SOIL SURVEY

OF

HANCOCK, SHELBY AND JOHNSON COUNTIES

BY

ALLEN DAVID HOLE

1912

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HANCOCK COUNTY.

LOCATION.

Hancock County is located a little east of the central part of the State, and is bounded on the north by Hamilton and Madison counties; on the east by Henry and Rush counties; on the south by Shelby County; and on the west by Marion County. It includes 307 square miles, lying in townships 15, 16, and 17, N., ranges 5, 6, 7, and 8, E., of the U. S. Land Survey.

HISTORY.

The earliest settlements within the county were made in the southeastern part, on Blue River, in 1818, and in Center Township, not far from the same time. In 1823 the whole of the present county was included in the new county of Madison, organized in that year; but five years later, in 1828, it was given an independent organization, and named in honor of John Hancock, one of the

[* The author has supplemented the knowledge gained from his own investigations in these counties by consulting various authorities on special subjects more or less closely related to the work undertaken. For example, the data in regard to farms, as to acreage, yield of different crops, etc., has been taken largely from the reports of the Census of 1910; some geological data from the reports of the Indiana Department of Geology, and from publications of the U. S. Geological Survey; and the historical summaries from various editions of county histories. For assistance with the work in the field acknowledgments are due to Messrs. B. W. Kelly, Mark Baldwin, and Willard Roberts; and for a careful study of the trees growing on the different soil types, to Mr. J. F. Thompson, the results of whose observations are incorporated in this report. The chemical analyses were all made by Prof. W. M. Blanchard of DePauw University under instructions given by State Geologist, Edward Barrett. In the mechanical analyses (made by the author), the sizes of particles determined are approximately as follows:

Clay, up to 0.01 mm. in diameter; silt, 0.01 mm. to 0.05 mm.;

Fine sand, 0.05 mm. to 0.15 mm.; medium sand, 0.15 mm. to 0.375 mm.; coarse sand, 0.375 mm. to 2.0 mm.

The methods used in the mechanical analysis were (1) agitation for 6 to 7 hours in a shaker, (2) a separation of the finer particles by the sedimentation process, and (3) a separation of the coarser particles by means of sieves. — A. D. H.]

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signers of the Declaration of Independence. In the same year, 1828, Greenfield, the present county seat, was laid out, and the county was divided into nine civil townships in most of which permanent settlements had already been made. Throughout the county from this time on settlements increased in number, and the work of changing the forest wilderness into well-kept farms went steadily on. With but little exception the land was everywhere to be cleared, and over large areas to be be drained before agriculture could be carried on successfully; and as must nearly always be the case in a newly settled country, markets for farm products were distant and the roads leading thither were for a considerable portion of the year almost impassable. Added to all these difficulties was the prevalence of malarial diseases, often in severe forms, a necessary result of the conditions under which the pioneers had to undertake their task. That all these difficulties have been met and largely overcome, the following items summarizing briefly the present conditions show:

(1) About 90 per cent. of the entire area of the county has been cleared and is now being used as farming land.

(2) Open ditches and tile drainage have reclaimed nearly all of the marshes and swamps which once covered such a large part of the county, and with this change has also passed away the prevalence of malarial diseases.

(3) Reasonably good roads are found practically everywhere; this means that either crushed stone or gravel, usually the latter, has been used as road metal so generally that there is scarcely a square mile in the county which cannot now be reached by continuous travel over reasonably good roads.

(4) Five railroads and four electric lines cross the county; two of each passing from east to west the entire length of the county; the others crossing the northeast, the northwest, and the southwest corners, respectively.

(5) There is no considerable area in any part of the county unsettled. The majority of the 20,000 inhabitants live on farms, which are as a rule well improved.

GEOGRAPHY AND GEOLOGY.

Almost the entire surface of the county is level to gently rolling, the streams having in general low gradients and correspondingly sluggish currents. Near the streams the surface is usually somewhat hilly, the relief being in places as much as 40 to 60 feet,

as for example (1) in the northwest corner of the county along small tributaries of Fall Creek; (2) along the lower part of the valley of Sugar Creek; and (3) in the southeast corner, near Blue River. The inter-stream areas rarely have relief exceeding 10 feet, while in places, notably in the west-central part of the county, there are numerous areas with practically level surfaces, the sites of former ponds and marshes which have been silted up or drained.

The natural drainage of the county is, in general, to the south and southwest, chiefly through tributaries of Blue River. Blue River itself crosses the southeastern corner of the county; Brandywine Creek drains a considerable area in the east-central and south-central parts, joining Blue River in Shelby County, some 12 or 13 miles south of the county line; Sugar Creek gathers the waters from a broad, irregular belt extending from the northeast corner of the county along the northern side well toward the northwest corner, thence southwestward, crossing the south line near the southwest corner; Buck Creek, a tributary which joins Sugar Creek six miles south of the southern boundary of the county, drains a large share of the western side; while tributaries of Fall Creek and White River receive the drainage from the remainder of the western and northwestern parts.

The valleys in which these streams flow owe their general direction to the slope of the surface of the material left by the continental ice-sheets when they finally withdrew from the region; many of the minor irregularities of the course of these valleys are also due to irregularities of the surface of the drift, as for example, the tortuous course of Sugar Creek from the northern and northeastern to the southwestern part of the county. Some of the characteristics of the valleys are clearly due, however, to conditions existing as the ice withdrew, which caused the drainage in certain places to be strikingly different from that which exists in the same places now. A notable example of this is the presence of relatively large valleys drained by disproportionately small, in some cases insignificant, streams. The best illustration of abandoned channels of this kind to be found in the county, is in the north-central part, extending in a general north-south direction about a mile east of the village of Eden. A part of this channel is referred to by Dr. R. T. Brown in the Fifteenth Report of the Department of Geology and Natural Resources of Indiana, where he notes the depression southward from Eden, but apparently without seeing the relation existing between the channel he describes and the equally striking

portion extending northward to the Madison County line. This northern portion begins at the county line somewhat east of the center of Sec. 9, T. 17 N., R. 7 E., as a flat-bottomed valley one-fourth of a mile wide and from 10 to 15 feet deep, extends west of south to the eastern part of Section 20, east of Eden, where it crosses Sugar Creek and continues its southwestward course to the north part of Section 29; from here its direction is southward until it joins the valley of Brandywine Creek in the middle of Sec. 16, T. 16 N., R. 7 E. The total length of this channel within the county is about 7½ miles; in parts of its course, the drainage is by open ditch or small stream, sometimes northward, sometimes southward; in parts there is no surface stream at all. Throughout most of its course the soil in the bottom is black, usually a clay loam to loam, with a considerable amount of organic matter. The hills on either side are usually of light colored clay loam with varying amounts of gravel and boulders, but sometimes containing stratified sand and gravel. At certain points the hills bounding the valley almost disappear, leaving the boundaries of the channel somewhat indefinite; this is especially the case on the east side at about the center of Sec. 29, T. 17 N., R. 7 E., where two kame-like hills alone mark clearly the limit of the valley; but in most places the valley boundaries are definite, being limited by distinct morainal hills.

This channel of 7½ miles is evidently only a part of a general north-south system of drainage which prevailed at a certain stage in the withdrawal of the ice-sheet. Southward the valley of the Brandywine itself seems to be a part of the same glacial channel, while northward, as observed by Leverett and by members of the U. S. Soil Survey, the channel extending from above Anderson to Pendleton and on across Fall Creek and Lick Creek to the southern boundary of Madison County, is to be accounted for only by the work of waters flowing under conditions entirely different from those of the present day. Leverett, on his map of the Maumee-Miami glacial lobe, marks the Anderson-Pendleton channel as subglacial, and calls attention to the close association of a similar north-south channel at Muncie with an esker. In view of the fact that the general slope of the surface of the drift is to the westward in northern Hancock and southern Madison counties, as shown by the westward course of Fall Creek, Lick Creek and Sugar Creek, each of which now cuts directly across this glacial channel, it would seem probable that for at least a part of the time in which the waters were forming the north-south valley the channel may have

marked the eastern boundary of a lobe of ice as the glacier retreated, and even after the withdrawal of the ice for a time may have afforded an outlet for waters due to ice melting and precipitation until the present east-west streams established themselves by virtue of their higher gradients.

The geological formations present in Hancock County include only those of the Pleistocene and Recent epochs, so far as exposures at the surface are concerned. Bed rock of Palæozoic age lies everywhere buried beneath a covering of glacial debris to a depth of from 100 to over 200 feet. Borings for natural gas have shown, for instance, a thickness of drift at Greenfield of 205 feet; at points about two miles northwest of Shirley, 125 to 130 feet. This drift is made up for the most part of unassorted material such as boulders, pebbles, gravel, sand, silt and finer particles mixed together in varying amounts and proportions. At the surface the boulders are occasionally sufficiently large and numerous to be especially noticeable, or even to interfere with the cultivation of the ground; as, for example, about six miles northward from Greenfield in Secs. 30, 31, and 36, T. 17 N., R. 7. E., where they form a distinct belt extending for nearly two miles in a northeast-southwest direction. Fig. 1 is from a photograph of a 12-foot granite boulder lying in Section 30 near the northern end of this belt. Some of the drift has, however, been assorted by the action of water so that in numerous places beds of sand and gravel are found nearly free from clay, silt and boulders. In general these stratified deposits are more abundant near the surface in the vicinity of the streams; but they are also found in the areas between the streams, as in Sec. 32, T. 17 N., R. 8 E., 1½ miles southwest of the village of Wilkinson, where gravel for use as road material is being taken out. In drilling or digging for wells, strata of sand and gravel are occasionally encountered, so that the drift is to be regarded as a great deposit, largely unassorted, to be classed as ground moraine, yet including many lenses and sheets of stratified deposits at different levels which are parts of outwash plains, valley trains, silted-up ponds, etc. In age, the unmodified drift, so far as ascertained by exposures at the surface, is referred to the Late Wisconsin stage.

The most important of the Recent deposits in the county include (1) alluvial deposits along streams such as flood plains, (2) alluvial fans in some places at the base of the steeper slopes, (3) lacustrine flats or silted-up ponds, and (4) accumulations of organic matter,

some of it to be classed as peat, though most of it containing too much finely divided mineral matter to deserve the name. These different forms of Recent deposits correspond to a considerable degree to some of the different soils to be described farther on; for example, the flood plains are in most cases to be classed as Wabash loam, and the silted-up ponds as Carrington black clay loam. Further description of these forms will, therefore, be given when the various soil types are described.

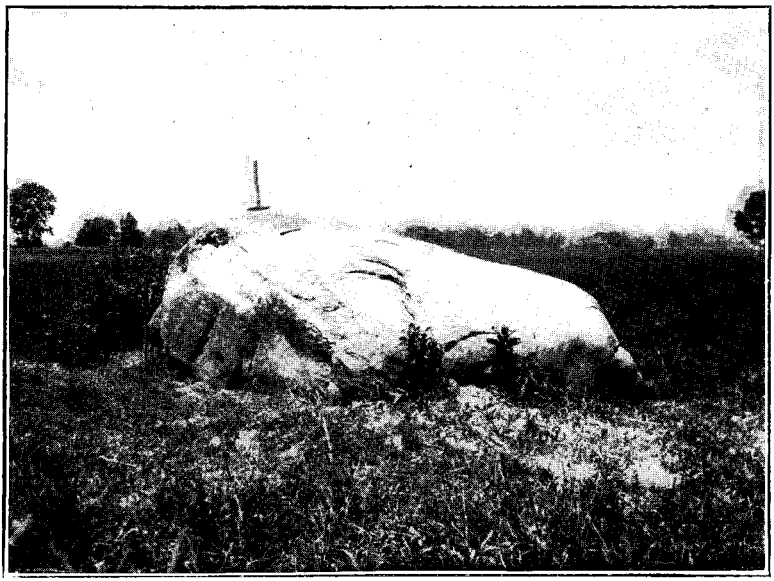

FIG. 1. Granitic Boulder in Section 30, Township 17 N., Range 7 E.; about six miles northward from Greenfield. (Photo by B. W. Kelly.)

