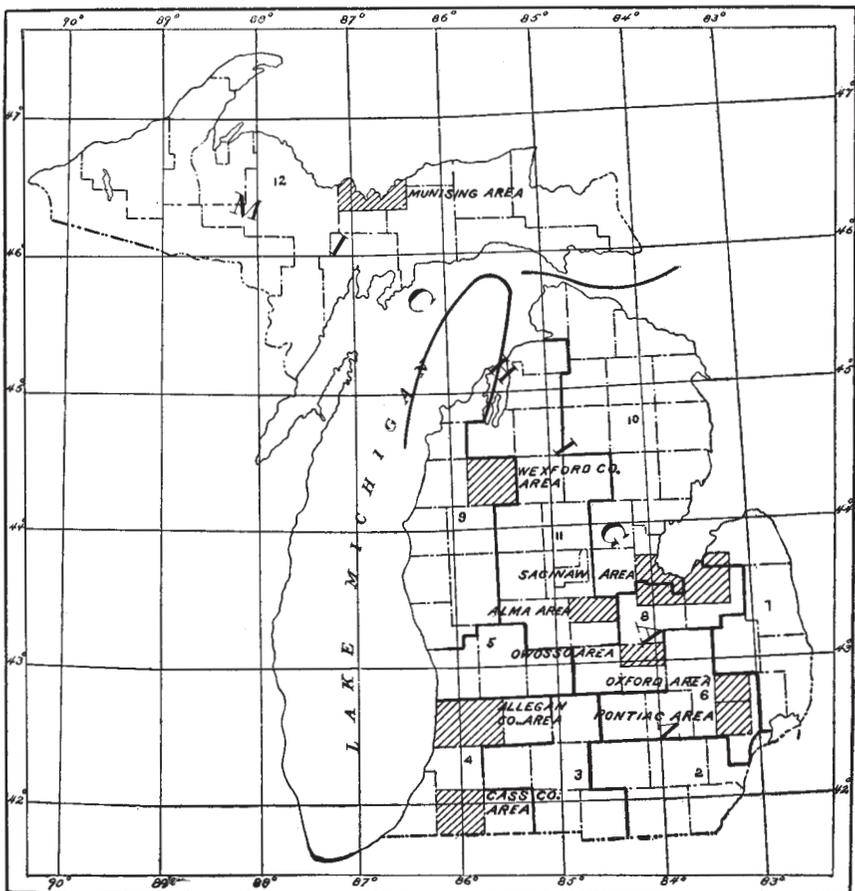


FIG. 1.—Sketch map showing location of the Wexford County area, Michigan.

Osceola counties, and on the west by Manistee County. The county is rectangular in shape, measuring 24 miles on each side. It is composed of 16 townships having a total area of 366,272 acres, or about 572 square miles.

The surface features of the county are characteristic of a glacial region. The topography generally varies from level to gently rolling, though there are considerable areas of broken and hilly land. Bluffs ranging from 50 to 200 feet in height are found along the Manistee River, the highest occurring in Springville, Wexford, and Hanover townships. Broken and hilly sections are found in the eastern and southern parts of Cedar Creek Township, the northern and eastern parts of Haring, the northern part of Selma, the northern and western parts of Boon, the eastern part of Slagle, the central part of Henderson, and the eastern part of Clam Lake townships. The roughest part of the county is north of Harriette in Springville and Antioch townships. The elevation of Black Briar Hill is about 300 feet above the general level of the county. An extensive level area lies directly north of Cadillac and extends through central and southern Selma, part of Boon and Henderson, and the greater part of Cherry Grove townships. The northeastern corner of Wexford Township is level, as is also a large strip along the Manistee River in Greenwood and Liberty townships. Through this level or undulating country the river has cut a deep channel. The streams, the hills—though they do not occur in continuous ranges—and the soil types have a tendency to follow lines parallel with the course of the glacier which traversed this region in a northeast-southwest direction.

The drainage of the county is into the Manistee and Muskegon rivers. The Manistee River crosses the area from northeast to southwest. It enters the northeast corner of Liberty Township and leaves the county in the southwest corner of Springville Township. The northern half of the county drains directly into this river through small branches. The southwest corner is traversed by the South Branch of the Manistee River, which unites with the latter in Manistee County. The southeast quarter of the county drains into Lake Mitchell and Lake Cadillac, thence through Clam River into the Muskegon River in Clare County. Both the Manistee River and the South Branch have sufficient fall to afford valuable water power, but at present no use is made of this within Wexford County.

