



Issued May 29, 1915.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE STATE OF INDIANA DEPARTMENT OF GEOLOGY,  
EDWARD BARRETT, STATE GEOLOGIST.

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SOIL SURVEY OF DELAWARE COUNTY,  
INDIANA.

BY

LEWIS A. HURST, OF THE U. S. DEPARTMENT OF AGRICULTURE,  
AND E. J. GRIMES, OF THE INDIANA DEPARTMENT OF GEOLOGY.

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W. E. McLENDON, INSPECTOR, NORTHERN DIVISION.

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[Advance Sheets—Field Operations of the Bureau of Soils, 1913.]



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## LETTER OF TRANSMITTAL.

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U. S. DEPARTMENT OF AGRICULTURE,  
BUREAU OF SOILS,  
*Washington, D. C., September 25, 1914.*

SIR: In extension of the soil survey work in the State of Indiana, a survey was made of Delaware County during the field season of 1913. This work was done in cooperation with the State of Indiana Department of Geology and the selection of the area was made after conference with State officials.

I have the honor to transmit herewith the manuscript report and map covering this area, and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1913, as provided by law.

Respectfully,

MILTON WHITNEY,  
*Chief of Bureau.*

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

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### MAP.

Soil map, Delaware County sheet, Indiana.



# SOIL SURVEY OF DELAWARE COUNTY, INDIANA.

By LEWIS A. HURST, of the U. S. Department of Agriculture, and E. J. GRIMES, of the Indiana Department of Geology.

## DESCRIPTION OF THE AREA.

Delaware County, comprising an area of 392 square miles, or 250,880 acres, is situated in the east-central part of Indiana, in the second tier of counties from the Ohio State line. Grant and Blackford Counties bound it on the north, Jay and Randolph Counties on the east, Henry County on the south, and Madison County on the west.

The surface is level to gently undulating, except near stream courses, where erosion has rendered it more rolling and in places even hilly, or where moraines exist. The descent to the stream courses is often abrupt or precipitous. The banks along the larger streams generally rise in two distinct terraces to the broken country, which merges rapidly into the broad level upland. Numerous old filled-in valleys in the county indicate that the preglacial topography was much more irregular than that of the present time. The two most prominent of such valleys are the one lying east of New Burlington, crossing Perry Township near the center and connecting with the West Fork of White River, and the one lying parallel to the Granville Pike northeast of Muncie, known as Muncie Prairie.



FIG. 1.—Sketch map showing location of the Delaware County area, Ind.

The greatest surface relief is found in the northeast and southeast portions, particularly near Prairie and Stony Creeks in Perry Township and Easleys Creek in Niles Township. Scattered throughout the county are numerous morainic knolls and ridges, many of which rise to an elevation of several feet above the general level of the surface. A number of kames or rounded hills of gravel and sand are to be seen in the county, the most important ones being found between Muncie and Granville and between Muncie and Smithfield. There are several in and about Muncie, but much of the gravel has been removed from them. A prominent chain of kames, or long, narrow ridges of sand and gravel, extends from a point 2 miles east of Granville to a short distance northeast of Muncie. Its elevation is about 30 feet above the general

surface level. The watershed between the West Fork of White River and the Mississinewa River presents the largest expanse of level till plain. The watershed between Buck and Bell Creeks is also rather level, with but little relief, except as the stream is approached.

The average altitude is between 900 and 1,000 feet above sea level. The general slope of the surface is from east to west.

The Mississinewa and West Fork of White River, with their tributaries, drain the county. The Mississinewa, having as its chief tributaries Easleys, Halfway, Pike, and Campbell Creeks, receives the drainage of the northern third of the county. The West Fork of White River drains the remaining two-thirds, Prairie, Buck, Mud, and Bell Creeks being the largest tributaries. A noticeable feature of several of the tributaries of these two rivers, including Pike, Mud, Buck, and Kilbuck Creeks, is that they flow parallel with and close to the rivers for a number of miles. There are indications that Mud Creek was an original channel, or at least a fork of the West Fork of White River, for in times of high water a portion of the overflow from the river floods this valley. Most of Buck Creek Valley is drained to the west into West Fork of White River near Yorktown, but less than a mile of the valley drains to the east into this river near Muncie. A similar condition exists in a more or less distinct valley tributary to Kilbuck Creek, which discharges most of its drainage west into the West Fork of White River through Kilbuck Creek, but is also drained for a mile or more into the Mississinewa. However, there is no evidence in this case that flood waters have passed through the valley from one river to the other.

The first permanent settlement in Delaware County was made in 1820. The earliest settlers came chiefly from the States to the east and from Kentucky and located along the West Fork of White River near the present towns of Smithfield, Muncie, and New Burlington. County government was granted in 1827.

The population has steadily increased since the organization of the county. In 1860 the census recorded a population of 15,753. According to the 1910 census there were 51,414 persons in the county. Of this number about 30,000 live in Muncie and other towns and villages, the remainder being distributed rather evenly over the rural sections.

Muncie, the county seat and largest town in the county, is situated on the West Fork of White River in Center Township, a little south of the center of the county and 55 miles northeast of Indianapolis. It is the center of a rich agricultural region, and the site of a number of important manufactories. The population of Muncie, according to the Thirteenth Census, is 24,005, which makes it the sixth largest city in the State.

Eaton, Albany, Gaston, Selma, and Yorktown are other important towns in the county. They are shipping and trading centers for the rich agricultural territory surrounding them and also have some manufacturing interests. The greatest impetus to the growth of these towns came in 1884, upon the discovery of natural gas. At the present time the supply of gas is very much depleted and is used by the farmers chiefly for domestic purposes. A portion of it is also used in the smaller towns and villages, as well as in Muncie, but the greater part of the gas now consumed in Muncie is piped from West Virginia fields. Since the depletion of the gas supply a few of the towns have lost a part of their manufacturing interests and the population has declined to some extent. In the vicinity of Selma a rather extensive oil field has been developed and is gradually being enlarged.

The first railroad in the county was the Cleveland, Cincinnati, Chicago & St. Louis (Big Four), 1852-53, from Indianapolis through Muncie. At the present time the county possesses a most excellent railroad system. Six steam roads and five trolley lines make transportation and shipping facilities adequate for all needs. Every town in the county and all but four villages are situated on either a steam railroad or a trolley line and many of them on both.

The first improved roads were constructed under the toll-pike system, which connected the principal towns usually by the shortest route and centered at the county seat. Such were the Centennial, Granville, Center, Wheeling, Bethel, Jackson Street, Yorktown, Middletown, Newcastle, Macedonia, New Burlington, Smithfield, and Selma pikes. Within the last 25 years these toll roads have been opened by the county to the public and supplemented by an excellent sectionized public road system, so that now every farmer has easy access to market. There are very few miles of unimproved roads, most of them being surfaced with gravel and in excellent condition. Unlimited quantities of gravel are available for constructing and repairing the roads. In recent years many macadamized roads have been built. Several of the main highways leading out from Muncie have been paved with vitrified brick for a distance of 1 to 3 miles into the county. Modern steel bridges span the various streams of the county.

Telephone lines and rural mail routes connect all parts of the county.

#### CLIMATE.

No official weather records for the county are available, but the data in the following table, compiled from records of the Weather Bureau station at Farmland, in the adjoining county of Randolph, may be taken as fairly representative of Delaware County.