ECONOMIC GEOLOGY.

Gravel.—In the Thirtieth Annual Report of the Indiana Department of Geology, Mr. A. E. Taylor (1905) summarizes the location of gravel deposits in substance as follows:

(1) The principal deposits are found along the larger streams and in certain areas of partially assorted drift, principally in the northeastern part of the county.

(2) Areas in which little or no gravel is found include (a) a strip about four miles wide along the western end of the county, and (b) certain areas in the north-central, east-central and southern parts.

Since that report was written some new deposits have been opened up, but it is still true that the main deposits are to be found along the larger streams and in sheets of outwash materials associated with moraines. A few of these deposits are above the level of ground water and so can be easily reached by excavations from which the gravel can be shoveled directly into the wagons which are to haul it away. By far the largest proportion of gravel in the county, however, lies below the water level, sometimes in streams, sometimes in flood plains or terraces, sometimes in the nearly level inter-stream areas. In such cases the gravel is brought to the surface by means of steam power applied either to an endless chain to which small buckets are attached, or to a cable carrying a single large excavating bucket. Fig. 2 shows the latter method of bringing up gravel from below the surface of the water. Data as to the amount of gravel used each year are not available; but the total must be large, since in addition to a very considerable amount used in concrete construction, plastering, etc., hundreds of cubic yards are applied every year to the repair of the numerous gravel roads already completed, and in the extension of the work to reduce still further the small percentage not yet improved in this way.

Water Supply.—An abundance of water may be secured at most places in the county by sinking a well to a depth not to exceed 30 to 40 feet. The exceptions to this are those points where there is exposed at the surface a thick layer of unassorted drift composed largely of rock particles of the fineness of clay, which obstructs the ready flow of the water. Even in such places as these some water is usually found, but not in sufficient quantity to afford a continuous supply. In general, however, such strata of nearly impervious drift are not thick enough to make the sinking of a satisfactory well too expensive or difficult.

The minimum depth of wells varies according to location, being least near streams and in the level areas which were formerly covered by water for almost the whole year. In such places the surface of the ground water may be within four or five feet of the surface throughout the year. This depth, although small, is nevertheless in the marshy areas a reduction of ground water level since the settlement of the county by almost its own amount, due to the opening of ditches and the increased evaporation because of the removal of so large a proportion of the forests. Wells sunk only to the level of ground water, while still numerous, are now being replaced by tubular wells which pass through the layers of sand and

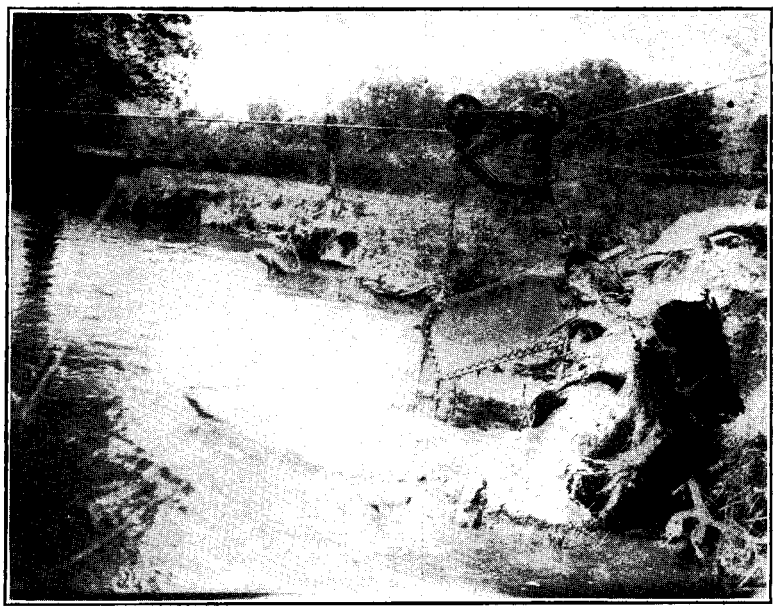

FIG. 2. Cable and single bucket for dipping gravel. Sugar Creek, in Hancock County. (Photo by J. F. Thompson.)

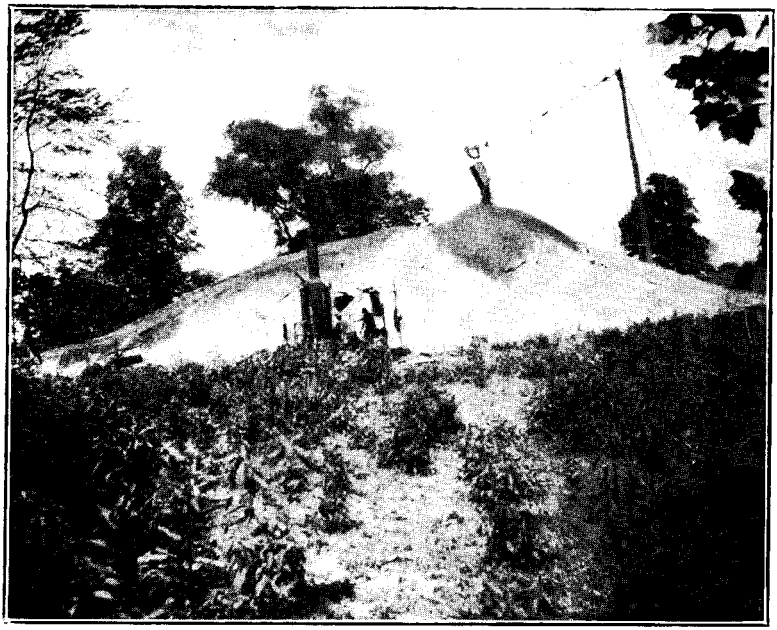

FIG. 3. Bucket shown in Fig. 2, in process of dumping a load. Sugar Creek, Hancock County. (Photo by B. W. Kelly.)

gravel near the surface, and after penetrating more or less impervious layers of glacial till, draw their supply of water from strata of sand and gravel lying 75 to 100 feet or more below the surface. The additional first cost of such wells is more than justified by the added security to health thus obtained, and by the certainty of an ample supply of water even in seasons of greatest drought.

Artesian, or flowing wells occur at a number of points in the county: (1) in the northern and northeastern parts near Shirley and at various points from three to six miles to the north and north-

FIG. 4. Flowing well in Section 13, Township 17 N., Range 7 E. Northern part of Hancock County. (Photo by B. W. Kelly.)

west; (2) in the central and west-central parts, as at Greenfield and near Philadelphia; and (3) at several points from three to six miles southward and southeastward from Greenfield. Most of these flowing wells are abandoned natural gas wells in which the casing has been allowed to remain because of the abundant flow of excellent water which is thus brought up from the surface of the underlying bed rock 100 to 200 feet below. The exact number and location of flowing wells which have been produced in this way in the operations of natural gas companies is difficult to ascertain, because in many cases the wells have been destroyed by the drawing of the casings when the yield of gas became too small to pay for the ex-

pense of cleaning out, repairs, etc. Fig. 4 is from a photograph of a well located in Sec. 13, T. 17 N., R. 7 E., near Sugar Creek. Investigations in this county alone are not sufficient to determine the source from which the water supplying these wells comes. It is, however, known from well-borings that the general slope of the surface of bed rock is here in a southerly direction; it is also reported that in certain cases in the northern part of the county the flow of one well seems to be affected by the opening of another well as much as two or three miles away along a north-south line. These two facts would indicate that the head causing the overflow lies somewhere to the northward. Furthermore, the abundant flow from so large a number of wells in which the pipe conveying the water ends at the surface of bed rock, would indicate that there is a continuous stratum of sand and gravel lying on bed rock and extending in a somewhat winding, irregular course across the county from the northeastern, through the central to the southeastern part. Flowing wells in the parts of Madison and Shelby counties adjacent to the areas in Hancock county where flowing wells occur, indicate that the portion of this water-bearing stratum underlying Hancock County is but a part of a continuous deposit of sand and gravel extending in a north-south direction across this part of the State; and, if so, the water which permeates this stratum is to be considered as an underground stream flowing on the surface of bed rock, whose position has been determined by drainage conditions which existed possibly in part before the first ice sheet which covered this part of the State appeared; existed certainly at least in part subsequent to the withdrawal of that earliest member of the series of glaciers that once covered this county.

Climate.

The general characteristics of the climate of the county are shown in the following tables, data for which has been supplied by Mr. V. H. Church, Section Director of the U. S. Weather Bureau at Indianapolis:

Table I. Mean Temperature and Average Precipitation at Greenfield.

Month.	Mean Temperature. Degrees F.	Average Precipitation. Inches.
January	29.9	2.97
February	29.7	2.68
March	43.2	4.80
April	50.8	3.08
May	61.6	4.22
June	70.6	3.52
July	73.8	3.46
August	73.2	2.78
September	68.2	3.18
October	53.9	3.40
November	42.5	2.56
December	32.1	2.59
Annual	52.5	39.24

Table II. Maximum and Minimum Temperatures.

Highest temperature recorded from 1904 to date.....100° in July, 1911.
Lowest temperature recorded from 1904 to date.....–17° January 7, 1912.

NOTE.—The lowest previous record was —16° in February, 1905.

Table III. Average Dates of Killing Frosts at Greenfield.

Last in spring.....April 21.
First in autumn.....October 16.

It will be observed from the above tables that the precipitation is well distributed throughout the year, so that crops do not ordinarily suffer. Occasionally, however, unusual conditions result in a reduction of the amount of rainfall which cuts down the yield in certain crops for the season; but such losses can to a considerable degree be prevented by a more careful management of the soils, in drainage, and in methods of cultivation adapted to the special conditions present at a given time. (See suggestions at the close of the report for this county.)

The maximum and minimum temperatures given are ordinarily of short duration, as may readily be inferred from the table of mean temperatures given. Temperatures of zero and below often occur when the ground is well covered with snow, which thus acts as a protection to winter wheat and to low fruit plants such as the strawberry plant. In general, however, the fact that zero weather and below is likely to occur each winter is taken into account in determining what varieties of fruit trees, plants, etc., shall be depended upon, and only those are chosen for extensive planting as have proved themselves capable of withstanding the lowest temperatures named.

AGRICULTURE.

Of the 196,480 acres in the county, 94.8 per cent., or 186,190 acres is in farms varying in size from less than three acres to 500 or more. As ascertained by the census of 1910, there are 2,154 farms in the county, of which about one-third include 50 to 100 acres each. In the 10 years from 1900 to 1910 the farming lands in the county increased nearly 100 per cent. in value, being listed in the latter year at a total valuation of $16,598,947, or an average of nearly $90 per acre; while the total valuation of farm property including buildings, implements, domestic animals, etc., adds over $5,000,000 to this amount, making an average of land and farm property together of about $120 per acre.

The following tables taken from the report of the census of 1910, show in condensed form the principal crops raised, the acreage, and the yield per acre; and the number and valuation of the principal kinds of domestic animals and poultry:

Table IV. Principal Crops.

