Soil Survey of Morgan County.

By J. B. Edmondson.

LOCATION AND DESCRIPTION.

Morgan County is situated in the south central part of Indiana. It is bounded on the north by Hendricks and Marion counties, on the east by Johnson County, on the south by Brown and Monroe Counties, and on the west by Owen and Putnam Counties. It comprises an area of 415 square miles, or 265,600 acres. Morgan County is within easy shipping distance of the city of Indianapolis, the Vandalia Railroad extending southwest through the central part and the Indianapolis and Martinsville Interurban running from Indianapolis to Martinsville.

The topography of the county is varied. The northern third is level to rolling, with evidence of heavy glaciation. The southern and central parts, however, are very rough and broken and are but poorly adapted for agricultural uses. In the central western part, the "Flats" extend into the county from Owen, comprising a level area of about 25,000 acres.

Morgan County lies entirely in the drainage basin of the White River with the exception of the extreme northwestern corner which is drained westwardly into Eel River. White River crosses the eastern boundary three miles south of the northern line, flows in a tortuous course southwest through the central part of the county and passes into Owen County at the extreme southwest corner. The tributaries from the north are White Lick Creek, Sycamore Creek, Lambs Creek, and Burkharts Creek, while the affluents from the south are Crooked Creek, Stotts Creek, Indian Creek, Little Indian Creek and Bryants Creek. The general slope of the county is to the southwest, the fall of White River being slightly over three feet per mile with an average elevation of 624 feet.

Where the surface is rolling the natural drainage is good, yet in many places the close texture of the soil renders drainage very difficult. These areas are usually marked by a light gray to whitish-colored soil with the surface covered with small, soft iron concretions, locally known as "buckshot" or "turkey gravel."
There are also wet areas of poorly drained soils found in the second bottoms of White River and the smaller streams in the southern part of the county—the "white slash" soils.

In the northwest part of the county is found a wide, low, inland valley, locally known as the "Lakes." From its outlet, into Eel River, west of Eminence, it extends in a northeasterly direction across Adams Township, touches the northwest corner of Gregg Township and reaches into Monroe Township to a point northwest of Monrovia. Here the wide ridge of rolling upland extending northward from the White River valley, several miles to the south, forms the divide between this and the level country farther to the northeast. (Hence, the statement made by a former geologist,* that the valley extends entirely across Morgan County and joins the White River valley in Marion County, is hardly possible.) The Lake region which was formerly covered with water the greater part of the year was slowly being reclaimed by the growth and decay of vegetation before the advent of the white man. By the use of large dredges and ditches this swamp has subsequently been converted into one of the richest farming regions in the State. Mud Creek, the only natural drainage basin of this valley, touches only the northern edge. Due to its low banks and shallow bed, its waters during the spring freshets spread out over miles of the surrounding country. A plan has been under consideration for some time to dredge out the bed of the creek through this region, in an attempt to prevent these destructive floods.

The lowest part of the valley extends east across the central part of Adams Township, nearly two miles south and approximately parallel to Mud Creek. This was the original outlet to the area, but the gradient being so slight it availed little as an outlet, becoming so filled in that drainage was stopped and the region was covered with the run off from the surrounding uplands a good part of the year. A few years ago, however, this old drainage course was reopened by a large dredge ditch and the drainage difficulties have been largely solved. The dredge or "Lake Ditch," begins in Monroe Township, northwest of Monrovia, and follows the lowest part of the valley in a southwesterly direction across the townships of of Monroe, the extreme northwest corner of Gregg, and across the central part of Adams, emptying into Eel River, northwest of Eminence. The ditch is about twenty miles long and is estimated to drain 64,000 acres of extremely fertile soil. Emptying into it

is a number of State ditches and many tile drains. In addition to this, the drainage facilities of the region have been much facilitated by the removal of an obstructing dam from Eel River and the straightening of its channel. By these means the water table in this area has been materially lowered although crops still suffer frequently from floods after excessive rains.

**GEOLOGY.**

Morgan County is entirely within the glaciated area. However, the topography of the southern part of the county has been but little affected by the ice invasion, for the drift deposit is comparatively slight. The southern limit of the Wisconsin ice-sheet extended in an irregular southeastern direction, crossing the western boundary near the southern limit of the "Lakes" and extending east to the White River. Here it dips sharply to the south and crosses the county line at the extreme southeastern corner. The water which resulted from the melting of this ice-sheet in the western part of the county sought an outlet to the west and carried away the soil, leaving the long inland valley mentioned above. Along the southern bank of the valley, in the vicinity of Hall, an immense number of large granite bowlders is found. These are so numerous in many places as to interfere seriously with cultivation. The hummocky, uneven character of the surface in this region bears evidence of unweathered glacial material. This strip of glacial debris is not more than half a mile wide here, but farther east the bowlder line extends north to the county line, numerous large ones being found in Harrison, northern Clay and Madison townships. South of this irregular line, the topography of the county is much more broken and hilly.

The early, or Illinoian ice-sheet extended entirely over Morgan County, the foot resting in Monroe County, a short distance south of the Morgan County line. The drift laid down by this glacier contained little sand and gravel, the body of it being of finer material—silt and clay. This deposit has had but little influence on the original drainage system of the area, and the underlying Knobstone formation was left with its deep, narrow ravines and water courses practically unaltered.

Indian Creek, flowing west across the southern part of the county, is characterized by a wide valley in which is found extensive areas of sand. This feature is especially in evidence in the region south and east of Martinsville, where the sand occurs in
high rounded hills skirting the valley and extending for more than a mile back from the present valley site, in the form of high, dune-like mounds. This sand may have been deposited here by the Illinoian ice-sheet, which evidently rested for a long period against the high Knobstone bluffs, rising for 200 feet above the Indian Creek on the south; or, more probably, it was transported to the present position by the waters of White River when that stream was a great glacial river, the sand either being derived from the disintegrating Knobstone sandstone or from the glacial debris. Doubtless the wind has assisted in fashioning the sand into the high rounded mounds we find in this region. The same formations are also found along the bluffs of the White River valley along its entire course through the county. The White River valley is very wide, the greatest width at Paragon being nearly four miles. In this region, the river valley lies 150 feet below the general level of the country and is marked by steep, precipitous bluffs. The bluffs, however, gradually decrease in height and abruptness as one proceeds up the river towards the northeast part of the county. From Martinsville north to the county line the greater part of the bottoms is underlaid with gravel sufficiently close to the surface to cause excessive drainage.

The entire county, with the exception of a small area in western Ray Township, is underlaid with the Knobstone formation. South of the line marking the limit of the Wisconsin ice-sheet, this formation is very much in evidence along the stream courses. Due to the soft character of the upper strata, the work of erosion has influenced the topography of the area very greatly. Into the larger stream valleys many deep, narrow ravines empty, which extend for long distances into the upland, gradually becoming deeper as they approach the streams until the valley level is reached. Large areas of such hills cover the greater part of Washington, Baker and Gregg townships, much of it being too rough for cropping. Numerous narrow, V-shaped valleys have been cut through the soft shale to a depth of 150 to 200 feet, giving the country a very rugged aspect. This feature is especially prominent in the region south of Martinsville.

The northeast part of the county is heavily glaciated, much of the material being as yet unweathered. The soil is interspersed with gravel and small boulders, the gravel being especially prominent on the higher points. The surface is underlaid with a deep layer of boulder clay. The townships of Madison, Brown, northern Clay and Gregg and eastern Monroe are included in this area.
Exposure of Knobstone Shale, found one-half mile north of Martinsville, showing the thin covering of clayey soil above. This shale is used by the Martinsville Brick Company.
Along the western border of the county, in northern Ray and southern Ashland townships, the Mitchell and Harrodsburg limestone form the surface rock for some distance into Morgan County, being a continuation of the same strata so evident in eastern Owen County. The presence of the former stratum is easily recognized by numerous sink-holes, the luxuriant growth of bluegrass and clover, the loose, brown, loamy appearance of the soil, and the magnificent growths of sugar and walnut trees. This region presents a strong contrast to the surrounding Knobstone area with its stunted growth.

CLIMATE.

The climate of Morgan County is moderate and healthful. Neither extreme of temperature is reached. The direction of the prevailing wind for the year is from the southwest, the percentage of sunshine throughout the year being 54. There is no weather bureau stationed in Morgan County, hence the following data is taken from the station at Indianapolis, ten miles to the northeast:

*Precipitation in Inches, Monthly and Annual; also Monthly Maximum and Minimum Temperatures as Recorded by the Indianapolis Station.*

<table>
<thead>
<tr>
<th>Month</th>
<th>Precipitation, Inches</th>
<th>Maximum Temperature, °F</th>
<th>Minimum Temperature, °F</th>
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</thead>
<tbody>
<tr>
<td>January</td>
<td>2.96</td>
<td>70</td>
<td>-25</td>
</tr>
<tr>
<td>February</td>
<td>3.09</td>
<td>72</td>
<td>-18</td>
</tr>
<tr>
<td>March</td>
<td>4.04</td>
<td>82</td>
<td>0</td>
</tr>
<tr>
<td>April</td>
<td>3.39</td>
<td>87</td>
<td>19</td>
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<td>4.00</td>
<td>96</td>
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<td>June</td>
<td>4.23</td>
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<tr>
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<td>4.06</td>
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<td>3.21</td>
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<td>November</td>
<td>2.98</td>
<td>76</td>
<td>-5</td>
</tr>
<tr>
<td>December</td>
<td>2.98</td>
<td>68</td>
<td>-15</td>
</tr>
</tbody>
</table>

The growing season is approximately six months long, with the precipitation well distributed through the year. The greatest rainfall occurs in June and the least in October.
HISTORY AND AGRICULTURAL DEVELOPMENT.

Morgan County was the undisputed home of the Miami tribe of Indians, before the advent of the white man. In 1818, a large tract of land in central Indiana, including the present county of Morgan, was ceded to the whites by the Indians. After this treaty, the settlers came rapidly to the "New Purchase" in search of homes. The first permanent settlement is alleged to have been made on the southeast side of White River, a short distance below the present site of Waverly. Cyrus Whetzel, who located near the mouth of Bluff Creek, made this section familiar to all immigrants coming west to central Indiana, for as early as 1818 he opened a trail through the wilderness from older settlements on White Water River in the eastern part of the State to the Bluffs on White River. This trace was the first public highway in this part of Indiana and became famous at "Whetzel’s Trace."

The areas along White River were settled long before the more remote sections. Adams Township was not settled until well in the thirties. The early settlers had the same struggle for existence as confronted all pioneers of that day, with which the present generation is so familiar. The broad fertile valley of White River was occupied first, then the rolling areas in the east and north. The rough, hilly sections were looked on with favor only by the hunters and trappers, who found an abundance of game.

Settlers found the Indians already raising small patches of corn in the valleys. As soon as possible the dense forests were cleared away and fields of corn and wheat were planted. Although the methods were crude, the native richness of the soil made possible good yields. Corn has always been the leading crop of the county. Not only are the wide stream bottoms especially adapted for the raising of this crop but the rich black soil of the Lake region is also unexcelled for the production of corn. In 1909, almost a million and three-quarters bushels of corn were raised in Morgan County on slightly over fifty thousand acres. Both the acreage and yield per acre have increased during the past thirty years. Very little commercial fertilizer is used with this crop, although many of the upland farms are in need of some such reinforcement. However, large amounts of barnyard manure are produced annually and practically all of it is used on the corn ground. Considerable corn of the white variety is raised, although there is some complaint against it as being "chaffy" especially in the stream bottoms.
Wheat is an important crop but has suffered a decided decline since 1880. In that year there were 33,944 acres which produced 487,434 bushels. In 1908, 26,502 acres were sown producing 377,487 bushels. This decline in the culture of wheat has come as a direct result of the failure of the soil to return profitable yields. Farmers can remember well the good old "wheat days," but many are sowing it now only as a means of getting their fields set in grass. The failure to observe the proper crop rotations and the indifference shown as to the needs of the soil in the past have resulted in this decline. Commercial fertilizers are generally used with this crop, usually one rich in phosphorus and potash. Bone meal and acid phosphate are used extensively, which contains from 12 to 15 per cent. of phosphoric acid. Where a legume is not grown regularly in the rotation, the nitrogen content of the soil is in imminent danger of being depleted where no attempt is made to restore it.