*Normal monthly, seasonal, and annual temperature and precipitation at Farmland,  
Randolph County.*

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
December.....	32.3	64	-14	2.70	1.77	1.90	5.3
January.....	27.0	70	-24	2.71	1.78	6.57	8.1
February.....	28.1	70	-19	2.80	0.74	3.91	6.6
Winter.....	29.1			2.81	4.29	12.38	20.0
March.....	38.8	79	- 2	3.49	1.72	3.96	5.9
April.....	50.2	86	18	3.24	1.07	3.57	1.2
May.....	61.1	93	30	4.34	4.15	5.89	0.2
Spring.....	50.0			11.07	6.94	13.42	7.3
June.....	69.9	96	38	4.02	5.59	4.60	0.0
July.....	73.5	102	44	3.35	3.69	0.90	0.0
August.....	71.1	98	43	5.77	1.08	5.96	0.0
Summer.....	71.5			11.14	10.36	11.46	0.0
September.....	65.0	94	30	3.29	3.04	9.02	0.0
October.....	52.6	86	16	2.19	0.95	2.32	0.1
November.....	40.4	74	2	3.10	4.26	3.30	1.9
Fall.....	52.7			8.58	8.25	14.64	2.0
Year.....	50.8	102	-24	39.00	29.84	51.90	29.3

The mean annual temperature of the county is 50.8° F. The highest recorded temperature is 102° F. in July and the lowest -24 F. in January, but such extremes are ordinarily of short duration. High temperatures are not uncommon in July, August, and September, but seldom continue long unless accompanied by extremely dry weather. The average annual snowfall is 29.3 inches. In severe winters snow may remain upon the ground several weeks, or even months. Ordinarily the ground remains frozen only a few weeks and a thaw is expected in February or March.

The average annual rainfall is 39 inches. This is rather uniformly distributed throughout the year, and the county rarely suffers from extreme drought or excessive moisture. The greatest rainfall occurs during May and June.

The length of the growing season is about 5½ months, the average date of the first killing frost in autumn and the last in the spring being October 10 and April 25, respectively. The earliest recorded date of a killing frost in autumn is September 6 and the latest in spring May 21.

## AGRICULTURE.

The early settlers of this section found it a dense forest of hardwood broken only by an occasional open, swampy prairie. Natural advantages caused them to stake their claims along the larger stream courses. The streams afforded access to outside markets by raft or flatboat and furnished power for mills, including those designed for sawing lumber, while the bottom lands, enriched annually by stream overflows, offered easy and profitable farming. Because of its adaptability to bottom-land soils, corn became the main crop. Large yields were also obtained when the uplands in the vicinity of the rivers were first cleared, these having in general better natural drainage than the more remote uplands.

A considerable section of the county was in its natural condition poorly drained and unfit for agriculture. A relatively large proportion of the land was, however, well suited for farming. The cost of installing artificial drainage in the wet areas, the so-called "black lands," and in many cases the lack of adequate drain-outlets prevented the use of these soils by the early settlers, but they have since been made the richest and most valuable lands of the county. Many thousands of dollars have been expended by private and community enterprises to reclaim the black lands and bottom lands along the more shallow streams. The first method employed in artificial drainage was the construction of open ditches, but in recent years these have been supplanted by tile drains.

The channels of almost all the smaller streams have been straightened and deepened by dredging throughout their entire length, and recently the question of straightening and deepening the channels of the West Fork of White and Mississinewa Rivers has been agitated.

The county's greatest wealth has always consisted of its fertile fields. The native forest was cut off when the revenue obtained from the sale of the lumber was a trifle compared with what its present value would be. The construction of steam and electric railroad lines, giving ready access to the larger markets, has been an important factor in the development of the agricultural resources of the county.

Corn, wheat, oats, rye, flax, and potatoes were among the early crops grown in the county. Hay was cut from the open prairie. Corn has always been the leading crop, and it is the aim of most of the farmers to increase the production of this grain. In some cases this has led to a depletion of the fertility of the soil, but the more progressive farmers have avoided this by efficient methods of soil management. The acreage of corn has steadily increased from 52,061 acres in 1889 to 71,706 acres in 1909, with a corresponding increase in production from 1,528,876 bushels in 1889 to 3,135,530 bushels

in 1909. The largest yields are obtained from the Clyde and Genesee soils, which produce approximately twice as much as the lighter colored clay soils (Miami). They are rated among the best corn soils in the State, and yields of 70 to 80 bushels per acre are not uncommon. The yields from the clay or Miami soils can generally be increased through better cultural methods, including fertilization and seed selection. Barnyard manure is the chief fertilizer for corn, little commercial fertilizer being used.

Experiments have shown that an application of 2 or more tons to the acre of ground limestone upon clover sod, before turning it under, especially upon the lighter colored soils, will increase the subsequent yields of corn. The effect of such an application will be even more apparent in the wheat and clover crops which follow the corn. Similar results have been obtained by subsoiling the clay lands or deepening the soil bed without turning too much raw material to the surface. A gradual deepening of the soil is generally recognized as beneficial. Too often the ground is plowed to the same depth year after year, so that a form of hardpan is produced which greatly retards the free circulation of air and moisture. The relative percentage of phosphoric acid and potash required properly to fertilize the different grades of land varies with the local conditions, but in general the lighter colored soils yield better returns from the use of phosphoric acid, while the darker colored soils give increased yields with potash. The latter usually contain sufficient nitrogen but are deficient in the other two elements of plant food.

An important factor in increasing the yields of corn is the selection of the variety best suited to the soil on which the crop is to be grown. Too often no attention is given to this matter or to the testing of seed corn. The seed to produce the best results should be strong in vitality and the kernels graded to uniform sizes in order to drop from the planter evenly. The best varieties to grow on the different kinds of soil should be worked out by the farmers themselves. The seed corn selected from the clay land should be planted on the clay lands so far as practicable and that selected from the black lands should also be kept for the black lands, selecting from experience the varieties best adapted to each grade of land. Well-selected home-grown seeds are generally preferable to any other on any soil. Attention to these methods should materially increase the yields from these lands.

The use of the check drill in planting corn permits the crop to be cultivated both ways, and hoeing is not often required. In general three to four cultivations are given the crop, though a fifth is not infrequent. Riding cultivators are used almost exclusively. The use of power corn cutters has also reduced the labor of harvesting

this crop. In the last few years a large percentage of the corn has been cut and stored for ensilage. This practice is being rapidly extended as the value of silo feeding becomes better understood. Ensilage is frequently prepared from corn and peas grown together.

There were 14,766 acres devoted to wheat in Delaware County in 1909, with a production of 190,963 bushels. Wheat is not considered a paying crop commercially in the county, but its value as a nurse crop for clover warrants its continued cultivation. The lighter colored Miami soils show the greatest adaptability to this crop. Too much attention can not be given to the selection of suitable varieties of wheat for the soil, as well as a proper grading of the seed. Rotation, fertilization, treatment of seed for disease, and the combating of insects require careful attention to insure the largest returns from this crop. The Purdue Experiment Station recommends the use of 300 pounds per acre of a fertilizer analyzing 2 per cent nitrogen, 8 per cent available phosphoric acid, and 2 per cent potash. This can be applied at the time of seeding by using a drill with fertilizer attachment. When clover has been turned under for corn and the latter is followed by wheat an application of 50 to 100 pounds of nitrate of soda is generally advisable, which can best be applied as a top dressing in spring. Where barnyard manure is used the most profitable results are secured when it is turned under with the clover sod preceding the planting of corn.