	Acres.	Bushels.	Tons.
Corn	61,637	2,950,148	.....
Oats	15,190	347,295	.....
Wheat	27,853	343,144	.....
Timothy hay	10,283	.....	13,334
Clover alone	3,295	.....	3,549
Timothy and clover mixed	3,273	.....	4,073
Clover seed	.....	837	.....

Table V. Domestic Animals and Poultry on Farms.

	Number.	Value.
Cattle	13,380	$404,592 00
Horses	9,406	996,940 00
Mules	530	68,575 00
Swine	43,707	282,089 00
Sheep	10,911	46,448 00
Poultry	147,540	87,357 00

It will be seen from Table IV that the average yield for corn is a little less than 50 bushels per acre; for oats not quite 23 bushels; for wheat between 12 and 13 bushels; and for hay about 1¼ tons per acre. It is to be noted, however, that on many farms the average yield is much higher than this; from reports received from farmers in response to questions sent out by the State Geologist, and from interviews with farmers while the field work was in progress it is known that yields of 80 bushels per acre for corn, and 20 bushels for wheat are not uncommon under favorable conditions.

It is recognized, however, that the county as a whole does not produce wheat as profitably as corn, and even in the case of the latter crop the yield is not yet up to the average that may be expected when the possibilities of the soil are fully realized. Definite suggestions as to the best methods to be pursued to increase the yield per acre are given at the close of this report.

Of the crops not yet much grown which promise excellent results, alfalfa should probably receive most attention. It is not, however, so much in the introduction of new crops as in more careful work in the case of crops already being grown, that the greatest increase of wealth may be expected.

As a whole the soil of the county is best adapted to heavy farming; nevertheless truck farming is engaged in successfully in some places, and might be profitably extended to the more sandy soils near the streams; even the level to slightly rolling inter-stream areas may, with careful treatment, be made to yield profitable crops of small fruits and vegetables as is being done in some sections to an increasing degree.

Dairying is not as a rule carried on except in a small way in connection with general farming. The total number of dairy cows in 1910 was reported as 6,301; of these but few were in large herds. In most cases where an attempt is made to maintain a herd, the milk or the cream is shipped to neighboring cities; the same method of disposing of the product is used by many who wish merely to have a convenient means of turning into cash the surplus milk for a part of the year. The use of centrifugal separators has very generally replaced the various gravity systems of separating the milk from the cream, wherever the amount of milk to be handled is large enough to justify it.

The chief obstacles to successful agriculture in this county may be enumerated as follows; a part of these obstacles have been largely removed, but much yet remains to be done before the possibilities of production from the soils of the county are realized:

1. The forest growth. This originally covered almost the whole county, consisting principally of oak, ash, walnut, beech, sugar maple, elm, and hickory. In a few places the original growth of timber has remained untouched by the lumberman's axe, as for example in a part of Sec. 23, T. 15 N., R. 5 E. (Fig 5); but about 88 per cent. of the farm land is now free from forests. Some further work in removing forests may possibly be done to advantage; but on the other hand some work in reforestation should be undertaken, especially in some of the more hilly belts.

2. Marshes and swamps. Areas over which water stood for a considerable portion of the year are found in the inter-stream areas near Buck Creek, Brandywine Creek, Sugar Creek, and their tributaries. Of these marshes but few now remain. The opening of large ditches, the deepening and straightening of many small stream channels, and the use of a large amount of tile in underdrains, have resulted in providing adequate means for the rapid removal of water, so that in but few places does it accumulate to the disadvantage of farming operations as it did generally a genera-

FIG. 5. Oak tree in forest in the southwestern part of Hancock County. (Photo by B. W. Kelly.)

tion ago. This does not mean, however, that the work of drainage is complete; it merely means that a prime difficulty, that of getting rid of water on and very near the surface, has been overcome.

3. Lack of sufficient air in the soil. This difficulty is closely associated with the presence of conditions which permit water to stand. Much of the soil is a clay loam which contains a sufficiently large percentage of very fine mineral particles to cause the soil to form into very compact layers or masses, and especially when well moistened to become more or less impervious to air. The work of

earth worms and other forms of animal life, the growth and decay of the roots of plants, and the alternate freezing and thawing in winter, all contribute something to the process of opening up the ground so that the air may have access to some depth. But all of these processes together are not sufficient to accomplish what is needed. The most effective means for most of the soil in the county is an extension of the system of tile drainage until all clayey soils are traversed by lines of tile not less than four inches in diameter, at an average depth of about 30 inches and not more than three to five rods apart. No other method is known which for soils of this kind will result beneficially in so many ways at the same time as in such a system of tile drainage if properly put in. For, in addition to supplying the especial lack here referred to, that of giving a sufficient amount of air to the needed depth in the soil, two other desirable results are accomplished, viz.: (1) The removal of the excess of moisture if any should occur; and (2) the gradual transformation of the soil and subsoil from a stratum compact and almost impervious to air into a layer filled with fine pores which can hold a large amount of moisture ready to be given up to the roots of plants in time of drought.

4. Other difficulties such as ignorance as to the proper management of soils under certain special conditions. Some of these will be referred to under the descriptions of different soil types, and others will be mentioned in the suggestions at the close of the report of the work done in the county.

Origin of the Soils.

The soils of this county are chiefly derived from the disintegration of rock materials left by the glacial sheets which came into Indiana from the north and northeast. As shown by the kinds of rock present in the soil in the form of boulders, pebbles, etc., part of this material came from the outcrop of granites, gneisses, diorites, and other crystalline rocks beyond the Great Lakes; and part came from the limestones, sandstones, and shales outcropping much nearer, that is, within the state; some, indeed, perhaps from points only a few miles away. In addition to this large amount of weathered glacial debris there is also included a small amount of fine mineral matter brought by the winds, and another probably larger amount of decaying vegetable matter which has been mixed with the mineral particles at the surface, giving the black color to the soil as found in streaks and patches in all parts of the county.

Soil Types.

The soil types found in the county with the approximate area covered by each is given in the following table:

Table VI. Soil Types.

Name.	Acres.
Miami clay loam	182,610
Wabash loam	6,250
Carrington black clay loam	5,400
Sioux loam	1,870
Wabash sandy loam	275
Meadow	50
Muck	25

The boundaries between the different types as shown on the accompanying map, are in some places drawn arbitrarily, as for example where the Carrington black clay loam joins the Wabash loam. In such cases the Wabash loam forming the flood plain of a small stream gives place gradually in the up-stream direction to the Carrington black clay loam as the area is reached which was covered with standing water for a considerable part of the year before the better drainage conditions were established. So, too, the boundary between other types is not always clearly marked; for instance, the Miami clay loam sometimes continues as the subsoil for considerable distances beneath the edges of the Carrington black clay loam, forming thus an irregular belt around the latter in which the surface soil is black, but having a yellowish mottled subsoil with some pebbles instead of the silty, drab colored subsoil to be found at the center of the area. In certain places, as in sections a few miles west and southwest of Greenfield, large areas of land with black surface soil have almost everywhere a subsoil practically the same as that of the Miami clay loam; these areas have, in general, been classed as Miami clay loam since the time available for detailed examination was too limited to make any accurate subdivisions of the type.

Miami Clay Loam.

This type includes about 93 per cent. of the total area of the county, and occupies the greater part of the inter-stream areas. Typically it is a light-colored soil formed from the weathering of unassorted glacial till. When deposited by the ice sheets it contained a large percentage of finely ground limestone mingled with much smaller quantities of finely ground shale, true clay, sand

grains, fragments of crystalline rocks, etc. At the surface the finely divided limestone has been leached out to a depth of from two to three feet, the other rock fragments have been much disintegrated, and decaying organic matter has been incorporated to some extent, so that the upper three feet shows in general the following section:

Light buff to light gray soil with few pebbles, 8 to 10 inches.

Yellowish to grayish-brown subsoil, sometimes mottled, usually quite compact, containing up to 4 or 5 per cent. of pebbles and rock fragments of small size, from 8 or 10 inches to a depth of three feet.

Below the depth of three feet, the material is in some cases a continuation of the unassorted glacial till practically to bed rock; but more often where tests have been made by well borings it gives place to sheets of stratified sand and gravel which alternate with strata of unassorted material.

In topography this type is nearly level to gently rolling, and can in nearly all cases be thoroughly drained. Since it occupies the higher points and ridges on which the water does not stand, and since the work of draining the marshes and other low-lying areas has been difficult and expensive, the Miami clay loam is as yet but poorly supplied with the necessary lines of underdraining, necessary not so much for the purpose of draining as for the purpose of aerating the somewhat heavy soil.

The original forest growth on this type of soil included white oak, beech, and walnut; sugar maple where sand is rather more abundant; and elm, hickory and ash in less well drained areas. The principal farm crops now raised are corn, wheat, and timothy and clover hay.

As shown by the mechanical analysis given below, this type has a high percentage of silt, making it thus less difficult to work than would be the case if the clay content were higher. The proportion of finer particles is, however, large enough to make care necessary in the preparation of the soil for crops as well as in the cultivation afterward, in order to avoid the formation of clods which, once formed, often cause trouble for an entire season. The plant food content is in general abundant, but only a small amount is available at any one time, so that the practice of using fertilizers is increasing, with results which seem to justify the expenditure of a considerable amount of time and money in this way. It is to be remembered, however, that the chief advantage from the use of a fertilizer is not always, if indeed ever, because of the actual plant food added to the soil; sometimes it is because the fertilizer destroys com-

pounds in the soil which prevent the healthy growth of crops; sometimes, because the elements of the fertilizer help to set free elements already in the soil. A careful study of the analysis of soils and fertilizers, with equally careful attention to the results gained under different conditions will eventually lead to safe conclusions in regard to the use of the various commercial fertilizers offered for sale.

In general, the Miami clay loam does not produce as much corn per acre as the Carrington black clay loam or the Wabash loam. There are cases, however, of careful farming in which the yield has been made through a series of years to average higher on the light-colored than on the dark-colored soils; so that it seems probable that the possibilities of improvement and permanent fertility are greater for the Miami clay loam than for any other soil type in the county.

Table VII. Mechanical Analysis of Miami Clay Loam. (Average.)

	Coarse Sand. %	Medium Sand. %	Fine Sand. %	Silt. %	Clay. %	Total. %
Soil	8.16	10.15	21.49	46.80	13.20	99.80
Subsoil	5.44	10.83	18.79	40.65	24.25	99.96

Table VIII. Chemical Analysis of Miami Clay Loam.

	Soil, 0″ to 10″.	Subsoil, 10″ to 3′ 0″.
Reaction to litmus	Neutral	Neutral
Moisture in air-dried soil	1.17%	1.11%
Total nitrogen	0.128%	0.049%
Analysis of soil dried at 105° C.—		
Volatile and organic	3.85%	2.50%
Insoluble in HCl (Sp. g. 1.115)	88.90%	89.60%
Soluble silica (SiO_2)	0.21%	0.22%
Ferric oxide (Fe_2O_3)	2.53%	2.63%
Aluminum oxide (Al_2O_3)	2.72%	3.78%
Phosphor. acid anhydride (P_2O_5)	0.64%	0.28%
Sulphuric acid anhydride (SO_3)	Trace	Trace
Calcium oxide (CaO)	0.29%	0.28%
Magnesium oxide (MgO)	0.41%	0.47%
Potassium oxide (K_2O)	0.15%	0.16%
Sodium oxide (Na_2O)	0.16%	0.16%
Total	99.86%	100.08%

Wabash Loam.

