THE WATER POWER OF INDIANA.

BY W. M. TUCKER.

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PART I.

INTRODUCTION.

The problem of water power in Indiana is one which will require several years of careful work to solve definitely. It is the most difficult of water power problems, because of two conditions: first, the water power of Indiana must be developed on low heads without great storage, and, second, the stream flow in Indiana is very irregular. In order to solve the problem definitely, it is necessary to determine for each site the exact geographical conditions surrounding it, and, the exact amount of water which can be depended upon at it. To determine the former, it is necessary to make a careful survey of each site, and to determine the latter, careful gage and current readings must be kept at one or more points on each stream to be investigated, for a period of several years. In the end, the time spent at each power site by the investigator, would probably average at least half the time spent thus far on the whole problem. The writer of this report does not claim that the results stated in the report are infallible, because sufficient time has not been spent to produce infallible results. The work, thus far, has been more for the purpose of locating power sites which are worthy of more careful investigation and to establish gages so that the data on stream flow will be accumulating. This work is only partially completed. A few more gages should be established. The rivers of the northern part of the State have not been traversed. Thus, this report is only a preliminary statement which the writer hopes will be of some benefit to those who continue the work.

In the preparation of this report the writer has received aid and suggestions from several persons whom he wishes to thank for favors. Mr. John A. Smith spent two months in the field during the summer of 1909. Dr. C. R. Dryer permitted the glacial map from his "Studies in Indiana Geography" to be used. The United States Weather Bureau permitted the use of data. The United States Geological Survey also permitted the use of data. Several railroad companies have permitted the use of their road profiles to determine elevations. Dr. E. R. Cumings and Dr. J. W. Beede have offered many suggestions and criticisms. The gage readers mentioned in the report have been careful and obliging. Many favors from various people have been received while working in the field.

Artificial light and heat are of equal importance with food, clothing and shelter to the human race in this latitude. The common sources of our light and heat are wood, coal, oil and gas. Wood has been abandoned as a means of heating except for family use and in very small manufacturing plants. The disappearance of our forests and the slow growth of forest trees make any attempt to produce fuel from this source impractical. Authorities on coal have decided that the available coal will supply the present demand for only a few decades[1]. Gas and oil fields have been found to be even shorter lived than coal fields. The weight of authority seems to indicate that the next two centuries will practically exhaust these four common fuels. A proper conservation of the present supply will greatly extend the life of these fuels, but with the present increasing demand for power the final exhaustion is but a matter of time. In the face of this situation the question as to the means of supplying this deficiency naturally arises. Several answers have been offered to this question. Among the means suggested, the most plausible ones are direct sunlight, wind power and water power. At the present time little has been done along the line of the direct sunlight engine. However, it is possible and probable that an engine will be invented which will be run for practical purposes by direct sunlight. It is known that the sunlight which falls upon the roof of any ordinary factory is sufficient to produce more power than is used in the factory. If an engine could be invented that would successfully concentrate and utilize this heat, it would still be necessary to store the power for use during the time when the sun is not visible. This could probably be done by a more highly perfected type of storage battery. Wind power has been used for an indefinite time as a means of propelling pumps and other machinery that require but little power. Attempts to use wind power on a large scale have always proved unsuccessful. It

[1] Conservation of Natural Resources in the United States, by Chas. R. Van Hise. p. 23.

is even more inconstant than sunlight. Because of the inconstancy of both wind and sunlight it is probable that neither will ever be used for large scale power purposes.