The first settlement was made in Wexford Township in 1863. The county was organized in 1869, being formed from a part of Manistee County. As first organized it included territory which was later cut off to form Missaukee County. Many of the residents are from Norway, Sweden, and Germany. Within the last few years Ohio, Indiana, Illinois, and southern Michigan have contributed to the inflow of settlers. The population in 1870 was 670, in 1880, 6,815, in 1890, 11,218, in 1900, 16,845. Slagle, Boon, South Branch, Henderson, Liberty, and Greenwood townships are the most thinly settled

and the least developed portions of the county. The population throughout the remainder of the county is quite evenly distributed.

Cadillac, the county seat, was incorporated in 1877 and was formerly called Clam Lake. It has a population of about 9,000, is the chief town of the county, and is probably the leading business place in northern Michigan. It is located in the southeastern portion of Wexford County, at the junction of the Grand Rapids and Indiana and the Ann Arbor railroads, and is 97 miles due north of Grand Rapids, Mich. It has all modern improvements and is the site of a number of manufacturing plants. Cadillac has always been a great lumber center, but at present agriculture is coming to the front, and the city is becoming a distributing point for all agricultural supplies and a market for all the farm products. Manton, with a population of about 900, is a thriving town in the northeastern part of the county in Cedar Creek Township. It is surrounded by good farming land and ships considerable quantities of farm produce. Gilbert, Yuma, Harriette, Mesick, Sherman, and Buckley are towns of less importance.

Wexford County is well supplied with railroads. The Grand Rapids and Indiana, built in 1870, crosses the eastern side of the county from north to south and the Ann Arbor from southeast to northwest. The Manistee and Northeastern traverses the northwest corner of the county.

The wagon roads are naturally sandy, but there is plenty of gravel in the county with which to make improvements. Many miles of road are graveled, and more work of this character is being done each year.

Cadillac and the small towns throughout the county afford a limited market for farm produce. The bulk of the potato crop is shipped to Southern States. Produce buyers are located in the various towns during the shipping season.

CLIMATE.

The following table, compiled from the records of the Weather Bureau station located at Ivan, in Kalkaska County, shows the normal monthly and annual temperature and precipitation, the absolute maximum and minimum temperature and precipitation, and total precipitation for the wettest and driest years.

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

Month.	Temperature.			Precipitation.			
	Mean.	Absolute max-imum.	Absolute min-imum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	24	54	-16	2.7	3.0	3.6	15.2
January	20	47	-19	2.6	3.1	5.0	28.0
February	18	54	-30	1.8	1.4	2.6	16.8
Winter	21			7.1	7.5	11.2	60.0
March	27	71	-23	2.0	.9	3.1	12.5
April	42	88	0	2.2	1.6	1.9	2.4
May	53	94	14	2.9	4.2	3.3	1.4
Spring	41			7.1	6.7	8.3	16.3
June	64	100	28	3.1	1.5	3.8	.0
July	68	98	32	2.7	.3	.4	.0
August	65	103	33	3.3	2.3	4.9	.0
Summer	66			9.1	4.1	9.1	.0
September	58	95	25	3.3	3.5	2.1	.1
October	46	85	12	2.9	2.2	5.8	1.6
November	33	68	4	2.9	2.4	2.0	13.0
Fall	46			9.1	8.1	9.9	14.7
Year	43	103	-30	32.4	26.4	38.5	91.0

The average date of last killing frost in spring is May 23, and of the first in the fall September 14.

The records of the Ivan station were selected because they cover a longer period and give more complete data than could be obtained within the area. Ivan is about 10 miles distant from the extreme northeast corner of Wexford County and has similar climatic conditions.

It will be seen that the absolute range of temperature is 133° F., with a mean annual temperature of 43° F. The highest recorded temperature is 103° F., while the lowest is -30° F. The mean annual precipitation is 32.4 inches; the total amount for the wettest year is 38.5 inches and for the driest year 26.4 inches. The average annual snowfall is given as 91 inches. The rainfall is fairly well distributed throughout the year, July being the driest month. Long continued droughts seldom occur. The drought of the present season, 1908, was the most severe in fifteen years. While the winters are cold, the temperature is uniform. The snowfall in December usually remains on the ground until in March or the early part of April. The climate during summer and fall is delightful.

The average date of the last killing frost in spring is May 23, and of the first in fall is September 14, giving a growing season of one hundred and thirteen days for the tenderest crops.