Although oats are not generally considered a paying crop, this grain fits in well with the customary rotation and is especially valued for its straw, which, when fed for hay in conjunction with ensilage, makes excellent roughage for stock. In 1909 there were 25,205 acres in oats, with a production of 678,661 bushels. The average, however, is usually 30 to 40 bushels per acre. Yields of 50 to 60 bushels are not uncommon. Oats are usually sown with an end-gate attachment at the rate of  $2\frac{1}{2}$  to 3 bushels per acre. Cowpeas and soy beans are being tried by many of the farmers as a substitute for oats.

Delaware County is not rated as a potato-growing county, but the number of acres devoted to this staple in 1909 was 1,927, with a yield of 150,162 bushels, or about 78 bushels per acre.

With the increased demand for canned tomatoes the cultivation of this crop is gradually being extended. The crop fits well into the system of rotation and when properly handled gives twice the profit per acre derived from a crop of corn. Many growers are netting a profit of \$70 to \$100 per acre where proper cultural methods are employed. More attention should be given to the breeding of earlier varieties and to methods of maturing the crop before it is killed by frost. The selection of profitable varieties is also often

overlooked. From the 890 acres planted in 1911 to tomatoes 4,886 tons were harvested.

The growing of English peas offers another source of revenue to the farmer. A crop of this character is profitable not only from the sale of the peas but because of its value to the soil as a nitrogen-storing agent.

The number of acres in clover in 1909 was 2,885, with a production of 3,365 tons of hay, or a little more than a ton to the acre. The small acreage sowed to this crop accounts largely for the low percentage of humus in the clay lands. Clover is not generally included in the rotation of crops, or if so it is turned under without being cut for hay, a practice which was not observed during the course of the survey. It was observed, however, that both the hay and the seed crops were removed. Cutting the second crop for seed robs the soil of much valuable humus. The acreage of timothy is being rapidly reduced.

The growing of alfalfa is receiving more attention each year, but its value as a feed is evidently not fully realized, or it would be more extensively cultivated. This crop is especially well adapted to the second-bottom lands or high terraces, on account of their porous subsoils, but with proper preparation it can be grown successfully on almost any soil in the county except Muck. Aside from its value as a money crop its value as a nitrogen-storing agent should recommend its culture, especially upon the lighter colored Miami soils, which are low in humus. To succeed with alfalfa it is necessary that the land be well drained, limed, thoroughly inoculated, well prepared, and free from weeds.

Fruit growing has been made a profitable industry in the few cases where proper attention has been given to spraying, pruning, etc., but in general the orchards are neglected. Many of the older orchards are infested with disease and insect pests, which spread to the more recent plantings. The present tendency is to plant too large orchards, which receive insufficient attention, while smaller orchards well sprayed and pruned would yield more profitable results. State inspection and modern methods of control are needed to make fruit culture a paying industry. The more rolling type of Miami silt loam and the Miami loam give the most satisfactory results in the growing of fruit.

The farmers of Delaware County who cultivate their own farms usually practice some form of crop rotation. A three-year rotation of corn, wheat, and clover is most commonly employed. This requires sowing wheat in the corn either before it is cut or in the stubble among the shocks. In either case the seeding is unsatisfactory, and a good stand is rarely secured.

The county is a stock-feeding rather than a stock-raising section. Cattle are imported from the western States, fattened on the farm produce, and then put upon the market. However, this practice has not been so profitable in the last few years on account of the scarcity of range cattle in the West.

The dairying industry is confined to supplying the local markets, but the excellent shipping facilities warrant its extension to markets outside the county.

The price of land in Delaware County has kept pace with the advance in other sections, and but little, if any, of it can be bought for less than \$125 to \$150 an acre. Well-improved farm lands frequently sell for \$200 to \$225 an acre. The high price of land is due in part to the fact that the more prosperous farmers are satisfied with their holdings and refuse to sell unless offered a price commensurate with the advantages afforded by a highly developed county such as this.

The average farm wages range from \$20 to \$25 per month, with board, lodging, washing, and feed for driving horse furnished, or, in the case of a married man, house, feed for horse, cow, etc. Harvest hands and extra laborers receive from \$1.50 to \$2.50 per day. The manufacturing and public works in Muncie, offering shorter working hours and the various attractions of city life, have drawn heavily upon the labor of the county, and desirable farm labor is scarce. Those who operate a farm of 160 to 240 acres seldom employ more than one regular helper, the work being done largely by the owner and his family.

According to the census, the average size of farms in 1910 was 82.4 acres. There were 240,483 acres in farms, of which 210,349 acres were improved. The value of the land and improvements, except buildings, was \$26,006,223; of buildings, \$3,649,276; implements and machinery, \$444,142; and live stock, \$2,616,481.

#### SOILS.

Glacial till left upon the recession of the ice sheet at the close of the late Wisconsin epoch covers the entire county to a depth of 50 to 200 feet. It is a heterogeneous mass, consisting chiefly of clay intermingled with sand, gravel, and silt. The material of the drift varies with the character of the rocks over which the glacier passed, granite, gneiss, limestone, sandstone, and shale from the Lake Superior region being intermixed and ground up with it. Niagara limestone underlies the glacial deposits throughout the county, but no rock outcrop occurs, though in a few places, notably in the vicinity of Muncie and Yorktown, it is near enough to the surface to be quarried. The first water-bearing gravel is reached at depths ranging from 10 to 60 feet.

The glacial till is the source of the upland soils of the county. The alluvial soils or bottom lands are stream-deposited material, formed chiefly of wash from the upland soils. On account of their depth, the underlying rocks have had little part in the formation of the soils of Delaware County, though they may have contributed to the ice-ground mantle covering the uplands, from which the various types are derived.

The various agencies of weathering have been at work upon the glacial drift or débris since deposition and have formed the present soils. The drift material, to a depth of 10 to 15 feet, is a very light brown to pale-yellow or grayish mixture of clay, fine sand, and silt, carrying a large proportion of gravel and small stones. The latter consist largely of granite, schist, gneiss, and limestone fragments. The limestone fragments are more conspicuous below 5 to 6 feet. Artificial exposures of the till usually weather to a loose, friable, silty to fine sandy loam or loam. It is generally calcareous and effervesces with hydrochloric acid. In many cases this material is supplemented with beds of gravel, particularly along the stream courses. The upper part of the glacial till to an average depth of 22 to 24 inches consists of a uniform silt or silty clay layer, which from its mechanical composition and general appearance is strongly suggestive of the loess. It is possible to attribute the regularity in depth of this silty mantle to the freezing and thawing of the soil, the depth to which the soil is pulverized by such action being fairly uniform. The covering is for the most part light colored, owing to a small content of organic matter, and is quite uniform in texture. The upland soils are known locally as "clay lands."

Five series of soils were mapped in the county, the Miami, Clyde, Rodman, Fox, and Genesee. The miscellaneous type Muck (including small areas of Peat) was also encountered.

