WATER LEVELS IN INDIANA

A Preliminary Report of the Ground Water Levels of the State based of Records of Twenty-six Observation Wells for which Long Time Records are Available

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Introduction

For the past several years there have been numerous reports regarding the lowering of the underground water table in various parts of the State. Some of these reports have been nothing more than rumors, while many of them are authentic but have been based on limited information.

As these rumors and reports spread, many of our citizens became alarmed and began to make inquiries and ask questions. If the ground water levels in Indiana are receding, how serious is the situation, and are they dropping at a rate which will ultimately result in a curtailment of the use of water for domestic and industrial purposes? Are we faced with a shortage of ground water and will the deficiency be permanent? What are we doing about the matter and what can we do to prevent a further decline in water levels? These are questions which have been asked many times and have been answered in many ways. Some answers have been based purely on supposition, others on local observations, and still others on data collected in specific areas.

During drought periods many shallow wells will fail and this may start rumors which can be exaggerated to the point where many people will begin to believe that every well in the state will soon be dry. Old settlers will recall how these wells always furnished plenty of water and when they go dry, surely the ground water level must be dropping at an alarming rate. Often times wells are reported dry, when upon investigation it is found that the water level had fallen below the bottom of the pump suction, and the well would continue to produce if the suction line was lowered. In other instances, well screens have become corroded

and plugged with minerals in the water, and because the yield of the well diminishes the well's failure is attributed to a lowering of the ground water level. On the other hand, evidence has been presented which shows that there has been a general decline in the level of the water in some wells over a period of years, and in some areas declines of thirty-five to fifty feet have been reported.

During the last few years there have been many reports of declining water levels especially in cities and industrial areas. Some of these are often substantiated with bits of facual data, but most of them are reports based on occasional observations and not on detailed or conclusive data.

With all of the apprehension that exists regarding ground water resources, it is doubtful if anyone knows exactly what is taking place, nor knows the true effect of nature's and man's influence on our underground waters. Most of the discussion which has taken place and the reports which have been made have been based upon heresay, or on information and data which have either been inadequate or have not covered a sufficient period of time to be in any way conclusive, especially for the State as a whole.

Factors Conducive to Lowering of Water Levels

Preceeding World War II, industries, business establishments, as well as home owners, were rapidly becoming "air-conditioning" conscious. As a result of this, many stores, theaters, business places, and homes, installed air-conditioning equipment. Much of this equipment required cool water for lowering air temperatures, and as a result, hundreds of wells were drilled and millions of gallons of water were pumped out of the ground each day for this purpose. After the water had passed through the cooling plant, in most instances it was run to the sewer and wasted.

New industrial processes have demanded increased amounts of water and a large percentage of this water has been taken from the ground. During the recent war greater quantities of ground water were used than ever before in the history of our State. As much as eighty million gallons of water a day was pumped from the ground to meet the needs of one war plant. Another plant used sixty million gallons of water per day. Is there any wonder why ground water levels could not have been lowered during the past decade?

Greater quantities of ground water also have been used in the rural areas during the past ten years. Prior to the rural electrification program, most farms were equipped with hand pumps and only a small percentage of farm homes had running water. Today, approximately sixty per cent of the farms in Indiana have been electrified and this has resulted in a much greater use of water, both on the farm and in the farm home. Many farm homes are now equipped with running water and with modern plumbing facilities. The use of water for washing and dairy purposes in the barns has also increaded the demand and need for additional water supplies.

In relative flat areas in northern Indiana, drainage projects have undoubtedly had some effect on the lowering of ground water levels, but to what extent can only be guessed since few data are available on this subject. Many of the lakes of northern Indiana are what might be termed "ground water lakes." When they are lowered by the lowering of their outlet channels, as has been done frequently, the ground water table will subsequently be lowered in the surrounding areas. Many of our lakes have been lowered as much as ten to twelve feet.

A general deficiency in precipitation may also lower ground water levels, since water in storage underground comes from rainfall which percolates through the earth's surface. During the dry years of

1941 and 1944 many farmers in southern Indiana carried or hauled water for stock and domestic use because their wells went dry. The majority of these wells are shallow and the water levels seem to vary rather consistently with the amount of rainfall over the general area. (This relationship is discussed more fully later in this report.)

During the last several years, there has been a marked deficiency in the amount of rain which has fallen. During the fifteen year period from 1930 to 1945, the average annual rainfall in Indiana ranged from a minimum of 29.71 inches in 1930 to a maximum of 46.03 inches in 1937. However, the average annual rainfall has been more than 5 inches below the 58-year average during 1930, 1934, 1936, 1940, 1941 and 1944 and the total accumulated deficiency in rainfall during this 15 year period, as recorded at Indianapolis, was more than 58 inches.

The rapid run-off of surface water caused by farm drains, dredged ditches, cleaning and straightening stream channels and clearing of timber land, without doubt has had an important effect on our water levels. In those areas of the State which are underlain by permeable soil and rock formations, surface water, if detained or held near its source, will gradually seep into the ground and replenish some of the water withdrawn from wells. The slowing up of surface run-off is often important in increasing the opportunities for recharge of our underground reservoirs.

Need for Long Time Study

Long time records are not available on ground water levels throughout the State, and for this reason we do not know what effect the things described above may have had on our underground water resources. Some general records are available in specific areas which indicate a rather alarming lowering of the water table in those particular areas. As stated in a report on the "Ground-Water Resources of the

Indianapolis Area" by Charles L. McGuinness, the declines in ground-water levels in Marion County resulting from pumping range from a few feet to more than 50 feet. Overdevelopment of the ground-water supplies in parts of the area has progressed so far that the yields of most wells declined greatly, and in 1941 the total yield of the wells in the over-developed areas was probably less than at any time during the period 1935-41.

A study is being made at the present time of the ground water resources in the South Bend area. Although continuous records of water levels are not available over a long period of time, fragmentory records indicate that water levels in this area have declined in individual wells about 10 to 20 feet during the past fifty years. In other industrial areas similar reports have been made and studies are now being made in some of those areas.

Although the reports on the decline of ground water levels have been incomplete and scattered, they have focused the attention of the public on the seriousness of what might happen if our underground water resources should gradually become depleted. Many people continue to pump water from a well for years without realizing that the water level in the well is continually changing, sometimes rising and sometimes falling. If a well continues to supply the quantities of water needed, no question arises as to whether or not the water level has declined. Only when the well fails to yield an adequate supply of water does the owner become interested in the water level. Before we can say with any degree of accuracy just what is happening to our ground-water resources, we must approach the problem in a scientific manner, and keep systematic records of water levels in many wells over a long period of time.

We must carry our studies even farther if we are to learn the answers to such questions as, are we taking water out of the ground at

a rate faster than it is being replenished by nature? If the underground water levels are receding, at what rate is this taking place and how serious is it? How is the underground water supply being affected by pumping and also by precipitation? These are some of the things which must be determined if we are to know the future of our water resources.

In order to evaluate seasonal fluctuations resulting from precipitation and fluctuations caused by the removal of water through wells, continuous records must be kept on the variation in the levels of the ground water table. Not until the rates of decline, or departures from normal, in underground water levels are established, can we determine the adequacy of our water resources to meet present and future demands. It is also necessary to collect data on the underground water levels in all sections of the State if we are to obtain a complete picture of our ground water supply.

Studies Now Being Made

Because of the wisdom and foresight of our legislators, who enacted laws providing for the study of Indiana's underground waters, these vital resources are now being studied with the hope of finding the answers to many of the perplexing problems which have risen in the past, and will arise in the future regarding our underground water supply. In 1943, the Eighty-third General Assembly enacted a law authorizing the Indiana Department of Conservation to make an investigation of the water resources of the State in cooperation with the U. S. Geological Survey. An annual appropriation was made for a 10-year period to carry on this investigational work. After the investigation was started, it was soon realized that the appropriation would not permit a thorough investigation of the water resources for the entire State, and again our Legislators wisely increased the appropriation during the Regular Session of the

Eighty-Fourth Indiana General Assembly.

A good start has been made in this investigational work, but the data and information collected to date are not sufficient to enable one to make a conclusive analysis of the many problems which are being studied. Considerable time will be required to make the studies which are necessary to properly appraise our water resources. Along with many detailed investigations of the areal extent of water-bearing formations, the quantities of water being withdrawn from the ground, the natural recharge of our underground water resources, and the correlation of such data with hydrologic studies, an observation well program is being carried on. This program is set up for the specific purpose of obtaining accurate data regarding the variation of ground water levels in all sections of the State.

Type of Information Available

For many years, the Indiana Department of Conservation has felt the need of learning more about the water resources of the State, but unfortunately little money was available to institute a State-wide investigational program. Through the Division of Geology, however, a small program was started under a cooperative agreement with the U.S. Geological Survey in 1935, at which time a number of observation wells were established and regular measurements were made to the water level in these wells. This program was carried on on a limited scale until funds became available for the State-wide water resources investigation.