AGRICULTURE.

The first farms in Wexford County were cleared in Wexford Township in 1863, but until about 1890 agriculture was of only secondary importance. Lumbering was then and had been for many years the leading industry. The annual output of the Wexford County mills at the present time is over 100,000,000 feet. During the early history of the county land could be purchased from the Government for \$1.25 an acre. The timber at that time had little value and was considered by many a hindrance to the advance of agriculture.

The entire county was originally timbered. The hardwood areas are more extensive than the pine, covering about 69 per cent of the county. The original hardwood growth was maple, beech, and elm, with a scattering of hemlock. The pine forests consisted mainly of Norway and white pine, with a very small proportion of jack pine. The land supporting these pine forests covers about 28 per cent of the county. The remainder consists of lakes and swamps which support a growth of spruce, white cedar, tamarack, and ash.

The first pine was cut in 1869-70. Not until the pine was nearly exhausted was much attention paid to the hardwood. The coming of the railroad about this time (1870) greatly stimulated the lumbering industry. The first operations in the hardwood began about 1888 and have since continued. There are still thousands of acres of virgin hardwood, though it is being rapidly cut off.

After the pine was cut, much of the land, being considered worthless, was allowed to revert to the State. However, there is no public land in the area at present, as it has been bought by individuals and land companies.

The earliest settlers were homesteaders, and the farm lands were selected from the hardwood tracts. Clearing the land was difficult. The trees were cut into logs, rolled into piles and burned, and the soil only slightly scratched before the crops were planted. As hardwood stumps decay quite rapidly, it was not many years until a few cleared farms were scattered throughout the northeastern part of the county. The first crops were potatoes, corn, oats, and enough garden truck for family use. Settlement on the farms was at first slow, and has never been rapid, but in late years it has been steady. This was at first a lumberman's country, but as the forests dwindled a lumberman would occasionally settle on a small tract. During the summer he would grow some crops on the partially cleared land and in the winter he would return to the woods. This custom still continues to some extent. Little success, however, could be expected on farms managed in this way. If the farm supplied the needs of the family during the summer that was thought sufficient, as work in the woods was sure to provide for the winter months. Where settlers were economical and

industrious success has been attained, as is evidenced by a few good farmhouses and substantial barns in each community.

Up to the present time settlement has been mainly on the hardwood land. Thousands of acres of this land cleared of timber can be bought from \$5 to \$15 an acre. The pine stump land is more difficult to clear than the hardwood land. If the land is allowed to lie a few years after the removal of the timber before attempting to remove the stumps it is more easily cleared, as the dry stumps are readily burned.

The present methods of farming are much better than those previously followed, though there is still considerable room for improvement in regard to seed selection, rotation of crops, and building up and maintaining the soil fertility.

In the cultivation of sandy soil, such as forms 97.5 per cent of the area of the county, it is advisable to plow shallow. On the Pine plains and Pine hill phases of the Miami sand a depth of 4 inches is sufficient, while on the Hardwood land phase the soil can be plowed perhaps 2 inches deeper. The reason for shallow plowing is that the amount of organic matter is limited to the first 2 or 3 inches; sometimes it is almost entirely lacking. If the land is plowed, say, 8 inches deep, all of this vegetable matter is buried, so that the young plants are not fed by it and do not get the thrifty start they should have. As a rule there is more organic matter in the Hardwood land phase, and therefore it can be plowed deeper than the pine land.

When land is cleared in the spring it is best not to plow until midsummer, since by that time there will be a good growth of weeds, grass, and other vegetation which when turned under will add considerable vegetable matter to the soil. The roller should be used freely to pack the soil, though it is advisable to follow the roller with a light harrow to make a surface mulch. This not only prevents evaporation and thus retains the soil moisture for the use of crops, but it also leaves the surface of the field slightly roughened and this reduces drifting and blowing out of the seed.

The chief money crop of the area is potatoes. In 1903 there were 5,426 acres planted to potatoes and a yield of 584,509 bushels was secured. The soil is well adapted to this crop, and where special attention is given to its cultivation exceptional yields are obtained. Occasionally a man will be found who has paid for his farm from the first crop of potatoes. The average annual shipment of potatoes from Cadillac is 450 cars of 650 bushels each. Potatoes are also shipped from other points in the area.