Water power has long been used for practical purposes. Before the use of steam is was the propelling power of the small mills, and many of these mills are still used. Water power is inexpensive, perpetual, and requires less attention than any other power when it is once installed. While the water power of Indiana must be used on a low head, it is a resource from which thousands of dollars could be realized if it were properly installed and utilized. The New York Water Power Commission estimates a saving over steam in the State of New York by the development of additional water power through reservoirs at twelve dollars per horse power per annum.[2] It requires at least ten tons of coal to produce a horse power for a year.[3] If Indiana could substitute 50,000 horse power by water for as much now produced by steam, which in all probability could be done, it would mean a saving of 500,000 tons of coal per annum in addition to the $12 per horse power saved by the substitution. This would be of great economic importance in increasing the life of coal. The amount of developed power in Indiana is but a small fraction of the available power. A rough estimate places this at about ten per cent. At present there is much interest in water power and a few sites are being developed. The valuable farm lands in the valleys of White River and Wabash River are a great hindrance to the full development of the water power of the State. If in the future the fuels are exhausted and the use of direct sunlight is not found to be feasible, the lowlands along these rivers will be condemned and used for storage basins for water power purposes. Until the demand for power becomes imperative the entire power of the State will not be developed.

A proper development of the water power of Indiana would bring about several other important results. The navigation facilities would be greatly increased; the increased storage would tend to purify the water; and the reservation of water in the storage basins would tend to lessen the damage wrought by floods. The three problems, water power, navigation and protection from floods, are very closely related. The great problem in each case is to bring about a regular stream flow. The following statement from Van Hise bears directly on this point:[4]

[2] 4th Annual Report N. Y. State Water Supply Commission. p. 234.

[3] Conservation of Nat. Res. in the U. S., by Chas. R. Van Hise. p. 124.

[4] Conservation of Nat. Res. in the U. S., by Chas. R. Van Hise. p. 173.

"The greatest difficulty of navigation is the unequal stream flow. At one time the stream is in flood, overflowing its banks, rolling down with great velocity toward the sea; at another time it is comparatively small, indeed often being divided into several small streams trickling over its bed. The conditions in either case are not favorable to navigation; in the first, because of the velocity of the stream, and in the second, insufficient depth to carry a vessel. In the projected improvements, according to Leighton, the first and most important step is to so control the streams as to get a nearly uniform flow.

"The holding of flood waters, and therefore securing greater regularity, may be accomplished to a considerable extent by levees on each side of the river bank at some distance from the low water river channel, so as to make a basin. At times of flood the water rises above the banks, and so makes between the levees a long, narrow, temporary lake which may require several days to fill and empty. Such intermittent levee reservoirs prevent damage from floods and to a reasonable extent regularize the flow of the stream.

"In many cases, in addition to a system of levees such as indicated, it will be necessary to construct at the headwaters of the great navigable stream adequate systems of reservoirs. We have seen that the development of reservoirs is of immense importance with reference to water power. Also it is of equal importance with reference to navigation."

Immense reservoirs could be constructed in Indiana, but this would necessitate the destruction of much valuable farm land, as stated in a previous paragraph.

GEOLOGY OF INDIANA.

The geological formations of the State have much to do with the drainage of the State, and a short discussion will be given here to that subject. The rocks of Indiana belong to the Paleozoic era, of which the representatives of the youngest and oldest periods are of the State. Systems in parenthesis are not represented in Indiana:

PALEOZOIC	(Permian) Pennsylvanian	Merom Sandstone. Coal Measures, Coal, Shale and some Limestone. Mansfield Sandstone.
	Mississippian	Huron Limestone and Sandstone. Mitchell Limestone. Indiana Oolitic Limestone. Harrodsburg Limestone. Knobstone, Sandstone and Shale. Rockford Goniatite Limestone.
	Devonian	New Albany Black Shale. Silver Creek. Sellersburg. Jeffersonville Limestone.
	Silurian	Lower Helderburg. Waterlime. Niagara Limestone. Clinton Limestone.
	Ordovician (Cambrian)	Richmond Limestone and Shale. Lorraine Limestone and Shale. Eden Limestone and Shale.