During the period from 1935 to 1943, observations had been started on nearly 200 wells at different times but because observers failed to continue taking readings for one reason or another, or observation wells were put back into service, there are comparatively few wells for which water levels records have been kept sufficiently long for long time studies. When the observation well program was begun,

C.C.C. camp personnel made the measurements of many wells, and when these camps were abandoned, the recording was discontinued.

Measurements of the water levels in a number of the original observation wells have been made more or less regularly, however, since they were established eleven years ago. In all, there are twenty-six wells for which continuous ground water measurements have been made since the initial observation well program was started. Plate II shows their location. The main purpose of this report is to summarize the records of these wells and to show graphically what has taken place regarding water levels in these areas for which continuous records are available.

Most of these wells are located in areas which have not been affected by pumping, and therefore, will reflect ground water conditions which have not been subjected to the artificial withdrawing of large quantities of water. Data on several wells located in Indianapolis are included in this report. These wells are located in areas affected by pumping, and it is reasonable to expect that their behavior will be different from those which are not affected by pumping.

There are other factors which must be taken into consideration in studying the variation of the water levels in these twenty-six observation wells, aside from their location with respect to wells which are being pumped. The pumping of shallow dug wells located near an observation well that is drilled to a depth of 200 feet or more may have a bearing on the variation of the water level at the observation well. Also the character and thickness of the water-producing formation will affect the water level in an observation well. Wells ending in sand or gravel deposits may perform differently from those ending in limestone, for example.

History of Observation Well Program

In addition to the observation wells for which continuous records are available, intermittent observations have been made on many other wells. While the data on these wells are of little value in making long time studies of ground water levels, they do furnish information which is helpful in making general observations. During 1935 and 1936, 71 observation wells were established which were fairly well distributed over the State, with 46 in the northern counties and 25 in the southern half of the State, 22 being on State property.

During 1937, water level measurements were made regularly in 75 wells located in 37 counties distributed from the northern border of the State to the Ohio River. During the first part of that year the rainfall was unusually heavy and many streams of the State, particularly those in the southern part, reached a high flood stage. January rains exceeded all previous records in the southern division, and some rivers including the Ohio and lower White were the highest of record. The relation of this unprecedented precipitation and the water level in the observation wells became a matter of study. In this connection the U. S. Geological Survey Water Supply Paper 840, states:

"During a rainy season in which the streams of the State were at flood stage, measurements of water levels as of January 15, 1937, in 19 shallow observation wells located in 12 counties in southern Indiana indicate that the ground-water levels were somewhat higher than in December 1936. This increase ranged from a fraction of a foot to slightly more than nine feet. The rise in the water levels exceeded eight feet in three of the wells and ranged from one to six feet in 10 of the wells. It was less than one foot in six of the wells. During this period in the central part of Indiana the rise in water level ranged from two to

13 feet in 10 shallow wells located in five counties. The rise in three of the wells exceeded seven feet. The water levels in a part of these wells were somewhat higher than any shown by previous records since the observations were started in 1935. It appears noteworthy that the water level in well 2, which is 265 feet deep and penetrates rock, in Hamilton County on the White River, rose seven feet within two weeks during that period when the White River was several feet above flood stage. The range in fluctuations in that well during 1936 was less than three feet."

Pumping caused the largest fluctuations observed in the water levels. During 1937 the fluctuation in different wells which are unaffected by pumpage ranged from less than three feet, as in Fulton 1 at Rochester, to more than 12 feet, as in Boone 1 in Lebanon. Relative to this larger fluctuation, the report above referred to states it "shows typical seasonal changes consisting of a gradual rise of the water level during autumn and winter, at the end of the growing seasons for much of the vegetation, and a decline in spring and summer, when transpiration and evaporation reach a maximum. During a winter when the ground is frozen over longer periods, so that no recharge of the water-bearing formations occurs, the water levels may decline after the rise due to cessation of some of the transpiration and evaporation at the end of the growing season for part of the vegetation."

More Observation Wells Added

Because of changes in personnel in the C.C.C. camps, and for other reasons, measurements on some of the wells were discontinued during 1938, but a few others were added to the program so that by the end of the year records were being tabulated on 60 wells. Of this number 41 were complete, or nearly so, for the year and 16 of these were higher and 25 were lower as the year ended. The average net decline of the water level for the 41 wells was approximately 0.7 foot. The average

rise for the 16 wells which were higher was 0.8 foot, and the average net decline for the other 25 wells was 1.6 feet.

Precipitation in the State during 1938 showed an excess above normal of slightly more than 1½ inches, but the excess was accumulated during the first half of the year and it was below normal during the last half. This condition probably is largely responsible for the lowering of the water level in 25 of the 41 wells measured during the year. However, the largest fluctuations occurred in wells affected by pumping. The average for the year was approximately 6.2 feet but in individual wells fluctuation ranged from about 1 to about 20 feet.

By the end of 1939 water levels were being measured periodically in about 60 wells in Indiana. During 1938 a detailed investigation of ground-water conditions in the Indianapolis area had been started and in 1939 measurements were started in 8 wells in the city. On two of the Indianapolis observation wells float-type automatic water-stage recorders had been installed. In all, about 1500 individual measurements were made in 1939.

Complete water-level records, or nearly complete, were recorded in 1939 on 42 wells, 35 of which showed net declines by the end of the year, six showed net rises, and one well had the same level at the end as at the beginning of the year. The average net decline for all of the 42 wells was 1.45 feet. Of 14 wells in the northern part of the State nine showed declines, one no net change and four showed net rises; of 24 in the central part, 22 showed net declines and two showed net rises; and four wells in southern Indiana showed net declines.

Precipitation in 1939, as in 1938, was above normal during the first half of the year and below normal during the last half. However, the total deficiency for the entire year was about a half inch. Seasonal fluctuations, as seasonal precipitations, were similar in 1938

and 1939. The highest stages were in March for most wells, though some were highest in April and a few in the early part of May. The lowest stages were late in the year and as the year ended the water level in 20 of the 42 wells was still declining. It is interesting to note that since measurements began on 20 of these wells their lowest level was reached late in 1939 or early in 1940 and that during both 1938 and 1939 the precipitation was slightly below normal.

Fluctuation in the 42 wells during 1939 had an average total range of about 6.6 feet, while fluctuations in individual wells ranged from 0.8 foot to about 19 feet.

Low Water Levels

For various reasons it was necessary to discontinue the measurements of some of the wells during 1940 but others were started during the year and tabulations were taken on a total of 60. Of this number the records were essentially complete on 52 wells, 15 of which were in or near Indianapolis. Water levels declined in 36 wells to a level lower than were recorded during 1939. In 1940, the water levels in practically all of the wells reached their lowest seasonal stages before the end of the year, but in 1939 in about half of the wells the level continued to decline to the end of the year.

Of the 17 wells in northern Indiana nine showed net rises in water levels from the fall of 1939 to the fall of 1940, six showed net declines and two showed no net change. Twenty-nine wells located in central Indiana showed greater decrease in levels. Of these 27 recorded net declines, one a net rise and one showed no net change. The average net decline for the 29 wells was 1.95 feet. Four wells of the six in southern Indiana showed net declines while two showed net rises. The average net decline for the six was 0.64 foot.

Principally because of the curtailment of the activities of

the Civilian Conservation Corps, the personnel of which had been making measurements, it was necessary to abandon some of the observation wells during 1941. However, essentially complete records were obtained for 51 wells during the year, including 14 in Marion County.

The records obtained in the 14 wells in Marion County as well as a few others, were in areas affected by heavy pumping for industrial, air conditioning and municipal purposes, or were located close enough to other wells to be affected when the latter were pumped. One well in Clay County was affected when the water level in a nearby artificial lake was practically drained. A well in Fulton County was affected by the water level in a raceway situated only a few feet away. In the remaining wells, according to the U. S. Geological Survey Water Supply Paper 936, the fluctuations in water levels are largely or wholly related to changes in natural conditions, principally to variations in the amount and distribution of precipitation

In the 37 other wells outside of Marion County the water levels averaged 0.36 foot higher on January 1, 1942, than on January 1, 1941, about 0.7 foot higher than on January 1, 1940, about 0.7 foot lower than on January 1, 1939, and about 1.4 feet lower than on January 1, 1938.

The average precipitation in the State was 32.66 inches during 1941, which was 7.02 inches below normal. Irregularly distributed precipitation during the spring of that year resulted in irregularly fluctuations in water levels. In 17 of the 37 wells outside of Marion County the lowest water levels for the period of record were reached in the fall of 1941, the average being about 0.1 foot lower than in 1940, and 0.83 foot lower than in 1939.