Corn is not especially adapted to the soil and climatic conditions. Both the dent and the flint varieties are grown and mature. Special attention should be given to developing a strain better adapted to existing conditions. In 1903 the acreage planted to corn was 6,093 acres with a yield of 137,354 bushels.

Oats are grown to some extent, but the soil is too light to give the best yields. The same is true of wheat. In 1903, 5,101 acres were in oats and 3,298 acres in wheat, yielding 142,093 and 46,630 bushels, respectively.

Some rye and buckwheat are also produced. These crops do very well and are frequently grown as green manuring crops.

A stand of clover can usually be secured without difficulty. It is best to seed in the spring without a nurse crop.^a In 1903, 5,560 acres were in clover, the yield averaging more than 1 ton per acre. The acreage of timothy was 9,175 acres, with a slightly lower yield. Alfalfa will grow here, and a few plants were found which had matured seed. It withstands the winter fairly well, being protected by deep snow. It is probable that a strain could be developed which would flourish in this region.

Cucumbers have been grown to some extent and when properly cultivated the yields are satisfactory. There are several pickle factories in the county.

Beans and pease are grown with fair success. Truck crops, such as cabbage, tomatoes, onions, beets, strawberries, and melons, are produced, but the supply does not equal the local demand.

The fruit industry has not been developed to any extent, but it has been demonstrated that the hardy varieties of apples, pears, grapes, and cherries will do well. Their color and quality are good. Peaches are not a success, as Lake Michigan, which is about 24 miles distant from the extreme western part of the county, does not modify the climatic conditions to a noticeable degree.

No definite system of crop rotation is followed. It is customary to plant potatoes on new ground for one or two years, and to follow this crop with corn. The land may then be seeded down and hay cut for one or two years, and after the sod is plowed potatoes are usually planted again. Fall wheat or oats may follow corn. Seeding is sometimes done at the time the oats are sown or the grass may be sown without a nurse crop. In old fields, where the yields have declined, rye and buckwheat are occasionally plowed under before planting potatoes.

Comparatively little live stock is kept. Cattle are allowed to range through the woods and cut-over lands. There are a few thoroughbred cattle, but most of the stock is of mixed blood. The dairy industry could be readily extended by making greater use of soiling crops and growing more ensilage. There are only a very few silos at present. A few sheep are kept, but the number could be increased, as there are large ranges over which they could feed. Each farm has a few hogs, but they are not raised extensively.

^a Farmers Bulletin No. 323, U. S. Dept. Agr.

Little difficulty is experienced in securing farm labor. Laborers get from \$20 to \$25 a month, with board, or from \$1 to \$1.50 a day during potato digging or harvest time. Many who work in the woods in winter go to the farms in summer. The wage in the mills is from \$1.75 to \$1.85 a day for ordinary labor, and in the woods from \$26 to \$28 a month, with board.

The Michigan census for 1904 states that there were 1,475 farms in the county, 91 per cent of which were operated by the owners, and the number is annually increasing. The average size of a farm is about 80 acres. The little renting done is on shares, the tenant furnishing everything and taking two-thirds of the crop. However, the ownership of land is easily acquired. Farms may be purchased on installments, and when a stipulated amount has been paid a deed is given and a mortgage taken for the balance due. Hardwood stump land brings from \$5 to \$15 an acre. When partially improved it sometimes sells as high as \$40, depending, of course, on the location. Pine stump land can be bought from \$2.50 to \$10 an acre.

As means to improve the general agricultural conditions of the county, it is suggested that more live stock should be kept, dairying increased, and soiling practiced to a greater extent. The soil and climatic conditions seem well adapted to the production of clover seed, which may be grown upon new lands that would not bring profitable yields of the grains or potatoes, the land improving from year to year and finally becoming well suited to general farming. It is recommended that the plowing under of green manuring crops, such as clover, rye, and buckwheat, should be more generally followed and that a systematic crop rotation should be substituted for the present irregular succession of crops. More attention given to seed selection will also improve conditions. It will also pay to give the crops more careful cultivation than at present. It is believed that the production of apples, pears, and grapes could be extended with profit.

SOILS.

The soils of Wexford County are derived from the mantle of glacial débris which covers to a great depth the southern peninsula of Michigan. While this material has been modified to a greater or less extent by erosion, by the action of wind, and by the growth and decay of vegetation, the surface material giving rise to the soil types is much more uniform throughout this county than in many other sections of the State. The underlying rocks have been covered to a depth of from 100 to several hundred feet and have had no influence whatever on the formation of the surface soils. The glacial material, which was originally derived from the breaking down of metamorphic and igneous rocks, was transported long distances by

the glacier and deposited as ranges of hills, rolling areas, or level stretches of land.