This type occupies only a little more than 3 per cent. of the total area of the county, being found as a narrow strip along the larger streams. It consists of a brown loamy to sandy soil 10 to 15 inches

deep, followed by a sandy subsoil to a depth of three feet or more. In places there is some gravel to be found in the soil, with usually a larger percentage in the subsoil; in small areas the gravel may be abundant. The original forest trees on this type of soil include as principal kinds beech, sycamore, elm, and soft maple. Some parts mapped as Wabash loam are still subject to overflow at times of high water, and are consequently not used for cultivated crops. Most of the type is, however, adapted especially to corn, of which excellent crops are raised; tomatoes and other vegetables are successfully grown on limited areas.

The surface of the Wabash loam is nearly level. Occasionally there are slight depressions at the base of the valley slopes, the sites of former bayous now nearly silted up; some such areas are yet undrained and owing to their small elevation above the stream cannot now be freed from the excess of water. The total area of such undrained portions is, however, very small, and with the deepening of the stream channels which is going on in most places these areas can finally be brought under cultivation.

Table IX. Mechanical Analysis of Wabash Loam.

	Coarse Sand. %	Medium Sand. %	Fine Sand. %	Silt. %	Clay. %	Total. %
Soil	6.51	15.02	30.34	39.17	9.90	100.94
Subsoil	5.47	15.18	29.32	39.55	10.22	99.74

Carrington Black Clay Loam.

The total area occupied by this type is less than three per cent. of the whole area of the county, but is distributed in many small, irregularly shaped patches chiefly in the western half of the county as shown on the accompanying map. Typically the soil of this type is 10 to 12 inches deep, black in color, loose under cultivation, and underlain by a drab to dark gray silty clay which is usually very compact and tenacious. In some of the areas mapped as Carrington black clay loam on the accompanying map there is a variation in the soil by an increase in organic content approaching the composition of muck, and in the subsoil by the presence of an abundance of sand. In general the areas belonging to this type are the sites of former marshes or ponds which have been filled up in part by silting up, in part by the accumulation of organic matter which has been incorporated with the soil. The original growth in these areas included elm, ash, some oak and hickory and, characteristically, button bush. When well drained the crop most profitably

grown now is corn, the yield being often from 80 to 100 bushels per acre. It is found, however, that with successive crops of corn without alternation with other crops, the yield diminishes, so that some plan of rotation is necessary to keep the yield up to even a fair average for other types of soil which are naturally less well adapted to corn production.

Before the drainage is complete soils of this type are likely to be sour; this can be corrected by the addition of mineral fertilizers, but best by an adequate system of ditches and under-ground drainage.

Table X. Chemical Analysis of Carrington Black Clay Loam.

	Soil, 0" to 8".
Reaction to litmus	Neutral
Moisture in air-dried soil	3.79%
Total nitrogen	0.306%
Analysis of soil dried at 105° C.—	
Volatile and organic	11.76%
Insoluble in HCl (Sp. g 1.115)	75.78%
Soluble silica (SiO_2)	0.13%
Ferric oxide (Fe_2O_3)	3.34%
Aluminum oxide (Al_2O_3)	5.75%
Phosphor. acid anhydride (P_2O_5)	0.51%
Sulphuric acid anhydride (SO_3)	0.10%
Calcium oxide (CaO)	1.50%
Magnesium oxide (MgO)	0.87%
Potassium oxide (K_2O)	0.33%
Sodium oxide (Na_2O)	0.42%
Total	100.49%

Sioux Loam.

This type occupies less than one per cent. of the total area of the county, and is found chiefly in the southeastern part along Blue River, and in the south central part along Brandywine Creek. In both localities it consists of a light brown or yellowish brown loam 10 to 12 inches thick with some pebbles scattered on the surface, underlain in places at a depth of from two to four feet by stratified sand and gravel sufficiently free from silt and clay to be used as road material. From both the soil and the subsoil above the gravel the calcareous material is practically all removed, the pebbles that remain being with but few exceptions fragments of crystalline rocks, chert, quartz, quartzite, and others which are not easily affected by the processes of weathering. The surface of this type is slightly

rolling, lies in general higher than the Wabash loam, and often between the latter and the Miami clay loam forming the slopes bounding the valleys. It thus constitutes terraces or second bottoms along streams. The drainage is usually good both on account of the surface configuration, and because of the underlying gravel which permits the water which may accumulate on the surface to settle away rapidly through the soil. Crops of all kinds generally do well on this type, the chief difficulty being that in dry seasons sufficient moisture is lacking. On account of the ease with which water passes through the soil it cannot long hold soluble fertilizers.

Wabash Sandy Loam.

One small area in the southeastern part of the county has been mapped as Wabash sandy loam. It lies chiefly in Sec. 35, T. 15 N., R. 8 E., within a valley which is now drained by an insignificant stream, but through which a very considerable amount of water no doubt passed at about the time of the withdrawal of the latest ice sheet. To the sediment deposited at that time has been added the wash from the adjacent hills, a kind of colluvial deposit which while not typically of the Wabash series nevertheless seems to be at least quite similar to what has been described under that name. The soil has a depth of from 10 to 18 inches, contains more fine to medium sand than is usually the case with the Wabash loam, is well drained, and for the most part works loose and mellow. The boundary between this type and the Carrington black clay loam farther up the valley is drawn arbitrarily; the change from the one type to the other is gradual and extends over a considerable distance, the color changing almost imperceptibly to a darker brown, then gray, and finally black, while the texture likewise shades off from the sandy loam through loam to typical clay loam.

Meadow.

Following the usage of the U. S. Bureau of Soils, the term "meadow" is here applied to small areas which are at present too poorly drained to be cultivated satisfactorily, and yet do not have the peaty, marshy character of the areas classified as muck. The composition of this soil cannot be stated accurately, but for the most part mineral ingredients seem to constitute a far larger percentage of the whole than organic matter. These areas are at present used only as pasture ground, but may in time become valuable for general farm crops.

Muck.

In many places small areas of a few acres each are found in which the soil is but little different from true peat. Only two of these areas are of sufficient size to be mapped, but the soil type is of interest to a considerable number of farmers because small patches of it occur in many places, and because soil of this kind has proven somewhat difficult to bring under profitable cultivation. The first difficulty is, of course, with the excess of water; and no method that can be applied will be successful until some system of drainage has reduced the water level to at least a foot, preferably much more than a foot, below the surface. The next difficulty usually becomes more evident in the second year of cultivation than in the first; that is, the looseness or lack of coherence, the "chaffiness" of the soil. The presence of a large percentage of partially decayed vegetable matter, or to state it on the other side, the absence of a sufficiently large percentage of finely divided mineral matter, causes the soil to dry out easily, so that corn, for example, after a short time of vigorous growth suddenly turns yellowish and either remains dwarfed or dies. Usually there is a considerable amount of organic acids present at a short distance below the surface, but if the drainage is good this does not last long in amount sufficient to damage the growing crops. The following methods of further treatment have been found to yield good results:

1. Most satisfactory results have come from a liberal application of stable manure. Several instances are recorded in the county in which one application was sufficient to bring about good crop-growing conditions.

2. Excellent results were secured in a few instances by mixing a considerable quantity of clayey soil with the muck. Where the muck consisted of but a thin layer, this was accomplished by very deep plowing, thus turning up to the surface a quantity of very finely divided mineral particles such as may usually be found below peat or muck. In another case lines of tile ditches were run through the muck area, and the clay thrown up in the work was scattered as widely as could conveniently be done.

3. Log heaps and brush piles burned on peaty soils have in some cases remedied the trouble. This will not suffice in all cases, however, since some such soils will at such a time take fire; and where fires have burned over considerable areas the possibility of profitable corn production has been postponed for an indefinite period.

4. The use of commercial fertilizers strong in potash has been reported as successful in one case. There is, however, some doubt as to the general efficacy of this method, since results reported do not in all cases agree.

SUGGESTIONS.

As a result of the work done in this county, the following suggestions are offered as pointing the way to what should be done as rapidly and as thoroughly as possible to increase the productiveness of the soil:

I. First in urgency is the need of more systematic and more extensive systems of drainage. This applies to practically all soils in the county except to parts of the Sioux loam; in only a few isolated instances are the farms in the county adequately supplied with proper drainage systems. It is not possible in the space properly allotted to this report to make clear the reasons for thus emphasizing a work which in some parts of the county has, it is true, been well begun. The following summary of the benefits of thorough drainage will, however, suggest the importance of the subject; the summary is taken in substance from Bulletin 254 of the Agricultural Experiment Station of the College of Agriculture of Cornell University:

1. Drainage removes the excess of water from the surface and from the pores of the soil.

2. Drainage is directly operative to change an unfavorable physical condition into a desirable one; such as to change a puddled, impervious soil into a granular, more open one.

3. Drainage increases the amount of moisture available to crops. Well drained soil, instead of allowing so large a proportion of the rainfall to drain away as is commonly believed, absorbs and retains a larger proportion than would be otherwise possible, and so makes it available in times of dry weather.

4. Drainage promotes the aeration of the soil; that is, the entrance into the soil of the external air, supplying the oxygen needed for the proper growth of living organisms in the soil.

5. Drainage permits the soil to maintain a higher average temperature than is possible in a wet soil, and thus by making a warmer soil lengthens the growing season for plants.

6. Drainage increases the available food supply by increasing the chemical activity in the soil.

7. Drainage enables a plant to make a better use of the food and moisture supply in the soil.

8. Drainage greatly reduces the injury to winter crops resulting from the freezing of large amounts of water in the soil.

9. Drainage reduces or prevents the erosion or washing of soils on a slope.

10. Drainage increases the yield of crops. It is known that the returns from cultivated land can be increased from 10 per cent. to 100 per cent. without any corresponding increase in other expenses.

Further particulars as to the best methods of putting in systems of drainage, with estimates as to cost, etc., can be secured from the above named bulletin which may be procured by addressing the Director of the Experiment Station at Ithaca, N. Y., or from Bulletin 199 of the Agricultural Experiment Station of the University of Wisconsin, to be procured by addressing the Director of the Agricultural Experiment Station of the University of Wisconsin, at Madison, Wis.

II. What commercial fertilizers can be used to advantage, what methods of culture are best, what rotation of crops to use, whether the sale or the feeding of grain is more profitable, and similar questions, cannot be answered in a general report such as this of necessity must be. But with the information in this report as a basis, further detailed suggestions as to what is probably best to be done in each separate case can be obtained by addressing the Director of the Indiana Agricultural Experiment Station at Purdue University, Lafayette, Indiana, giving as fully as possible all the particulars in regard to the kind of soil, kinds of crops raised, and the results obtained thus far.

SHELBY COUNTY.*

LOCATION.

Shelby County is located southeast of the central part of the State and is bounded as follows: on the north by Hancock County; east by Rush and Decatur counties; south by Decatur and Bartholomew counties; and west by Johnson and Marion counties. It includes 408 square miles, lying in townships 11, 12, 13 and 14, north, ranges 5, 6, 7 and 8, east, of the U. S. Land Survey.

[* The geological formations and the soils of Shelby County are in part very similar to those of Hancock County. In so far as the characteristics of the two counties are practically identical, the discussion for Hancock County will not be repeated; such parts of the latter report, however, as should be read in order to insure a full understanding of the conditions in Shelby County, will be indicated in the appropriate connection in each case.—A. D. H.]

HISTORY.