Precipitation during 1941 was again below normal, the drought being broken by heavy rains in October. Soil was unusually dry so that it absorbed the rain and runoff was relatively small, this recharge

of ground-water probably was responsible for the average net rise in January of the following year but it was not sufficient to offset the declines during 1938 and 1939.

Effect of Heavy Pumping

In Marion County the records show the effect of heavy pumping. The Indianapolis area pumpage was between 30 and 35 million gallons a day during 1938; during 1941 it was more than 50 million gallons a day. The average net declines in the Marion County observation wells during 1938 and 1939 were roughly comparable to those of the State. During 1940 and 1941, however, while wells outside Marion County showed successive average net rises of 0.32 foot and 0.36 foot, those in the county showed successive declines of 2.12 and 1.47 feet. While the effects of the increase in pumpage were apparent in all the observation wells in Marion County, it was more marked in two of them located in areas of heavy pumping.

Average precipitation during 1942 was 41.19 inches, which was 1.99 inches above the yearly average since 1887. It was fairly evenly distributed throughout the year and ground water recharge more than made up for the deficiency of the previous drought year. This was reflected in the wells outside of Marion County which were not so affected by pumpage, for the water level averaged a little more than 2 feet higher at the end of the year than at the beginning. Also the low stages in 1942 averaged a little more than a foot higher than those of 1941, and were thus about a foot higher than those of 1940 and slightly higher than those of 1939.

Marion County, where the observation wells are affected by the heavy pumpage in the Indianapolis area, the above normal precipitation relieved a situation that would have been serious if the below normal precipitation of the two previous years had continued. The flow in

streams was higher than normal and considerable quantities of surface water were used in the city. The heavy precipitation, therefore, not only recharged the ground-water but relieved the pumpage requirements. Indianapolis area pumped an average of approximately 47 million gallons a day during the year, which was 5 million gallons a day less than in 1941.

The average precipitation in the State during 1943 was 37.45 inches, which was 1.72 inches below the average for 57 years of records. It was so unequally distributed as to time so that the excess in spring caused floods and the deficiency in fall caused droughts. The above normal precipitation in the previous year and the excess in the first half of 1943 resulted in an above normal supply of ground water. This probably accounted for the highest observed water levels for the periods of record in 15 wells during the spring of 1943. The deficiency in precipitation during the last half of the year, which was particularly severe in the southern part of the State, caused water levels in most wells to decline during that period. In several of them lower stages were reached than in 1941, two reached the lowest stages on record, and at the end of the year many wells were still declining.

In December 1941, there were 131 observation wells in the observation well program that had begun in northern Indiana in 1935. There were 78 wells added that year and nine wells were abandoned. Of the remaining 122 wells, four were measured at irregular intervals, 11 once a month, 21 twice a month, 63 once a week, four daily and 19 were equipped with water-stage recorders. Approximately 5000 individual measurements of water level were made.

The deficiency in precipitation, which began in the summer of the previous year, continued during 1944. Although during February, March, April, May and August it was above normal the annual precipitation

for the State was 5.25 inches below the average for the 58-year period of record, or 33.83 inches. Water levels raised in all wells following the rains of the three spring months, the highest levels being recorded in June. For the remainder of the year levels declined in most of the wells, which was probably the result of the deficiency in precipitation and the usual seasonal conditions such as the use of water by plants during the growing season and evaporation during summer.

During 1945 several observation wells were added to the program. In December of that year the water level of 150 wells were being measured, as compared to 131 wells for the same month of the previous year. Of this number 24 were equipped with automatic recorders. In addition to these wells measurements were being taken on the water levels in 42 wells in connection with a special drainage study of the Jasper-Pulaski State Game Preserve area.

Rainfall during the year was the heaviest since the observation well program was started. The precipitation was 49.68 inches. This was a little more than 10 inches more than the annual average for the previous 58 years, which was 39.08 inches. Many of the observation wells had declined more or less regularly up to this year but because of the heavy rainfall this level raised as shown by the accompanying charts.

Data on Observation Wells for Which Long Time Records are Available

Long time water level records are available on two wells in Clark County. They are located in the Clark State Forest which is in the northwestern part of the County in the area commonly known as the Knobs. This section is much dissected and attains altitudes in excess of 1,000 feet. The drift appears as discontinuous patches of unsorted material through which surface water percolates freely. The timber in these areas retards rapid surface run-off and where the drift fills the

valleys the seepage into them supplies ground water reservoirs over longer periods than would otherwise be possible.

Clark 1 is known as the Schlamm Well. It is an unused dug well having a diameter of 48 inches and a depth of 34.3 feet. The first measurement was made December 2, 1936, and on September 6, 1941, an automatic water-stage recorder was installed. There has been wide and rapid fluctuations in the water level which has been rather closely related to precipitation. The range has been from 26.69 feet in December 1944 to 1.3 feet in February 1937, a variation of 25.39 feet.

Clark 2 is located on the Purdue Camp Site in the State Forest. It is also an unused dug well being 36 inches in diameter and 28 feet deep. The records were begun December 2, 1936, and the fluctuation has ranged nearly the entire depth of the well. In November 1944, it was pumped dry but during the following March and April following a period of considerable rainfall it was within a foot of the surface. In March and April of 1945 it nearly overflowed.

The Fulton 3 well is located in the eastern part of Rochester at the U. S. Fish Hatchery west of Lake Manitou. It is an unused driven well, diameter $1\frac{1}{4}$ inches. The depth is 23.5 feet, ending in sand and gravel. Records have been kept on this well since September 1935. The water-level fluctuation has been comparatively low, considering that this is a shallow well. It has ranged from 10.1 feet below land surface datum in February 1940 to less that two feet in May 1945. The yearly average for the period since records have been kept was lowest during 1940 and the annual rain fall was also lowest during that year, while the highest average was in 1942 when the annual rain fall was highest.

Glacial deposits cover Fulton County from a few feet to 300 feet in depth. The well is located in the morainal belt which has only mild relief and consist of typical accumulations of sand, gravel and

associated till with boulders. There are 24 lakes in the county, all of them being located in depressions of the moraines which comprise this belt. The abundance of lakes indicate that the water table is near the surface. However, seepage of surface water is prevented or retarded over parts of the area by impervious formations but wells can obtain fairly abundant supplies of water below them.

Hamilton 2 is located in Noblesville on property of the Public Service Company of Indiana. It is known as the "Old Ice Plant Well" at the City Water Plant. It is a driven well, 8 inches in diameter and is 265 feet deep terminating in Silurian limestone. It is probably not affected by pumpage from nearby wells that do not reach sedimentary rock, nor to a great extent by variations in rainfall. In 1945 when the rainfall at Noblesville was 8.71 inches above normal, the water level remained near normal and the range was only 3.8 feet. However, during the flood of the winter of 1936-37 when nearby White River reached 5½ feet above flood stage, the water-level in this well raised about 7 feet from the measurement of January 5 to that of January 15.

The first measurements were made in November 1935 and with only short interruptions has been recorded regularly since that time. In the locality of this well, as in most of the surrounding area, there is a glacial deposit of an average thickness of about 100 feet. Below this, Silurian formations occur in the northeastern half of the county and those of Devonian age in the remainder of the county. These formations crop out at the surface in a few locations in Hamilton County. In the vicinity of the observation well, water is encountered both in the glacial drift and the upper formations of the bed rock.

Harrison 1 and 3 are both located in Harrison County State Forest not far from the Ohio State River. Both are unused dug wells of shallow depth. Measurements on No. 1 were started in September 1936

and have been made regularly twice a month practically all of the time since then. Though the well is only 11 feet deep the water-level has never been recorded below about 5½ feet from the surface. Since it is located near Lowe Pond it is probably affected by this body of water.

Measurements on No. 3 were begun late in 1938 and except for a period of about 4 months records have been kept regularly. This well is 25 feet deep ending in gravel. Water-level is presumably not affected by pumping and shows rather uniform seasonal fluctuations; that is, high in the spring and a gradual slow decline through the summer and the fall. Since records have been taken the range in either well has not exceeded six feet.

The entire county is quite rugged, the eastern part being knob-like in topography while the western third in which these wells are located is less rugged and is characterized by sinkholes into which surface water drains and percolates underground. The entire county is a part of the unglaciated area of southern Indiana. The unconsolidated deposits, which fill most of the valleys, and low parts of the topography are not, as a rule, sources of ground water except near the Ohio River and along the lower courses of larger streams. Many deep wells drilled for oil and gas in this county encountered salt and sulphur waters in formations below the Borden, and cannot be depended upon to supply potable water. The shallow wells and impounding reservoirs apparently are the best sources of supply.