With the exception of a few square miles, the soil of Wexford County consists of one type—the Miami sand, an important member of the Miami series, which embraces the upland timbered regions of Michigan, Wisconsin, Ohio, Indiana, Illinois, Iowa, and Minnesota. As found in Wexford County this soil occurs in three phases. The Clyde series, a group of soils found in old lake beds and reclaimed swamps, is represented in the county by one type, the Clyde clay loam, of which there is less than one-half square mile. There is about four times this area of Dunkirk clay loam and a much larger though relatively small area of Muck.

The following table gives the actual and relative extent of the soil types mapped in the Wexford County area :

Areas of the different soils.

Soil.	Acres.	Per cent.
Miami sand	357,120	97.5
Muck	7,744	2.1
Dunkirk clay loam	1,152	.3
Clyde clay loam	256	.1
Total	366,272	.....

MIAMI SAND.

Hardwood land phase.—The soil of this phase of the Miami sand to an average depth of 6 inches consists of a brown or grayish slightly loamy sand of medium texture. The amount of organic matter present varies considerably, the larger proportion being usually found in fields which have been under cultivation for a number of years and in which crops of rye or clover have been frequently turned under. In some areas of virgin soil leaf mold has added a relatively large quantity of organic matter to the soil, but its occurrence is not uniform, as forest fires from year to year burn off the leaves and grass, leaving only a little ash to be incorporated with the soil. As a rule, the amount of fine material and organic matter present is small, and the soil is loose, open, and very easy to cultivate.

The subsoil to a depth of 36 inches, and often to a depth of 4 to 8 feet, consists of a dark-brown or yellow sand, which becomes lighter in color as the depth increases. There is a smaller percentage of fine material in the subsoil than in the soil. On the surface, and mixed with both soil and subsoil, there is a small percentage of glacial gravel. In many places gravel beds are found within 3 feet of the surface, usually occurring in small knolls or on the sides of hills. Some stones and a few boulders are scattered over the surface, but

not in sufficient numbers to interfere with cultivation. The only section in which stones occur to any considerable extent is in the southeastern corner of the county, in the eastern half of Clam Lake Township. This area has been indicated on the soil map by means of symbols.

At frequent intervals throughout this soil small areas of clay outcrop or lie close to the surface. These areas are often only a few rods in extent, but where large enough they are mapped as Dunkirk clay loam. In other places the fine material from the underlying clay seems to have become mixed with the overlying soil, which gives it more compactness and sufficient coherency to stand up in road cuts. In such places the soil is more retentive of moisture and slightly more productive, but as the areas of this character are comparatively small no attempt was made to show them as a distinct type.

The Miami sand (Hardwood land phase) covers by far the greater part of Wexford County. The largest continuous area comprises most of Colfax, Selma, Boon, Antioch, Springville, and Wexford townships.

The surface varies from level to broken and hilly, the major portion being gently rolling. An extensive level strip is found in the vicinity of Yuma and extending to the south. The northeast portion of Wexford Township is also level. Other smaller stretches of level land are scattered throughout the type. The roughest area lies between Harriette and Mesick, in Springville and Antioch townships. A very pronounced range of bluffs extends along the north bank of the Manistee River across Springville and the southeast corner of Wexford townships. Other broken areas are also found throughout the county.

Owing to the character of the topography and the loose, open nature of the soil and subsoil, the natural drainage is good and only in a few depressed areas is artificial drainage necessary.

The material composing the Miami sand in its several phases is glacial débris, though the texture of the Hardwood land phase is more uniform than is usually the case with glacial deposits.

The original forest growth consisted of maple, beech, elm, ash, and hemlock, with white cedar, spruce, and tamarack in the swampy depressions. The larger portion of this phase has been cut over, though large tracts of virgin forest still remain. The most extensive forest now remaining occupies the southern half of Antioch Township. By far the greatest proportion of soil under cultivation in the county is of this phase, though large areas are still in the "slashing" stage. This land is being quite rapidly cleared, and each year new farms are opened up and put under cultivation.