The area now included in Shelby County was once a part of the territory occupied by the Delaware Indians. Two years after Indiana was admitted as a State, a treaty was made with the Indians by the Government according to the provisions of which they sold their land, but retained the right of occupation for two years more, or until 1820. Some settlements were, however, made before the Indians withdrew, the first being on Blue River not far from the present site of Marion in the autumn of 1818. The county was organized under an act of the Legislature, in 1821, and was named Shelby County in honor of Isaac Shelby, an officer in the Revolutionary War and War of 1812, and at one time Governor of Kentucky.

Following the organization of the county, settlements were made in increasing number, and the work of removing the forests, draining the marshes, and making roads went steadily on. In the year 1850 Shelbyville, the county seat, was incorporated, and within the next ten years a dozen villages were laid out in different parts of the county. At present about 90 per cent. of the farm land has been put in condition for cultivation, and the roads which reach every section of the county are for the most part gravelled and kept in good repair. Four railroads and two electric lines cross the county, affording thus convenient means of travel, and giving also transportation facilities for produce within reasonable distance of even the most remote sections.

GEOGRAPHY AND GENERAL GEOLOGY.

In general the surface is level to gently rolling, with its average slope to the west of south. In certain parts of the county the natural drainage was so poorly developed that many ponds and marshes existed when the first settlers came into the county. This was particularly the case in the strip of low-lying land extending southward from Shelbyville, still referred to occasionally as "The Slough." The removal of so large a percentage of the forests, and the systematic efforts at drainage have now so far reduced the water level that nearly all of these former marshes can be cultivated. Two poorly drained areas of small extent are shown on the accompanying map; one, two miles southeast of Waldron; the other one-half to three-fourths of a mile west of Boggstown; in a number of other places similar areas, too small to be mapped, are found.

With the exception of a few small areas in the southeastern part

from which the water flows into tributaries of White River, the entire county is drained by Flat Rock Creek, Big Blue River and their tributaries. Big Blue River traverses almost the entire length of the county, entering at the north end three and one-half miles from the east side, and leaving on the west side a little more than two miles from the southern boundary. Within the county it receives as tributaries Little Blue River, which enters from the east at Shelbyville; and Brandywine Creek which joins it from the north nearly five miles farther to the west. Sugar Creek with its tributaries Little Sugar Creek and Buck Creek, drains the northwestern part of the county and joins Blue River a few miles beyond the county line in the southeastern part of Johnson County. The interstream areas are in general flat to gently rolling. Rather notable exceptions to this are found in the very prominent drift hills in the southwestern part of the county near Mt. Auburn, and to the east and northeast of Marietta. Near the valleys the topography is often very hilly. This is particularly the case of the slopes adjacent to Flat Rock Creek, for here the underlying rock is near the surface and contributes somewhat to the formation of more pronounced irregularities of surface.

The underlying rock in this county has been determined to be Silurian and Devonian in age; outcrops are found in numerous valleys in the southeastern part near Waldron and St. Paul, and in the bed of Blue River at Shelbyville. The hills, ridges, and interstream areas are, however, even here practically all covered with soil which is made up largely of material derived from the weathering of glacial debris. Occasionally there are areas in this part of the county where the increased number of chert fragments and the scarcity of glacial pebbles suggest a close approach to a residual soil; but even at such places there are no considerable areas in which the usual clear signs of the glacial origin of the soil are lacking. Over much of the county the drift covers the bed rock to depths varying up to 100 feet or more, consisting of alternating layers of glacial till, sand, gravel, etc., some of which is assorted and was deposited as sediment from currents of flowing water, and some a heterogeneous mixture of finely ground rock, clay, silt, sand, pebbles and boulders, with the addition in places of fragments of tree trunks, roots, leaves, grasses and other organic matter. In general, the inter-stream areas may be said to consist more commonly of unassorted drift, that is, of glacial debris in the form of morainal masses; while near the streams the material near the surface is

more largely assorted, some no doubt having been laid down by the waters which flowed from the disappearing ice-sheet, but some deposited by waters of a much more recent time.

As has been noted by various observers, a part of the county evidently received a considerable coating of loess, which has now become mixed to a greater or less extent with other material, forming a soil high in its percentage of silt, and where the loess was especially large in amount, producing a soil lighter and more porous than is usually to be found in glacial soils outside loessial areas. At a few isolated points both soil and subsoil were found to be practically alike, made up of almost typical loess such as is found for instance on the bluffs at Muscatine, Iowa, at Kansas City, Mo., or at Omaha, Neb.; all such places found were, however, too small to be mapped.

Usually the soil to a depth of from 10 to 15 inches is very silty, free from clods or pebbles, and light buff in color, while the subsoil is much more like the subsoil of the moraines, that is, made up of clay or finely ground rock along with some silt, sands, and occasional pebbles of various kinds and sizes. Over considerable areas, moreover, even in the southern part of the county, the surface material was not found to be noticeably silty or loess-like. A few cases in the west central part of the county are shown on the accompanying map of soils classed as Knox silt loam; these are more pronounced in type both as to soil and subsoil than the majority of the areas which show a pronounced loessial character at the surface. With the exception of these areas of silt loam, it may be said, roughly, that the valley of Big Blue River divides the county into two divisions on the basis of the abundance of the silt or loess contained in the upper layers of the soil; the division to the east and south of the river showing a higher percentage of loess than that to the north and west.

Reference has been made in the report on Hancock County (page 35) to certain valleys which evidently were formed by streams of water flowing under conditions very different from those which exist today. Shelby County likewise affords examples of valleys of this kind, but on a much more extensive scale. The principal places in which it is evident that former drainage conditions were strikingly different from those of the present, are as follows:

1. As is indicated on the accompanying map by the areas marked Sioux loam, waters at one time passed, in the north central part of the county, either from the valley of Brandywine Creek

to that of Big Blue River, or in the contrary direction; or, possibly, the waters may have passed, some of the time one way, some of the time the other.

2. At Shelbyville, waters no doubt once flowed southward from the Blue River valley along "The Slough," later to join with the waters of Lewis Creek and Flat Rock Creek, or possibly in part to return again into the Blue River valley between the high gravelly hills northeast of Marietta. A fuller description of "The Slough" will be given in discussing the Sioux loam type of soil; but it may be said here that for three miles south of Shelbyville this valley, three-fourths of a mile to a mile wide, is at present drained only by underground movement of the water, by lines of tile drains, or by insignificant surface streamlets. Present drainage conditions could never account for the formation of such a depression.

3. Two and one-half to three and one-half miles northward from Marietta, waters from the valley of Blue River at one time spread westward, flowed thence in a southwesterly direction, and dividing a mile and a half or more northwest of Marietta, separated into two streams one of which returned to Blue River, while the other passed over into the valley of Sugar Creek. This inference, based on the topographic and areal relations involved, is confirmed by a record made some 20 years or more ago when the water from Blue River at flood was seen to flow westward at the southern side of the gap indicated about two and one-half miles north of Marietta, disappearing in this case, however, before reaching Blue River again by sinking away into the somewhat gravelly loam which is found in the old stream channel.

Economic Geology.

The principal economic products found in the geological formations of the county are (1) gravel, (2) limestone, and (3) an abundant supply of water.

Gravel.—As in Hancock County, the deposits of gravel near enough to the surface to be taken out economically are found in or near the larger valleys; considerable deposits in the inter-stream areas are, however, not wanting, especially in the prominent hills in the southwestern part of the county. The location of the principal gravel pits in use in 1905 is given by Mr. E. J. Cable in the Thirtieth Annual Report of the Department of Geology of the State. As shown by him, there are certain parts of the county not supplied with sufficient gravel of quality suitable for road making, and as a consequence a long haul is necessary in such sections. Other

deposits have, however, become available since that time, as for example, the stratum lying a few feet below the surface in the old valley southward from Shelbyville. At a point about one-fourth of a mile northeast of Fenn's Station, in the north half of Sec. 30, T. 12 N., R. 7. E., gravel is being taken out by means of an endless chain to which small buckets are attached, some such method being necessary because the ground water level is here not more than five or six feet below the surface of the valley bottom. The section so far as exposed by the work here is as follows:

FIG. 6. Gravel dipped by means of buckets attached to an endless chain. Near Fountaintown, Shelby County. (Photo by B. W. Kelly.)

1. Loamy soil with pebbles mostly of cherts, granites, diorites, and other crystalline rocks, and much deecayed gneisses, three feet.
2. Stratified sand and gravel, containing a large percentage of limestone pebbles and very subordinate amounts of little weathered crystalline rock fragments, 22 feet.
3. Compact till (unassorted glacial material), to an undetermined depth.

A majority of the roads in the county are gravelled and kept in good repair; a very considerable percentage of the road mileage is, however, little improved beyond grading and the construction of such bridges and culverts as are most needed.

Stone.—Limestone for building and for burning into lime is quarried at a number of points in the southeastern part of the county, notably near St. Paul. Some of the strata, as pointed out by State Geologist Collett in the Eleventh Annual Report of the Department of Geology and Natural History of the State, are suitable for road material, but so far but little use has been made of them for this purpose.

Underground Water.—The underground water supply over the greater part of the county is contained in beds of sand and gravel, and is reached by wells varying in depth from five or six to 100 feet or more. While in many places a permanent supply of water may be obtained from shallow wells, considerations in regard to health have prompted the sinking of an increasing number of tubular wells to a depth sufficient to secure a supply which is free from the injurious compounds so generally found at certain times of the year, at least, in surface waters.

As noted in the report for Hancock County, the belt within which flowing wells occur extends into the northern part of this county, those at Morristown being the examples best known. What the limits of this low-lying water-bearing stratum may be has not been determined.

CLIMATE.

The climatic conditions are but slightly different from those in Hancock County. The following tables give the data from observations made at Shelbyville, and are furnished for this report by Mr. V. H. Church, Section Director of the U. S. Weather Bureau at Indianapolis:

Table XI. Mean Temperature and Average Precipitation at Shelbyville.

Month.	Mean Temperature. Degrees F.	Average Precipitation. Inches.
January	30.8	3.04
February	29.7	2.90
March	43.8	3.17
April	51.4	3.76
May	63.0	4.75
June	71.4	4.25
July	74.3	4.79
August	73.6	3.18
September	68.1	3.44
October	55.3	4.12
November	41.8	2.75
December	31.2	3.01
Annual	52.9	43.16

Table XII. Maximum and Minimum Temperatures.

Highest temperature recorded from 1905 to date, 103° in July and also in August, 1911.

Lowest temperature recorded from 1905 to date, –18° on January 7, 13, and 16, 1912.

NOTE—The lowest previous record was 17° below zero, Feb. 1905.

Table XIII. Average Dates of Killing Frosts at Shelbyville.

Last in spring	April 21
First in autumn	October 15

It will be observed by comparing the data for the three counties here considered that the chief difference in the climatic conditions is that the precipitation is greatest in Shelby County, the increased amount being well distributed throughout the year.

AGRICULTURE.

Of the 260,480 acres in the county, 96.7 per cent. or 251,903 acres, is in farms varying in size from less than three to over 500 acres. As ascertained by the census of 1910, there are 2,702 farms in the county, of which over one-half (58 per cent.) include 50 to 175 acres each. The farming land in the county increased a little more than 100 per cent. in value in the 10 years from 1900 to 1910, being listed in the latter year at a total valuation of $24,890,457, or an average of nearly $100 per acre; while the total valuation of farm property including buildings, implements, domestic animals, etc., adds about $6,500,000 to this amount, making an average valuation of land and farm property together of nearly $125 per acre.

The following tables taken from the report of the census of 1910, show in condensed form the principal crops raised, the acreage, and the yield per acre; and the number and valuation of the principal kinds of domestic animals and poultry:

Table XIV. Principal Crops.