Oats are not raised extensively in Morgan County, the acreage usually being confined to the actual needs of the farms. In 1909, about six thousand acres were sown to this crop, with a yield of approximately twenty bushels per acre. Oats usually follow corn, and the ground is either plowed in the spring or the oats are "disked in" with a disk harrow. Where the spring work is rushing and the ground is of a loose friable nature the latter method is to be recommended.

Timothy is the prevailing hay crop, with an acreage in 1909 of 14,904 acres. Some of the heavy flat areas produce timothy more successfully than any other crops. Clover is excluded from many sections of the county by the lack of drainage and the acidity of the soil. There is a great need for an increase in the clover production and a more general use of cowpeas or soy beans as a soil renovator. In order to supply this need, the "sick" condition of the soil must be corrected by more thorough drainage and a liberal use of ground limestone.

Tomatoes are receiving a great deal of attention in the vicinity of Martinsville. Nearly 800 acres were devoted to this crop in 1911, with an average net return of $65 per acre. They were raised to some extent in the White River valley, but for the most part they were produced in the uplands. The Van Camp Canning Factory located at Martinsville is doing much to encourage farmers in this enterprise. A carload of special fertilizer was used on this crop, the rate of sowing being about 200 pounds per acre. This not only hastens the ripening, thereby eliminating danger from
frosts, but the quality of tomato is much better. A more definite system of crop rotation needs to be worked out and practiced, especially in the uplands.

In addition to this, about 600 acres each of peas and sweet corn were raised in the White River bottoms. The former crop is an important one as a soil enricher since it belongs to the legume family. The products of these crops are disposed of at the Van Camp Canning Factory.

One of the points of special interest is the operation of a ginseng farm a few miles southeast of Martinsville, in the heart of the hilliest of the county. It is operated by T. J. David who, in partnership with Mr. Green of Martinsville, owns the farm. They have nearly an acre and a half under cover of an arbor made of a framework over which is stretched laths woven together by wire. The purpose of this is to protect the shade-loving plants from the sun. The ginseng is planted in beds under the 'arbor,' in rich, loamy soil. It requires from seven to eight years after planting the seed for the roots to become of marketable size. Besides the roots, many thousands of seeds and young rootlets are sold every year to other growers throughout the country. Several thousand dollars worth of the product is sold yearly from the farm. This novel little farm nestled in among the hills is one of the most interesting spots in the county.

The northern half of the county produces a large amount of live stock, especially hogs and cattle. Much of the grain raised is fed on the farm and the manure returned to the soil. Where the region is not favorable to the raising of grain, however, much of the stock is disposed of when young. Dairy farming has received a great deal of attention in eastern Morgan County during recent years. Practically every farmer who operates his own farm has constructed a silo for preserving his feed, and large amounts of fodder are cut and shredded every year. Some of the most prominent dairy herds in the State are found in this section. Much of the milk is hauled to the stations and shipped to Indianapolis, but in the more remote districts milk routes have been established for gathering up the milk.

The horticultural interests of the county are not large. Fruit growing has received but little attention, although its soil is peculiarly adapted to the growing of fruit trees. In many hilly regions where the land is lying idle at present orchards could be planted which, after a few years of proper care, would prove a profitable investment. One of the most successful peach orchards
found in the county was on one of the steep hillsides south of Martinsville.

Martinsville, the county seat, is located on the east side of White River in the south central part of the county. It has a wealth of natural resources, the greatest of which are its mineral waters and clays. The city is located on the Pennsylvania Railroad and a branch of the Big Four. It contains seven sanitariums which are accommodated to give treatment for individuals by virtue of the medicinal qualities of the mineral water. These sanitariums have gained a wide reputation as proficient health resorts and are drawing guests from every part of America. Probably 25,000 guests visit these sanitariums annually, bringing to the town not less than a million dollars. The Martinsville and Adams Brick Works are located north of the city and together are turning out daily 120,000 brick of the best quality. The Van Camp Canning Factory is doing much in furnishing a market for the crops of the region. Martinsville has a population of 4,500.

Mooresville, a town of 1,608 population, is located on White Lick Creek in the eastern part of the county. It is an excellent trading center, there being excellent shipping facilities to Indianapolis from this point. Eastern Morgan County has become an important dairy section and large quantities of dairy products are shipped from Mooresville.

Brooklyn has 572 inhabitants, and is known chiefly by the close proximity of Bethany Park. The Indiana Drain Tile Company is located here, which is making a high grade of tile from the shale found in abundance south of the town.

Other towns of local importance are Morgantown, in the extreme southeastern corner of the county, Paragon, seven miles southwest of Martinsville, Monrovia, in eastern Monroe Township, and Eminence, in southern Adams Township.

SOILS.

The soils of Morgan County are quite diversified, due to the varying influences which the southern invasions of the ice-sheets had on the different parts of the county. The soils of the northern half, which bears the drift of the later Wisconsin glacier, are much coarser in texture and have much greater depth. Those derived from this source are also much stronger agriculturally than the soils found south of the line marking the southern limit of this glacier.

The soil of the southern part of the county is the typical loess-
ial formation that covers the greater part of Owen and Greene counties farther south. The underlying Knobstone formation, however, is never far beneath the surface and in the extreme southern part of the county it has influenced the soil to some extent by its contribution of weathered shale. This soil is poorly adapted for farming, both on account of the rugged topography which characterizes the area and the poor quality of the soil.

There are nine types of soil recognized in Morgan County. Most of these are readily recognized as distinct types, although some are closely related in general appearance and texture. The Knox silt loam includes practically all the upland soil of that part of the county lying south of the Wisconsin drift. It is also found north of this line in small areas. The Waverly silt loam is a closely associated type, although it owes its present position to different agencies. The greatest area is found in the central western part, in the vicinity of Lewisville. This comprises the eastern portion of the "Flats," the body of which lies across the line in Owen County. The type is also found in the different stream bottoms.

The Coloma sandy loam is the rather coarse upland soil of northeastern Morgan County, representing heavily glaciated areas. The Wabash loam is the typical soil of the stream valleys. The Carrington silt loam is found principally in the "Lake" region and small areas of low ground at other points in the northern part of the county. The Knox sandy loam comprises the conspicuous dune-like sand hills skirting the valley of the White River, principally on the eastern side. The Sioux sandy loam is found in White River bottom from Waverly northward to the county line. Its gravelly subsoil is characteristic. The Miami clay loam and Dover silt loam are types of upland soil in central Morgan County.

**Waverly Silt Loam.**

The largest area of Waverly silt loam is found in Ashland Township, east of Lewisville. It is an ashy grey to white fine silt loam, averaging in depth from five to eight inches. There is no demarcation between the soil and subsoil, the latter gradually verging into a heavy, stiff, silty loam of practically the same color. At a depth of 18 inches, brown streaks of clay, iron stains and iron concretions mottle the subsoil. The soil is heavy and compact and is usually saturated with water for long periods during the winter and spring.

The type is found rather extensively in the Indiana Creek bot-
tom, through Washington Township, and also in the valley of White River, along the boundary between Baker and Ray townships. In this region, the erosion of the hills has been excessive and the product which was carried down has been redeposited along the terraces of these streams. In the White River bottom, the type is rarely found in the first bottom, but along Indian Creek it constitutes the principal soil on the south and west side of the stream, through Washington Township. This is accounted for by the close proximity of the high, badly eroded bluffs on that side, while on the opposite side the valley is wide and sandy, with no abrupt bluffs subjected to the erosive process.

The drainage facilities of this area are very poor. It occupies level regions, which in the valleys are low and difficult to drain artificially. The natural humus content is very low and the heavy sodden condition of the soil makes further incorporation of organic matter into it a difficult problem, since it is burned out rapidly by the sun. The type has probably never supported vegetation in abundance, and the growth of hardwood timber has done little towards increasing the amount of humus. White oak, jack oak, beech, elm, hickory and poplar trees originally grew on this type.

The agricultural value of the Waverly silt loam depends on local influences as well as the season. During wet seasons, or after a cold wet spring, this type is greatly handicapped, due to the lack of drainage and the cold, sour condition of the soil. However, in dry years, it is a fair agricultural soil. Corn averages about 30 bushels per acre and wheat 12. The most successful crop, however, is timothy, which is used both for hay and for pasture. Oats are grown rather extensively, yielding 20 to 25 bushels per acre. Little clover is grown on this type, it being practically eliminated by the poor drainage and acid condition of the soil. A considerable number of sheep and cattle is raised on the rolling pasture land.

The Waverly silt loam cannot be farmed successfully until drainage is made more effective and the soil acidity corrected. Practically all the soil of this type is lacking in lime, a deficiency which must be supplied before further operations will prove satisfactory. A third need which must be supplied in some way is the addition of organic matter, preferably through the plowing under of some rank growing legume, such as cowpeas or soy beans.

The results of mechanical analysis of the Waverly silt loam are as follows:
SOIL SURVEY OF MORGAN COUNTY.

CARRINGTON SILT LOAM.

The Carrington silt loam is a dark brown to black loose mellow silt loam with an average depth of 15 inches. This is underlaid by a heavy stiff clay subsoil which, at first grey, gradually becomes lighter as the organic matter decreases until it is a light yellow color. The subsoil contains more sand than the surface soil and small water-worn pebbles are frequently encountered. In some places the subsoil changes to a stiff, bluish clay, under which it becomes quite sandy. The water table is never far below the surface and is often found at a depth of two feet. In the eastern edge of the area, small gravel is scattered over the surface and is found interspersed through the heavy subsoil.

The most important area of Carrington silt loam is found in the “Lakes,” in the northwestern part of the county, comprising the typical black soil of that region. It contains a large amount of organic matter, the greater part of it formerly being a low, wet swamp. At a depth ranging from 10 to 15 feet below the surface is found a thick bed of coarse, water-bearing sand and gravel. This doubtless marks the original bed of the lake before the subsequent filling in process began. This coarse material is found throughout the area and at some points is so coarse that it is pumped out for road material. A gravel pit of this kind is found in Monroe Township, in Section 8, and another in Adams Township, in Section 6. The per cent. of sand, however, is too great to warrant its extensive use for road metal. The area, except at its lowest points, is spotted with slight elevations rising from 10 to 30 feet above the general level of the lowland. These hills are in many cases taken advantage of by the farmers as favorable locations for building sites. In the field the soil is difficult to handle, since it is so widely different from the surrounding black loam. It is usually a light yellow to grey loose loam, with usually a large per cent. of sand. These points, as a rule, receive the bulk of the barnyard manure produced on the farms. Other low mounds of almost pure sand are found in the northern part of the area.
These were doubtless thrown up by wind and water at an early period.

Ordinarily, the soils of this area are loose and mellow, but if given improper treatment, a poor physical condition will result. If the fields are tramped by stock through the winter, or the ground is plowed when too wet, it becomes extremely difficult to reduce to proper tilth. While the area is fairly well drained at present, there are many sections which would be greatly benefited by a more thorough system of underground drainage. The open, porous nature of the soil makes this process very effective, and in no soil in the county can tile drainage be installed to a greater financial advantage. The many open ditches throughout the area assist greatly in the drainage problem and furnish excellent outlets for the tile drains. The one thing above all others, however, that has developed this area was the construction of a deep dredge for a distance of 15 miles, through the heart of the region. This ditch is estimated to be worth a million dollars to the townships through which it runs. It is known as the "Lake Ditch" and has assumed the proportions of a good-sized creek.

The Carrington silt loam is preeminently a corn soil. In this region, corn is the principal crop and thousands of acres are raised, producing from 50 to 80 bushels per acre. In the past, the benefits accruing from crop rotation have been largely ignored, and corn has been raised year after year. But even this rich, black soil is beginning to show the effects of such exhaustive systems, and more attention is being given to the raising of other crops. Wheat is raised rather extensively and where the growth is not too rank very good yields are obtained. During wet seasons, however, there is great danger of lodging. In more favorable seasons, the yield ranges from 15 to 25 bushels per acre.

Clover grows well, producing an abundant growth. When sown thickly, it makes an excellent quality of hay. This crop could be used to great advantage as a green manuring crop preceding the corn crop. Timothy is not grown extensively for hay, since the quality of hay is too coarse for best use. Oats are raised, usually for home consumption only, producing from 25 to 50 bushels per acre. In this region of much corn, a great number of hogs and cattle are raised annually. However, the grain produced is not all fed on the farms, for much of it is sold to feeders, nearer the markets.