The Miami series is the most extensive and widely distributed. It consists of two types, the Miami silt loam and Miami loam, a flat phase of the former also being indicated on the map. The silt loam with its flat phase is the predominating soil in the county, covering 67.8 per cent of its area. The Miami loam is more or less morainic in origin and is confined largely to a single body in the southwestern corner of Liberty Township, though a few isolated areas are found elsewhere.

The ice sheet left an uneven surface containing many shallow depressions which existed as ponds, marshes, and small lakes until they were artificially drained. Before being drained, however, they had been filled to a greater or less extent by clay, sand, and vegetable matter. The soils in them are black and have been mapped as the members of the Clyde series, including the loam and silty clay loam

types. They differ from the Miami in color and in occurrence in poorly drained areas. The silty clay loam is the most extensive of these dark-colored soils.

The Rodman silt loam is confined largely to a chain of kames lying northeast of Muncie. This type and the Miami and Clyde soils constitute the upland soils of the county.

The first-bottom lands subject to overflow were included in two types of the Genesee series, the loam and silty clay loam. The loam is confined almost entirely to the bottom lands along the larger streams, which are more sandy owing to the wash from the silty upland soils and also from exposure of the coarser substratum. The silty clay loam occurs along the smaller streams, where drainage has been more sluggish and the bottom lands are silty. The Genesee silty clay loam grades so imperceptibly into the Clyde silty clay loam that often no definite boundaries between them can be determined. The origin of the two is frequently very similar, the Genesee being developed along the smaller streams, which often occupy old filled-in valleys, while the Clyde originates in shallow basins or depressions.

The Fox loam represents the second bottoms or terraces built up by overflow waters when the streams were flowing at higher levels than at present.

Muck, which includes some small areas of Peat, represents the accumulation of organic matter in lakelets and ponds in various stages of decomposition. Its extent is limited to a few small areas, the largest of which is Big Prairie in Washington Township.

The various types are described in detail in the subsequent chapters. The following table gives the names and extent of the several types mapped in Delaware County:

*Areas of different soils.*

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Miami silt loam.....	26,816	67.8	Rodman silt loam.....	2,048	.8
Flat phase.....	143,360		Clyde loam.....	1,408	.6
Clyde silty clay loam.....	53,376	21.3	Muck.....	1,408	.6
Genesee silty clay loam.....	10,432	4.1	Miami loam.....	704	.3
Genesee loam.....	7,680	3.1			
Fox loam.....	3,648	1.4	Total.....	250,880	.....

#### MIAMI SERIES.

The soils of the Miami series are brown, light brown, or grayish, and are underlain by yellowish and brown, heavier textured subsoils. Mottlings of brown and light gray are present in the subsoils in many places. The surface drainage is usually good, but artificial drainage

is necessary in some of the heavier types. The soils are in the main derived, through weathering, from glacial till of a generally calcareous nature.

#### MIAMI SILT LOAM.

The surface soil of the Miami silt loam to an average depth of 10 inches is a brown or yellowish-brown, loose, mellow silt loam, grading into a heavier silt loam or silty clay loam. Below 15 to 18 inches a dark-brown heavy silty clay is encountered, which in turn is underlain at 20 to 24 inches by a more friable silty to sandy boulder clay. Below 3 to 4 feet the substratum materials are more heterogeneous, being a mass of clay, sand, gravel, and rock fragments. In the vicinity of stream courses pockets of stratified sand and gravel are frequently encountered in the lower substratum.

The surface soil is usually slightly coarser in texture than that of the flat phase, described later. The color is also darker, owing to better drainage with higher oxidation and aeration of the soil and subsoil. Where the type occurs on knolls and ridges the surface is somewhat sandy. Such areas are usually only an acre or two in extent. Where erosion is excessive along the steeper embankments varying quantities of gravel and other coarse materials are found, the finer materials having been carried to lower levels by the drainage water. Boulder clay is not infrequently exposed where the slopes have been deeply gullied. The gravelly areas are confined to narrow strips along the steeper slopes approaching the deeply dissected stream valleys, or upon the narrow morainic ridges and sharper knolls.

The boundaries between this type and the Rodman silt loam were drawn largely from the character of the substrata, which was determined by boring with the auger and by the cross-sections in gravel pits. Where this type merges into the flat phase the boundaries are not definite ones.

Practically all the type can be cultivated with labor-saving machinery, but if more attention were given to contour plowing the tendency of the soil to wash could be greatly checked. So far as practicable the Miami silt loam should be allowed to remain in pasture a greater part of the time. When it is cultivated the plowing should be deep, so that more of the surface water will be absorbed and the run-off, with its attendant erosion, lessened.

This type is usually found bordering the stream courses. It is most extensively developed in the northeastern and southeastern parts of the county. A high table-land occurs in the vicinity of Crossroads in the southwestern part of the county which is similar in color to this soil.

The soil is well suited to wheat, and fair yields are obtained, but as a rule the yields of corn are low. It is probably the best fruit soil in the county, owing to the better aeration of the soil and subsoil. Apples and pears have a better keeping quality and are more highly flavored than those grown upon the heavier soils. Where orchards are planted for commercial purposes, and on a large scale, a soil of this character should be chosen.

*Miami silt loam, flat phase.*—The surface soil of the Miami silt loam, flat phase, to an average depth of about 8 inches, is a compact silt loam of gray to yellowish-gray color when dry and darker gray or brown color when moist. Below 8 inches, and to a depth of 15 or 18 inches, the texture passes from a silt loam to a silty clay loam and the color becomes mottled gray and brown. Below 18 to 20 inches a rather stiff yellowish-brown to dark mottled silty clay is encountered, and at 24 to 30 inches this grades into a similarly colored friable silty to sandy bowlder clay. The substratum below 3 to 4 feet is an intermixture in varying proportions of clay, sand, and gravel of a lighter brown to grayish color.

The Miami silt loam, flat phase, occupies the greater proportion of the better drained uplands, and although the topography is smoother than that of the typical soil it ranges from level to undulating.

The surface soil of this phase throughout the county is a fairly uniform silt loam, the local differences being chiefly those of drainage, surface configuration, and color. Where the surface is more undulating the texture is slightly coarser, darker in color, or more brownish, and less coherent. A few chert, granite, limestone, and quartz pebbles are encountered in the soil mass, especially below 24 to 30 inches, or upon the surface where erosion has carried away the finer soil particles. The occurrence of bowlders was not infrequent when the land was first put under cultivation, but on account of the introduction of labor-saving machinery, which necessitated their removal, only a few remain. They have been appropriated largely for building purposes.

The Miami silt loam, flat phase, is found in all parts of the county, and is the most extensive soil in the county. The proportion of the area occupied by this soil is greater in the eastern half than in the western half. This distribution has a direct relation to the better natural drainage of that section. As drainage courses are approached there is usually a gradual shading off in color from the ashy gray of the flat phase to the brown color of the typical soil bordering the stream courses. In the early settlement of the county the pioneers naturally showed a preference for this soil because of its better drained condition, the Clyde soils being in a semiswampy condition

and in many cases having no apparent drainage outlets. When first brought under cultivation the flat phase was rich in organic matter and much more productive than at the present time, as is shown by the greatly reduced yields of wheat, a crop to which this soil is naturally well adapted. Continued cultivation without recourse to proper methods of crop rotation has greatly reduced the natural store of humus, and to this depletion of organic matter is due the light color or leached appearance of the soil and the physical condition indicated by its tendency to run together when wet, and clod.