	Acres.	Bushels.	Tons.
Corn	85,829	4,092,210	
Oats	4,949	106,075	
Wheat	58,354	755,387	
Timothy hay	7,983		10,537
Clover alone	9,109		10,937
Timothy and clover mixed	3,981		5,495
Clover seed		7,057	
Potatoes	666	65,824	

Table XV. Domestic Animals and Poultry on Farms.

	Number.	Value.
Cattle	15,759	$462,408
Horses	12,795	1,258,540
Mules	860	105,990
Swine	49,631	306,080
Sheep	10,751	46,468
Poultry	180,468	111,438

The general conditions in regard to farm crops is much the same as in Hancock County, and practically all that has been said under the heading of Agriculture in the report for that county applies also to Shelby County. The principal differences to be noted are (1) that the soil in the inter-stream areas in Shelby County has, especially in the southern part, a somewhat higher average content of silt, which has the effect of making the soil in general somewhat more loose and easily worked; and (2) that there is in Shelby County a very much larger proportion of the acreage which is underlain at a depth of a few feet by sufficient sand and gravel to insure excellent drainage except at times of unusual precipitation. The treatment of these somewhat gravelly, well drained soils should, of course, be very different from that given to the heavier, more compact types; tile drains need not be laid so close together as in the more clayey soils, and fertilizers of different composition are usually to be chosen.

The presence of considerably larger areas of well drained, looser, warmer soils has made profitable the introduction of truck farming to a much larger extent than in Hancock County. At present, tomatoes and sugar corn are the crops most largely grown, the entire yield being in most cases disposed of to canning factories.

Origin of the Soils.

As in the case of the soils of Hancock County, the soils of this county owe their origin chiefly to the work of the great ice sheets which once covered this part of the State, and to the agencies and processes that accompanied them. In Shelby County the chief differences to be noted are as follows:

1. So far as the surface layers are concerned, there is much more assorted drift than in Hancock County; that is, more sand and gravel at and near the surface, much of it in stratified beds, covered now more or less completely by a layer of soil which is due to processes of weathering and the effects of the growth of

plants since these deposits were made. The presence of stratified drift in larger amounts than in Hancock County implies the former presence of a correspondingly greater abundance of water, which is to be accounted for by the fact that the county, lying as it does farther down the inclined surface over which the ice moved, has been obliged to accommodate in its various drainage channels not only the water formed from precipitation and the melting of ice within its own borders, but also the water coming from the greater area of the higher slopes above. This has resulted in the presence of a larger proportion of gravelly and sandy soils.

2. The presence of a larger proportion of silt in the upper layers of the soil, especially in the southern part of the county. This is due primarily to the greater amount of loess deposited here chiefly by the agency of the wind at some time after the withdrawal of the ice.

SOIL TYPES.

The following table gives the names of the soil types found in the county, with the approximate area covered by each:

Table XVI. Soil Types.

Name.	Acres.
Miami clay loam	207,755
Sioux loam	26,690
Wabash loam	22,760
Carrington black clay loam	2,000
Coloma sandy loam	455
Knox silt loam	385
Wabash fine sandy loam	280
Miami gravelly loam	80
Meadow	50
Wabash sandy loam	35
Muck	20

The boundaries between the different types as shown on the accompanying map is in some cases drawn arbitrarily, as for example in places where Carrington black clay loam joins Sioux loam, especially in the areas southwest of Boggstown and northeast of Fairland. Much detailed work, including many more borings than the time allotted for the field work permitted, would be necessary in order to establish the boundaries with complete accuracy; in general, however, the lines mark approximately the place where the character of the soil changes.

In some cases, as for example in the Sioux loam, the character-

istics of the soil vary somewhat from place to place within the boundaries indicated for the type; this grouping of somewhat different soil types under one name has also been necessary because of the large amount of time which would have been required to determine the boundaries of these minor subdivisions. Further reference to variations of soil characteristics in a given soil type will be made in connection with the detailed description of types farther on.

Miami Clay Loam.

This type includes about four-fifths of the total area of the county, occupying in general the areas between the streams. In most places it consists of a light colored soil 8 to 12 inches deep, with a rather high percentage of silt, underlain by a compact yellowish to grayish brown mottled subsoil containing a higher percentage of clay than the soil together with some pebbles and small rock fragments. Occasionally in the areas between the streams, patches of other types are found, as for example, the Carrington black clay loam occupying shallow depressions in the surface, and the Coloma sandy loam or the Miami gravelly loam, which rise either as islands from the mass of morainal material from which the Miami clay loam has been formed, or as accumulations deposited on top of the general morainic surface. In certain places within the area mapped as Miami clay loam frequent strips and patches of dark gray to black soil occur; a majority of such areas within the county have a subsoil very similar to that of the typical light colored areas adjacent; some, however, of size large enough to be of importance to the owner, yet too small to be mapped accurately, have a drab to gray silty subsoil, or even in some cases a subsoil containing abundant sand and gravel. Such variations are, however, not common.

The chief differences between the Miami clay loam in Shelby County and that in Hancock County are (1) the general presence in Shelby County of a larger amount of silt deposited originally as loess; and (2) the presence in places in the southeastern part of Shelby County of a noticeable amount of material derived from the weathering of the underlying bed rock which is here near the surface. In character of original forest growth there is to be noted the presence in Shelby County of an increased number of sassafras bushes and trees, and, especially in the southern part, the presence of a larger number of tulip trees (commonly known as yellow pop-

lar), of large size; stumps of trees of the latter species still remaining show a diameter of trunk of six to seven feet or more.

For a discussion of questions relating to drainage and the use of fertilizers on this type, see the report for Hancock County, pages 55 and 56, the conditions on the Miami clay loam in the two counties with respect to these matters being much the same:

Table XVII. Mechanical Analysis of Miami Clay Loam.

	Coarse Sand. %	Medium Sand. %	Fine Sand. %	Silt. %	Clay. %	Total. %
Soil	7.02	7.82	20.87	51.89	12.68	99.98
Subsoil	3.65	5.63	17.23	50.18	23.29	99.98

Table XVIII. Chemical Analysis of Miami Clay Loam.

	Soil, 0″ to 11″.	Subsoil, 11″ to 3′ 0″.
Reaction to litmus	Neutral	Neutral
Moisture in air-dried soil	1.22%	2.88%
Total nitrogen	0.079%	0.43%
Analysis of soil dried at 105° C.—		
Volatile and organic	2.82%	3.33%
Insoluble in HCl (Sp. g. 1.115)	90.00%	83.74%
Soluble silica (SiO_2)	0.15%	0.22%
Ferric oxide (Fe_2O_3)	2.50%	4.47%
Aluminum oxide (Al_2O_3)	3.12%	6.36%
Phosphor. acid anhydride (P_2O_5)	0.35%	0.24%
Sulphuric acid anhydride (SO_3)	0.02%	Trace
Calcium oxide (CaO)	0.32%	0.48%
Magnesium oxide (MgO)	0.35%	0.77%
Potassium oxide (K_2O)	0.11%	0.26%
Sodium oxide (Na_2O)	0.22%	0.39%
Total	99.96%	100.26%

Sioux Loam.

This type occupies about one-tenth of the total area of the county and includes some of the most productive land now under cultivation. There are here included under this name several variations from the type described under the name Sioux loam by the U. S. Bureau of Soils. The most general characteristics of the type as mapped in this county are (1) the loamy to sandy character of the soil, which extends to a depth of from 10 to 12 inches and contains up to 10 per cent. of gravel scattered through it; and (2) the increasing amount of gravel and sometimes of finer soil particles

as well in the subsoil, which sometimes at a depth of three or four feet rests upon beds of stratified sand and gravel. The prevailing color of the soil is light brown; but this shades off in places into gray and even black as the content of organic matter increases; in other places into yellowish or reddish brown colors as the iron oxide present predominates. Topographically, the Sioux loam is level to gently rolling, by far the greater part being nearly level; low hills and ridges 8 to 10 feet above the general surface, however, occur.

In its relation to other types the Sioux loam lies, in general, between the Wabash loam found near the streams, and the Miami clay loam which forms the slopes bounding the valleys, the general elevation of its surface in such cases being intermediate between the two. In the case of the old valleys referred to, which are not now occupied by streams of any considerable size, the Sioux loam often fills the entire valley as shown in the area south of Shelbyville; in other places areas of Carrington black clay loam are surrounded by Sioux loam, as in the old valley northeast of Fairland. Here the change of drainage conditions seems to have left certain depressed areas which, for a long time the site of ponds, have finally filled up by the slow washing in of silt and the accumulation of organic matter.

The drainage is as a rule good; in the case of the terrace-like portions, both on account of its topographic position and on account of the abundance of gravel and sand which lies at a short distance below the surface; in the case of the areas lying lower down in the valleys because of the porous character of the soil alone. Some portions, especially those surrounding former depressions in old valleys, are, however, in some places in need of additional ditches or lines of tile drainage, and the suggestions given on pages 55 and 56 of the Hancock County report apply.

Table XIX. Mechanical Analysis of Fine Earth of Sioux Loam.

	Coarse Sand. %	Medium Sand. %	Fine Sand. %	Silt. %	Clay. %	Total. %
Soil	21.71	11.19	12.95	44.52	9.43	99.80
Subsoil	23.36	10.46	11.91	34.32	20.11	100.16

NOTE.—In the above sample, the following percentages of pebbles and gravel above 2.0 mm. in diameter were found:

Soil, to a depth of 9 inches..... 9.50%
Subsoil, 9 inches to 1 foot 6 inches..... 20.40%

The amount of gravel at 1 foot 6 inches below the surface became too great to permit the auger used in obtaining the sample from penetrating deeper.

The Sioux loam is in general considered a rich soil, but the yield of wheat, especially, is very much increased by the use of commercial fertilizers. Fertilizers sold under a guarantee of a minimum of constituents as given below, used on soil of this type in 1911, at the rate of 150 pounds per acre, seemed to produce a notable increase in yield:

Table XX. Constituents of Fertilizers Used for Wheat.

	A.	B.
Total nitrogen (N)	0.8%	1.2%
Potash soluble in water (K_2O)	4.0%	2.5%
Soluble and reverted phos. acid (P_2O_5)	8.0%	8.0%
Insoluble phosphoric acid (P_2O_5)	1.0%	1.0%

Wabash Loam.

This type of soil occupies a little less than nine per cent. of the total area of the county, and consists of a brown to a dark brown or nearly black loam 10 to 15 inches deep, followed by a subsoil which sometimes differs but little in composition though sometimes having an increased proportion of sand. Locally gravel is abundant; in other places the usually loamy character of the soil gives place to strips and patches of a silty or even clayey soil rich in organic matter, the sites of former bayous or other depressions in the flood plains of streams which have gradually filled up with material finer than that of which the flood plain, in general, is composed. These areas in some places approach muck in composition, but in only two points in the county were they found to be sufficiently large and well marked to be indicated on the map. As shown on the accompanying soil map of the county, the Wabash loam occupies the areas next to the streams, forming the low, rich, level first bottoms, which are especially well adapted to corn.

A chemical analysis of soil of this type is given below; for mechanical analysis, and for further details as to topography, etc., see the discussion of Wabash loam in the report for Hancock County, pages 50 and 51.

Table XXI. Chemical Analysis of Wabash Loam.