Jackson 1 located in Jackson State Forest, near the office of the abandoned C.C.C. camp, south of Browntown, is an unused dug well 16.5 feet deep. First measurements of water levels were made late in 1936 and except for two interruptions have continued to the present time. It is believed this well is not affected by pumping. Its fluctuation has been high and abrupt, the range since recordings were

started being 10.3 feet; or from 1.2 feet to 11.5 feet below measuring point. A comparison of the water level and the precipitation of the nearest station in Seymour shows there is a rather close relationship between the two.

This well is located near the Knobstone escarpment which is characterized by the greatest relief feature and most prominent topographic form in Indiana, commonly known as the Knobs. All of Jackson County, except a strip along the western boundary, has been glaciated, and rather thin deposits and residual soils cover most of the area. Springs are numerous and shallow wells, terminating in the thin beds of sand and gravel, generally supply an abundance of water for domestic use. The county is drained by two major streams; the east fork of White River and the Muscatatuck River, which converge in the southwest part of the county.

These rivers and their tributaries supply an abundance of water to recharge ground water reservoirs in the stream valleys. On the up-lands the drift material is either absent or so thin that shallow wells cannot be depended upon. Some deep wells which penetrated the bed rock is this area have produced salt water and deep wells are not a reliable source of potable water.

Jennings 1 is located in the northwest part of Muscatatuck State Park near North Vernon. It was first measured in December 1936, but since that time there have been several periods when water level records were not taken. It is an unused dug well 19 feet deep. It is probably not affected by pumping and shows an extreme seasonal fluctuation. For the period since measurements were begun fluctuation has been 15.30 feet, or from a high of 1.68 feet to a low of 16.98 feet.

Jennings County is in the glaciated area and unconsolidated deposits exceed 100 feet in some localities, although in many places

rock strata of Silurian and Devonian age are exposed. There is evidence that during glacial time the Muscatatuck River was impounded so that an extensive lake existed. The wide valley of this river has since filled with deposits which are fine-grained and yield only small quantities. This is also true of tributary streams. In such areas springs are numerous and wells ranging from 12 to 35 feet in depth supply water. Their capacity, however, is regulated to a great extent by seasonal rainfall which is the source of recharge for underground water reservoirs. In parts of the county where New Albany shale is exposed or is near the surface, shallow wells are not dependable.

Madison 2 is located near 32nd Street and Central Avenue in Anderson. It is an unused drilled well of the Anderson Water Department. The depth is 156 feet and the source of water is gravel. Measurements of water levels were begun in the fall of 1935 and records show the fluctuation ranged from 10.9 feet below measuring point to 18.4 feet or 7.5 feet. Although this well is presumably not affected by pumping of nearby wells, it probably is affected by the pumpage from the area as a whole. The range of water level in this well is comparatively low. This may indicate that the underground reservoirs in the vicinity of Anderson are large and are recharged, probably by seepage through the gravel deposits in the White River valley. The drift material over the entire county averages about 100 feet in thickness but well logs show that in some localities it is nearly 500 feet thick. Wells in Anderson ranging in depth from 18 to 350 feet have produced an abundant supply of water. Two wells drilled by the Municipal Water Department in the summer of 1928 furnished 1,500,000 gallons per day.

Five wells in the Indianapolis area have been under observation for 7 years or more and the records are included in this report. They are all drilled wells, ranging in depth from 110 feet to 314 feet.

All except one penetrates bed rock and all are presumably affected by pumping of other wells in the area.

Marion 2 is located in the Security Trust Building, at 130 East Washington Street, Indianapolis. It is 110 feet deep, ending in gravel. This well is equipped with an automatic water-stage recorder. The first measurements were made in October 1935 and during the period of observation the water level has fluctuated from 47.44 feet to 71.55 feet, below the land surface.

Marion 3 is located in the north part of the Emmerich Manual Training High School on South Meridian Street in Indianapolis. This well is 200 feet deep and reached limestone at about 70 feet below the surface. The first measurement was made in October 1935 and the water level has fluctuated from 50 feet to 71.16 feet below the point of measurement.

Marion 4 is located in the valley of Lick Creek near South Meridian Street and Edwards Avenue in Indianapolis, on the property of Layne-Northern Co., Inc. This is an unused drilled well which is 304 feet deep terminating in limestone. The first measurements were taken late in 1937 and the fluctuation has ranged from the top of the well to 15.72 feet below the point of measurement.

About 1000 feet north at a greenhouse is a well which is 4 inches in diameter and 368 feet deep. It penetrates the same limestone formation as Marion 4 well and is equipped with a pump, having a capacity of about 30 gallons a minute, which operates from one to 18 hours a day to provide water for sprinkling plants at the greenhouse. For seven weeks during July and August in 1939 a record was kept of the time the pump started and stopped and for every period the pump operated the water level in the Marion 4 well showed a marked and continuous decline until the pumping stopped. Then, almost immediately, the water level

began to rise.

Marion 9 is an unused drilled well located at the former American Brewery Company on West Ohio Street near the Indianapolis Water Company Canal. It is 220.5 feet deep ending in limestone. The first measurements were made in July 1939 and the fluctuation of the water level since then has ranged from 43.38 to 62.48 feet below point of measurement.

Marion 10 is located in the basement of the U. S. Federal Building on Meridian and Ohio Streets in Indianapolis. It is an abandoned drilled well 314 feet deep ending in limestone. The first measurement was made in August 1939 and during the period since records have been made the fluctuation in the water level has ranged from 50.64 feet to 70.78 feet below the land surface.

The entire surface of Marion County is covered with alluvial deposits and glacial drift. The thickness is more than 200 feet in some localities. The broad filled-in valley of White River is rich in deposits of gravel through which water passes and in which water is stored in large quantities. Parts of Indianapolis are located on these gravel deposits which are two miles or more in width. These extensive sand and gravel reservoirs along the river and its tributaries are the most prolific sources of water supply in Marion County.

Underlying the drift are rocks of Devonian and Silurian age. In the western part of Indianapolis and in western Marion County the uppermost formation is Devonian shale which is not a good water-bearing stratum. In the eastern part of Indianapolis and east of the City, Devonian limestone occurs directly below the drift materials. This is approximately 50 feet thick and is quite porous and is usually a dependable source of ground water. The Devonian strata rests on a Niagaran limestone which is such a reliable source of water that most wells

in this area, including many of the Indianapolis Water Company, are drilled through the first formation and into the Niagaran strata.

Montgomery 1 is an unused dug well located in Waveland. It is 16.5 feet deep, terminating in gravel. An automatic water-stage recorder was installed in this well in September 1944 and it has a rather complete record of water levels. First measurements were made in September 1935 and during the period since then the water level has fluctuated from 4.78 feet to 15.45 feet from the point of measurement. These records show abrupt seasonal fluctuations and indicate that the water level is rather closely related to the amount of rainfall.

Montgomery County was covered by both the Illinoian and Wisconsin glaciers and several morainic belts occur in the areas. This observation well is located on one of these moraines in the southwest corner of the county. The drift varies considerably in thickness due to preglacial erosion of bed rock. Where these unconsolidated deposits are thick enough, wells from 15 to 30 feet deep usually supply sufficient water for domestic use. Though, like the observation well, they are affected by the amount of water in the underground reservoirs which depend largely on rainfall for recharging. Much of the bed rock is shale and nonwater-bearing and deep wells in this area have produced water which has not been potable.

Morgan 1 is located in the Morgan-Monroe State Forest in front of Shady Rest Cabin south of Martinsville. It is an unused dug and drilled well 46.3 feet deep, presumably not affected by pumping. The first measurements were taken in December 1936 but the records since that time are not complete, as there were some periods of several months duration when water level measurements were not taken. Reports available show that there has been a range of 9.24 feet, or from 2.71 feet to 11.95 feet below the surface.

The Illinoian glaciation covered the entire county except a small portion near the south border where the topography is marked by the northern limits of the knobstone bluffs. The observation well is located in this area. Glacial deposits in the county are comparatively thin and contain more silt and clay than are usually found elsewhere. However, where glacial deposits are thick enough wells will yield potable water. This is true in the wide river bottom of White River where glacial deposits are comparatively thick and are composed of sand and gravel. The City of Martinsville obtains water from two wells which terminate in gravel in the White River valley. It is reported that water stands in these wells within 18 feet of the surface and their total estimated production is 1,000,000 gallons per day. Bed rock formations consist of strata of the Devonian and Mississippian age, the upper-most series of which are principally shale and are nonwater-bearing. Underlying these are water-bearing formations which have been penetrated by several wells in Martinsville but the water is mineralized and is used for therapeutic and medicinal purposes.

Noble 3 is an unused driven well located about a mile northwest of Merriam in the southern part of the county. This well is 27 feet deep and is probably not affected by pumping of nearby wells. However, since measurements were first taken in 1935 there has been a wide range in fluctuation of water level totaling nearly 14 feet. The records show abnormal fluctuation for short periods which might indicate that this well was pumped during emergencies. During the period since records have been kept on this well the water has ranged between 11.6 feet to 25.5 feet below the measuring point.