Very little commercial fertilizer is used on this type. A more general use of the leguminous crops, for the necessary nitrogen
supply, is to be urged, as well as a more systematic rotation of crops. Farmers in some localities are experiencing trouble with "wilt" or erroneously called "alkali" spots, in their fields. Such areas are common in black soils and are due to a deficiency in the potash content of the soil. This is easily demonstrated by scattering over these spots a quantity of wood ashes, before planting the corn, and noting the beneficial results. The application of muriate of potash at the rate of 60 to 75 pounds per acre will usually correct this deficiency. However, this type responds readily to careful treatment. As an example, Mr. Elvin Hurt, a young farmer living west of Hall, has paid particular attention to the thorough drainage of his farm and to its fertilizer demands. As a result, he has repeatedly raised corn averaging 90 bushels, and on one occasion reached the 100 bushel mark.

The results of the mechanical analysis of the Carrington silt loam are as follows:

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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface 12 in., Central Sec. II, Adams Twp…</td>
<td>Black, loose silty loam</td>
<td>.2</td>
<td>.3</td>
<td>2.0</td>
<td>9.1</td>
<td>26.8</td>
<td>57.7</td>
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<td>1.3</td>
<td>13.6</td>
<td>23.9</td>
<td>29.0</td>
<td>27.7</td>
<td>3.9</td>
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**Chemical Analysis of Carrington Silt Loam.**

Collector, Edmondson.

Reaction to litmus ........................................ Neutral
Moisture in air-dried soil ........................................ 2.61%
Total soil nitrogen ........................................ 0.413%

Analysis of fine soil dried at 105° C.—

Volatile and combustible ........................................ 10.37%
Insoluble in 1.115 HCl ........................................ 79.81%
Soluble silica (SiO₂) ........................................ 0.10%
Ferric oxide (Fe₂O₃) ........................................ 1.70%
Alumina (Al₂O₃) ........................................ 5.75%
Phosphoric acid anhydride (P₂O₅) ........................................ 0.32%
Sulphuric acid anhydride (SO₃) ........................................ 0.10%
Calcium oxide (CaO) ........................................ 1.10%
Magnesium oxide (MgO) ........................................ 0.44%
Potassium oxide (K₂O) ........................................ 0.14%
Sodium oxide (Na₂O) ........................................ 0.27%

Total ........................................ 100.19%
Knox Sandy Loam.

The Knox sandy loam is a dark grey to nearly black, loose sandy loam, ranging in depth from eight inches in some localities to 24 inches in other places. The subsoil is a light yellow, stiff sandy loam, usually with enough clay present to make it compact and rather tenacious. Fine gravel is often mingled with the subsoil. In regions where the soil is deep, the subsoil usually grades into a loose, yellowish brown sand, with a small per cent. of silt and clay. This is often the case on the higher points. On the crests of the ridges and knolls, the surface is dark grey in color and contains a relatively large amount of humus. The soil is very loose and loamy, carrying a large per cent. of medium sand.

The type occurs chiefly along the bluffs of the White River in a somewhat broken strip of varying width, through the entire county. The topography is characterized by rounded mounds of low relief rising from the valley floor near the bluffs, or they may extend as high as the bluffs themselves, which are 100 to 150 feet above the river. Often the sandy soil extends back for some distance in the upland, making a gently rolling, hummocky surface. The widest area is found east of Martinsville, bordering the extensive valley of Indian Creek. Here the sand extends for more than a mile east of the valley and is found in high, prominent, dune-like mounds or high narrow ridges.

The Knox sandy loam was probably derived from glacial material which was assorted and laid down by the water. Without doubt, much of this deposition took place during the recession of the ice-sheet, when the channel of the White River carried enormous volumes of water. While the wind may have been an active agent in the formation of the high "dunes," yet the frequency with which the heavier material is found, both on the surface and in the subsoil, points rather to the action of the water as the chief agent. In one of the lower mounds, east of Martinsville, the material is sufficiently coarse to warrant the opening of a gravel pit.

The surface of the Knox sandy loam is very open and loose, due both to the predominance of sand and the influence of the humus content. The drainage is excessive in some places and crops burn out easily. Due to the openness of the surface soil, it does not wash badly, since the surface waters quickly percolate through the soil.

This type is a fair agricultural soil, although in the more sandy phases the lack of moisture is a limiting feature. Corn is grown rather extensively, with an average yield of 40 bushels per acre.
Wheat is also a staple crop, yielding 8 to 14 bushels per acre. The type, however, is well adapted for blue grass and clover and should be used more extensively as pasture land. It should be protected by vegetation and exposed just as little as possible to the rays of the sun, since the humus tends to burn out badly. Little commercial fertilizer is used on the type, it being the common belief that such treatment fails to prove profitable. However, this type is relatively low in nitrogen, which is usually the limiting element, and should be supplied through a greater use of the legumes, especially cowpeas and soy beans. These crops not only furnish the soil nitrogen, but afford a large amount of organic matter if the crop is turned under. The type is especially adapted for the raising of watermelons, many of which are grown in the vicinity of Martinsville. It is a warm soil, and suited likewise for any quick growing crops that mature before the dry season advances.

The mechanical analysis of the Knox sandy loam is given in the following table:

<table>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N. E. Sec. 26, Harrison Twp.</td>
<td>Dark grey fine sand.</td>
<td>.0</td>
<td>.1</td>
<td>.6</td>
<td>21.1</td>
<td>50.0</td>
<td>16.8</td>
<td>8.9</td>
</tr>
<tr>
<td>Subsoil</td>
<td>Light yellow, fine sand</td>
<td>.0</td>
<td>.0</td>
<td>2.0</td>
<td>28.1</td>
<td>54.1</td>
<td>8.0</td>
<td>7.4</td>
</tr>
</tbody>
</table>

**Waukesha Sandy Loam.**

The area of Waukesha sandy loam comprises the northeastern part of the county. It is a type of variable texture, the higher points resembling very much a gravelly loam, while the level areas are much finer in texture. The surface is a light brown to reddish brown sandy loam, with a considerable amount of gravel scattered over the surface. The gravel is usually not more than one to two inches in diameter on the level or sloping areas, but on the crests of the ridges and hills it becomes considerably larger. The subsoil is a stiff, reddish brown, heavy sandy loam, somewhat coarser than the surface. At 30 inches, a heavy gravelly substratum of coarse sand, gravel and clay is encountered. This becomes very hard and oftentimes resembles hardpan. The heavy gravelly subsoil is present throughout the area, although the color of the surface soil changes sometimes from a reddish brown to a dark grey, this phase usually being found in the depressed areas.

The topographic features of this type are marked by a gently
rolling, uneven surface, or by sharply rolling to hilly areas in regions where erosion has been great. The low mounds and hills, that characterize the type, usually contain large quantities of sand and fine gravel, which gradually decrease as the level is reached. The higher hills or ridges, however, which are often 50 to 75 feet in height and resemble moraines in appearance, contain much coarse material. These are oftentimes so rocky and broken that they are very difficult to cultivate. The soil tends to wash badly and the slopes are in many cases badly broken by gullies.

The Waukesha sandy loam represents the glacial deposits of the Wisconsin ice-sheet. Much of it has been reworked by wind and water, but the greater part is residual. Bowlders are very numerous throughout the area, many of them being of enormous size. The "Big Bowlder," noted formerly by Prof. Brown,* is found in Madison Township, in Section 4, measuring "in length, 15 feet, 4 inches; greatest breadth, 13 feet; height above ground, 11 feet, 9 inches."

The Waukesha sandy loam is an average agricultural soil. The worst feature is its incapacity to retain moisture during the dry seasons. Consequently, crops are liable to suffer from droughts. This is more true of the more sandy or gravelly phases, however, for much of it has sufficient body to prevent excessive drying out. Corn, which is grown quite extensively, yields 35 to 50 bushels per acre. Much of the corn in this area is made into ensilage or is cut and shredded. While this method is an excellent means of preserving the roughage of the farm and makes possible a greater production of manure, it on the other hand decreases the amount of vegetable matter to be returned to the soil. This being the case, the manure should be carefully conserved and a covering of vegetation turned under as often as possible, in order to prevent a deficiency in the humus supply. Dairy farming is engaged in rather extensively in this section, and the farming methods are somewhat more intensive than are found in other parts. Mr. H. B. Johnson, who operates a large dairy near Mooresville, has worked out the following rotation; corn for two years, wheat one year and clover one year. The entire clover crop is turned under for the first crop of corn and barnyard manure fertilizes the second crop. Most of the corn itself is made into ensilage. With the wheat is sown 250 pounds of commercial fertilizer. By this system, there is little trouble experienced in maintaining the productiveness of the soil.

Wheat was formerly held in much greater favor than at pres-

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*Geological Report, 1883.
ent. In its virgin condition, this type was able to yield 20 to 30 bushels per acre. But in recent years, the yield has slowly declined and with it the acreage. Wheat yields, on the average, about 14 bushels, but when the crop is fertilized the yield is much higher. Large amounts of commercial fertilizer are used on both corn and wheat. The grade which is used most extensively and which probably most nearly meets the needs of the soil is one containing 10 to 12 per cent. of phosphoric acid and two to four per cent. of potash. Where the nitrogen is supplied by leguminous crops and barnyard manure, the productiveness of the soil is easily maintained.

Clover grows well in some localities, but in others it does not thrive. This fact, together with other indications, points toward acid conditions in some of the level, poorly drained sections. Wherever this is suspected, an application of lime should be made. The land is valued at $75 to $110 per acre.

The results of the mechanical analysis of this type are given in the following table:

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<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N. E. Sec. 16, Madison</td>
<td>Light brown, gravelly</td>
<td>11.5</td>
<td>.8</td>
<td>3.2</td>
<td>1.8</td>
<td>13.6</td>
<td>49.3</td>
<td>19.1</td>
</tr>
<tr>
<td>Subsoil</td>
<td>Reddish, stiff sandy clay</td>
<td>4.3</td>
<td>1.3</td>
<td>24.0</td>
<td>22.5</td>
<td>21.2</td>
<td>18.8</td>
<td>7.8</td>
</tr>
</tbody>
</table>

**Chemical Analysis of Waukesha Sandy Loam.**

Collector, Quinn.

Reaction to litmus ........................................ Neutral

Moisture in air-dried soil ................................ 1.86%

Total soil nitrogen ...................................... 0.187%

Analysis of fine soil dried at 105° C. —

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatile and organic</td>
<td>5.24%</td>
</tr>
<tr>
<td>Insoluble in 1.15 HCl</td>
<td>86.07%</td>
</tr>
<tr>
<td>Soluble silica (SiO₂)</td>
<td>0.13%</td>
</tr>
<tr>
<td>Ferric oxide (Fe₂O₃)</td>
<td>1.51%</td>
</tr>
<tr>
<td>Alumina (Al₂O₃)</td>
<td>5.45%</td>
</tr>
<tr>
<td>Phosphoric acid anhydride (P₂O₅)</td>
<td>0.41%</td>
</tr>
<tr>
<td>Sulphuric acid anhydride (SO₄)</td>
<td>0.05%</td>
</tr>
<tr>
<td>Calcium oxide (CaO)</td>
<td>0.23%</td>
</tr>
<tr>
<td>Magnesium oxide (MgO)</td>
<td>0.33%</td>
</tr>
<tr>
<td>Potassium oxide (K₂O)</td>
<td>0.19%</td>
</tr>
<tr>
<td>Sodium oxide (Na₂O)</td>
<td>0.24%</td>
</tr>
</tbody>
</table>

Total .................................................. 99.86%
Sioux Loam.

This type occurs as a long, narrow strip in White River bottom, north of Waverly. It is a dark brown, loose sandy loam, with an average depth of 10 inches. The texture becomes coarser as the depth is increased, until at 24 to 30 inches beds of gravel are reached. This substratum of gravel often extends to a depth of 8 to 10 feet. It is waterlaid and the gravel is usually not more than $1\frac{1}{2}$ inches in diameter.

The type occurs as a long, narrow terrace, extending along the western side of the White River valley. The surface is usually level, but sometimes is gently rolling. Gravel is scattered over the surface, and is especially prominent on the elevations and near the edge of the terrace, bordering the Huntington loam. The terrace is elevated 10 to 15 feet above the first bottom.