	Soil to a Depth of 12 Inches.
Reaction to litmus	Neutral
Moisture in air-dried soil	2.19%
Total nitrogen	0.238%
Analysis of soil dried at 105° C.—	
Volatile and organic	7.14%
Insoluble in HCl (Sp. g. 1.115)	82.02%
Soluble silica (SiO_2)	0.12%
Ferric oxide (Fe_2O_3)	3.98%
Aluminum oxide (Al_2O_3)	4.81%
Phosphor. acid anhydride (P_2O_5)	0.32%
Sulphuric acid anhydride (SO_3)	Trace
Calcium oxide (CaO)	0.64%
Magnesium oxide (MgO)	0.56%
Potassium oxide (K_2O)	0.25%
Sodium oxide (Na_2O)	0.23%
Total	100.07%

Coloma Sandy Loam.

This type is represented by a few hills and ridges in various parts of the county, which, in general, rise notably above the general level. As shown by the mechanical analysis below, the percentage of sand grains medium in size is high, but enough finer particles are present to make the soil well adapted to general farm crops. In part these hills seem to be due to the work of the wind. and so far are to be regarded as weathered sand dunes. There is a noticeable absence of all pebbles or rock fragments above the size of coarse sand grains. The color of the soil is light buff to light gray, changing gradually into a somewhat reddish brown subsoil at a depth of 10 to 12 inches. As is the rule with sandy soils in such locations, the drainage is good; as is also usually the case with naturally well drained soils, crops are likely to suffer on account of the lack of sufficient moisture in times of drought. It is to be noted, however, that there is seldom a season in which the moisture is not sufficient in amount to insure at least a fair crop. Corn and wheat are grown successfully on this type, but it is also well adapted to truck farming.

Table XXII. Mechanical Analysis of Coloma Sandy Loam (average).

	Coarse Sand. %	Medium Sand. %	Fine Sand. %	Silt. %	Clay. %	Total. %
Soil	22.88	42.39	12.08	13.02	9.36	99.66
Subsoil	23.84	41.42	12.53	7.79	14.27	99.85

Miami Gravelly Loam.

Like the Coloma sandy loam, the Miami gravelly loam is found only as prominent hills and ridges; but unlike the former it contains an abundance of pebbles and gravel, with occasional boulders. In part the materials of which it is composed are stratified, and sufficiently free from the finer particles of mineral matter to make excellent road material. In part, however, it is unstratified, made up of the heterogeneous mixture of materials characteristic of glacial debris; so that these hills, made up partly of unassorted morainal material, partly of assorted outwash materials, are to be classed as kames closely associated with morainal sheets and ridges. The soil is in general not well adapted to the production of farm crops, but is used largely as pasture land. It will be noted, however, that the total area of this type within the county is small.

Other Types.

The other types found in the county, all small in amount of area covered, are as follows: Carrington black clay loam, Wabash sandy loam, Wabash fine sandy loam, Knox silt loam, Meadow, and Muck; the location of each of these types is shown on the accompanying map. For the description of all except the Knox silt loam and the Wabash fine sandy loam, the report on Hancock County may be consulted, since the characteristics there named are practically the same for the like-named types in Shelby County.

The Knox silt loam, and the Wabash fine sandy loam are each small in area; the former being found in areas sufficiently large to be mapped only in the west central part of the county; the latter in a single tract along the south side of Flat Rock Creek.

The Knox silt loam as here mapped differs from the Miami clay loam found in the southern part of the county chiefly in the larger percentage of silt in the subsoil. As has been remarked already, the percentage of silt at the surface is high, but in the subsoil the increased proportion of finer particles and the common occurrence of pebbles such as characterize the moraines, seem to require the reference of the greater part of the light colored upland soils to the Miami clay loam. In numerous small areas, however, the subsoil has also a high percentage of silt with fewer pebbles, and in such places the soil is referred to the Knox silt loam type. The general characteristics as to topography, crop adaptation, etc., are much the same as for the adjacent areas of Miami clay loam.

The Wabash fine sandy loam differs from typical Wabash loam,

which it much resembles, in the larger percentage of fine sand and in the lower percentage of finer particles. It consists of a soil 12 to 15 inches deep of dark brown color, and a subsoil to a depth of 2 feet, 6 inches, containing a rather larger percentage of brownish to grayish sand underlain by a stratum which includes an abundance of gravel. The area is in general well drained, but is not uniformly productive. In the parts lying near to the hills of Miami clay loam to the south and southeast, the proportion of finer particles in the soil increases, becoming a true loam; the transition belt is, however, narrow and has not been separated on the map from the more sandy portion nearer the stream.

SUGGESTIONS.

The suggestions given at the close of the report for Hancock County, page 55, apply also to Shelby County, with the exception that the fact that there is a larger percentage of soil of the Sioux loam type alters somewhat the degree of emphasis placed upon the question of drainage when applied to the county as a whole. But even in the case of the Sioux loam, the extension of systems of drainage is not only desirable but important.

JOHNSON COUNTY.*

LOCATION.

Johnson County is located south of the central part of the State, and is bounded as follows: On the north by Marion County; east by Shelby County; south by Brown and Bartholomew counties; and west by Morgan County. It includes 320 square miles lying in townships 11, 12, 13 and 14 north, ranges 3, 4 and 5, east, of the U. S. Land Survey.

HISTORY.

The area now included in Johnson County, like that of Shelby County, was once a part of the "New Purchase," a tract of land purchased from the Delaware Indians in 1818. At about the same time the first step toward the settlement of the region was taken

* The characteristics of the soils of Johnson County are in many respects quite similar to those of Hancock and Shelby counties, described in the preceding parts of this report. In so far as these characteristics are practically identical, the discussion will not be repeated; such parts of the reports of the two counties last named, however, as should be read in order to give a full understanding of the conditions in Johnson County, will be indicated in the appropriate connection in each case.—A. D. H.

by Jacob Whitzel, who marked out a trail through the wilderness from his home in Franklin County as far west as to the bluffs of White River. Along this "trace" and along an old Indian trail crossing the county from south to north, the earliest settlers came, making settlements in 1820 near Edinburg in the southeast corner of the county, and at the mouth of Pleasant Run in the northwest corner. In 1821 the first settlements were made at or near the present site of Franklin, and in the following year the county was organized and named Johnson County in honor of Judge John Johnson, a judge of the Supreme Court. From this time on the number of settlements increased and the work of conquering the wilderness kept pace here with the precisely similar work being carried on by pioneers in the adjoining counties. As in the adjacent parts of the State, the work of removing the forests, draining the land, building houses, and making roads, called for continued efforts under conditions which were at times most trying; for not only were many of the comforts of life lacking, but also even necessities were at times exceedingly difficult to procure, and added to hardships of all other kinds, was that of the prevalence of malarial diseases in many places, which if not so immediately fatal as some others, nevertheless drew heavily on the resources of strength and hope which are such necessary elements of success for men and women who at any time are in the midst of the accomplishment of great tasks. That the task undertaken by these pioneers has been carried well toward completion, is shown by the fact that of the total area of farm land in the county about 85 per cent. has been cleared and put in good condition for cultivation.

Means of easy communication is provided for practically all parts of the county by a system of roads, most of which are well gravelled and kept in good repair, and by railroads which bring transportation facilities within reasonable distance of even the most remote sections. Of the latter there are three crossing the county, together with one electric line.

The present population of the county as ascertained by the census of 1910, is 20,394 of which by far the larger per cent. is made up of those who live on farms; those whose business interest, therefore, has for its principal object the development of the resources of the soil.

GEOGRAPHY AND GENERAL GEOLOGY.

The surface of the county is made up of two distinct types of topographic features, viz.: (1) level to gently undulating plains, and (2) areas much dissected, hilly and broken. The latter is found especially in the southwestern and western parts of the county, the former in practically all of the remaining part.

The entire county is drained by White River, Blue River, and their tributaries. Roughly speaking, the western one-third belongs to the drainage system of White River, which crosses the extreme northwest corner of the county. Most of its tributaries which rise within the borders of the county cross the county line and join the main stream some miles to the west and southwest. Blue River crosses the extreme southeast corner of the county, but receives within the limits of the county Sugar Creek, which with its principal tributary, Young's Creek, and numerous smaller branches, drains all the remaining area. The highest ground in the county constitutes, therefore, a broad, flattened ridge or watershed extending in a north-south direction three or four miles west of the central line of the county, and bending eastward at both its north and south ends to reach points at or beyond the middle north-south line. The top of this watershed and most of the area lying to the east of it forms the level to gently undulating plain already referred to; the area lying to the west of the watershed is, in the southern half of its extent generally hilly and broken.

The underlying bed rock is, in the western and southwestern portion, a part of the Knobstone group of the Mississippian formation; over the remainder of the county, members of the Devonian. Outcrops of the Knobstone group occur frequently in the valleys, extending in some cases well up to the heads of the streams on the western side of the divide, and contributing to the conditions which have made the broken, hilly topography already referred to. Only to a slight degree has the material of this formation contributed to the constituents of the soil now covering the hills and ridges between the numerous valleys in which the outcrops occur. Outcrops of the Devonian shale are very rare in the county, only one place being cited in the Thirteenth Annual Report of the State Geologist, where the geology of the county is discussed.

The geologic formations of chief importance so far as the soils are concerned are (1) the great sheet of glacial debris of Pleistocene age, and (2) the modified Recent forms which this material has assumed under the influence of agencies operating since the ice

withdrew. The amount and character of the glacial deposit varies considerably in different parts of the county, from comparatively thin, notably loessial patches in the southwestern part, to typically morainal deposits farther north which reach a maximum thickness of possibly nearly 200 feet.

Of the morainic areas, perhaps the most striking is the series of ridges and hills extending a little south of east from Greenwood to within two miles of the eastern boundary of the county. One of the most noticeable features about this moraine is the number of granitic boulders to be seen at the surface, some of which are of unusually large size. Some of the largest have been broken in pieces and removed, but records have been preserved of several which had a maximum diameter of over 18 feet. In other parts of the county other features of the drift are more noticeable, as for example the kame-like ridges and hills of gravelly loam in the northwestern part of the county, or the nearly level sheets of outwash along the valleys of Sugar Creek, Blue River, or White River.

Economic Geology.

The economic products from the geological formations in this county are in general limited to the two which are to be found throughout this part of the State, viz.: gravel and underground water.

Gravel.—The distribution of gravel is to be stated practically as in the case of the similar deposits in Hancock and Shelby counties; one difference, however, may be mentioned, that is, that in this county a larger proportion of the gravel used is obtained from pits opened in kame hills, rather than from beds of river gravel or from deposits lying below the ground water surface in level, low-lying areas of glacial outwash. The principal deposits of each kind known in 1905 are described and mapped by Mr. E. J. Cable in the Thirtieth Annual Report of the State Geologist; and while some pits have been opened since that report was written, the general areas in which gravel is found are still the same. No figures are available as to the amount used each year, but the total must be large.

Underground Water.—The general facts recounted in the reports on Hancock and Shelby counties as to the reduction of ground water level in recent years, and the present custom of attempting to secure water for drinking purposes from a depth of from 50 to 100 feet below the surface, need not be repeated here

since much the same conditions in regard to the water supply prevailed in each of these three counties at the time of the settlement of the country, and the change from disease-breeding to healthful conditions has likewise followed about the same course. Johnson County has, however, in its southwestern part the advantage of springs of excellent water far greater in number than can be found in those counties in which the topography is more uniformly level.

CLIMATE.

The climatic conditions are but slightly different from those of Hancock and Shelby counties. The following tables give the data from observations made at Franklin, and furnished for this report by Mr. V. H. Church, Section Director of the U. S. Weather Bureau at Indianapolis:

Table XXIII. Mean Temperature and Average Precipitation at Franklin.