The field crops grown at present are potatoes, corn, oats, wheat, rye, buckwheat, beans, pease, and clover, with cabbage, tomatoes, root

crops, and strawberries as garden crops. Potatoes are the money crop, the soil being well adapted to their growth. Yields range from 100 to 300 bushels per acre, with an average of about 150 bushels. Corn, while grown to considerable extent, is not as successful as in the southern part of the State. Both dent and flint varieties are grown. Late spring and early fall frosts sometimes damage the crop, and special attention should be given to developing varieties better suited to the short season. The yields range from 20 to 45 bushels per acre. The soil is light for oats and wheat, but both are grown, the former yielding from 25 to 40 bushels and the latter from 12 to 22 bushels per acre. Rye and buckwheat do very well, as do also beans and pease. Clover is a valuable crop, producing from 1 to 1½ tons of hay per acre. It also gives good yields of seed and should be grown for this purpose, as the crop finds ready sale at good prices. Alfalfa, while not grown to any extent at present, will yield fairly well if given proper care. In Selma Township some alfalfa was seen which had gone to seed. The plants were thrifty and the seed well developed. It is very seldom that alfalfa will seed in Michigan, but if attention were given the matter of selection a strain could doubtless be developed which would regularly mature seed. The hardy varieties of apples, pears, plums, and grapes do well and the fruit industry could be profitably extended on this phase of the Miami sand.

Commerical fertilizers are not used to any great extent at present, but a small amount of stable manure is applied. Clover, rye, and buckwheat are sometimes plowed under, a practice which should be more generally followed in order to build up and maintain the productiveness of the fields.

Farms on this soil, partially improved, bring from \$10 to \$40 an acre, depending on location and improvements. Stump land can be bought as low as \$7.50 an acre. Timbered land is owned principally in large tracts by the large lumber companies and is not for sale.

Pine plains phase.—The Miami sand (Pine plains phase) to a depth of 2 to 4 inches consists of a brown or grayish medium sand, carrying only a very small proportion of organic matter, underlain to 36 inches, and usually much deeper, by a yellowish-brown or yellow sand of medium texture, which becomes lighter in color with increased depth. There is present on the surface and mixed with both soil and subsoil a small amount of glacial gravel. At intervals throughout this soil, as in the Hardwood land phase, clay sometimes outcrops or comes very near the surface. It is probable that the greater part of the phase is underlain by clay, though the depth of its occurrence is irregular and it often lies so far from the surface as to have little or no influence on the crops. In the borings a thin layer of clay from 1 to 3 or 4 inches in thickness is sometimes encountered, and in deep road cuts these layers are also seen. On account of the loose,

open character of this soil it is very easily cultivated and the natural drainage is good.

The largest area of the Pine plains phase occurs along the Manistee River in the north and northeast portions of the county. Another extensive area is found to the north and northeast of Lake Mitchell. Smaller areas are found in the southwestern part of the survey.

The topography is level or undulating. The area north of Cadillac has somewhat the appearance of an ancient valley. Clam River, the outlet of Lake Mitchell and Lake Cadillac, passes through this valley before entering the Muskegon River in Clare County.

The original forest growth consisted of Norway and white pine, all of which has been removed. In the extreme northeastern and southwestern parts of the county some jack pine was found. In texture the soil very much resembles the phase first described, but the organic matter content is smaller and the timber growth is entirely different. The present vegetation consists of poplar, birch, huckleberries, and sweet fern.

Though all the merchantable timber has been removed, only a very small percentage of this phase is under cultivation. All that is necessary to fit the land for cultivation is the removal of the pine stumps. This is a matter of some difficulty and expense, the cost of clearing ranging from \$10 to \$20 an acre. This difficulty, however, is now being overcome to an extent.

There has recently been erected in Cadillac a plant for the manufacture of turpentine from the Norway pine stumps, and this will enable the farmers to have their land cleared of stumps without expense to them. The company will pull the stumps and pay \$2 a cord of 4,000 pounds for them, or they will pay \$4 a cord for stumps delivered in Cadillac. They also hope to utilize the white pine stumps in making pulp. It is estimated that from 20 to 40 per cent of the pine in the county is Norway.

The crops grown on the Pine plains phase are potatoes, oats, corn, rye, buckwheat, beans, pease, and clover. Potatoes are grown more extensively than any other crop, and, considering the light character of the soil and the methods followed, the yields are good, ranging from 75 to 150 bushels per acre. The yield could be materially increased by plowing under green crops such as clover, rye, or buckwheat, thus increasing the organic matter content and the water-holding capacity of the soil. The yields of corn, oats, beans, and pease are lower than on the Hardwood land phase. Hardy varieties of apples, pears, and grapes do fairly well, though not grown to any extent. The area of clover should be extended and clover seed made one of the money crops of the farming system.