The entire scale of rock in Indiana is sedimentary, composed of limestone, shale, sandstone and coal. In general the strata are horizontal, but there is a considerable dip toward the southwest which becomes more pronounced toward the southwest. Thus there is a continual change of formations from east to west across the State. However, each formation may be traced from the Ohio River northward for many miles until it disappears beneath the glacial drift. This arrangement has a peculiar effect upon the drainage of the southeastern part of the State. The Niagara and Clinton limestones are very hard and form a long, high divide almost on a line from Madison to Cambridge City. Whitewater River and some smaller streams skirt the east edge of these formations and flow south. West of this divide are the long, low grade tributaries of White River. Thus the Whitewater River and smaller streams drain the Ordovician formation of the State exclusively. On the other hand the White and Wabash Rivers flow directly across the rock formations of the State, and as each formation appears the previous formation disappears beneath it. This has a remarkable influence upon these streams in certain cases. An example of this is on the Muscatatuck. For about ten miles below Vernon this stream flows on Jeffersonville limestone. This limestone is hard and forms abrupt bluffs and a rocky bed for the stream. There is no underflow and the stream is of fair size. Near the Euler bridge the limestone disappears beneath the surface and the soft New Albany shale forms the bed of the stream. The valley broadens and is filled with a deep deposit of alluvium. Much of the water disappears as underflow. The diminished stream becomes filled with drift and could scarcely be recognized as the same stream.

The softer formations weather more rapidly and the streams in these formations have broad valleys filled with deposits of alluvium. The general level of the country is also greatly reduced by erosion in these formations. Other formations are harder. In these formations the stream valleys are restricted and the general level of the country much higher. Thus the State has a series of plateaus extending in a north south direction across the State and representing the harder formations of rock. There are three of these plateaus which are very distinct. A line from Madison, Jefferson County, to Cambridge City, Wayne County, approximately represents the crest of the plateau formed by the Niagara limestone. A line from Jeffersonville, Clark County, to Danville, Hendricks County, is near the crest of the Knobstone plateau. The other plateau is formed by the Mitchell and Huron limestones and the Mansfield sandstone and is approximately represented by a line from eastern Perry County to Greencastle, Putnam County. These plateaus are partially or wholly obliterated by the deep glacial deposits in the central part of the State.

GLACIOLOGY OF INDIANA.

Much of Indiana has been glaciated. Two distinct periods of glaciation are usually recognized. The limits to which these glaciers reached are shown on the map, Fig. 1. The two glaciers are known as the Illinois and Wisconsin glaciers.

The Illinois glacier is the older of these and reached a more southerly limit. Much of the deposit of this glacier has been carried away by the streams. The streams have cut through the drift which it deposited and have their beds in the solid rock beneath. Thus this glacier has little bearing on the subject of water power.

The Wisconsin glacier, which is more recent, has obliterated to a great extent the previous drainage in the part of the State which it covered. During and since the disappearance of this glacier a new drainage has developed which has not yet carved its way through the heavy drift to bed rock. This condition has a marked effect upon the streams. The drift acts as a great storage basin for ground water. The continual appearance of this ground water causes the stream flow to be more uniform and permanent. The presence of many lakes in the Wisconsin glacial area also tends to regulate the flow of streams. Some of these lakes cover several square miles. No investigation as to the storage facilities of these lakes has been made. No lakes occur in the State outside of the