The type is not of any particular importance as an agricultural soil. The coarse nature of the subsoil and its close proximity to the surface make it unable to endure drought. However, the general farm crops are raised on it and in years of well distributed rainfall fair yields are obtained. The gravel in the subsoil is used extensively for road metal and for concrete.

Wabash Loam.

The Wabash loam is the typical soil of the stream valleys, confined usually to the first bottoms. It is a dark brown to grey loose loam, with an average depth of 12 inches. It is rather variable in texture, but usually contains a relatively large per cent. of medium sand. The subsoil is not sharply defined. It grades gradually into a lighter colored, slightly heavier, sandy loam, with the texture differing but little from the surface soil. The type contains a large amount of humus, the lighter phases of the soil indicating a lower humus content. In the regions where the bluffs are high, erosion has influenced the type considerably. This is especially noticeable along the bluffs north of Martinsville, where the soil is made much heavier by the washing down of the clay and silt. The most extensive area of this type is found in the valley of White River, but others occur in the valleys of Eel River, the eastern part of Indian Creek, White Lick Creek, and those of the smaller tributaries. The surface is level and low in places, which makes it rather difficult to drain.

The Wabash loam is derived from glacial till, which has been carried down and redeposited by the water of the stream along
SOIL SURVEY OF MORGAN COUNTY.

which it is now found. The greater part of it is still subject to overflow, which deposits the sediment that tends to maintain the high state of fertility. It is especially adapted for the raising of corn, and a large part of the type is devoted to this crop every year. Systematic crop rotations have been sacrificed on many farms to the extent that not a few are showing evidences of exhaustion. The average yield of corn is about 50 bushels per acre, with maximum yields of 70 to 80 bushels. The white varieties of corn are held in favor on this type.

Wheat and oats are not grown extensively, the danger from floods and the tendency to lodge making these crops unprofitable on this type. Wheat, when favored with a good season, yields 15 to 20 bushels per acre, although the quality is usually not so good as that produced on the upland. Clover does well in areas not subject to overflow, and should be grown more extensively. Timothy is little raised on this type on account of its rank growth and the damage incurred from overflow.

A considerable acreage of tomatoes is grown on this type, in the vicinity of Martinsville. The yield is large and the quality fair. Peas and sweet corn are also raised to some extent in this region. The type is especially adapted for the former crop, and large financial returns are realized from its culture.

Commercial fertilizers are not used extensively. Where the soil has been cropped continually for a long period, some farmers are resorting to this method of improvement. Fertilizers containing potash and phosphoric acid are used with good results. The refuse from the canning factory at Martinsville, composed largely of pea vines, is being used to great advantage as a manure in improving the run down condition of the soil. A systematic rotation of crops is essential in keeping the soil in its highest state of production. The land is valued at $90 to $150.

The mechanical analysis of the Wabash loam is given in the following table:

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sec. 33, Washington Twp.</td>
<td>Soil</td>
<td>.0</td>
<td>0.6</td>
<td>1.1</td>
<td>14.0</td>
<td>34.1</td>
<td>40.2</td>
<td>9.0</td>
</tr>
<tr>
<td>Sec. 33, Washington Twp.</td>
<td>Subsoil</td>
<td>.6</td>
<td>1.1</td>
<td>2.0</td>
<td>14.4</td>
<td>22.2</td>
<td>51.4</td>
<td>7.6</td>
</tr>
</tbody>
</table>
REPORT OF STATE GEOLOGIST.

Chemical Analysis of Wabash Loam.

Collector, Edmondson.

Reaction to litmus ................................................. Neutral
Moisture in air-dried soil ..................................... 1.43%
Total soil nitrogen ............................................ 0.185%

Analysis of fine soil dried at 105° C.—

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatile and combustible</td>
<td>4.33%</td>
</tr>
<tr>
<td>Insoluble in 1.115 HCl</td>
<td>84.93%</td>
</tr>
<tr>
<td>Soluble silica (SiO₂)</td>
<td>0.12%</td>
</tr>
<tr>
<td>Ferric oxide (Fe₃O₄)</td>
<td>2.40%</td>
</tr>
<tr>
<td>Alumina (Al₂O₃)</td>
<td>5.93%</td>
</tr>
<tr>
<td>Phosphoric acid anhydride (P₂O₅)</td>
<td>0.44%</td>
</tr>
<tr>
<td>Sulphuric acid anhydride (SO₃)</td>
<td>0.08%</td>
</tr>
<tr>
<td>Calcium oxide (CaO)</td>
<td>0.46%</td>
</tr>
<tr>
<td>Magnesium oxide (MgO)</td>
<td>0.75%</td>
</tr>
<tr>
<td>Potassium oxide (K₂O)</td>
<td>0.26%</td>
</tr>
<tr>
<td>Sodium oxide (Na₂O)</td>
<td>0.29%</td>
</tr>
</tbody>
</table>

Total ......................................................... 99.99%

MIAMI CLAY LOAM.

The Miami clay loam is a heavy, greyish yellow loam with a high per cent. of clay. When wet, it is dark grey but on drying out it changes to a light ashy grey. The soil has a smooth floury feel to the touch, and contains but a small per cent. of sand. It varies in depth from five to eight inches, with the greater depth in the depressed areas. The subsoil is a heavy, light yellow clay loam, which is stiff and tenacious when wet but on drying becomes very hard and compact. It is inclined to break into cubical fragments to a depth of 20 inches after which it becomes more stiff and heavy. Below this depth, the subsoil is mottled with streaks of greyish white which become more distinct as the depth is increased. The per cent. of medium sand increases in the subsoil although the finer materials determine its character.

The Miami clay loam is found in the eastern part of the county. Its largest area lies northeast of Martinsville, and smaller ones occur farther north in Madison Township. In the former area it occurs as a comparatively thin mantle overlying the residual Knobstone shale. The depth varies from three to 15 feet, the greater depth being at the foot of the slopes. Where the shale has been weathered, it has influenced the overlying soil, making it heavier, with a lighter color.
With the exception of the residual material, derived in the above way, the Miami clay loam is of glacial origin. Numerous boulders are found in the northern areas, but this feature is not so prominent at the southern extremity.

The surface configurations are marked by gently rolling areas in the north and a rough broken region in the south. The glacial invasion apparently had but slight effect on the topography of the latter region, and the old drainage system remains practically unaltered, although the mantle of drift is well distributed over it.

The Miami clay loam is a fair agricultural soil, in its better phases. In level or depressed areas, the natural drainage is poor and must be supplemented with artificial drains. It tends to wash badly and in the rough areas, this presents another problem in its management. Corn is raised with some success, although the yields are usually small, ranging from 20 to 30 bushels per acre. Wheat, when sown with fertilizer, produces from 10 to 18 bushels per acre of good quality. Timothy makes a rather short growth but yields an excellent quality of hay. In some localities, the type shows indications of acidity and doubtless the greater part of it would be benefited by an application of lime, with a corresponding increase in the efforts to introduce a larger amount of organic matter into the surface soil.

The type formerly supported forests of beech, sugar, poplar and elm. Most of these trees have been removed, but the rougher areas are still covered with second growth timber.

This type is deficient in organic matter and efforts should be made to turn under as much vegetable matter as possible. Of the plant food elements, doubtless phosphorus is the most nearly depleted, although the nitrogen content is low unless supplied by clover and legumes. A good crop of cowpeas or soy beans turned under would do much to insure a successful corn crop. The soil also responds quickly to any form of organic matter that is added to it in the form of manures.

This type has proven to be well adapted for tomato culture, by the farmers in the vicinity of Martinsville. A large acreage is devoted to this crop every year with returns as high as $85 to $90 per acre. These high profits are realized, however, after the careful starting of the young plants, proper fertilization and cultivation. The quality of the crop produced is of the best. If the tomato crop was worked into the rotation with wheat or oats and clover, excellent results would be obtained. At present, few farmers are adhering to any definite rotation.
Fruit growing should be developed on this type. It is well adapted to the growing of fruit trees and the quality of fruit produced is superior.

The results of the mechanical analysis of the Miami clay loam are given in the following table:

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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>E. Center Sec. 26, Wash-</td>
<td>Dark grey, compact</td>
<td>0</td>
<td>0</td>
<td>.25</td>
<td>2.1</td>
<td>1.0</td>
<td>63.1</td>
<td>32.0</td>
</tr>
<tr>
<td>ington Twp.</td>
<td>Lighter yellow, stiff</td>
<td>0</td>
<td>0</td>
<td>.10</td>
<td>5.9</td>
<td>2.1</td>
<td>60.9</td>
<td>17.7</td>
</tr>
</tbody>
</table>

**DOVER Silt Loam.**

The Dover silt loam is confined to a small area along the western line of the county, south of Lewisville. It marks the region where the Mitchell limestone comprises the surface stratum, and is the same type that extends westward over wide areas in Owen County. It is a loose, friable silt loam, about 10 inches in depth, with a light brown to reddish brown color. There is no sharp line between the soil and subsoil, the texture remaining much the same, with a slight increase in the sand content. The color gradually changes to a light, yellowish brown, and is often mottled with gray streaks.

The Dover silt loam is a loessial soil which has been favorably influenced by the weathering of the soft limestone underlying it. Outcrops of the limestone ledges are frequent on the sharp elevations and in the vicinity of the stream courses. The topography is rolling, but is seldom sufficiently broken to prevent cultivation. Numerous sink holes are found throughout the area, which are often a great hindrance to the farmer where they occur in the fields.

This type is a strong agricultural soil. It is especially adapted to the growing of grass and clover. Consequently, the area is almost unexcelled as pasture land. Corn grows well and produces 35 to 50 bushels per acre. Wheat is grown extensively, the yield ranging from 12 to 20 bushels of excellent quality. Much of the type is used as blue grass pasture for sheep and cattle.

The characteristic trees of the type are black and white walnut, sugar and poplar. Practically all of this valuable timber has been removed, although considerable smaller and second-growth timber still remains in the woodlots on the farms.
Knox Silt Loam.

The Knox silt loam is a light brown to ashy gray silt loam with an average depth of seven inches. It is underlaid by a heavy, stiff, light yellow subsoil which at a depth of 15 inches becomes mottled with gray and white streaks. The color of the soil is determined largely by the drainage facilities in the different areas. Where the drainage is poor over large areas or even in small spots, the soil is ashy gray or almost white with iron concretions often on the surface or found through the body of the soil.

The Knox silt loam is composed of glacial material which has drifted to its present position by the action of the wind. This fact accounts for the absence of coarse material on the surface. The greatest area is found extending irregularly across the central part of the county, south of the line marking the southern limit of the late ice sheet. The line dividing the Knox silt loam from the Miami clay loam on the north is difficult to determine accurately, the chief difference between the two types being the presence of glacial pebbles and boulders on the surface of the latter area and with a subsoil of boulder clay.

The Knox silt loam is an important agricultural soil where the topography is not too broken, as in the case in the southern part of the area. The productiveness of this type also depends a great deal on the methods practiced in farming it. The soil is easily exhausted where no care is taken towards the maintenance of its productiveness and many farms are suffering in this respect at present.

The type was originally covered with forests of poplar, beech, oak, elm and sugar trees. Consequently, other vegetation has been comparatively slight, and with the clearing of the forests the soil was left with comparatively little humus, a deficiency which is apparent after years of farming, where no efforts are made to replace the organic matter. Stable manure produces excellent results, due both to the addition of humus to the soil and the increase in the nitrogen supply, which is almost universally low.

Many sections of this area are poorly drained, and before they can be improved, tile drains must be installed. There are often indications of acidity in the soil, the chief of which is the failure of clover to grow normally. This fact practically precludes the possibility of applying the most efficient method for improving the soil—the use of legumes, especially clover, cowpeas and soy beans, for pasture or for turning under. Ground limestone applied at
the rate of 1,500 to 2,000 pounds per acre, where acid conditions are suspected, will remedy this defect.

Corn is grown on the Knox silt loam rather extensively, yielding 20 to 40 bushels. Little fertilizer, except stable manure, is used on this crop, the latter having very beneficial results. An excellent quality of wheat is raised, although the average yield is about 12 bushels. Oats are raised only for home use and yield from 20 to 30 bushels.