This phase responds quickly to fertilization and thorough cultivation. It retains moisture remarkably well for a light soil. The

land ranges in value from \$5 to \$20 an acre, depending upon location and improvements.

Pine hills phase.—The Pine hills phase of the Miami sand to a depth of from 2 to 4 inches consists of a gray or brownish medium sand, containing very little organic matter. The subsoil, to a depth of 36 inches and usually much deeper, consists of a yellow medium sand, which becomes lighter in color with increasing depth. There is present on the surface and mixed with the soil and subsoil from 5 to 15 per cent of gravel.

The topography is rolling to hilly and broken. On account of this and the loose, open character of the soil the natural drainage is very free and the soil is droughty. As far as types of native vegetation and soil texture and structure are concerned, this soil is identical with the Pine plains phase. The difference in topography and agricultural value, however, is so marked that it was considered advisable to show the soil as a distinct phase. It contains a little more gravel than the Pine plains phase, but this in itself would not justify a separation.

The most of the Pine hills phase occupies the southern part of Cedar Creek, the northern and eastern parts of Haring, and the northeastern part of Clam Lake townships. Another area of considerable extent is found in the southern part of Cherry Grove Township.

The original timber growth consisted of Norway and white pine, all of which has been removed. The tree growth at present consists of poplar and birch, with an undergrowth of shrubs, such as huckleberries and sweet fern.

Only a few scattered fields are cultivated, and it is unlikely that much of the phase will ever be utilized for agriculture. It is really a nonagricultural soil and should be reforested. Land of this character can be bought from \$2 to \$10 an acre.

The following table gives the average results of mechanical analyses of fine-earth samples of the three phases of Miami sand:

Mechanical analyses of Miami sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Hardwood land phase:		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	Per ct.	Per ct.	Per ct.	Per ct.
19086, 19633, 19635	Soil	1.0	15.9	28.9	39.6	3.1	8.3	2.9
19087, 19634, 19636	Subsoil ...	.5	18.5	27.2	44.8	3.2	3.4	2.5
Pine plains phase:								
19084, 19631	Soil .....	.3	16.9	32.2	39.3	2.1	6.1	2.9
19085, 19632	Subsoil ...	.2	14.6	35.1	43.1	2.3	2.4	2.3
Pine hills phase:								
19639	Soil .....	.0	10.1	45.1	36.1	1.4	5.0	2.2
19640	Subsoil ...	.0	11.1	49.4	34.7	.9	1.6	2.2

DUNKIRK CLAY LOAM.

The soil of the Dunkirk clay loam consists of 4 to 6 inches of light-brown heavy loam, silt loam, or light clay loam. The subsoil to a depth of 36 inches is a brownish-red clay loam or clay. The variation in the soil texture is due to the fact that the type occurs only in small areas and the material is more or less mixed with the surrounding lighter soils. Although this is the heaviest soil in the area and the most difficult to cultivate, no trouble is experienced in securing a good seed bed if plowed under favorable moisture conditions.

There are only a few square miles of the Dunkirk clay loam in the county. One small area occurs about 1 mile south of Lake Cadillac and another of about equal size is found in the southeastern corner of Greenwood Township. Other smaller areas occur throughout the county, many being too small to be represented upon the soil map.

The Dunkirk clay loam is of glacial origin, and the greater proportion of the county is probably underlain at varying depths by material similar to that giving rise to this type of soil.

The surface is level or gently rolling. The natural drainage is fairly good, though in some places it could be materially improved by tile drains.

The same crops are grown on this soil as on the Miami sand (Hardwood land phase), but the yields are usually somewhat better. It is a strong, productive soil. Plowing should be deeper than on the light soils, and more thorough subsequent cultivation is necessary. It is better adapted to the production of hay and grain than to potatoes.

CLYDE CLAY LOAM.

The Clyde clay loam consists of a light-textured black clay loam to a depth of 6 or 8 inches, underlain by a bluish or drab-colored, heavy plastic clay loam extending to a depth of 36 inches. The soil is variable, being more or less mixed with material from the adjoining lighter types of soil.

The area of this soil is very limited—less than 1 square mile in all. This occurs in two small areas in the eastern part of Greenwood Township. It was formerly swamp land, but having been reclaimed it is now used for the production of hay. Yields of from 1 to 2 tons per acre are obtained. The natural drainage is poor, but open ditches have been constructed to carry off the surplus water.