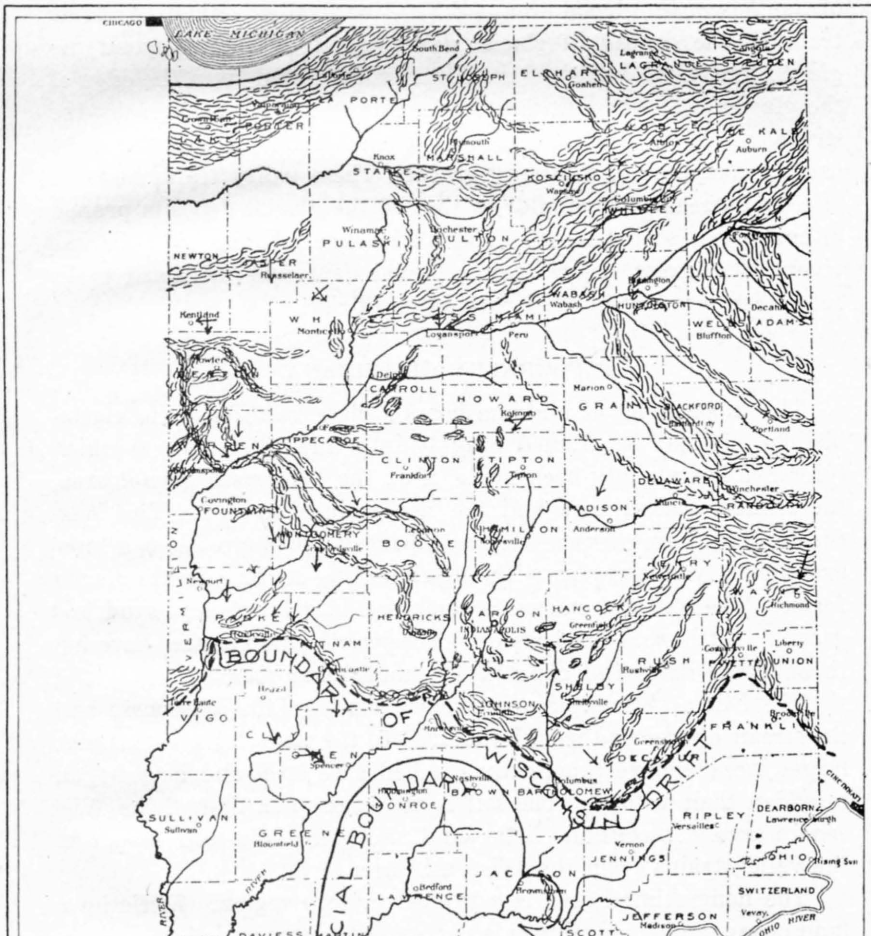
LAKE MICHIGAN
CHICAGO
BOUNDARY OF WISCONSIN DRIFT
GLACIAL BOUNDARY
GLACIAL MAP OF INDIANA. after Frank Leverett.
Legend.
MORAINES
STRIAE
BEACH LINES
0 10 20 30 40 50 Miles
NEWTON
PULASKI
CARROLL
HOWARD
GRANT
CLINTON
TIPTON
MADISON
DELAWARE
BOONE
HAMILTON
HENDRICKS
HANCOCK
PARKE
VIGO
SULLIVAN
GREENE
MONROE
JACKSON
JENNINGS
RIPLEY
DEARBORN
SWITZERLAND
JEFFERSON
KNOX
DAVIESS
ORANGE
WASHINGTON
SCOTT
CLARK
FLOYD
CRAWFORD
HARRISON
PERRY
WARRICK
SPENCER
POSEY
VANDERBURGH
DUBOIS
FRANKLIN
UNION
RUSH
SHELBY
JOHNSON
BARTHOLOMEW
OHIO RIVER

Fig. 1.

Wisconsin glacial area. Many streams flow south off of the edge of the Wisconsin glacial area and have long valley trains. A valley train is the deposit of glacial debris which is found beyond the glacial line in the valley of a stream which flowed from the edge of the glacier. The deposit was made during the glacial area by the stream which was then overladen with sediment. A valley train is usually composed of sand and gravel. These valley trains have an effect on stream flow similar to that of the glacial deposits proper, although not so extensive. The Whitewater, White and Wabash rivers have great valley trains. Good dam sites are hard to locate when a valley is filled with glacial drift.

TOPOGRAPHY OF INDIANA.

The topography of Indiana bears a close relation to its glacial history. It may be divided roughly into three divisions, to which reference has already been made, i. e., the Wisconsin glacial area, the Illinois glacial area and the nonglaciated region. The Wisconsin glacial area forms the major part of the State. It is a topographically young region with an undulating surface due to glacial forms. The soil is deep and is composed largely of clay, sand and gravel. Little rock is exposed. Occasionally the streams have cut through the drift and exposed the underlying rock.

The Illinois glacial area is much older than the Wisconsin and the streams have cut through the drift to the underlying rock. The larger streams have practically reached base level and have begun to widen their valleys. The soil is not so deep as that of the Wisconsin area. It contains little sand and gravel deposits except in the valley trains from the Wisconsin area.