Fruit growing is engaged in to some extent on this type, and should be encouraged as the soil is specially adapted for this use.

The mechanical analysis of this type is as follows:

|-------------------|-----------------|------------------------|------------------------|------------------------|----------------------|--------------------------|-----------------|----------------|
Soil Survey of Owen County.

By J. B. Edmondson.

LOCATION AND DESCRIPTION.

Owen County is situated midway between the central and southwest part of Indiana. It is bounded on the north by Morgan and Putnam counties, on the east by Morgan and Monroe counties, on the south by Greene County, and on the west by Clay County. It contains 396 square miles, or 253,440 acres.

The topography of the county varies from a low, flat area in the northeastern part, comprising about one-eighth of the county, to a rolling upland in the southwest, and to a region rivaling any in the State for its rough, broken surface, including a strip of territory six to ten miles wide extending in a southeasterly direction across the entire county. The great diversity found in the topography is due to a number of causes. The broad, level plain in the northeastern part marks the site of a filled-in lake bed which was undoubtedly formed by the later ice-sheet, the foot of which seems to have rested for a long period against the high ridges of limestone to the south and west. In the less hilly region of southwestern Owen, the general slope of the surface is considerably less than farther east and north. As a result, the enormous volume of water which issued from the melting ice-sheet, after cutting through the great barriers of sandstone and limestone, was compelled to give up a portion of its load of silt and clay, on reaching the lesser slope. This resulted in a gradual filling of the stream valleys which, together with the erosion of the hills, has had a decided leveling effect on the topography of that region.

The wide range of hills extending obliquely across the county is of peculiar interest, both on account of its wildly picturesque scenery and the varied geological formations which are exposed in numerous bold outcroppings along the stream courses.
DRAINAGE.

The county is drained by the White River and Eel River and their tributaries. The White River flows in a southwesterly direction across the southeastern corner of the county, entering just east of Gosport and crossing the southern boundary at about the central point. The affluents from the south are Raccoon Creek, Mills Creek and McCormack's Creek, on the north it receives Indian Creek, Limestone Creek, Mill Creek, Rattlesnake Creek, Fish Creek and Lick Creek. Some of the stream bottoms, especially those of Fish and Lick Creeks, which have received the products of erosion from the already badly eroded uplands, have poor natural drainage, due to the high silt and clay content of the washed-in material.

In the region underlaid with Mitchell limestone, the drainage is very largely underground. The surface waters from such areas find their way through the numerous sink holes into subterranean channels, and ultimately burst from the hillsides as spring or flow from the mouths of caves.

The streams in the southeastern part of the county are entrenched in deep, narrow valleys, often with steep, precipitous bluffs of limestone on either side showing evidences of enormous quantities of water which these streams must have at one time carried. The White River in this region flows from 100 to 250 feet below the high bluffs that skirt the narrow, fertile valley.

In the western part of the county, the streams are inclined to be sluggish, and often have shallow, ill-defined valleys. This is especially true of Fish Creek, the gradient being so slight that the channel is being gradually filled with brush, water plants and sediment. There has been a noticeable decrease in the size of the stream, even during the time of the older inhabitants of the region.

CLIMATE.

The climate of this area is not different from that of central Indiana. Since there is no weather bureau stationed in the county, the table below gives the data obtained at Worthington, which is only seven miles south, in Greene County.
REPORT OF STATE GEOLOGIST.

Normal Monthly and Annual Precipitation and Monthly Temperature (maximum and minimum).

<table>
<thead>
<tr>
<th>Month</th>
<th>Rainfall, Inches</th>
<th>Temperature, °F</th>
<th>Maximum, °F</th>
<th>Minimum, °F</th>
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<tr>
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<td>3.04</td>
<td>71</td>
<td>-23</td>
<td></td>
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<tr>
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<td>3.47</td>
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<tr>
<td>April</td>
<td>3.48</td>
<td>89</td>
<td>21</td>
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<td>18</td>
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<td>Year</td>
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Average Date of the Earliest and Latest Killing Frosts.

<table>
<thead>
<tr>
<th>Place</th>
<th>Length of Record, Years</th>
<th>Last in Spring</th>
<th>First in Autumn</th>
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<tbody>
<tr>
<td>Indianapolis</td>
<td>30</td>
<td>April 16</td>
<td>October 19</td>
</tr>
<tr>
<td>Bloomington</td>
<td>12</td>
<td>April 19</td>
<td>October 20</td>
</tr>
<tr>
<td>Worthington</td>
<td>15</td>
<td>April 22</td>
<td>October 24</td>
</tr>
<tr>
<td>Washington</td>
<td>12</td>
<td>April 16</td>
<td>October 19</td>
</tr>
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The dates of the first and last frosts in this vicinity correspond closely with those of other points in central Indiana. The growing season is practically six months long. The rainfall is rather evenly distributed through the year, the greatest precipitation being in March and June and the least in October. The prevailing direction of the wind during the year is as follows: winter, northwest; spring, southwest; summer, southwest, and autumn, west.

GEOLOGY.

Geologically, Owen is one of the most interesting counties in the State. Owing to its peculiar position with respect to the foot of the Wisconsin ice-sheet which rested a few miles to the north, the glaciology of the region while not heavy is quite pronounced. On the other hand, the mantle of drift soil deposited is sufficiently thin to allow frequent exposures of the underlying strata. This was made more pronounced by the remarkably deep trenches and gorges cut through the underlying strata by the glacial waters which sought an outlet to the southwest. It was this agent that left the rough, broken topography we find today
in portions of Owen County, making it a region unsurpassed in Indiana for its romantic beauty and inspiring scenery. Nature seemed to have at hand all the necessary material upon which to exercise the power of her mightiest of agents in fashioning this land into what has been justly termed "The Switzerland of Indiana." The results of her handiwork are seen in precipitous hills divided by deep, narrow ravines, in thousands of springs bursting from the ledges on the hillsides, in a surface honeycombed with sink holes and undermined by great caverns of unknown extent, and in caves of romantic beauty and grandeur. A remarkable phenomenon is found five miles southwest of Spencer in the form of a natural bridge, spanning a gorge 22 feet wide, with a ledge of limestone 10 feet wide and 18 feet high. Caves abound throughout the region, some of the most notable being Boone's Cave, Porter's Cave, Spring Cave and Freeman's Cave.

There are seven geological formations within the county, the productive coal measures being the latest formation. Coal is found in a strip five to six miles wide along the western line, in the upland areas. The Mansfield sandstone underlies it and outcrops to the east, along Lick Creek covering eastern Jefferson and the uplands of Lafayette Townships. It is also found in the southeastern part of the county capping the hills above the Huron limestone. It is especially prominent in Clay Township and extends through Jefferson into Marion and Jackson townships.

The Huron limestone, joining the Mansfield on the east, extends north through the central part of the county. Frequent outcrops are found in western Jefferson, in Franklin and Lafayette Townships. Much of the road material of the region is made from this limestone.

The Mitchell limestone forms the bed of White River south of Spencer and is found in northern and eastern Clay Township, outcropping along Raccoon Creek. At the old site of Green's Mill in Section 20, west of Freeman, the stream runs between sheer walls of limestone, capped with sandstone, 80 feet in height. The bluffs are beautifully clothed with a noble forest of Hemlock (Tsuga canadensis (L) Carr) which clings to the almost perpendicular rocks. The Mitchell limestone forms the surface formation in practically all of Washington Township, east of the White River. Here again is found some beautiful scenery. Some of the largest sinkholes in the county are found in this region, the surface being very rough and broken. The McCormack's Creek, issuing from the broad, level "Flatwoods," has cut a remarkable gorge through
the limestone to a depth of over 100 feet. This spot can not be surpassed in the State for its wild and romantic scenery. The Mitchell limestone also forms the surface rock of the rich, rolling "Kentucky blue grass plains" through Wayne and parts of the adjoining townships. The outcrops are not so bold nor so numerous in the northern part of the county, owing to the thick mantle of glacial drift overlying it. The Falls at Cataract, at which place the waters of Eel River plunge a distance of 80 feet in a series of rapids and two successive falls, are formed by ledges of Mitchell limestone.

The Bedford Oolitic limestone outcrops near Romona, at which place is located one of the large quarries of the county. This limestone is also found in the region northwest of Gosport.

The Harrodsburg formation is found in the northeastern part of the county in the vicinity of Gosport, and north through eastern Wayne and Harrison Townships. In this region, the overlaying strata are deeply buried under a layer of silt and clay carried in from the uplands, which has resulted in the so-called "Flats."

The Knobstone, the oldest formation in the county, is found only in a narrow strip east and northeast of Gosport. This strip marks the irregular western boundary of this formation which comprises the surface rock of practically all of Morgan County to the east.

The Flat Woods.—This region is a peculiar geological feature located southeast of Spencer, in the southeast corner of Washington Township, and extending into Monroe County. It is a low, level basin, covering an area of 14,000 acres within the boundary of Owen County. It is completely surrounded by high hills which rise abruptly from the floor of the basin. There are but two breaks in this rim in Owen County, through which McCormack's Creek and Ellison's Creek pass. The former furnishes the principal drainage system.

The geology of the area has been a subject of considerable study. Prof. Collet\(^1\) pronounced this basin to be a portion of the original valley of the White River, which he believed to have flowed through the present channel of McCormack's Creek and continuing southwest through the Raccoon Creek channel, joining its present channel where that creek empties.

This theory, however, has been subsequently disproved by Hopkins and Siebenthal\(^2\) after comparing the different elevation of

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\(^1\) Geological Report, 1875.

\(^2\) Geological Report, 1895.
the region. In order for White River to flow down the above channel, it would have to run at a level of 150 feet higher than at present. Yet Bean Blossom Creek, which empties into the White River a few miles to the north, is clearly a post-glacial stream and could not possibly have flowed in that direction if the above were true, and at the same time cut down to its present depth.

The later explanation advanced by these men is that the Flat Woods is the site of a shallow, glacial lake. The McCormack’s Creek gradually pushed farther to the southwest, until it finally “tapped” the enclosed body of water and drained it. The large amount of water thus liberated and the fall of about 150 feet in two miles account for the narrow, deep gorge of McCormack’s Creek.

The soils of the Flat Woods were quite uniform and the greater part was classed as Waverly silt loam. They are discussed fully in this report under the soils.

HISTORY AND SETTLEMENT.

As far back as history and tradition go, Owen County has been a favorite resort for the red man. The region supplied all that he could wish in game, fish, wild fruit and rich river valleys. Over the area roamed the Pottawatomie, Miami and Delaware tribes. Many traditions of Indian origin are still afloat in Southern Owen of enormous lead and silver mines, which as yet have not been located.

The first settlement was made in the county in 1816, just northeast of the present site of Spencer, seven years after the territory was ceded to the Whites by the treaty of Ft. Wayne. The first settlers were Philip Hart, accompanied by his family, and James Bigger. By 1820 quite a number of settlers had located in this neighborhood. At this time the country was infested with wild animals and treacherous Indians. The hills were covered with a magnificent forest of poplar, sugar, walnut, oak, beech and elm, few of which have withstood the ravages of the white man to the present time.

The task of clearing the land was indeed no small one. But the stout-hearted pioneers hesitated at no task, and gradually the forest gave way to the plow. The methods were necessarily crude, the “jumping shovel” plow being used to break the rough, stumpy ground. Corn was the main crop, and due to the native richness of the soil good yields were obtained.
Owen County was organized in 1818 and named in honor of Maj. Abraham Owen, a veteran who lost his life in the Battle of Tippecanoe. The site of the county seat was located on the north bank of White River and was named in honor of a Captain Spencer, another hero of the same battle.

The settlers generally came from the south—Kentucky, Tennessee, or Virginia. While the new country was destined to become an agricultural one, yet much time was spent by these sturdy woodsmen in hunting and fishing, many of whom found greater pleasure and profit in this, their favorite pursuit, than in devoting their time and attention to matters pertaining to the farm. As the country became more and more settled and the soil began to show signs of exhaustion, the difficulty was met by merely clearing new areas, and abandoning the old fields. This system, which was practiced for many years, especially in the rougher and more thinly settled regions, resulted in inestimable injury to the soils for the future generations. The steep hillsides were cleared of every tree, shrub and vine that would tend to hold the soil together, and as a consequence a few years of careless tillage resulted in the washing of the surface soil down the slopes, leaving exposed the bare unproductive subsoil. In the regions where the Mansfield sandstone is close to the surface, on hundreds of hillsides the vestige of fertility has been carried away, leaving a bare surface of sterile sand and clay, overstrewn with bits of broken sandstone. In other places, where the loessial drift is deeper, the exposed subsoil is slowly being converted into a productive soil again, through natural agents. This is accomplished by the profuse growth of fine grass—locally known as "dog hair" grass—which is followed by dewberry and blackberry briers and sassafras shrubs. In this manner, hundreds of acres of abandoned land have been overrun and is being protected from the further destructive action of water.