As the soil is variable and of such small extent no samples were collected for analyses.

MUCK.

Muck consists of vegetable mold in various stages of decomposition. The greater portion is of black color and thoroughly decom-

posed; the remainder is brown, and would be more properly classed as peat if of sufficient extent. There are no extensive areas of Muck, but it is found along parts of nearly all the smaller streams and to a slight extent along the Manistee River.

The original growth consisted of white cedar, spruce, and tamarack, with some ash.

The Muck is shallow in small areas, often not exceeding 1 foot, while in the larger areas it extends to a depth of from 3 to 10 feet. Except in a few places, where the substratum is clay, it is underlain by sand.

None of this soil is cleared and under cultivation. At present it is poorly drained and in a swampy condition. Most of it is capable of being reclaimed, and when cleared and put under cultivation will be a valuable soil, especially for gardening.

SUMMARY.

Wexford County lies in the northwestern portion of the southern peninsula of Michigan. It has an area of 366,272 acres, or about 572 square miles. The topography varies from level to hilly and broken, the greater part, however, being level to gently rolling. Except in the southeastern corner, which drains through Clam River into the Muskegon River, the drainage of the county is into the Manistee River.

The first settlement was made in the area in 1863, and in 1869 the county was organized. Cadillac, the county seat, was incorporated in 1877 and is the most important point in the county. Aside from its importance as a lumber town, it is fast coming to the front as a distributing center for agricultural supplies and as a shipping point for all farm products. Its population at present is 9,000.

The Grand Rapids and Indiana, the Ann Arbor, and the Manistee and Northeastern railroads traverse the county.

The winters are long and cold, but the temperature is uniform. The climate in summer is delightful and vegetation grows rapidly. The average annual rainfall of 32.4 inches is fairly well distributed throughout the year.

Originally the county was covered with forest. The pine has been removed and also the greater part of the hardwood. About 15 to 20 per cent of the area is under cultivation, and by far the greater proportion of this is in the Hardwood land phase of the Miami sand.

Lumbering is still an important industry. The output of the mills within the county amounts to over 100,000,000 feet annually. The cut-over lands are being settled and agriculture is coming to the front.

The products of the farm are potatoes, corn, oats, wheat, rye, buckwheat, hay, beans, pease, garden truck, and fruit. Potatoes form the

money crop. The soil is well adapted to potatoes and yields range from 75 to 300 bushels per acre. Oats and wheat do fairly well, but wheat should be confined to a heavier soil. Although corn matures here, both flint and dent varieties being grown, a strain better adapted to the soil and climatic conditions should be developed. Rye and buckwheat do well, also pease and beans. The hardy varieties of apples, pears, and grapes do well, though not grown extensively. The dairy industry while unimportant is growing. The dairy products are all consumed in the local markets.

No definite crop rotation is followed, but it is customary to grow potatoes on new ground for one or two years, usually followed by corn, after which the field may be seeded. Potatoes usually follow the sod. Rye and buckwheat and clover are sometimes grown as green manure crops. No commercial fertilizers are used, but some barnyard manure is applied.

Labor for the farm can be readily secured for \$20 to \$25 a month, with board. About 91 per cent of the farms are operated by the owner. The average size of a farm is about 80 acres.

Four soil types, including Muck, were mapped. Miami sand, which is shown in three phases, is the most extensive type, covering 97.5 per cent of the county, the most important phase being locally known as hardwood land. Although a light soil, it yields well and its productiveness can be maintained by proper cultivation and fertilization. The average value of farms on this phase of the Miami sand is from \$15 to \$20 an acre.

The Miami sand (Pine plains phase) is also a light soil, but it has agricultural possibilities which are just beginning to be developed. The soil contains but little organic matter, but as it responds quickly to intelligent treatment it can be built up and profitable yields secured.

The Miami sand (Pine hills phase) is a nonagricultural soil and the entire area should be reforested. It represents the broken and billy land, and only a few fields have been cleared.

The Dunkirk clay loam is the heaviest type in the area. It is adapted to general farming, but owing to its small extent it is unimportant.

Less than 1 square mile of the Clyde clay loam was mapped. It is devoted to the production of hay, which does very well.

The areas of Muck are uncleared and still remain in a swampy condition. They will form a valuable soil when brought under cultivation.



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