The extent of this phase in any particular field can usually be distinguished from that of the Clyde soils not only by the lighter color but also by the more vigorous growth on the latter soil in the early development of the crops, especially corn, oats, and hay. With the exception of wheat, the average yields of crops on the Miami silt loam, flat phase, are but little more than half those obtained from the Clyde silty clay loam. However, the better quality of grain produced on the Miami soils tends to counterbalance the larger yields of the Clyde.

In order to insure early maturity of the crops this soil is often plowed in the early spring when too wet. The result is that heavy clods are formed which are not reduced to proper tilth by subsequent cultivation. The impaired condition of the soil affects its productivity. Fall plowing has been recommended to offset this condition and to aid in storing moisture. The turning under of rye after it has served as a winter cover crop has proved successful in keeping the soil loose and moist. Where tests are made this soil, as stated before, showed a decided acid reaction, indicating the need of lime. Clover, cowpeas, Canada field peas, soy beans, rye and oats stubble, all tend to improve the physical condition of the soil when plowed under.

Potatoes, tomatoes, beans, peas, sugar corn, and small fruits grown upon this soil are firmer and less subject to decay than the same crops grown upon the Clyde soils, but the yields are seldom as large. Owing to this preference is usually given the Clyde silty clay loam when tomatoes are grown for canning purposes. This soil is better adapted to fruit growing than the darker soils, but for such purposes the typical soil of this type is preferred.

The original forest growth consisted of beech, black walnut, white oak, yellow poplar, red oak, shellbark hickory, redbud, wild plum, flowering dogwood, etc.

Although the flat phase of the Miami silt loam is never valued so highly as the Clyde soils, some of the best improved farms in the county are located on it. Land values range from \$125 to \$200 an acre. Where modern methods of culture are used the returns from this soil are increasing, the crops being more certain than upon the Clyde soils.

## MIAMI LOAM.

The surface soil of the Miami loam to an average depth of 12 to 15 inches is a brown to slightly reddish brown silty to fine sandy loam or light loam. The subsoil is a yellowish-brown or slightly reddish brown heavy sandy loam or a friable silty to fine sandy clay. The line of demarcation between the soil and subsoil is not sharply drawn, but is rather a shading off in color and texture from one to the other. The tendency is for the soil to become lighter with depth, or more yellow.

This type is confined chiefly to an area of about 1 square mile in Liberty Township, and includes part of secs. 19, 20, 29, and 30, T. 20, R. 11. Smaller areas are found in other sections of the county. The topography is undulating to slightly rolling.

The soil is cultivated to the usual farm crops without reference to adaptation. Because of its loose, friable structure it admits of a free circulation of air and moisture, responds readily to the use of fertilizers, and is easy to till. Unlike the Miami silt loam, it does not run together or bake. A soil of this character warms up rapidly and is especially well adapted to truck crops. Small fruits, potatoes, melons, cucumbers, and root crops of all kinds should yield better returns from this soil than can be obtained from the usual farm crops. It should also be well adapted to alfalfa, if limed. The soil is deficient in phosphoric acid, which is required to produce the maximum yields, especially if wheat is one of the crops upon it.

This type, along with the Miami silt loam, is valued at \$150 to \$175 an acre when well improved.

## RODMAN SERIES.

The types included in the Rodman series have surface soils varying in color from medium or light grayish brown to yellowish gray, with sometimes a slight reddish cast. The subsoil is brown, usually of a darker shade than the soil. The material is assorted to a greater or less extent—always much more so than glacial till materials—so that the soils are more leachy, less retentive of moisture, and more droughty than the soils derived directly from till. The material may contain sandstone, shale, limestone or granite, gneiss or other crystalline rocks. The deposits have been formed within or underneath the ice and left as characteristic kames and eskers of the glacial regions. The topography is rolling to hilly or steep and rough, with occasional flat-topped or truncated hills. The soils of this series have not been subjected to material modification by glacial-lake waters, though in some cases they may have been covered by them. The kame and esker material, which has been sub-

jected to considerable modification, will be classed with the Dunkirk or other glacial-lake series.

RODMAN SILT LOAM.<sup>1</sup>

The surface soil of the Rodman silt loam to an average depth of 8 to 10 inches is a brown silty loam grading into a darker brown silty to sandy clay. This is underlain at 30 to 36 inches by a sandy gravelly loam. Below 4 to 5 feet stratified layers of sand and gravel are sometimes encountered. These gravel deposits, however, appear to be confined to pockets rather than to underlie the entire esker or kame in which they occur. The type is for the most part confined to a broken ridge or chain of eskers with a general north-east-southwest course across the county, starting from a point about 2 miles northeast of Muncie. The average elevation above the surrounding country is from 20 to 30 feet.

The soil varies somewhat with the topographic features. Where the slope is gradual, the surface is a fairly uniform light silt loam, but where the descent is more rapid, the underlying sandy material is often exposed, in which case the resulting soil is a sandy to gravelly loam. However, the lighter material is seldom of more than a few acres extent in a single body.

This type is cultivated along with the Miami silt loam and to the same crops. Owing to its well-drained condition, it is well suited to fruit culture. Some of the largest gravel pits in the county have been opened in the ridges included with this type, and its use for this purpose will probably continue until the supply of gravel is exhausted. The pits thus established ruin the land for cultivation, but the revenue from the gravel greatly offsets its value for agriculture.

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

*Mechanical analyses of Rodman silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
281604.....	Soil.....	2.1	7.4	5.2	6.3	6.0	54.6	18.5
281605.....	Subsoil.....	3.0	24.0	22.6	11.2	3.2	18.1	17.9

The following sample contained more than one-half of 1 per cent calcium carbonate (CaCO<sub>3</sub>): No. 281605, 19.22 per cent.

CLYDE SERIES.

The soils of the Clyde series are dark brown to black in color, overlying gray, drab, or mottled gray and yellowish subsoils. They have been formed in lakes, ponds or low, poorly drained areas within

<sup>1</sup> Small areas of Rodman loam, too small to show on the map, are included.

glaciated regions through the influence of poor drainage and the accumulation of organic matter acting on the original glacial till of the basins or on accumulations of water-laid material washed into and deposited on the floor of the basins. They are distinguished from the Poygan soils by the gray instead of reddish subsoils, and from the Fargo in the general moderate to low content of lime. The topography is level and the soils are naturally poorly drained, but when reclaimed they are highly productive and valuable for corn, grass, sugar beets, cabbage, and onions.

#### CLYDE SILTY CLAY LOAM.

The surface soil of the Clyde silty clay loam consists of 8 or 9 inches of dark-brown to grayish-black heavy silt loam or silty clay loam. The subsoil is a bluish-black silty clay grading into a drab to slate-blue heavy plastic clay. The color gradually becomes lighter with depth to about 18 to 20 inches, where a gray and drab, brown-mottled, stiff, rather impervious clay is encountered. Below 30 to 36 inches this heavy material is underlain by a more friable, silty to fine sandy clay of a light-gray color and highly stained with iron, or by a low-grade marl or quicksand. Where this type occupies old partially filled-in glacial channels the lower substratum is composed largely of coarse sand and gravel.