The nonglaciated area is a typical mature region. Little level land occurs and the drainage is perfect. The streams of this region are flooded during rainy seasons and dry or very much diminished during dry weather. The Mitchell limestone belt, which extends from Mauckport, Crawford County, to Waveland, Montgomery County, is an exception to the foregoing statement. In this belt the drainage is to a great extent subterranean on account of the extensive development of caves. This condition causes the runoff of this belt to be much more uniform than the runoff of the rest of the nonglaciated region. The surface of this belt is undulating and covered with sinkholes. Blue River is in this belt. The east fork of White River crosses the nonglaciated region from Seymour to the west line of Martin County.

HYDROGRAPHY OF INDIANA.

The Wabash and White rivers drain the major part of the State. All of the State except the extreme northern and northeastern part drains into the Mississippi. The Maumee, Calumet and St. Joseph rivers drain the northern part into the Great Lakes. The White and Wabash rivers are of much the same character. Both are long streams formed by many tributaries. Both have a slight fall throughout their courses. Both flow off the Wisconsin glacial area and have long valley trains. Blue River, which drains Washington, Harrison and Crawford counties, and Whitewater River, which drains the southeastern part of the State, have much higher gradients than the White or Wabash. They are small streams and partake of the nature of the headwaters of the larger streams. Both these streams have a fairly regular flow. In the case of Blue River this is due to the underground drainage of the Mitchell limestone, while in the case of Whitewater River it is due to the vast amount of glacial gravel deposited at its source.

No swamps or lakes of any considerable size occur in the southern part of the State. The lowlands along all streams are very valuable farm lands. This fact makes available storage basins very scarce under the present demand for water power. However, if the time comes when the water power will be more valuable than the farm land, good storage basins can be constructed. At the present time the feeder dam with the long head race seems to be the best means of utilizing power on the larger streams.

ACCESSIBILITY OF WATER POWER.

Much of the water power of the State is not accessible under the present conditions except by transmission in the form of electricity. Electricity can be successfully transmitted for 150 to 200 miles. Blue River has no outlet for the products of its power except at Milltown, where it is crossed by the Southern Railway. However, all the power of this stream lies within forty miles of Louisville, Ky. The Whitewater River is paralleled by the Whitewater Division of the C., C., C. & St. L. Railroad. This road is a branch line and not in first-class condition. The power from this stream could be transmitted to Cincinnati, O., Richmond, Ind., and other small cities in the vicinity. The east fork of White River is paralleled by the P., C., C. & St. L. Railroad from Edinburg to Seymour and by the B. & O. S.-W. Railroad from Seymour to Washington. It is also crossed by the Monon and Southern Indiana railroads at Bedford and Seymour respectively. The west fork of White River is paralleled by the L. E. & W. Railroad from Noblesville to Indianapolis and by the I. & V. Railroad from Indianapolis to Edwardsport. It is also crossed by the Monon, Indianapolis Southern and Southern Indiana railroads at Gosport, Bloomfield and Elnora respectively. Both forks of White River are paralleled by traction lines on their upper courses. The power on the Wabash is more accessible than that on the previously mentioned streams. Large cities are located on its banks at intervals of fifteen to twenty-five miles and small cities are more numerous. The railroad facilities in this part of the State are well developed. One of the best power streams in the State is the St. Joseph. Only a small portion of this stream is in Indiana, but it has a steep grade, a deep and narrow channel, a good volume of water and a steady flow. At least two large power plants are now in operation on this river. This power is used at South Bend, Mishawaka and vicinity.

CLIMATE OF INDIANA.

The climate of Indiana is very uncertain. Sudden changes of weather are very common. The prevailing winds are from the southwest, but the passing of a cyclonic storm often causes the wind to blow from every quarter in the twenty-four hours. The mean annual rainfall of Indiana is about forty inches. The rainfall varies considerably from year to year and the monthly and geographical distribution vary greatly. The following table shows the mean annual and mean monthly rainfall for the years 1900 to 1909, inclusive:

(This table is given in inches of rainfall.)