Month.	Mean Temperature. Degrees F.	Average Precipitation. Inches.
January	29.5	2.91
February	30.0	2.53
March	40.9	3.58
April	52.7	2.44
May	63.5	3.72
June	71.8	3.78
July	76.6	2.52
August	72.0	2.85
September	65.9	3.04
October	53.9	2.50
November	41.5	3.48
December	33.0	2.90
Annual	52.6	36.25

Table XXIV. Maximum and Minimum Temperatures at Franklin.

Highest temperature recorded, 107° in July, 1901.

NOTE—This record covers the period from 1887 to 1908, inclusive, but within that time the July records are missing in the following years: 1889, 1891, 1892, 1894, 1895, 1896, 1897, 1898, 1904, and 1906.

Lowest temperature recorded, 17° below zero, February, 1905.

NOTE—January and February records are complete for the entire period of record, 1887 to 1908, inclusive.

Table XXV. Average Dates of Killing Frosts at Franklin.

Last in spring ..... April 21
First in autumn ..... October 18

It will be observed by comparing the data for the three counties here considered that the chief difference in the climatic conditions is the fact that the average annual precipitation is somewhat less in Johnson County than in either of the other two.

AGRICULTURE.

Of the 206,080 acres in the county, 95.8 per cent., or 197,403 acres, is in farms varying in size from less than three to over 1,000 acres. As ascertained by the census of 1910, there are 2,025 farms in the county, of which over one-half include 50 to 175 acres each. The farming land in the county increased nearly 118 per cent. in value in the 10 years from 1900 to 1910, being listed in the latter year at a total valuation of $19,204,550, or an average of over $97 per acre for the entire county; while the total valuation of farm property, including buildings, implements, domestic animals, etc., adds over $5,000,000 to this amount, making an average valuation of land and farm property together of about $125 per acre.

The following tables taken from the report of the census of 1910, show in condensed form the principal crops raised, the acreage, and the yield per acre; and the number and valuation of the principal kinds of domestic animals and poultry:

Table XXVI. Principal Crops.

	Acres.	Bushels.	Tons.
Corn	58,615	2,982,253	
Oats	3,480	91,522	
Wheat	38,862	640,831	
Timothy hay	6,532		9,418
Clover alone	10,275		13,549
Timothy and clover mixed	3,416		4,807
Clover seed		6,645	
Potatoes	339	33,842	

Table XXVII. Domestic Animals and Poultry on Farms.

	Number.	Value.
Cattle	16,019	$512,923
Horses	9,577	996,243
Mules	1,124	135,430
Swine	41,335	288,881
Sheep	11,596	51,997
Poultry	126,381	82,381

Statistics are not available for the acreage and value of tomatoes, sweet corn, etc., which are raised in considerable amount for sale to canning factories; nor for orchard fruits and small fruits

which are also produced in larger quantities than in the two other counties on which report is here made. Fruit raising and truck farming have been developed to a greater extent in Johnson County than in Hancock or Shelby, largely because the county has over a larger proportion of its area soil with a higher percentage of sand and silt, and so is better adapted to such crops. Care is needed, however, in this kind of farming as well as in grain raising, to see that a proper rotation of crops is maintained. That this has not always been carefully done is shown by the fact that tomato growers, for example, find that by successive plantings on the same ground the possibilities of yield have been reduced about half; but that after the land is allowed to "rest," it will again produce large yields.

In general, the soil conditions in this county are so similar to those of Hancock and Shelby counties, that the discussion in those reports of other plans of agricultural work will apply in most particulars to Johnson County also.

Soil Types.

The following table gives the names of the soil types found in the county, with the approximate area covered by each:

Table XXVIII Soil Types.

Name.	Acres.
Miami clay loam	179,710
Wabash loam	10,050
Sioux loam	7,950
Carrington black clay loam	3,490
Miami loam	2,500
Coloma sandy loam	2,000
Miami gravelly loam	380

With respect to the degree of accuracy of the boundaries of soil types shown on the accompanying map, the considerations mentioned on page 65 of the Shelby County report also apply to Johnson County; as, for example, as follows: (1) Three to four miles northwest and west of Needham, the boundaries between the Sioux loam and Carrington black clay loam are for the most part not clearly marked lines; the division is indicated on the map in each case at the approximate position of the place where the general character of soil and subsoil changes. (2) One and one-half miles west of Whiteland where the Wabash loam joins Carrington black clay loam, there is also a gradual shading off of the characteristics

of the one soil as the other is approached. (3) In some respects even more obscure is the line of separation between the types Coloma sandy loam, Miami loam, and Wabash loam, in the northwestern corner of the county. The relations here are very complex and only the most extended, detailed examination would suffice if the soil types in this area were distinguished with complete accuracy.

Further reference to variations of soil characteristics in a given type as mapped will be made in connection with the detailed description of types farther on.

Miami Clay Loam.

This type occupies about 87 per cent. of the total area of the county, and differs but little from the Miami clay loam as described in the report for Shelby county. The percentage of silt is high in the soil, which usually extends to a depth of from 10 to 12 inches below the surface, but the subsoil is more nearly that of a typical clay loam. Over the larger part of the area occupied by this type the material out of which the soil has been formed is unassorted glacial till, containing some pebbles and some boulders of large size, as in the case of the morainic ridge extending eastward from Greenwood through Rocklane. In a smaller part of the area stratified sand and gravel is occasionally found near the surface. The character of the type changes somewhat in the southwestern part of the county, where the thickness of the covering of drift is less. Here the loess has formed a proportionately larger part of the soil, but except for small areas there is still abundant evidence of its glacial origin. For example, in the extreme southwestern part of the county along Indian Creek, pebbles of crystalline rocks in variety are almost everywhere present in the subsoil, with occasional erratic boulders, constituting thus typical glacial till. In places this subsoil is covered by comparatively thin sheets of almost pure loess, but usually some of the glacial material is present even in the uppermost layers.

The color of the Miami clay loam is, over a considerable part of the county, a light brown to ash gray, with numerous streaks and patches of black in certain sections at the surface. In the southwestern part of the county the color is sometimes decidedly reddish to yellowish, due no doubt to the presence of a larger proportion of iron supplied by the fragments of underlying bed rock which have been incorporated into the soil.

The drainage of this type is in general not good, and while on some farms systems of practically perfect tile drains have been put in, there is yet much more such work to be done before the possibilities of the soil can be realized. One sign of this lack of adequate drainage and aeration of the soil is the presence of numerous small iron concretions which in cultivated fields appear after a rain as little brown balls one-sixteenth to one-fourth of an inch in diameter. Such concretions were noted in abundance at several places, as for example in fields on the east side of the Illinois Central Railroad half a mile south of Frances Station, and again in the east half of the northwest quarter of Sec. 16, T. 13 N., R. 3 E.

For further details in the discussion of this type see the reports for Hancock and Shelby counties, pages 48 and 66.

Table XXIX. Mechanical Analysis of Miami Clay Loam.

	Coarse Sand. %	Medium Sand. %	Fine Sand. %	Silt. %	Clay. %	Total. %
Soil	11.96	21.06	24.88	28.90	12.51	99.31
Subsoil	10.69	15.87	21.19	30.35	21.57	99.67

Table XXX. Chemical Analysis of Miami Clay Loam.

	Soil.	Subsoil.
Reaction to litmus	Neutral	Neutral
Moisture in air-dried soil	1.21%	1.90%
Total nitrogen	0.108%	0.051%
Analysis of soil dried at 105° C.—		
Volatile and organic	3.81%	7.72%
Insoluble in HCl (Sp. g. 1.115)	88.26%	73.33%
Soluble silica (SiO_2)	0.20%	0.20%
Ferric oxide (Fe_2O_3)	2.62%	4.20%
Aluminum oxide (Al_2O_3)	3.93%	6.15%
Phosphor. acid anhydride (P_2O_5)	0.10%	0.55%
Sulphuric acid anhydride (SO_3)	0.01%	0.01%
Calcium oxide (CaO)	0.34%	4.68%
Magnesium oxide (MgO)	0.38%	2.18%
Potassium oxide (K_2O)	0.13%	0.34%
Sodium oxide (Na_2O)	0.18%	0.35%
Total	99.96%	99.71%

Wabash Loam.

This type occupies about five per cent. of the total area of the county, the greater part forming the rich, level first bottoms along White River, Blue River, and Sugar Creek; smaller and less typi-

cal belts being found along some of the smaller streams. It presents no new characteristics in this county, so that the descriptions and discussions referring to this type in the reports for Hancock and Shelby counties, pages 50 and 69, may with equal correctness be applied to the form in which it occurs here.

Sioux Loam.

This type occupies a little less than four per cent. of the total area of the county, and presents no peculiarities beyond those found in the same type in Shelby County; indeed, by far the greater part of the area classed as Sioux loam in this county, lies along the eastern side and is a continuation of the more extensive areas already described in the report for Shelby County, page 67.

There is, however, added here the results of a chemical analysis of a sample of Sioux loam soil taken from this county:

Table XXXI. Chemical Analysis of Sioux Loam.

	Soil.
Reaction to litmus	Neutral
Moisture in air-dried soil	0.71%
Total nitrogen	0.081%
Analysis of soil dried at 105° C.—	
Volatile and organic	2.72%
Insoluble in HCl (Sp. g. 1.115)	91.60%
Soluble silica (SiO_2)	0.15%
Ferric oxide (Fe_2O_3)	2.04%
Aluminum oxide (Al_2O_3)	1.84%
Phosphor. acid anhydride (P_2O_5)	0.33%
Sulphuric acid anhydride (SO_3)	0.02%
Calcium oxide (CaO)	0.40%
Magnesium oxide (MgO)	0.24%
Potassium oxide (K_2O)	0.11%
Sodium oxide (Na_2O)	0.13%
Total	99.58%

Miami Loam.

The name Miami loam is here applied to a poorly defined area in the northwestern part of the county which is pretty generally characterized by a somewhat loose, deep, loamy soil (12 to 15 inches), of light brown color, and a more compact subsoil which, however, soon shows first an increase in the amount of sand present, then an increase in the amount of gravel and pebbles which in some

places is too great to permit an auger to penetrate to a depth of three feet. In color the subsoil is at first somewhat more yellowish than the soil, but often changing to a brownish shade. The proportions of pebbles, sand, and finer particles is variable; where the sand predominates the yellow color is likely to be found; where pebbles with silt and clay are more abundant a brownish color usually prevails.

The topography of this area is rolling to nearly level, and is generally well drained.

The area as mapped is not uniform over its whole extent. In some places true clay loam is present, and drainage conditions are poor as shown by an abundance of small iron concretions on the surface. In other places there are patches of sandy to sandy loam soils. The boundary as shown on the map is, therefore, only approximate, but is located at about the position where the change in soil characteristics takes place.

Other Types.

The other types occurring in this county have all been described in the reports for Hancock and Shelby counties, and their general characteristics are not, therefore, repeated here. One type, the Coloma sandy loam, should, however, be mentioned since it is here mapped to include considerable areas of level to gently undulating land as well as the prominent hills which, as in the case of the soil of this type in Shelby County, are evidently to be regarded as weathered sand dunes. As has been remarked already in another place the boundary of the area mapped in this county as Coloma sandy loam is to be regarded as only approximately marking the position of change in the characteristics of the soil.

SUGGESTIONS.

The most important practical suggestions for the treatment of soils in this county must be directed first to improvements in the drainage systems of the uplands, and second to other matters of farm management, of which the use of commercial fertilizers constitutes an important part. For a detailed discussion of these points, see the report for Hancock County, pages 55 and 56.