Glacial moraines are numerous in Noble County which accounts for the varied rolling topography and the large number of lakes. The glacial deposits are known to reach a thickness of nearly 500 feet and

the ground water table being near the surface, because of the lakes, wells terminating gravel deposits in drift material can usually be depended upon to supply water. Wells supplying several of the towns in the county terminate in the drift and furnish an ample year-round supply.

Three observation wells in Porter County have been under observation almost continually since 1935. Porter 1 is an observation well of the Valparaiso Water Department located at the pump house at Flint Lake about 3 miles north of Valparaiso. It is a drilled well 110 feet deep ending in sand. The record of this well indicates that it is effected during certain periods by pumping of nearby wells. The first measurement was made in October 1935 and since that time the fluctuation has ranged from 50.63 feet to 57.85 feet below the point of measurement.

Porter 2 is a dug well located at Waverly Beach in Indiana Dunes State Park. It is only 20 feet deep and presumably not affected by pumping but may be influenced by the stage of Lake Michigan. This well shows a rather uniform fluctuation which is probably due to the controlling level of Lake Michigan. First measurement was made in October 1935 and during the period in which records were taken the fluctuation ranged from 9.83 feet to 13.8 feet below the point of measurement.

Porter 3 is also located in Indiana Dunes State Park. It is a driven well 16 feet deep terminating in sand. Its behavior has been similar to that of Porter 2 which further indicates it is probably not influenced by pumping of nearby wells but may be influenced by the stage of Lake Michigan. First measurement was made in October 1935 and the water level has ranged from 11.19 feet to 17.3 feet below the point of measurement.

There are three main physiographic division in Porter County, one includes the glacial Lake Chicago which borders Lake Michigan and

is characterized by low sand ridges which are remnants of the old beach lines. Porter 2 and 3 are located in this division. Seepage from Lake Michigan supplies recharge for reservoirs in sand at shallow depths.

Porter 1 is located in the division known as Valparaiso Morainic System. The natural lakes of the county are found in this area and indicate that the water table is probably close to the surface. Both of these areas contain water in the drift materials which ranges from 25 to 200 feet in thickness. Though bed rock has not been used as a source of water supply some test wells which have penetrated them indicate they are productive. However, one well drilled northwest of Valparaiso filled with salt water at a depth of 1,145 feet and one drilled into bed rock at the Dunes State Park contained large quantities of sulphur water.

Pulaski 1 is located in the basement of the suporintendent's home in Jasper-Pulaski State Game Preserve. It is an unused drilled well 148.5 feet deep terminating in rock of Devonian age. The first measurements were taken late in 1935 and with the exception of one period of several months duration have been kept continuously since that time. Fluctuation in the water level has ranged from 7.39 feet to 10.05 feet below the measuring point. Almost the entire county is covered by sand ridges and marshes, by glacial drift that attains a thickness of 200 feet in some localities. Under this drift the bed rock in the northern part of the county is of Devonian age, and that of the southern is Silurian age. There appears to be an abundant supply of water in the drift material and also in the mantle rocks which are near the surface in the eastern part of the county.

St. Joseph 1 is an unused driven well located at the pumping plant of the Water and Light Department of Mishawaka. It is 40 feet deep and ends in a gravel deposit. A record of this well shows abrupt

changes in the water level, which indicate that it is affected by pumping of nearby wells and perhaps by the St. Joseph River. The first measurement was taken in October 1935 and a complete record has been kept since that date. The water level has fluctuated from 4.46 feet to 13.4 feet below the measuring point.

St. Joseph County is drained by three river systems. The Kankakee River heads near South Bend and is separated from the St. Joseph River by low gravel flats. While low-land areas along streams comprise much of the county, there is an area of up-lands in the eastern and southeastern part where glacial moraines have caused a rolling topography. Most of the lakes of the county are located in the depressions in these moraines and from them the underground reservoirs in the glacial drift may be recharged with water. The observation well is located in the valley outwash of the St. Joseph River. Mishawaka secures its water supply from a number of wells in which water stands from 8 to 14 feet below the surface. During the Wisconsin glaciation a large part of the river basins were formed into lakes and marshy areas. The drift material averages about 150 feet in thickness and are rich in gravel deposits. Records of wells drilled into bed rock show that mineralized or salt water was encountered.

The records of two observation wells in Starke County are included in this report. The first measurements on these wells were made in June 1936 and with only short interruptions have been continued since that time. Starke 1 is located at Bass Lake Fish Hatchery. It is an unused drilled well 180 feet deep terminating in gravel deposits. Fluctuation has ranged from 11.28 feet to 16.80 feet from the point of measurement during the period in which records have been kept.

Starke 2 is also an unused drilled well. It is located at a mint still near the Junction of State Highwyas 10 and 29. This well is

85 feet deep and its source of water is gravel. The range of fluctuation during the period in which records were kept is 1.15 feet to 6.19 feet below the point of measurement.

Since these two wells are located in the same geological formation and their source of water is gravel, it is interesting to compare their behavior. Their seasonal fluctuations are similar but those of well 2, which is 85 feet deep, are much more abrupt that those of the other well, which is 180 feet deep.

The entire county is flat and characteristic of an old lake plain. During the later part of the glacial period and perhaps for some time following the glaciation, much of the county, particularly the Kankakee valley, was occupied by an extensive lake and marsh land. The accumulation of sand in the old lake area has subsequently been blown into ridges and dunes, which are now found in many parts of the county. In some localities this sandy material is more than 30 feet thick. Underlying it is clay which must be penetrated to secure water from the underlying sand and gravel deposits. Though the water table is near the surface and is replenished by surface water, it has been lowered considerably in this county by drainage ditches. In wells terminating in gravel at North Judson, a short distance west of the observation wells, water stands at 8 feet below the surface. Rocks underlying the drift are of Devonian age and under much of the county is New Albany shale. This is almost impervious to water but some sources are found directly beneath it. Deep wells drilled for oil and gas have encountered salt water in the lower formations.

There are two wells in Steuben County on which records have been kept since September 1935. Both wells are located in Pokagon State Park and are unused driven wells of shallow depth. Each terminated in gravel deposits of the glacial drift and are presumably not affected by

pumping. Steuben 1 is 12.5 feet deep. Steuben 2 is 17.2 feet deep. The fluctuation ranged from near the mouth of each well to 4.72 feet below the point of measurement for well 1, and 6.4 feet for well 2. These two wells have a similarity in seasonal fluctuation both as to the time and extent of the variation. This indicates the relation of recharge of underground reservoirs to rainfall.

The entire county is covered by glacial moraines giving a rolling topography. In the depressions are located many lakes and marsh areas. Many of these marshes are remnants of former lakes. The Wisconsin glacial drift covers the entire surface to 350 feet or more in depth. The lakes are fed by streams and springs resulting from the percolation of water through the loose gravel and sand deposits. The water table, as might be expected from the large number of lakes in this area, is close to the surface. This is born out by the water level in the two test wells. Since there is an abundance of water in the glacial materials, and as they are so thick in this county, there has been no need for drilling for water in bed rock. One test well that was drilled near Ashley penetrated bed rock at 329 feet and salt water at 475 feet. This was probably in the Mississippian formation.