YEAR.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mn. An.
1900	1.71	3.77	2.06	1.64	4.96	5.54	4.66	3.41	2.06	2.56	4.26	1.20	37.83
1901	1.44	1.66	3.40	2.67	2.54	4.35	1.30	3.10	1.54	3.35	1.30	3.29	30.57
1902	1.41	1.00	3.12	2.05	4.32	7.45	3.38	2.26	4.76	2.58	3.68	4.07	40.08
1903	2.28	4.40	2.95	4.43	3.16	3.72	3.51	3.91	1.85	2.67	1.82	2.16	39.96
1904	4.18	2.54	8.10	3.32	3.33	3.04	2.95	2.46	3.44	1.06	0.36	3.48	38.64
1905	2.16	2.05	2.52	3.74	5.96	3.61	4.59	5.03	3.48	4.89	2.68	2.43	43.70
1906	3.09	1.33	5.16	2.13	2.30	3.44	3.18	4.67	4.07	1.95	4.09	4.20	29.82
1907	6.95	0.48	4.90	2.80	3.71	4.69	4.95	3.83	2.90	2.73	2.79	4.09	44.98
1908	1.63	5.79	4.40	4.40	6.28	2.00	2.94	1.93	0.97	0.34	2.03	1.59	34.70
1909	3.67	5.82	2.88	5.16	4.71	5.16	5.26	3.00	2.66	3.70	3.21	3.09	47.75

The following maps (Fig. 2) for the years 1908 and 1909 are fair representations of the geographical distribution of the precipitation over the State.

The temperature of the State is as variable as the rainfall. Sudden and radical changes are common. While the mean annual temperature of the State does not vary greatly, the mean monthly temperature is very variable. The following table shows the mean monthly and mean annual temperature of the State for the years 1900 to 1909, inclusive:

YEAR.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mn. An.
1900..........	32.6	26 5	35.6	52.4	64.8	71.1	75.6	78.7	70.3	61.9	42.8	33.2	53.8
1901..........	30.4	23.4	40.4	48.7	60.7	73.4	81.2	75.0	66.8	55.8	38.6	26.9	51.9
1902..........	28.4	21.5	43.6	50.8	66.2	69.6.	75.7	71.1	63.8	56.7	49.5	29.7	52.2
1903..........	27.2	29.8	46.7	51.8	65.4	66.0	74.9	72.1	66.5	55.1	38.4	24.2	51.5
1904..........	21.7	24.5	40.7	46.8	62.0	69.6	73.0	71.2	67.2	53.8	41.9	29.2	50.1
1905..........	23.1	20.9	46.0	51.7	63.6	71.7	73.9	74.1	67.8	54.1	41.7	32.9	51.7
1906..........	35.4	28.7	31.9	54.6	63.7	70.9	73.7	76.1	70.4	54.1	41.9	33.8	52.9
1907..........	34.1	29.5	48.3	43.4	56.8	67.9	74.8	71.7	65.8	51.7	39.7	33.9	51.5
1908..........	30.8	29.0	45.2	52.7	63.9	70.8	75.5	73.9	70.2	54.9	43.9	34.1	53.8
1909..........	31.9	36.1	39.6	50.8	59.9	72.2	72.6	75.0	64.3	50.3	50.9	24.0	52.3

FORESTS OF INDIANA.

Eighty-five per cent. of the area of Indiana was originally heavily forested. The prairie district occupied a small portion of the northwestern part of the State. In this part the timber was confined principally to the lowlands. In all parts of the State the timber has been cut for lumber and to clear the farm land, until now only twenty per cent. of the original forest, seventeen per cent. of the total area of the State, remains. The cutting off of the forests of the State has had a great influence on the drainage. When the forests were still intact, the fallen leaves, mold and shade tended to retain the surplus of water during the rainy seasons, and this water, given out gradually, tended to equalize the stream flow. Floods were less common then and the streams flowed more uniformly. The removal of the forests and the systematic drainage of the land causes the water, during the rainy seasons, to flow directly into the streams. Thus the streams are flooded during the wet weather and soon dry up after the rains cease. This condition is especially true of the portion of the State south of the Wisconsin glacial boundary. In the Wisconsin glacial area the sand and gravel deposits serve to some extent the same purpose as the leaves, mold and shade of the previously forested area of the unglaciated region. The effect of the removal of the forests is shown by the remains of old water-mill sites, on small streams which are now dry for more than half the year. Many of these small power mills were run continuously fifty years ago. These power sites are now impractical except where immense storage basins can be constructed. In this connection is another interesting statement from Van Hise:[5]