The farmers of Owen County, for the most part, own their farms, and during the past few years have been making an intelligent effort to increase the productivity of their soils. This movement has not been without results, as evidenced by the increased yields and other indications of increased prosperity when compared with conditions ten years ago. During the past few years, however, there has been a restless feeling among the farmers of Owen County, which has resulted in many "selling out" to seek more promising locations. Their farms, in very many cases, have been sold and added to the neighboring farms. Through this
process, there has been a decided increase in the size of the farms, with a corresponding thinning out of the rural population. It is a deplorable sight to note the number of houses thus abandoned throughout southern Owen County, many of which are still in excellent repair. This movement means that instead of a tendency towards more intensive methods of farming, which would lead to the rapid development of the agricultural welfare of the county, the tendency has been in the opposite direction—towards extensive methods. This condition is to be deplored, for a "land poor" farmer contributes much towards keeping a county poor.

The people are noted for their generous hospitality and friendliness. While there are few so-called wealthy farmers, yet the great mass of the people are intelligent, independent and industrious and are now making rapid strides towards better methods of farming.

Spencer, the county seat, is situated in a beautiful valley on the north bank of White River, in Jefferson Township. It is a city of 2,150 inhabitants. The Vandalia Railroad passes through it, which affords a good outlet for the products of the surrounding country. Formerly traffic was carried on on the White River before it became unnavigable for flatboats. The new court house has just been completed, which is the pride of the county.

Gosport is a town of 776 inhabitants, situated some ten miles up the river from Spencer, on the same side. It has two railroads, the junction between the Vandalia and Monon Railroads being at this place. It assumed considerable importance as a shipping point during the early history of the county. It is located in the richest section of the county, the wide, fertile valley of the White River stretching away to the southwest, and a rich limestone region to the north and west—the latter a veritable "Kentucky bluegrass soil."

Coal City is situated on the Indianapolis and Evansville Railroad, in one of the rich coal fields of the State. It has 325 inhabitants, and is a prominent trading and shipping point.

Quincy, located in Taylor Township, on the Monon Railroad, was formerly of considerable importance as a trading point. The town has made but little progress however during the past forty years.

Patricksburg, a thriving town of 500, is situated in Marion Township, on the Indianapolis and Louisville Railroad. It early came into prominence as a trading point and a number of industries have been located here. It is also in the region of the rich coal belt.
Freedom, one of the oldest towns in the county, is located on the Vandalia Railroad, in the valley of White River. It has 325 inhabitants, but is of little importance commercially.

Besides these there are numerous villages nestled in among the hills, usually consisting of a store or two, a schoolhouse, and possibly a church. Most of these villages have "seen better days" for before the advent of the rural routes, postoffices were located at these points and served as a gathering place for the farmers of the vicinity. Some of these villages are White Hall, Freeman, Arney, Cuba, Atkinsonville, Farmers, Hausertown, Cataract, Cunot, Adel and Jordan Village.

AGRICULTURE.

Agriculture follows the general lines, with but little attention devoted to special crops. The prevailing crops are corn, wheat, oats and hay. Corn is raised throughout the county, but the creek and river valleys afford the best soil for this purpose. In the rougher districts, corn is not being grown so extensively as formerly, since repeated cultivations result in destructive erosion of the soil on the steep slopes. In the western and northeastern sections, however, where the surface is more level, corn is grown extensively on the upland with fair yields. Considerable commercial fertilizer is used with this crop, and many instances of remarkable increases in yield have been noted where even a light application of nitrogen and phosphatic fertilizers was made. In the southern and western part of the county, farmers are relying more and more on these fertilizers for profitable crop returns. Generally the most approved methods are employed in the farming operations, yet there is need for further improvement in various ways. The old type cultivator with broad shovels should be discarded and a system of shallow, level cultivation substituted. The latter method lessens the danger of washing, decreases the amount of soil exposed to the drying effect of the sun and wind, and lessens the danger of injuring the roots of the growing corn.

The acreage of corn grown in the county has varied but little during the past thirty years. However, the yield per acre has increased materially. In 1880, 22,108 acres were grown, yielding 505,392 bushels, while in 1910, 22,711 acres produced 686,672 bushels.

Wheat was at one time grown much more extensively than at present. In 1880, the acreage was 23,787, yielding 295,378 bu-
shels, while in 1910 only 10,608 acres were sown, with a yield of 124,398 bushels. Wheat is confined chiefly to the more level regions of the western and northern parts. The practice of sowing commercial fertilizers with this crop has been a general one during the past few years. On the upland, usually a fertilizer rich in phosphoric acid and potash is used. This, where clover has a regular place in the rotation, gives good results, but where no successful attempt is made to supply the nitrogen with a leguminous crop, the soil, naturally deficient in organic matter, is soon depleted of this important element. The poor management of the soil during the earlier days is responsible for the later decline of the wheat crop. The yield per acre ranges from 8 to 25 bushels, the better farmers who are making special effort to conserve their soils obtaining the larger yield.

Oats are raised in practically all parts of the county but more extensively in the level regions. In 1880, 8,161 acres were grown, producing 106,474 bushels as against 8,566 acres yielding 59,476 bushels in 1910. Very little commercial fertilizer is used with this crop. The soil is well adapted to oats if greater care is exercised in sowing the crop.

Grass is grown extensively throughout the county. The soil is especially adapted to the raising of timothy, more particularly in the flat regions. While the acreage has increased during the past thirty years, the yield per acre has decreased somewhat. In 1880, 15,037 acres were grown yielding 22,368 tons, as against 20,524 acres producing 18,965 tons in 1909. The extensive use of this crop in the rotation to supply the hay to the exclusion of clover is significant when correlated with the present low state of productivity of many of the farms. Clover has never been held in favor as a grass crop, chiefly because the condition of much of the soil has been unfavorable to its growth. In 1880, 3,972 acres were raised, as against 2,170 acres in 1909. The soil conditions which are holding the farmers down to a 30 bushel corn crop, a 10 bushel wheat crop and practically excluding the all-important clover crop are discussed under the soils proper.

Fruit growing in Owen County has received but little attention, yet opportunities along this line are excellent. The soil is well adapted for fruit trees and much of the upland which is of little value for farming could be profitably turned into orchards. The superior quality of the fruit that is being produced from the well cared for orchards warrants a more serious consideration of this proposition. The great need at present, however, is for more at-
tention being given to the fruit trees which have already reached the bearing age. It is apparent from the appearance of the trees, that very little attention has been given them and as a consequence many orchards are suffering from the ravages of various pests.

The soil of central Owen County has been recognized for some time as being peculiarly adapted to tobacco raising. Many tobacco growers from the Southern States have located here and are growing an excellent quality of tobacco. It is usually marketed at Louisville.

Owen County has never been an extensive stock raising or dairy section. This is due largely to the poor adaptation of the soil for heavy grain farming, which naturally prevents winter feeding. Consequently, much of the stock is sold when young to more favorably located feeders. In the broad, rolling limestone area, comprising the greater part of Wayne Township and stretching west and north into the adjoining townships, is found excellent pasture land. In this section, cattle and sheep are raised rather extensively.

Dairying is slowly becoming recognized as a profitable business and will do much toward improving the soils. Silos are being built in many parts of the county and greater care is being exercised in preserving the feed on the farms. One of the great needs of the county is more and better live stock.

SOILS.

The soils of Owen County show great uniformity in texture, the different types varying comparatively little in this respect. Practically the entire area is classified in the silt loam group. Very little sand or gravel is found distributed through the soil, although it is more in evidence in the northern part of the county.

There are seven soil types recognized in the area. However, there are considerable variations in each type which, when not sufficiently prominent to warrant the introduction of a new class, are considered as phases of the type in which they are found. The classes of soil which are recognized in Owen County are as follows: The Knox silt loam, by far the most extensive soil in the county, comprising most of the upland soil or nearly four-fifths of the county; the Wabash silt loam, the soil of the White River bottom and some of the other streams; Wabash fine sandy loam, found chiefly in Eel River bottom; Waverly silt loam, the built-up soil in various depressed areas; Carrington silt loam, small areas of black soil in low regions; Knox sandy loam, occupying a series of
low mounds and ridges along White River valley; and a small area of peat found in the northwestern part of the county.

KNOX SILT LOAM.

The Knox silt loam represents the prevailing soil type of Owen County. With the exception of small areas of Knox sandy loam, practically all the upland soil falls in this class comprising about four-fifths of the county. It is a light yellow to greyish white silt loam from 8 to 12 inches in depth. When wet, the soil changes to a dull grey. The subsoil is a compact yellowish-red silty loam, somewhat heavier than the surface soil. It is mottled with streaks of light grey or white. These are sometimes very faint, but in some places the yellow and white are about evenly divided, especially in the poorly drained areas. In wet regions, the soil is invariably lighter in color, due to the absence of the iron compounds which are often extracted from the body of the soil in the form of small, soft, inert concretions found scattered over the surface. Small areas of this nature are found throughout the extent of the Knox silt loam, and are usually very difficult to manage. At a depth of 24 inches, the subsoil becomes heavier and tends to break into cubical fragments.

The Knox silt loam contains but little sand or gravel. Under cultivation it is very easily handled if not worked when too wet. The soil on the surface is loose and friable, with a "floury" feel, but it becomes compact a few inches below the surface and runs together badly. Care must be exercised not to work the soil when too wet since it puddles easily and becomes very cloddy. Originally, it supported large forests of hardwood timber of poplar, sugar, oak, beech and elm. Consequently it is low in humus content, the light color of the soil indicating this deficiency. The color of the soil can be changed materially by the incorporation of a liberal supply of organic matter, in the form of barnyard manure and vegetation.

The Knox silt loam is derived from loessial drift which is composed of the finer glacial material. It owes its deposition to wind and water, the former agent doubtless being the principal one. The wide topographic range in which the type is found is striking. On the crests of the highest hills which are protected from erosion, on the level areas, and in the older valleys the texture and appearance of the soil are identical. In the southern part of the area, the surface is very rough and the mantle of loess is comparatively thin. On many of the prominent points the soil has been entirely carried
away by erosion, leaving bare the residual sandstone beneath. The silty soil has insufficient clay to hold it together firmly and consequently it tends to wash badly. In the hilly sections, the greatest problem of the farmer is the one of erosion. Gullies are formed rapidly which generally reach to the bottom of the loessial drift, before they are checked. These washes are started at the slightest provocation and in a remarkably short time become so large as to be very difficult to manage. Hundreds of acres of the best upland soil in the county have been practically ruined for all time by this destructive process, which has been allowed to go on through neglect and carelessness. However, by careful cultivation and by keeping the slopes in growing crops or grass as much as possible, farmers are able to minimize the danger in this respect.

In the northern and western part of the area, the topography is more level and the general farming value of the soil is greatly increased. When properly handled it is well adapted for the raising of corn and wheat, producing often as high as 50 and 25 bushels respectively. However, the average yield does not exceed 30 bushels of corn and 12 bushels of wheat. The soil is rather easily exhausted, and at present much commercial fertilizer is used. This usually consists of bone meal, containing from ten to twelve per cent. of phosphorus and sometimes with the addition of one to two per cent. of potash. Very little nitrogen is applied in the form of fertilizer, although the nitrogen content of the soil has become very low. Since very little livestock is raised in the county, there is a correspondingly small amount of manure produced; so this source of nitrogen is likewise denied the soil.

Timothy does well on the Knox silt loam, this crop being one of the most extensive grown. Clover or other leguminous crops have a limited use, due chiefly to conditions of the soil unfavorable to their growth. Yet it is through the use of these crops that the failing nitrogen supply can be most economically maintained or increased. Until these conditions are corrected then, farmers will be seriously handicapped, since the growing of nitrogen gathering crops is among the first essentials of successful farming.