Name of Well	Location	Type	Depth (Feet)	Source Of Water	Lowest Observed Water Level Level	Lowest Observed Water Level Date	Highest Observed Water Level Level	Highest Observed Water Level Date	Range
Clark 1	Clark State Forest	Dug	34.3	Gravel	26.69	Dec. 31-1944	1.3	Feb. 15-1937	25.39
Clark 2	Clark State Forest	Dug	28	Gravel	24.46	Nov. 29-1944	0.05	June 3-1943	24.41
Fulton 3	Rochester	Driven	23.5	Sand and Gravel	10.1	Feb. 1-1940	1.90	May 23-1945	8.2
Hamilton 2	Noblesville	Drilled	265	Limestone	27.33	Sept. 15-1941	14.71	May 19-1943	12.62
Harrison 1	Harrison County Forest	Dug	11	Sand and Gravel	5.65	Nov. 15-1941	0.00	Apr. 15-1939	5.65
Harrison 3	Harrison County Forest	Dug	25	Gravel	7.8	Sept. 30-1941	2.00	Mar. 21-1939	5.80
Jackson 1	Jackson County Forest	Dug	16.5	Sand and Gravel	11.5	Sept. 27-1945	1.2	Apr. 15-1939	10.3
Jennings 1	Hascatatuck Park	Dug	19	Sand or Gravel	16.98	Dec. 15-1943	1.86	Jan. 15-1937	15.12
Madison 2	Anderson	Drilled	156	Gravel	18.40	July 5-1944	10.9	Nov. 15-1938	7.50
Marion 2	Indianapolis	Drilled	110	Gravel	71.55	Sept. 21-1941	47.44	Apr. 12-1938	24.11
Marion 3	Indianapolis	Drilled	200	Limestone	71.16	Oct. 7-1941	50.00	Mar. 29-1938	21.16
Marion 4	Indianapolis	Drilled	304	Limestone	15.72	May 27-1941	3.92	Apr. 16-1938	11.80
Marion 9	Indianapolis	Drilled	220.5	Limestone	62.48	Oct. 3-1942	43.38	Mar. 26-1941	19.10
Marion 10	Indianapolis	Drilled	314	Limestone	70.78	Aug. 29-1941	50.64	Feb. 13-1940	20.14
Montgomery 1	Waveland	Dug	16.5	Sand or Gravel	15.45	Nov. 16-1940	4.78	Jan. 15-1937	10.67
Morgan 1	Morgan-Monroe Forest	Dug and Drilled	46.3	Sand or Gravel	11.95	Oct. 15-1940	2.71	Aug. 14-1945	9.24
Noble 3	NW of Merrian	Driven	27	Gravel	25.5	Dec. 14-1935	11.6	May 18-1939	13.9
Porter 1	Valparaiso	Drilled	110	Sand	57.85	Mar. 31-1945	50.63	Aug. 3-1943	7.22
Porter 2	Dunes S.P.	Dug	20	Sand	13.8	Oct. 18-1935	9.83	Oct. 1-1945	3.97
Porter 3	Dunes S.P.	Driven	16	Sand	17.3	Dec. 23-1940	11.19	July 2-1945	6.11
Pulaski 1	Jasper-Pulaski Game Preserve	Drilled	148.5	Rock	10.05	Nov. 2-1944	7.39	Apr. 29-1939	2.66
St. Joseph 1	Mishawaka	Driven	40	Gravel	13.34	Aug. 6-1941	4.46	May 25-1943	8.88
Starke 1	Bass Lake	Drilled	180	Gravel	16.80	Feb. 16-1945	11.28	June 1-1943	5.52
Starke 2	Bass Lake	Drilled	85		6.19	Sept. 15-1941	1.15	Mar. 16-1944	5.04
Steuben 1	Pokagon S.P.	Driven	12.5	Gravel	4.72	Nov. 1-1935	1.00	June 1-1943	3.72
Steuben 2	Pokagon S.P.	Driven	17.2	Gravel	6.4	Dec. 1-1941	0.03	Apr. 15-1939	6.43

Monthly Water Level Records for Clark 1

Observation Well in Clark State Forest

Years 1936 - 1945 (Inclusive)

Water level in feet below land surface datum

	1936			1940			1942			1944		
Dec.	2	23.6	Mar.	11	11.7	Jan.	6	25.7	Jan.	15	25.51
	1937			30	15.3	Mar.	1	15.04		31	25.62
Oct.	15	22.9	Apr.	22	3.35		16	5.20	Feb.	15	25.87
Nov.	3	23.4		30	8.7	Apr.	2	9.10		29	25.99
	15	23.0	May	16	13.3		15	8.60	Mar.	15	21.45
Dec.	1	23.5	June	5	12.5		30	15.45		31	7.58
	17	23.1		18	18.0	May	16	18.15	Apr.	15	6.87
	1938		July	2	19.0		30	14.47		30	7.06
Jan.	3	22.5		16	20.0	June	15	17.60	May	15	12.35
	19	23.3	Aug.	2	20.8	July	1	13.25		31	16.90
Feb.	1	16.6		20	21.3		14	16.10	June	15	19.58
	15	17.2	Sept.	2	22.2		31	18.95		30	21.37
Mar.	3	14.6		16	22.4	Aug.	15	20.65	July	15	22.50
	15	3.5	Oct.	1	22.4		31	21.89		28	23.15
Apr.	17	11.8		4	22.16	Sept.	15	22.61	Aug.	16	23.87
May	2	15.7		17	22.5		30	23.16		28	24.20
	13	17.0	Nov.	4	22.9	Oct.	15	23.59	Sept.(Av.)		24.63*
	31	18.3		18	23.0		31	23.95	Oct.	"	25.48
June	15	19.2	Dec.	3	23.6	Nov.	30	24.45	Nov.	"	26.08
July	16	16.7		16	24.0	Dec.	31	9.95	Dec.	"	26.53
Aug.	1	16.3		1941			1943			1945	
	15	16.6	Jan.	3	23.3	Jan.	30	17.7	Jan. (Av.)		20.01
Sept.	1	17.8		17	23.7	Feb.	27	14.65	Feb.	"	17.66
	15	19.0	Feb.	5	23.8	Mar.	31	10.2	Mar.	"	6.64
Oct.	3	19.6		15	23.8	Apr.	30	11.35	Apr.	"	6.23
	18	20.3	Mar.	5	24.1	May	31	12.5	May	"	9.99
Nov.	4	21.2		25	24.2	June	30	17.85	June	"	12.42
	16	21.0	Apr.	3	24.8	July	15	19.85	July	"	15.65
Dec.	7	21.2		18	14.9		31	21.15	Aug.	"	20.01
	20	21.5	July	15	23.15	Aug.	14	22.07	Sept.	"	22.17
	1939		Aug.	4	24.0		31	22.71	Oct.	"	23.29
Jan.	5	21.7	Sept.	4	24.7	Sept.	15	23.19	Nov.	"	23.73
	19	21.3		15	24.8		30	23.64	Dec.	"	20.87
Feb.	2	11.3	Oct.	3	25.1	Oct.	15	23.97			
Mar.	7	3.4		13	25.22		30	24.19			
	15	3.4	Nov.	1	25.4	Nov.	15	24.54			
Aug.	24	19.3		17	25.45		30	24.82			
Sept.	5	19.7	Dec.	1	25.65	Dec.	18	25.13			
	25	20.2		15	25.75		31	25.29			
Oct.	5	20.4									

* Monthly average given from Sept. 1944 to Dec. 1945

Monthly Water Level Records for Clark 2

Observation Well in Clark State Forest

Years 1936 - 1945 (inclusive)

Water level in feet below land surface datum

	1936			1940			1942 (Cont.)					
Dec.	2	11.0	Mar.	11	10.3	Mar.	1	14.83	Jan.	31	13.68	
	1937			30	10.45		16	9.6	Feb.	15	13.70	
Oct.	15	11.2	Apr.	22	3.25	Apr.	2	4.9		29	13.68	
Nov.	3	11.1		30	1.8		13	1.79	Mar.	15	13.33	
	15	9.9	May	16	2.1		30	2.76		31	10.90	
Dec.	1	11.3	June	5	3.5	May	16	1.1	Apr.	15	6.71	
	17	11.2		18	4.7		30	13.45		30	2.21	
	1938		July	2	5.5	June	15	4.7	May	15	2.01	
Jan.	3	11.3		16	6.9	July	1	5.1		31	3.99	
	19	11.3	Aug.	2	9.2		14	6.05	June	15	5.40	
Feb.	1	11.3		20	11.0		31	7.6		30	7.55	
	15	11.1	Sept.	2	11.6	Aug.	15	8.9	July	15	9.90	
Mar.	3	9.4		16	12.1		31	9.71		28	11.36	
	15	5.0	Oct.	1	12.2	Sept.	15	10.8	Aug.	16	12.56	
Apr.	17	1.8		4	12.09		30	11.4		28	12.60	
May	2	2.7		17	12.5	Oct.	15	11.7	Sept.	6	12.48	
	13	3.5	Nov.	4	12.3		31	11.88		13	12.46	
	21	2.6		18	12.4	Nov.	30	11.75		20	12.49	
June	15	4.0	Dec.	3	12.6	Dec.	31	11.07	Oct.	4	12.40	
July	16	4.9		16	12.3		1943			18	12.60	
Aug.	1	5.1		1941		Jan.	30	11.20		25	12.73	
	15	5.6	Jan.	3	12.6	Feb.	27	8.16	Nov.	1	12.69	
Sept.	1	6.6		17	12.5	Mar.	31	1.2		8	12.76	
	15	6.4	Feb.	5	12.5	Apr.	30	1.15		15	24.41	
Oct.	3	9.2		15	12.7	May	31	2.7		29	24.46	
	18	9.2	Mar.	5	13.2	June	3	0.05	Dec.	6	24.37	
Nov.	4	9.9		25	13.0		30	5.95		13	24.30	
	16	10.2	Apr.	3	13.2	July	15	7.25		20	24.37	
Dec.	7	10.4		18	12.85		31	9.07		27	24.32	
	20	10.6	July	15	12.25	Aug.	14	10.32		1945*		
	1939		Aug.	4	12.4		31	11.60	Jan.	(Av.)	23.92	
Jan.	6	9.5	Sept.	4	13.0	Sept.	15	12.05	Feb.	"	20.38	
	19	10.6		15	13.1		30	12.32	Mar.	"	3.32	
Feb.	2	10.3	Oct.	3	13.3	Oct.	15	12.56	Apr.	"	.92	
Mar.	7	3.6		13	13.37		30	12.71	May	"	1.44	
	15	1.6	Nov.	1	13.3	Nov.	15	12.87	June	"	2.17	
Aug.	24	8.97		17	13.3		30	12.04	July	"	4.54	
Sept.	5	9.7	Dec.	1	13.2	Dec.	18	13.21	Aug.	"	7.61	
	25	10.1		15	13.45		31	13.34	Sept.	"	10.66	
Oct.	5	10.2		1942			1944		Oct.	"	11.10	
			Jan.	6	13.45	Jan.	15	13.55	Nov.	"	11.26	
									Dec.	"	11.15	

* Monthly average given for the year 1945.