"It is estimated by McGee that, by injudicious farming and deforestation, the water table has been lowered in the eastern part of the United States by from ten to forty feet. Indeed, he estimates that of the shallow wells and springs in this part of the country, at least three-fourths have failed. The springs have dried up; the small brooks have ceased to flow; the wells have been sunk to lower levels.

"In this matter we have an exceptional situation with reference to water which is somewhat analogous to that of the minerals. We are using the supplies of the past and not restoring an equal amount. This we are doing to some extent because of our present need; but also more wells are drilled in many artesian areas than are necessary; and when they are not in use, which is often the larger part of the year, the water from them is allowed to run off freely. Usually it is not realized that such waste lessens the head and makes available a smaller amount when water is again needed. This waste of underground water is analogous to the waste of natural gas. Strange as it may appear, waste of this kind is allowed to continue not only in humid regions where water is not appreciated, but in arid regions where it is of such fundamental importance. Such waste should be prohibited by law and the law should provide means for its enforcement.

"Already strict laws exist in a number of the States of the West; this is illustrated by the State of California. It is clear that laws preventing waste of underground water are constitutional upon substantially the same grounds as are the laws with reference to the waste of natural gas. This is clearly indicated by decisions which have been rendered in various courts.

"It is important to get into the ground a sufficient amount of water so that the water table will be maintained at a convenient depth. This is especially important in the arid and semi-arid regions; for there often the underground water is the only certain source of this element for domestic purposes and for irrigation.

"In various places in the West, and especially where the underground water has been drawn upon heavily for irrigation, as in the fruit ranch district of southern California, the level of the underground water has been seriously lowered, in some cases as much as

[5] Conservation of Nat. Res. in the U. S., by Chas. R. Van Hise. pp. 113-114.

from ten to forty feet. In this region, notwithstanding national forests and great storage reservoirs, at times of flood a large amount of water has been allowed to go down to the sea. The streams gain their water in the mountains from which they emerge to the lowlands through cañons. At the mouth of the cañons are great coarse alluvial cones. Recently a concrete headgate has been placed across the Santa Ana, the largest of the rivers of the San Bernardino range, so that at times of flood the water may be diverted from its bed and spread over the sand and gravel of the cone; the water is rapidly absorbed by this coarse material and passes underground. In this way the level of the underground water in the San Bernardino basin has been raised a foot, notwithstanding the increasing demand upon the underground reservoir. This method of preventing water from flowing to the sea in arid regions, where the streams come out of cañons at the mouths of which are alluvial cones, is likely to have a wide extension in the West.

"The above is a somewhat special method of getting the precipitation underground. On a much wider scale increasing the proportion of precipitation which goes underground may be accomplished by covering the earth with vegetation, by contour plowing, and by cultivating in such a manner as to leave a rough surface."

The whole of this quotation simply shows the opinion of an expert upon the subject of conservation of water. The paragraph concerning the West shows the care taken by agriculturists in that section of the country to take care of all the water possible. The last paragraph is applicable to Indiana. It is indeed astonishing to notice the poor grade of farming carried on in many parts of the state. Fields are left absolutely bare for a whole summer and some for years. Such fields not only drain off most of the water which falls upon them, but the hard, bare crust causes the evaporation of underground water to be much greater. Upon such fields even a rank growth of weeds is a blessing, except for the seeds which they produce. One of the secrets of successful farming in this State is the power of the farmer to properly handle the ground water under his land. When every farmer understands the secret of conserving ground water and puts this knowledge to practical use, the dry well and intermittent spring problems will be greatly lessened and the facilities for waterpower will be somewhat increased.