One of the difficulties of the Knox silt loam is the acid condition that prevails. Closely associated with this is the lack of thorough drainage. This does not include the entire area, as there are sections where neither condition is found. However, the texture of the soil is so fine that, with the heavy compact nature of the subsoil, natural drainage is poor even on the sloping areas. The soil is not only wet and cold by virtue of the above
SOIL SURVEY OF OWEN COUNTY.

conditions, but the free circulation of the air through the soil, a most important requisite to the growing plant, is prevented as well.

The lack of drainage further promotes the accumulation of organic acids in the soil. It is safe to say that the greater part of the area of Knox silt loam, while probably not giving a strong acid reaction, would nevertheless be benefited materially by an application of ground limestone. Where there is an abundant growth of red sorrel and bracted plantain, a sparse growth of cultivated crops, a heavy sodden condition of the soil, and the failure of clover, the acidity of the soil is apparent. The amount of ground limestone necessary to correct this condition depends somewhat on the nature of the soil, but from two to four tons per acre every three or four years will usually produce excellent results.

Thorough tile drainage will do much to improve the aeration of the soil as well as afford an escape for the soil water. The tile should not be laid more than thirty inches below the surface or the laterals more than five rods apart. Cement tiles are being used quite extensively in some sections and where correctly made are proving quite satisfactory.

There is no denying the fact that the drainage and liming proposition would prove an expensive one and would necessarily need to be introduced slowly, with a view to make "one acre pay for another." With the accomplishment of these things and with a frequent turning under of heavy crops of cow peas or soy beans this soil could easily be made to double its present yield in a short time. The land is valued at from $5 to $20 per acre in the most broken regions and $40 to $60 per acre in the more level locations. The Knox silt loam responds generously to careful, scientific treatment, and in many cases the productivity of the soil has been increased one hundred per cent. in a remarkably short time by such treatment. It is especially adapted to the growing of fruit trees and many promising young orchards are found in the area.

The results of the mechanical analysis of the Knox silt loam are given in the following table:

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</table>
The Waverly silt loam is a light grey to white colored soil with an average depth of five to eight inches. The subsoil is a heavy grey to white heavy silty loam mottled with light yellow to buff streaks. Numerous iron stains are also encountered in the subsoil and iron concretions are frequently found. The Waverly silt loam contains but little sand or gravel although in certain parts of the area the iron concretions interspersed through the soil are sufficiently numerous to give it a gravelly texture. The topographic features are marked by flat, low areas with poor drainage facilities. The soil in many places is "crawfishy," and presents a cold, wet, sterile appearance.

The largest areas of Waverly silt loam are found in the northeastern part of the county, comprising the so-called "Flats." In the "Flatwoods" district, in southeastern Washington Township, the soil is of this type. In the former area, the surface is underlain at a depth of from 12 to 15 feet with a deep layer of fine sand. This sand carries an abundance of water and is a typical "quicksand." In digging wells in the region, this stratum gives considerable trouble if attempts are made to penetrate it. It doubtless marks the bed of the shallow lake which formerly spread out over this area. The subsequent filling in, with the finer materials from the surrounding uplands which was spread out over this bed of sand, accounts for the heavy mantle of soil above it. There are also small areas found along the smaller stream courses. In the spring, the soil remains wet and miry until late, making it impossible to plow until the season is well advanced. So soft and miry is it that stock finds great difficulty in walking across the fields. The tracks thus made often remain throughout the entire summer, for when once dry the surface is very hard and compact. When wet, the soil is a dull grey, but on drying it bleaches out to an ashy white. In the cultivated fields, the surface is loose and free from clods but becomes very compact below the surface.

The drainage facilities of the Waverly silt loam are very poor. The level topography, the close texture of the soil which often reaches over ninety per cent. of silt and clay, and the almost impervious subsoil, account for this poor drainage. So nearly impervious is the subsoil that water stands on the surface for long periods in small depressions, while directly beneath it the subsoil remains apparently dry.

The soil is made up of glacial material which has been re-
worked by water and deposited in the lower areas, forming wide, level plains. In the stream valleys, it is usually found in the second bottoms and is known as "white slash" land. Much of it is due to the erosion of the adjoining uplands, by which process the finer material is carried down and re-deposited in the valleys. Consequently, the resulting soil is naturally low in organic matter. This absence of humus, together with that of the iron oxides, which are usually found locked up in small brown concretions, results in the greyish color of the soil. The surface can be made much darker however by heavy applications of manure or other forms of vegetable matter.

The explanation for the presence of these concretions, locally known as "turkey gravel" or "buckshot," has received considerable attention both from farmers and geologists. They are invariably associated with a light colored soil and one that is poorly drained. It seems that the iron compounds in the soil possess a strong chemical affinity, not well understood, and that this affinity is promoted by a heavy un-aerated soil that is saturated with water. The result of this action is the drawing together of the iron oxides towards a common center and the forming of the soft, brown pellets so common in wet soils. The ashy grey appearance of the soil is made so by this extraction of the coloring matter, which is principally the iron oxides. The remedy for these soils is thorough drainage. With the excess of water removed and the air given free-access to the upper soil particles, the tendency for these compounds to become concentrated into concretions is destroyed. It is further alleged by a former geologist* that after a few years of thorough drainage the concretions already formed will gradually dissolve and re-color the soil. The greater part of the Waverly silt loam has been affected in the above way, and similar smaller areas are found throughout the Knox silt loam. These latter areas range in size from mere spots, often occupying slightly elevated ridges or knolls, to several acres in extent.

Doubtless the lack of drainage is the most serious problem of the farmers in these areas. The installation of a complete system of artificial drainage is an extremely difficult matter, since the close texture of the soil prevents the tile from "drawing" more than two rods on each side. Hence, to drain the soil effectively, the laterals must not be more than four rods apart, with the tile not more than thirty inches below the surface. Cement tiles are

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* Geological Report 1890.
being used quite extensively in the vicinity of Quincy. H. H. Mitchell and J. D. Truax, farmers in Harrison Township, have proven the practicability of making their own tiles. They own and operate a small cement tile machine and are able to turn out from 400 to 600 tiles per day at a cost of not over 12 cents per rod. The initial cost of the machine and equipment did not exceed $60. On a large farm, such an investment would assist greatly in solving the drainage problem.

The greater part of the Waverly silt loam is sour and an application of ground limestone at the rate of from two to five tons per acre is strongly to be recommended. If the soil is then livened up by incorporating into it as much organic matter as possible in the form of green manuring crops or barnyard manure, it would be in proper condition for successful farming. According to an estimate of J. B. Abbot, soil expert at the Indiana Experiment Station, it would require $30 per acre to improve this soil in the way described above. While this seems a staggering proposition at first sight, yet even though introduced slowly highly productive farms will result in a few years and a corresponding increase in land values.

At present there is no convenient place to secure ground limestone in the county, and if shipped in from distant points the freight expenses are excessive. With the farmers anxious to obtain the material and with an unlimited supply of natural limestone close at hand, an excellent opportunity is here offered for the building up of a new and important industry—that of operating stone crushing mills. The demand for the product, once created, would increase rapidly. Such a movement would do more to assist in building up the wealth of the county than almost any other.

Timothy is the most successful crop grown on this type although the other crops are raised as well. The average yields are 30 bushels of corn, 11 bushels of wheat, and 20 bushels of oats. Much of it is kept in permanent pasture for sheep and cattle, the land ranges in value from $25 to $50, depending on the location.

The following table gives the results of mechanical analysis of the Waverly silt loam:

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</thead>
<tbody>
<tr>
<td>Sec. 17, Washington Twp. In Flatwoods</td>
<td>White, silty soil</td>
<td>.0</td>
<td>.0</td>
<td>1.4</td>
<td>7</td>
<td>3.4</td>
<td>80.3</td>
<td>10</td>
</tr>
<tr>
<td>Subsoil</td>
<td>Stiff, mottled clay</td>
<td>.0</td>
<td>.3</td>
<td>6.5</td>
<td>23.4</td>
<td>15.5</td>
<td>42.5</td>
<td>11.0</td>
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</tbody>
</table>
SOIL SURVEY OF OWEN COUNTY.

Collector, Edmonson.

Reaction to litmus ........................................ Neutral
Moisture in air-dried soil ................................ 1.57%
Total soil nitrogen .................................... 0.065%

Analysis of fine soil dried at 105° C.—

Volatile and organic ........................................ 3.17%
Insoluble in 1.115 HCl .................................. 87.76%
Soluble silica (SiO₂) .................................... 0.18%
Ferric oxide (Fe₂O₃) ...................................... 1.74%
Alumina (Al₂O₃) ........................................... 4.84%
Phosphoric acid anhydride (P₂O₅) ...................... 0.14%
Sulphuric acid anhydride (SO₃) ......................... 0.03%
Calcium oxide (CaO) ..................................... 0.42%
Magnesium oxide (MgO) .................................. 0.43%
Potassium oxide (K₂O) .................................. 0.17%
Sodium oxide (Na₂O) .................................... 0.23%

Total ...................................................... 99.11%

WABASH SILT LOAM.

The Wabash silt loam is one of the chief soils of the White River valley. It is a loose, dark brown to almost black soil ranging in depth from 10 to 15 inches. It contains a small per cent. of sand with a high content of silt, giving it its characteristics properties. There is no definite line between the soil and subsoil, the texture changing but little to a depth of 36 inches where there is an appreciable increase in the coarser materials. The surface is loose and mellow and is very easily cultivated. The high content of organic matter, to which the soil owes its color, gives it an open, porous nature that prevents it from baking or cracking. The areas adjacent to the streams are subject to frequent overflow, although very little of it is covered by water for any length of time. The color of the soil becomes somewhat lighter as the distance from the stream is increased, due to the decreasing humus content.

The Wabash silt loam is an alluvial soil, having been transported and redeposited along the streams where it is now found. It is of glacial origin, and much of it has been derived from the surface of the glacial drift during the heavy rains. In fact the soil owes its natural productiveness to this deposit of fertile sediment from the fields, as well as to the large amounts of organic matter contained in it. The texture of the soil is not entirely uniform, the per cents of sand and silt varying in different places.
Usually the parts remote from the stream show more fine sand than the areas bordering the stream. The surface is level and often-times low. Natural drainage in these sections is limited, and artificial drainage must be resorted to before the soil can be cultivated successfully.

The Wabash silt loam is especially adapted for the raising of corn, the yield ranging from 50 to 80 bushels per acre. It is not so well adapted for the production of the small grains, however, since the rank growth of these crops induces lodging. Very little manure or commercial fertilizers are used on this type. Due to its special adaptation for the production of corn and its supposed inexhaustible fertility, a regular system of crop rotation is seldom practiced. Instead, corn is often raised on the same soil year after year. Clover does well on this type and makes an abundant growth. This crop should be used more extensively as a green manuring crop for corn, since it is not adapted to the crops of a general rotation. Timothy makes too rank a growth for the best quality of hay and the further danger of overflow prohibits it from being grown extensively. The type is especially drought resistant and on the other hand crops do not drown out easily where artificial drainage is employed. The land is valued at $100 to $200 per acre.

The soil originally supported large forests of poplar, oak, beech and elm, but most of this has been cut away and the area is practically all under cultivation. The White River bottom comprises the greatest area of this type although it is also found in the smaller stream bottoms, where the erosion from the hills has not influenced the soil too greatly. The bed of the White River is shallow and its course is tortuous. As a consequence, the river is continually encroaching on the adjoining fields, especially at the sharp bends where the banks are being rapidly pushed back at the expense of the fields. Much damage is being done every year by this destructive process.

The following table gives the results of the mechanical analysis of the Wabash silt loam:

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</thead>
<tbody>
<tr>
<td>Sec. 23, Washington Twp.</td>
<td>Soil</td>
<td>0.1</td>
<td>0.4</td>
<td>0.2</td>
<td>6.2</td>
<td>14.8</td>
<td>63.1</td>
<td>14.8</td>
</tr>
<tr>
<td>Sec. 23, Washington Twp.</td>
<td>Subsoil</td>
<td>.0</td>
<td>.8</td>
<td>.1</td>
<td>3.4</td>
<td>12.4</td>
<td>68.3</td>
<td>15.0</td>
</tr>
</tbody>
</table>
SOIL SURVEY OF OWEN COUNTY.