The Clyde silty clay loam forms the greater part of the "black land" areas of the county. The term applies to the dark surface soil, which was in part formed from the decay of the native vegetation while these areas were in a semiswampy condition. The lower situations, favoring the accumulation of vegetable matter, are naturally darker than the better drained portions, where the type gradually shades off into the lighter color of the upland soils. The deepening of the color toward the lower level is due to the movement of the surface waters in that direction, carrying in suspension the finely divided soil particles and plant remains from the adjacent uplands, and also to the fact that originally the water remained longer in the lower depressions and supported a more luxuriant native growth of aquatic sedges and grasses, which on decomposing added to the store of organic matter.

The Clyde silty clay loam occupies the swampy and poorly drained depressions of the late Wisconsin glaciation and is largely residual from materials composing that formation. It was originally covered with water throughout a greater part of the year, but by means of open and tile drains the surface waters are now removed almost as rapidly as they fall.

Practically all of the type is under cultivation. It constitutes some of the richest lands in the county, and the value of a farm is largely determined by the number of acres of Clyde soils it contains.

The type occupies irregular-shaped depressions in the upland. It is widely distributed over the county, but is most typically developed in the northwestern part. The largest unbroken areas occur in the vicinity of Gaston in Washington and Harrison Townships. It is also rather extensively developed in Hamilton and the southern part of Union Townships. It is distributed in small tracts in the southwestern portion of the county and is least developed in the north-eastern and southeastern sections.

The Clyde silty clay loam is rated as one of the best corn soils in the State, yields of 60 to 70 bushels per acre being frequently obtained. Oats produce 50 to 60 bushels an acre, but in wet seasons this crop lodges badly, with considerable loss, except when it is cut and used for hay. Alsike and red clover and timothy produce from 1½ to 2 tons of hay per acre.

Experiments on the soil have demonstrated that the yields of corn and oats can be greatly increased by the use of potash fertilizer. When commercial fertilizers are used a mixture of 8 per cent phosphoric acid and 8 to 10 per cent of potash is recommended. Nitrogen is not generally needed, but where it is deficient it should be supplied by legumes grown in the usual crop rotation.

With proper draining and liming of the soil alfalfa can be grown successfully on this type. The yields will be larger than upon the lighter colored soils, but the quality will not be so good and more time will be required to cure the crop properly.

The native forest growth upon the Clyde silty clay loam consisted of swamp white oak, pin oak, white elm, silver maple, bur oak, black ash, and prickly ash, and some of the characteristic plants of smaller growth were the button bush, spice bush, and wild rose.

The results of mechanical analyses of samples of the soil and subsoil of the Clyde silty clay loam are given in the following table:

*Mechanical analyses of Clyde silty clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
281612.....	Soil.....	1.5	2.6	3.0	9.2	9.4	54.8	19.6
281613.....	Subsoil.....	2.1	3.8	2.8	9.7	18.0	48.4	15.1

The following sample contained more than one-half of 1 per cent calcium carbonate (CaCO<sub>3</sub>): No. 281613, 30.72 per cent.

CLYDE LOAM.

The surface soil of the Clyde loam to an average depth of 9 or 10 inches is a black, mucky silt loam or heavy loam. The high content of organic matter not only contributes to the fertility and friable, mucky nature of the surface soil, but also causes its dark color. The

subsoil is a heavy, black to bluish-black silty clay loam which grades below 10 to 12 inches into a slaty-blue to grayish silty clay, and this in turn into a mottled brown, drab, and gray, rather stiff, plastic clay. At a depth of 30 to 36 inches a friable silty to fine sandy clay or low-grade marl is encountered, which is generally light gray in color and deeply stained with iron. As the depth increases the content of fine sand or other coarser materials generally increases, and in some cases a wet, loose fine sand similar to quicksand forms the basic material of the lower stratum.

The Clyde loam never supported a growth of timber, and the pioneers always referred to it as "prairie land," a term usually applied to all treeless soils, whether well drained or low lying. The native growth included a variety of sedges, grasses, cat-tails, flags, button bush, and willows. The better drained portions supported a heavy mantle of native prairie grasses, which was the chief source of hay for the early settlers. The annual decay of this native prairie vegetation imparted to the Clyde loam its high content of organic matter. It is frequently referred to as "made land," a term which is more applicable to the Muck type. "Chaffy land" is also a name given to the looser, deeper phases of the type which more nearly resemble Muck. The "chaffy" condition is more noticeable when the type is first put under cultivation. Corn planted upon the "chaffy" areas makes a vigorous growth in the early stages of development, but usually turns yellow or "burns" before maturity. This condition may frequently be corrected by the free use of barnyard manure and potash fertilizer, deeper plowing, and more thorough cultivation, in order to aerate and sweeten the soil as much as possible. The use of commercial fertilizers containing potash and phosphoric acid in the proportion of about 2 parts of the former to 1 of the latter has generally resulted in increased yields from this type.

The largest single body of the Clyde loam is found in secs. 29, 30, 31, T. 22 N., R. 9 E. The next largest body forms the outer border of Big Prairie in sections 16 and 21 of the same township. Smaller areas are found throughout the county, including portions of the valleys occupied by Prairie Creek in Perry Township and Muncie Prairie in Hamilton Township. This type usually occurs closely associated with the Clyde silty clay loam or Muck.

Until within recent years the Clyde loam was valued only for hay and pasturage, owing to the fact that it occupies old filled-in valleys and shallow lakes or ponds and has no natural drainage outlets, but with the establishment of artificial drainage practically all of the type has been brought under cultivation. Corn is the chief crop. Oats produce a rank growth and are liable to lodge. This tendency may be overcome to some extent by sowing the oats thicker than is generally practiced upon the lighter colored soils.

## FOX SERIES.

The types in the Fox series have brown surface soils and brown to yellowish-brown subsoils. The series has typically a level topography, drained here and there by potholes or by valleys eroded since the deposition of the material as outwash plains or as terraces along streams within the glacial area or flowing out of it. The soils, therefore, consist largely or wholly of glacially derived material, but an essential characteristic is the presence of at least 25 per cent of limestone.

## FOX LOAM.

The soil of the Fox loam is a brown to slightly reddish brown light silty loam or loam, with an average depth of 12 inches, grading into a yellowish-brown silty clay loam. Below 18 to 20 inches the subsoil is a brown, friable silty to sandy clay, with a variable intermixture of coarse sand and gravel. The content of coarser material increases with depth. Below 30 to 36 inches a sandy, gravelly loam is generally encountered, which in turn is underlain by stratified layers of sand and gravel. The surface soil is subject to local variations, including small areas of sandy loam or gravelly sandy loam which were too small to be mapped separately.

The Fox loam is generally referred to as second-bottom land, although it may occupy both second and third terraces. The term "sugar-tree flats" is sometimes applied to it in this county, though the term is not as applicable as in Hamilton, Marion, and other counties, where the Fox loam spreads out over considerable areas. The boundary between the first bottoms and the terraces is usually more distinct in this county than that between the terraces and the uplands. Only in a few instances was a bluff line found marking the latter condition, but it is not unusual to find a high, steep bluff marking the descent to the streams where no terraces intervene.

The Fox loam differs from the Miami soils in the darker color and coarser texture of its surface and the position it occupies upon the terraces along the larger stream courses. The soil of the former type contains less silt and the subsoil a much larger percentage of gravel than either of the Miami soils except the Miami loam. The open, porous nature of the subsoil permits a free movement of moisture. For this reason it warms up more quickly, and the crops make a more rapid growth. It is an easy soil to cultivate, and a mellow seed bed is readily obtained.