Monthly Water Level Records for Fulton 3

Observation Well in City of Rochester

Years 1935 - 1945 (inclusive)

Water level in feet below land surface datum

	1935			1939			1942 (Cont.)			1944 (Cont.)		
Oct.	17	9.24	Jan.	1	8.6	Sept.	4	5.70	June	26	5.91
Nov.	2	9.60	Nov.	1	8.4	Oct.	1	6.48	July	3	5.98
	15	9.48	Mar.	1	7.3	Nov.	9	8.38		10	6.06
Dec.	2	9.50	Apr.	1	7.3	Dec.	10	8.41		17	6.08
	16	9.00	May	1	6.45		1943			24	6.21
	1936		June	1	6.0	Jan.	4	7.84		31	6.21
Jan.	2	8.95	July	1	6.5	Feb.	2	8.30	Aug.	7	6.50
	16	8.36	Aug.	1	6.98	Mar.	1	8.30		14	7.00
Feb.	1	8.75	Sept.	1	8.1	Apr.	5	6.38		21	7.20
	15	8.98	Oct.	20	8.83	May	1	4.20		28	7.21
Mar.	6	8.42		1940		June	3	3.27	Sept.	4	7.32
	17	8.70	Feb.	1	10.1	July	5	4.97		18	7.84
Apr.	16	6.64	Mar.	1	7.4	Aug.	2	5.88		25	8.33
May	4	5.47	Apr.	1	8.2	Sept.	6	6.27	Oct.	4	8.27
June	1	5.4	May	1	6.08	Oct.	6	7.72		9	8.17
	18	7.0	June	1	6.37	Nov.	1	8.00		23	8.58
July	3	7.1	July	1	7.0		15	8.05	Nov.	3	9.25
Nov.	18	8.63	Aug.	1	7.79	Dec.	1	8.05		6	9.25
Dec.	1	9.00	Sept.	1	7.82		15	8.01		20	9.14
	17	9.16	Oct.	1	8.18		1944			27	9.28
	1937		Nov.	1	9.55	Jan.	1	8.26	Dec.	5	9.42
Jan.	4	8.64		20	9.50		15	8.28		11	9.40
	16	8.16	Dec.	1	9.60	Feb.	1	7.98		18	9.42
Feb.	1	8.27		1941			15	9.05		26	9.45
	16	8.48	Jan.	1	9.41	Mar.	1	7.06		1945*	
Mar.	2	8.56	Feb.	12	9.3		15	6.77	Jan.	(Av.)	7.53
Apr.	1	7.65	Mar.	12	9.33	Apr.	1	6.37	Feb.	"	7.42
	15	5.27	Apr.	9	5.34		10	7.81	Mar.	"	6.64
May	5	4.84	May	3	4.50		17	6.02	Apr.	"	4.04
June	11	4.98	June	3	5.45		24	4.37	May	"	2.45
July	2	5.6	Aug.	4	6.6	May	1	4.79	June	"	3.16
	17	5.17	Sept.	2	7.39		8	4.93	July	"	4.20
	31	5.9		29	8.23		15	4.47	Aug.	"	5.04
Dec.	1	8.91	Nov.	3	8.72		22	4.64	Sept.	"	5.33
	1938			1942			29	5.00	Oct.	"	6.11
May	4	5.0	Feb.	9	6.32	June	5	4.90	Nov.	"	6.32
June	1	6.4	June	11	5.78		12	5.38	Dec.	"	6.40
July	1	4.7	July	2	5.31		14	5.44			
Sept.	1	7.6	Aug.	6	5.32		19	5.60			

* Monthly average given for year 1945.

Monthly Water Level Records for Hamilton 2
Observation Well in Noblesville
Years 1935 - 1945 (inclusive)

Water level in feet below land surface datum

	1935	
Nov.	2	25.3
	16	25.4
Dec.	5	25.65
	16	25.58
	1936	
Jan.	1	25.60
	18	25.46
Feb.	2	25.48
	15	25.45
Mar.	15	24.00
Apr.	4	23.95
May	2	24.15
	16	24.25
June	2	24.42
	15	24.57
July	1	24.80
	13	25.01
Aug.	1	25.29
Sept.	1	25.70
	16	25.60
Oct.	1	25.66
	16	25.58
Nov.	1	25.6
	16	25.57
Dec.	1	24.96
	15	25.42
	1937	
Jan.	5	24.44
	15	17.25
Feb.	1	19.55
	16	20.55
Mar.	2	21.17
	16	21.54
Apr.	1	21.48
	16	21.52
May	1	20.98
	16	21.43
June	2	21.64
July	1	22.20
	16	22.37
Sept.	1	23.12
	16	23.07
Oct.	1	23.56
	16	23.39
Nov.	16	23.42
Dec.	1	23.60
	16	23.72
	1938	
Jan.	2	23.15
	15	22.73

	1938 (Cont.)	
Feb.	1	23.05
	15	20.18
Mar.	2	22.36
	15	21.11
Apr.	2	18.60
	17	18.85
May	3	19.94
	16	20.36
June	1	20.28
	16	20.62
July	16	20.57
Aug.	1	21.08
	15	21.34
Sept.	16	22.17
Oct.	16	22.65
Nov.	1	22.68
Dec.	3	22.81
	1939	
Jan.	2	23.37
	15	23.32
Apr.	2	21.22
	16	20.29
May	15	21.84
June	3	21.40
July	15	22.59
Aug.	3	22.48
Oct.	3	23.16
	16	23.46
Nov.	4	23.18
Dec.	16	23.58
	1940	
Feb.	1	24.39
	17	24.02
Mar.	2	23.61
Apr.	14	23.34
May	19	23.02
Aug.	1	25.02
	16	25.38
Sept.	5	25.35
Oct.	2	25.11
	15	26.47
Dec.	3	25.28
	1941	
Jan.	5	25.37
Feb.	1	25.69
Mar.	15	25.77
Apr.	15	25.78
May	1	25.94
	16	26.46
June	16	25.56

	1941 (Cont.)	
Aug.	1	27.06
	16	27.11
Sept.	15	27.33
Oct.	16	27.02
Nov.	5	26.93
Dec.	2	26.20
	1942	
Jan.	15	26.41
Feb.	15	25.02
Mar.	4	24.93
	31	24.13
May	15	23.60
June	2	22.58
July	5	23.29
Aug.	1	24.08
Sept.	1	24.22
Oct.	5	24.35
Dec.	1	24.22
	1943	
Jan.	2	23.94
Mar.	1	24.18
Apr.	8	23.49
	30	23.68
May	19	14.71
Aug.	1	21.70
Nov.	1	23.38
	1944	
Jan.	17	24.24
Feb.	4	24.61
	11	24.70
	18	24.74
	25	24.43
Mar.	6	24.75
	11	23.96
	20	24.70
	27	24.71
Apr.	8	23.70
	17	20.80
	22	20.86
May	4	21.02
	10	21.37
	19	20.99
June	7	22.25
	19	22.54
	26	22.77
July	6	23.06
	14	23.35
	21	23.98
	28	22.50
Aug.	8	23.25

	1944 (Cont.)	
Aug.	25	24.10
Sept.	4	24.50
	12	24.35
	20	24.40
Oct.	1	24.44
	11	24.59
	23	24.60
	30	24.58
Nov.	6	24.60
	19	25.20
	26	25.40
Dec.	4	25.20
	24	24.80
	1945	
Jan.	1	24.75
	7	24.75
	21	24.85
	30	23.95
Feb.	5	25.01
	15	24.75
Mar.	2	24.65
	9	23.85
	16	23.79
	23	23.82
Apr.	8	22.66
	17	22.90
	30	22.84
May	8	22.86
	16	22.44
	21	22.75
June	5	22.81
	20	21.05
July	1	21.57
	9	21.72
	19	22.32
	26	22.98
Aug.	8	23.10
	14	23.28
	29	23.15
Sept.	4	23.23
	14	23.40
	25	24.44
Oct.	2	24.47
	8	23.40
	25	22.77
Nov.	5	22.80
	12	22.82
	27	22.85
Dec.	27	22.81
	31	23.47