KNOX SANDY LOAM.

The Knox sandy loam is found in small areas along the bluffs of the White River. Its texture is the coarsest of any soil found in Owen County. It is a dark grey, loose sandy loam, with the properties of a sand in places where the organic matter is low. The subsoil is not marked distinctly from the soil, the color gradually becoming lighter with depth until at 20 inches it is a light grey sand with but little humus. The soil is composed of medium to fine sand, and carries a considerable amount of organic matter, which, in places, where it is protected from the burning out effect of the sun, gives it a very dark appearance. However, where the surface is exposed to the action of the sun by cultivation, the soil presents a lighter color.

The Knox sandy loam occurs mostly as elevations along the bluffs of White River valley. These present the appearance of terraces in some sections, as is found on the eastern side of White River opposite the town of Freedom, or they may occur as a chain of low, rounded mounds or ridges which lie between the valley and the upland proper. Such an arrangement is found in southwestern Washington Township in Section 30.

The Knox sandy loam is derived from either of two sources. The sand is either the result of the disintegration of the residual sandstones in the regions farther northward and has been transported to its present position by the water; or the sand may be of glacial origin which was dropped by the Wisconsin ice-sheet, several miles to the north, and carried down to be redeposited where it is now found. The action of the wind doubtless assisted in the formation of the dune-like mounds.

The type ranks fairly well as a general agricultural soil. It is not able to resist long periods of dry weather, for the crops burn out easily. The soil is so open that natural drainage is often excessive. The type is well adapted for water-melons and garden truck. The areas found in this county are too small to be considered among the more important agricultural soils.

DOVER SILT LOAM.

The Dover silt loam is closely associated with the limestone regions of the county. It varies in color from a reddish-brown to a light brown silt loam with enough fine sand to give it a loose, open texture. The soil averages from 8 to 12 inches in depth although there is no sharp differentiation between the soil and subsoil. The
subsoil verges into a heavy yellow or reddish-brown loam, usually somewhat lighter than the surface. The content of sand increases somewhat with depth, giving it, in the better drained areas, a loose granular structure. At a depth of 36 inches the subsoil becomes a light yellow, and is often mottled with streaks of grey or white. Often in the level areas the subsoil becomes a stiff, tenacious, reddish-brown, heavy loam with the properties of clay. Such phases, however, are usually found in the vicinity of its closely associated type, the Knox silt loam.

The Dover silt loam comprises one of the best agricultural soils in the county. It is a typical loess, derived from glacial debris, which, after its deposition, has been greatly influenced by the residual stratum of limestone which underlies it. It is the result of the weathering of this limestone and the mixing of the weathered material with the mantle of loess that differentiates it from the Knox silt loam and makes it a distinct type. The Dover silt loam is characterized by a rolling to hilly topography with long gradual slopes and wide valleys. The elevations are seldom so abrupt as to cause exposures on the hillsides and consequently, the surface, which is matted with an abundant growth of grass roots, is seldom broken. Thus, the danger of washing is reduced to a minimum in the uncultivated areas.

The type is underlaid almost entirely by the Mitchell limestone and the surface is pitted in many places with sinkholes, ranging from a few feet in diameter, to those covering an acre or more. Throughout the area, outcroppings of the limestone are found on the sharper slopes although they seldom interfere with the cultivation of the fields. The beds of the streams are usually composed of this stratum.

The Dover silt loam is especially adapted to the growing of bluegrass, by virtue of its abundant lime content, its open, porous surface and the excellent drainage. The grass grows luxuriantly and furnishes good pasture throughout the summer. A large part of the soil is kept in permanent pasture for sheep and cattle. This is especially true in Wayne Township. Here the farmers are making a practice of cutting the weeds in the woods pasture every summer and in other ways are caring for them. The soil is open and loose, and requires but little work to produce an excellent seed bed. Corn does well, especially when an application of barnyard manure is added. It produces from 30 to 65 bushels per acre, with an average of about 45 bushels. Wheat is grown rather extensively.
and averages about 15 bushels per acre. Commercial fertilizers are not used extensively, although there were many inquiries as to the fertilizer needs of this soil. Doubtless an application of a fertilizer rich in phosphorus would produce the best returns, provided clover or some other legume is grown regularly in the rotation. If not, nitrogen should be supplied in the fertilizer, although the latter method is not to be recommended since this element can be furnished much more cheaply through the legumes.

The Dover silt loam is the only upland soil in the county that shows no indications of sourness. The close proximity of the Mitchell limestone layer is responsible for the wholesome condition of this type. Clover does well, there being little trouble in getting a stand or an abundant growth during favorable seasons. It is also well adapted for alfalfa and this crop should be raised more extensively, as but little is being grown at present.

The principal area of this type is found north and west of Gosport, extending through Wayne and into the adjacent townships. Other areas are found in Clay and Washington townships. The timber growth on this soil is quite characteristic and furnishes a means of readily recognizing the type wherever encountered. The original forests were confined almost wholly to black and white walnut, sugar and poplar trees. Many fine specimens of walnut and sugar trees still are to be found, but the poplars have practically all been cut away.

The large number of sinkholes characteristic of this area has handicapped the farmers a great deal. Generally, bushes and young trees are allowed to grow up in these depressions which prevent them from becoming larger and hold the soil from washing in. However, some of the more enterprising farmers have practically eliminated them from their fields by choking the underground openings with stones and rubbish and filling in with dirt. A number of sinkholes on the farm of Mr. Holt Pickens, in Montgomery Township, was treated in this manner and the surface has been made practically level. The drainage of the area is to a large extent underground, the water escaping rapidly after the rains through the sinkholes into the subterranean channels.

The following table gives the results of the mechanical analysis of the Dover silt loam:
REPORT OF STATE GEOLOGIST.

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</thead>
<tbody>
<tr>
<td>N. E. Sec. 30, Wayne Tp.</td>
<td>Reddish brown loose loam</td>
<td>.0</td>
<td>.0</td>
<td>.55</td>
<td>11.6</td>
<td>10.4</td>
<td>66.8</td>
<td>10.0</td>
</tr>
<tr>
<td>Subsoil</td>
<td>Brown, compact, stiff</td>
<td>.0</td>
<td>.0</td>
<td>10.1</td>
<td>25.9</td>
<td>14.3</td>
<td>29.9</td>
<td>19.3</td>
</tr>
</tbody>
</table>

Chemical Analysis of Dover Silt Loam.

Collector, Edmondson.

Reaction to litmus ........................................ Neutral
Moisture in air-dried soil .................................. 1.48%
Total soil nitrogen ........................................ 0.087%

Analysis of fine soil dried at 105° C.—

|                          |                             |                         |                         |                         |                       |                          |                 |
|--------------------------|------------------------------|-------------------------|-------------------------|-------------------------|-----------------------|--------------------------|-----------------|----------------|
| Volatile and combustible |                              | 3.47%                   |                         |                         |                       |                          |                 |
| Insoluble in 1.115 HCl   |                              | 86.05%                  |                         |                         |                       |                          |                 |
| Soluble silica (SiO₂)    |                              | 0.16%                   |                         |                         |                       |                          |                 |
| Ferric oxide (Fe₂O₃)     |                              | 2.34%                   |                         |                         |                       |                          |                 |
| Alumina (Al₂O₃)          |                              | 6.37%                   |                         |                         |                       |                          |                 |
| Phosphoric acid anhydride (P₂O₅) |               | 0.33%                   |                         |                         |                       |                          |                 |
| Sulphuric acid anhydride (SO₃) |               | 0.07%                   |                         |                         |                       |                          |                 |
| Calcium oxide (CaO)      |                              | 0.30%                   |                         |                         |                       |                          |                 |
| Magnesium oxide (MgO)    |                              | 0.53%                   |                         |                         |                       |                          |                 |
| Potassium oxide (K₂O)    |                              | 0.21%                   |                         |                         |                       |                          |                 |
| Sodium oxide (Na₂O)      |                              | 0.20%                   |                         |                         |                       |                          |                 |
| Total                    |                              | 100.12%                 |                         |                         |                       |                          |                 |

WABASH FINE SANDY LOAM.

The Wabash fine sandy loam is an alluvial soil, the largest area being found in the Eel River bottom, with smaller areas in the valley of the White River and minor streams. It is a dark brown to black, mellow soil with a depth ranging from 12 to 15 inches. The surface has a comparatively small amount of sand, feeling to the touch much like a silt loam. However, the sand content increases rapidly with depth and at 30 inches often runs as high as fifty per cent. The subsoil grades into a very heavy, stiff, sandy clay which, on drying, is extremely hard. It is of a lighter color than the surface, being a dull drab with light yellow spots of clay or iron oxide.

The area of Wabash fine sandy loam in the extreme southwestern part of the county in Eel River bottom is low and inclined to be marshy, in the vicinity of the stream. The entire area is sub-
ject to overflow and great damage is done to the crops every year by these untimely floods. In seasonable years, however, this type is very productive, being especially adapted for the raising of corn. From 80 to 90 bushels per acre are commonly obtained. But during the wet seasons, crops suffer greatly and are often drowned out. Artificial drainage is being employed to some extent with excellent results. But even then the water drains out very slowly, since the fall is so slight. The main difficulty lies with the Eel River itself. The general slope of the region is very slight; the elevations of Johnstown, at the point where the river crosses the Owen County line, and Worthington, three miles farther south, are exactly the same. Consequently, the stream where it touches Owen County is very sluggish and the channel has become slowly filled up with accumulations of brush, trees and mud. What little impetus the current might have is practically destroyed by the meandering course which the stream takes. So when the floods are brought down from the more sloping regions above, the results are a general overflow, at this point. After the destruction of two successive crops in this way, farmers have refused to farm it longer, at such a risk of losing everything, and consequently hundreds of acres of rich soil are now lying idle. However, a project is being considered, of deepening and straightening the channel of Eel River for a distance of 23 miles along the county line. In this distance, the channel would be shortened to one-third its present length by eliminating the crooks. This would affect about 35,000 acres in the valley and the estimated cost would not exceed ten dollars per acre. The present price of the land in this region is from $20 to $30 per acre and if they succeeded in preventing the destructive floods and securing a good outlet, the value of the land would increase in a short time to $75 to $100.

In the valleys of the smaller streams, the drainage is usually good. Corn is the staple crop. Tomatoes are grown quite successfully in Franklin Township on this type.

The Wabash fine sandy loam is of glacial origin, having been carried down by the streams and redeposited. The subsoil varies considerably, sometimes changing to a bed of fine sand which shows evidence of water deposition. Where the valleys are narrow and erosion of the hills has been extensive, the identity of this type is lost in the deluge of silt and clay that is spread out over it. Many fields in these valleys, once very fertile, have been practically ruined by this fine material washed down from the bare, unproductive hills.
The mechanical analysis of the Wabash fine sandy loam is as follows:

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</thead>
<tbody>
<tr>
<td>Sec. 36, Jefferson Twp... Soil</td>
<td>.0</td>
<td>.9</td>
<td>1.0</td>
<td>12.4</td>
<td>25.7</td>
<td>47.2</td>
<td>11.9</td>
<td></td>
</tr>
<tr>
<td>Sec. 36, Jefferson Twp... Subsoil</td>
<td>.0</td>
<td>.4</td>
<td>3.1</td>
<td>28.5</td>
<td>28.6</td>
<td>33.2</td>
<td>5.6</td>
<td></td>
</tr>
</tbody>
</table>

Peat.

The only bed of peat found in the county is located in Jackson Township, Section 12, on the farm of Mr. Robert Martin. It is a low-lying, swampy region, in the valley of Jordan Creek. A study of the region reveals evidences of the existence of a long, narrow lake, at one time in the history of this valley. A large number of springs open from the eastern slope and have kept the soil saturated with water. As a result, water-loving plants have grown up and decayed for ages until a deep bed of soft springy peat has been formed. There had been no attempt to utilize this area until the Martin brothers undertook the task of draining it. This proved a big proposition, but it was accomplished by means of a large number of tile drains, and excellent corn is being raised on it at present.

The layer of organic matter is from three to four feet thick, under which is found a deep layer of water-bearing sand.

Lying north of the peat bed is a small area of black muck. This is difficult to handle, and spots are found on which corn will not mature. Such spots are evidently very deficient in potash and this fertilizer should be added when the crop is planted.