The type is confined largely to the terraces along the West Fork of White River in the southern and Mississinewa River in the northern part of the county. The largest bodies are situated in the vicinity of Albany and Eaton, along the Mississinewa River, and Muncie and Smithfield, along the West Fork of White River. Other and smaller

bodies occur intermittently along these streams. A number of small bodies were also mapped in the valley previously mentioned as occupied by Prairie Creek in the vicinity of New Burlington. The Fox loam is probably of alluvial origin, having been deposited when the streams along which it occurs were flowing at a higher level than at present.

This soil is especially well adapted to alfalfa, and in other sections of the State good yields are usually obtained, particularly where lime is liberally applied. It also produces good crops of potatoes, tomatoes, peas, beans, etc., and where markets are accessible profitable returns can be had from these crops.

The predominating timber growth was hard maple, from which fact the type received its local name of "sugar-tree flats." Other hardwood growths included black walnut, beech, white oak, etc.

This type, along with the first-bottom lands, is valued at \$150 to \$200 an acre.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the Fox loam:

*Mechanical analyses of Fox loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
281608.....	Soil.....	2.0	6.0	8.2	15.2	8.3	43.7	17.1
281609.....	Subsoil.....	2.4	6.6	8.4	13.8	7.3	36.8	24.5

GENESEE SERIES.

The Genesee series includes soils formed from dark-brown to grayish-brown alluvial sediments deposited along the major streams and their tributaries throughout the northeastern glaciated region, particularly where the Dunkirk, Volusia, Miami, and Ontario series constitute the principal upland soils. The soils of this series also occur for a short distance south of the glaciated area, where main streams have their headwaters in areas covered by these soil series. The sandy members of the series are prevailingly light brown to gray, and the loam and silt loam members darker brown. The soils of this series are subject to either annual or frequent overflow.

GENESEE LOAM.

The surface soil of the Genesee loam to a depth of 12 to 15 inches is a medium to dark-brown loam or silty loam, except in the immediate vicinity of the streams, where it is generally sandy, the latter material being deposited by the swifter currents, which transport the coarser particles. The subsoil is quite variable in texture and

structure, but is similar in color to the overlying materials. The substratum materials are not infrequently of the same general character as the surface soil, but the tendency is for the texture to become lighter or more sandy with depth, sometimes grading into a loose medium to fine sand or gravel below 24 to 30 inches. Owing to the uneven distribution of the alluvial materials, the type is subject to local variations. Where the currents are swifter at times of overflow, a condition found where the first bottoms are narrow, the alluvial materials thus deposited are more sandy than those deposited in the outlying bends where the waters are less swift. In the latter case the resultant soil is a silt loam or heavy loam, somewhat darker in color than the coarser-textured phase of the type.

The Genesee loam is subject to frequent overflows, and the constant additions of alluvium aid in the maintenance of its fertility, but the crop yields have shown a gradual decline since the land was first cleared and drained. This condition is due largely to the tendency to cultivate corn to the exclusion of other crops. Where this soil is lighter in texture and well drained, it is one of the best trucking soils in the county. It responds readily to the use of barnyard manure and commercial fertilizers and is easy to cultivate. It is especially well adapted to root crops, cucumbers, cantaloupes, etc. The overflows seldom come at a season of the year to interfere with the use of the soil for trucking.

The Genesee loam is confined almost entirely to the first-bottom lands along the Mississinewa and West Fork of White River, and occurs continuously throughout the course of the two rivers. The largest area is found southwest of Yorktown, along the West Fork of White River. The next largest is found in the vicinity of Eaton, along the Mississinewa. Another area of considerable extent occurs just south of Albany. The areas mentioned are those in which the valleys reach their maximum widths.

The Genesee loam is an alluvial soil, composed of reworked materials from the upland glacial soils that have been redeposited by the streams along which it occurs. The surface is generally level. The original forest growth consisted of silver maple, white elm, buckeye, red oak, sycamore, and hickory. The greater portion of the type is under cultivation and but little of the native timber remains standing. The areas not under cultivation have been cleared of underbrush and are used for pastures. Where this soil was low lying and poorly drained, ditches have been constructed to carry off the excess water. The open structure of the soil and subsoil permits the ready percolation of the surface waters, so that the soil dries out rapidly after floods.

Below are given the average results of mechanical analyses of samples of the soil and subsoil of the Genesee loam:

*Mechanical analyses of Genesee loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
281627, 281637.....	Soil.....	1.1	3.3	3.8	18.8	19.4	40.6	12.9
281628, 281638.....	Subsoil.....	2.8	5.5	5.4	18.7	17.1	36.9	13.8

The following samples contained more than one-half of 1 per cent calcium carbonate ( $\text{CaCO}_3$ ): No. 281627, 17.97 per cent; No. 281628, 23.54 per cent; No. 281638, 23.04 per cent.

GENESEE SILTY CLAY LOAM.

The Genesee silty clay loam consists of 8 to 10 inches of medium to dark-brown heavy silt loam or silty clay loam, which grades into a darker brown, almost black, silty clay, and this in turn into a drab to slate-blue, stiff, plastic clay, mottled with dark-brown to reddish-brown iron stains. The stains may in part be due to the decay of roots from the native vegetation, which have penetrated the subsoil. The color of the substratum becomes lighter with depth. Where this type merges into the Clyde silty clay loam, the boundary between them can not be definitely fixed, owing to their similarity in color and texture. When the type occurs in old partially filled-in valleys, its origin is somewhat similar to that of the Clyde silty clay loam where the latter type occupies ponded areas and elongated depressions. Along Stony Creek, in Perry Township, the surface soil is more loamy, being similar to the Genesee loam, though the subsoil is quite heavy.

The Genesee silty clay loam is, for the most part, formed of reworked glacial till, deposited by the streams along which it occurs, or is composed of wash from the adjacent uplands. The dark color of the soil is due to the accumulation of organic matter from decayed vegetation, since these bottom lands were low and semiswampy until adequate drainage was established by dredging. Narrow strips of sandy materials are sometimes encountered adjacent to the streams, but the limited extent of these areas did not warrant their separation. They should be correlated with the Genesee loam. The heavier materials were deposited in the lower situations.

The Genesee silty clay loam occurs in first-bottom lands along the smaller stream courses, being most extensively developed along Kilbuck, Jakes, Bell, Buck, Mud, Prairie, and Easleys Creeks, which form the principal tributaries of the Mississinewa and West Fork of White Rivers. It occurs in narrow strips seldom exceeding one-fourth to one-third of a mile in width.

Most of the streams along which this type occurs have been straightened and deepened by dredging and practically all the land which was formerly poorly drained is under cultivation. Some of the largest yields of corn in the county have been obtained from this type. It is subject to overflow, but the floods generally come at the season preceding the planting of the crop. Yields of 70 to 80 bushels per acre are not uncommon and the average is between 50 and 60 bushels. Heavy yields of oats are obtained where they do not lodge and the full crop can be harvested. It is also one of the best grass soils of the county, yields of  $1\frac{1}{2}$  to 2 tons being obtained.