Monthly Water Level Records for Harrison 1
Observation Well in Harrison County State Forest
Years 1936 - 1945 (inclusive)

Water level in feet below land surface datum

	1936	
Dec.	2	2.94
	1937	
Jan.	15	1.5
Feb.	1	1.5
	15	1.25
Mar.	1	1.20
	15	1.28
Apr.	1	1.28
	15	1.5
May	1	1.20
	15	1.37
June	1	1.64
	15	1.54
July	1	3.40
	15	2.64
Aug.	1	3.87
	15	3.70
Sept.	1	3.62
	15	3.56
Nov.	1	2.02
	15	2.90
Dec.	1	2.90
	15	1.10
	1938	
Jan.	1	1.04
Feb.	1	4.0
	15	4.2
Mar.	1	1.6
	15	1.0
	30	1.4
Apr.	18	1.4
May	1	1.7
	15	2.4
June	2	2.1
	15	2.3
July	5	2.4
	15	2.6
	30	2.8
Aug.	15	3.8
	31	3.1
Sept.	15	3.7
	30	3.6
Oct.	25	2.84
Nov.	1	2.66
	15	2.61
Dec.	1	2.56
	15	2.51
	1939	
Jan.	11	1.00
Feb.	1	0.50
	15	0.00
	28	0.00
Mar.	21	2.00
	31	0.00
Apr.	15	0.00

1939 (Cont.)		
Apr.	30	0.80
May	15	2.10
June	1	3.10
	15	4.88
July	1	2.68
	15	3.10
	31	3.48
Aug.	15	2.54
	31	3.10
Sept.	15	2.48
Oct.	1	3.08
	15	4.25
	31	4.70
Nov.	15	3.61
	30	2.94
Dec.	15	2.60
	31	2.55
	1940	
Jan.	15	1.06
	31	1.30
Feb.	15	0.66
	29	0.85
Mar.	15	1.06
	31	0.53
Apr.	15	1.02
	30	1.01
May	15	2.98
	31	0.87
June	15	2.59
	29	2.45
July	15	2.41
	31	3.24
Aug.	15	3.64
	31	4.00
Sept.	14	3.78
	30	4.11
Oct.	12	4.22
	15	4.24
	31	4.59
Nov.	15	3.71
	30	2.56
Dec.	15	2.32
	1941	
Jan.	1	1.55
	15	1.55
Feb.	1	2.3
	15	.41
Mar.	1	2.39
	16	2.33
Apr.	1	2.33
	16	2.21
May	1	2.97
	15	2.75
June	2	3.6
	16	2.43

1941 (Cont.)		
June	30	4.05
July	15	4.0
	31	4.5
Aug.	15	4.7
Sept.	1	4.9
	15	5.2
	30	5.6
Oct.	14	5.60
	31	5.6
Nov.	15	5.65
Dec.	1	3.28
	16	2.8
	1942	
Jan.	1	0.5
	31	1.1
Feb.	16	.6
	28	1.8
Mar.	31	1.5
Apr.	30	2.6
May	31	2.9
June	30	2.7
July	31	3.6
Aug.	31	2.8
Oct.	5	2.7
	1943	
Feb.	1	0.75
Mar.	27	0.64
Apr.	15	0.80
	29	0.87
May	15	0.57
	31	0.56
June	15	2.33
July	17	2.41
Aug.	2	2.10
	14	2.94
Sept.	1	2.66
	15	2.33
Oct.	2	2.62
	17	2.25
	30	2.15
Nov.	18	2.02
	30	2.45
Dec.	16	2.37
	31	1.30
	1944	
Jan.	15	2.08
	31	2.10
Feb.	15	2.20
	29	.70
Mar.	15	1.44
	31	.85
Apr.	17	.95
	30	1.56
May	15	2.07
	31	1.00

1944 (Cont.)		
June	15	2.01
	30	2.09
July	15	2.29
Aug.	1	3.20
	17	3.20
Sept.	1	2.00
	15	2.14
	30	1.00
Oct.	15	2.17
	31	2.64
Nov.	16	2.19
	30	2.14
Dec.	15	1.91
	1945	
Jan.	3	.95
	17	1.00
Feb.	2	1.63
	14	.82
Mar.	7	.71
	15	.69
Apr.	5	1.29
	14	.60
May	5	.92
	27	2.12
June	4	1.87
	11	.55
	20	.96
	25	2.30
July	2	1.97
	11	2.47
	16	1.75
	23	2.45
	30	1.21
Aug.	8	2.34
	16	2.59
	22	2.76
	27	2.88
Sept.	3	2.88
	10	2.72
	17	2.39
	24	2.83
Oct.	1	1.87
	8	2.02
	15	2.47
	22	2.62
	29	2.67
Nov.	5	1.97
	12	.49
	19	1.41
	26	1.13
Dec.	2	1.34
	9	2.01
	23	2.22
	30	.90

Monthly Water Level Records for Harrison 3

Observation Well in Harrison County State Forest

Years 1938 - 1945 (inclusive)

Water level in feet below land surface datum

	1938		1940 (Cont.)			1942 (Cont.)			1944 (Cont.)		
Oct.	25	6.27	Aug.	15	6.56	July	31	6.2	Oct.	31	7.22
Nov.	1	6.37		31	6.87	Aug.	31	5.7	Nov.	16	7.26
	15	6.32	Sept.	14	6.85	Oct.	5	6.6		30	7.32
Dec.	1	6.29		30	7.10		1943		Dec.	15	7.37
	15	6.27	Oct.	12	7.22	Feb.	1	3.80		1945	
	1939			15	7.28	Mar.	27	3.16	Jan.	3	5.25
Jan.	11	4.69		31	7.37	Apr.	15	3.15		17	3.06
Feb.	1	3.08	Nov.	15	7.35		29	3.16	Feb.	2	3.23
	15	2.99		30	7.34	May	15	3.02		14	3.02
	28	3.09	Dec.	15	7.30		31	3.61	Mar.	7	2.69
Mar.	21	0.80		1941		June	15	4.20		15	3.08
	31	3.08	Jan.	1	7.3		30	4.97	Apr.	5	3.08
Apr.	15	3.05		15	7.3	July	17	5.19		14	3.12
	30	4.30	Feb.	1	4.4	Aug.	2	4.40	May	5	3.02
May	15	3.90		15	3.2		14	5.08		27	3.56
June	1	3.27	Mar.	1	4.05	Sept.	1	5.76	June	4	4.28
	15	5.17		16	4.26		15	6.10		11	2.54
July	1	4.03	Apr.	1	4.25	Oct.	2	6.38		20	3.05
	15	7.44		16	2.78		17	6.61		25	3.46
	31	5.40	May	1	3.95		30	6.69	July	2	4.16
Aug.	15	5.73		15	4.9	Nov.	18	6.84		11	4.82
	31	5.99	June	2	4.9		30	7.00		16	4.82
Sept.	15	6.62		16	5.79	Dec.	16	7.07		23	5.18
Oct.	1	7.03		30	6.2		31	7.17		30	5.08
	15	6.66	July	15	6.5		1944		Aug.	8	5.45
	31	6.80		31	6.6	Jan.	15	7.26		16	5.66
Nov.	15	6.82	Aug.	15	7.1		31	7.37		22	5.83
	30	6.98	Sept.	1	7.3	Feb.	15	7.47		27	5.85
Dec.	15	6.90		15	7.5		29	4.45	Sept.	3	6.03
	31	6.89		30	7.8	Mar.	15	3.15		10	6.15
	1940		Oct.	14	7.76		31	3.00		17	6.18
Jan.	15	6.89		31	7.7	Apr.	17	3.11		24	6.26
	31	7.20	Nov.	15	7.45		30	3.15	Oct.	1	6.19
Feb.	15	3.16	Dec.	1	7.74	May	15	3.44		8	6.16
	29	3.04		16	7.7		31	4.49		15	6.24
Mar.	15	3.01		1942		June	15	5.23		22	6.32
	31	3.16	Jan.	1	5.7		30	5.76		29	6.35
Apr.	15	3.15		31	3.2	July	15	6.13	Nov.	5	6.40
	30	2.80	Feb.	16	2.8	Aug.	1	6.44		12	6.40
May	15	3.67		28	3.2		17	6.71		19	6.42
	31	3.33	Mar.	31	6.30	Sept.	1	6.77		26	6.02
June	15	4.51	Apr.	30	4.1		15	6.84	Dec.	2	3.40
	29	5.36	May	31	7.35		30	6.97		9	3.23
July	15	5.75	June	30	3.8	Oct.	15	7.07		23	3.28
	31	6.22								30	3.08