When the seasons are favorable a good tilth is obtained with this soil, but too often when the spring planting has been delayed by unfavorable weather conditions the soil is turned up wet and forms large compact clods which can not be broken down readily by subsequent cultivation. Thus haste to get the crop in frequently impairs the physical condition of the soil for even more than one season. Owing to the profitable returns from corn grown upon this soil, the tendency is to grow it continuously, and rotation is practiced only to a limited extent. Although the fertility of the soil is maintained in part from the constant additions of alluvium, the crop yields will decline unless rotation is practiced. Experiments have demonstrated that the yields can be considerably increased when potash fertilizers are used. Where the soil is well drained heavy yields of tomatoes are obtained.

The original forest growth consisted of silver maple, white elm, swamp white oak, bur oak, pin oak, black ash, cottonwood, and other hardwoods.

#### MISCELLANEOUS MATERIAL.

##### MUCK.<sup>1</sup>

This type includes the two organic soils, Muck and Peat, which are alike in origin but are distinguished from each other by the state of decomposition of the vegetable matter of which they are composed. The term "made land" is frequently applied to this type, since it was built up from the remains of cat-tails, rushes, sedges, grasses, etc., which originally occupied and filled up the shallow lakes and ponds in which Muck and Peat now occur. The Muck is of a dark-brown to black color, while the Peat is lighter brown and is more fibrous, consisting of a less decomposed mass of vegetable matter than Muck. The depth of this material varies from several feet near the center of the area to only a few inches at the margin. There is but little change in color with depth, but the deeper material is usually in a less advanced stage of decomposition. This surface material is generally underlain by a bluish-black, stiff, plastic clay which grades into a similarly textured clay of a drab to gray color mottled

<sup>1</sup> Includes small areas of Peat.

with brown. In some places a highly decomposed impure marl is encountered in the lower depths of the subsoil or substratum.

The Peat was included with the Muck since it usually occurs in too small areas to be mapped separately, though the two types show a distinct agricultural difference where they are typically developed. Muck has a much greater value for general farming or trucking. Peat is usually found near the centers of the bodies, where the accumulations of organic matter have been more recent and have not undergone as thorough decay, though it sometimes occurs in spots throughout the areas.

The largest single body of this type occurs in Washington Township and is known locally as "Big Prairie." It is here that the largest proportion of Peat is found. Smaller bodies of Muck are found in other sections of the county.

The native grasses which grew luxuriantly upon the Muck lands were the chief source of hay for the early settlers, and these lands were used almost exclusively for hay and pastures until recent years, when they have been reclaimed by artificial drainage. The drainage was poor, owing to the nearness of the water table to the surface. Dredged outlets have since made it possible to drain these areas. At first large open ditches were constructed and these supplemented by smaller underground tile drains. Open ditches constructed along the margin of the swampy areas to intercept the drainage from the adjacent uplands will aid further in the reclamation of these lands.

The greater part of the Muck areas has been brought under cultivation, being used chiefly for corn, although considerable timothy and oats are also grown. The latter crop is not so successful as on other soils, since it makes a rank growth and lodges badly. Timothy and alsike clover do well and are easily seeded, but the two should be grown in combination to get the best results.

Crops grown upon Muck are more susceptible to injury from frost, which settles in the lower situations. It is often necessary to make one or more replantings of corn to obtain a stand, and early frosts sometimes prevent this crop from maturing.

This type is especially well adapted to celery, and its culture should be extended. Onions, cabbage, Irish potatoes, beets, turnips, cauliflower, and other garden crops also do well. The returns in northern Indiana and adjoining States from celery and other truck crops far exceed those from the general farm crops.

Experiments with potash salts and phosphatic fertilizers have usually been profitable from the increased yields obtained. The tendency of the crops to "burn" on this soil can be largely corrected through the use of potash as well as by liberal applications of barnyard manure. Lime judiciously applied is also beneficial. This land is valued at from \$100 to \$150 an acre.

## SUMMARY.

Delaware County is situated in the east-central part of Indiana and has an area of 392 square miles, or 250,880 acres.

The surface varies from level to undulating and in some places broken. The average elevation above sea level is between 900 and 1,000 feet.

The Mississinewa and the West Fork of White River and their tributaries drain the county. The Mississinewa receives the drainage of the northern third, while the West Fork of White River drains the remainder.

The first settlement in the county was made along the banks of the West Fork of White River in 1820. County government was granted in 1827.

The population of the county is 51,414, of which about 16,000 is rural.

Muncie, the county seat and sixth largest city in the State, is situated on the West Fork of White River near the center of the county. The population is about 25,000. It has a number of important manufacturing interests. Albany, Eaton, Gaston, and Selma are important towns of the county.

The county is highly developed and enjoys the advantages of good homes, towns, schools, churches, excellent roads, telephone lines, electric interurban lines, and rural mail delivery.

An excellent system of pikes and sectionized gravel roads exists. There are only a few miles of unimproved roads.

Six steam railroads and five trolley lines afford excellent transportation facilities.

The prosperity of the county is due chiefly to its productive soils, though there are also a number of important manufacturing industries.

The annual mean temperature is 50.8° F. The mean temperature for the winter months is 29.1° F., and for the summer 71.5° F. The average rainfall is about 39 inches, which is well distributed throughout the year. The growing season has a duration of 5½ months.

Corn is the principal crop. Wheat, oats, and hay are also grown in considerable quantities, though the combined acreage of wheat and oats does not equal that of corn. Much corn is cut and stored for ensilage, as green feed for stock in winter. Cowpeas are also being grown and used for this purpose.

Tomatoes, peas, beans, etc., are grown for canning. This is profitable and promises to become more general. Trucking is carried on also to supply the local markets.

Much of the farm produce is fed to live stock, cattle from the States farther west being brought in and fattened for market.

No dairying is carried on except that required to supply the local markets. With the excellent shipping facilities at hand this industry could seemingly be profitably extended.

Land prices range from \$100 to \$225 an acre.

Five series of soils were recognized and mapped in the county. The Miami, Clyde, and Rodman occur upon the uplands, and the Fox and Genesee upon the bottoms and terraces. The so-called "clay" lands are included in the Miami series, and the greater part of the "black" lands in the Clyde.

The upland soils are derived directly from glacial till of the late Wisconsin stage. They have undergone local changes which give rise to the various types. The bottom lands are derived from reworked and redeposited materials which represent wash from the uplands.

Of the Miami series two types were mapped, the silt loam and loam. The former, including the flat phase, is the most extensive and widely distributed type in the county. The Miami loam occupies morainic ridges and is of small extent. The Miami soils are best adapted to wheat and fruit growing.

The Clyde silty clay loam is the predominating type of that series. Only a small acreage of the Clyde loam, the only other type of this series developed in the county, was mapped. The Clyde soils are especially well adapted to corn. Good yields of oats and hay are also obtained.

The Fox loam occupies the greater proportion of the higher terraces. This soil is well adapted to alfalfa.

Of the Genesee series two types were mapped, the silty clay loam and loam. The silty clay loam is the predominating type of the series and occurs along most of the tributaries of the two rivers. The Genesee soils are best suited to corn. Oats and hay also produce good yields.

The Rodman silt loam represents the only member of that series mapped in the county. It occupies eskers and kames principally in the east-central part of the county.

The undifferentiated soil, Muck, is of very limited extent in the county.

The agriculture of the county is in a highly developed and prosperous condition. Scientific farming is practiced to some extent, but much can be done to increase crop yields by more careful study of the individual soil types and their crop adaptability.

[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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