

# Well Water Recessions in Illinois

BY

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DEPARTMENT OF REGISTRATION AND EDUCATION  
**STATE WATER SURVEY DIVISION**  
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STATE WATER SURVEY DIVISION

A. M. BUSWELL, *Chief*

## WELL WATER RECESSIONS IN ILLINOIS<sup>1</sup>

BY G. C. HABERMEYER<sup>2</sup>

An artesian well 711 feet deep was drilled in Chicago<sup>3</sup> in 1864 at the corner of Chicago and Western Avenues and the pressure at the ground surface was about 80 feet. The owners of the well proposed to drill two 15-inch wells and secure water (20,000,000 gallons a day) at sufficient pressure to supply the city without pumping. Their expectations have never been realized, for, although many wells have been drilled into the same water-bearing stratum and other strata of which Professor Leighton has spoken, and the quantity of water pumped is increasing, the water level has receded until many wells have been abandoned on account of the high cost of pumping from great depths.

An important factor in the lowering of the water level is the increase in the quantity of water pumped and this will be discussed briefly for: (1) wells into porous material overlaid only by porous material, (2) wells piercing several water-bearing strata with water from all but the bottom stratum cased out, and (3) wells piercing several water-bearing strata with no water cased out.

Figure 1 shows a well into porous material into which water from the ground surface percolates freely. The line through *O* shows the water level when not pumping and the line marked *H.G.L.*, hydraulic grade line, marks the water surface when pumping. With little lowering of water level the yield may vary nearly in proportion to the lowering. As the bottom of the stratum is approached the relative area of flow decreases and the velocity increases more rapidly, giving higher friction loss and greater lowering in proportion to the yield, until the bottom of the stratum is reached when increased lowering gives no increase in yield.

Pumping for a long time at a higher rate than the rate at which water enters the stratum will cause a continued lowering of the water

<sup>1</sup> Presented before the Chicago Convention, June 9, 1927.

<sup>2</sup> Engineer, Illinois State Water Survey, Urbana, Ill.

<sup>3</sup> History of the Chicago Artesian Well. Religio Philosophical Publishing Association. 1866.

level until the level is near the bottom of the stratum and then the yield will decrease.

Figure 2 shows an artesian well piercing two water-bearing strata with water from the upper stratum cased off. The line through *O* shows the height to which water rises in the well when not pumping and the line marked *H.G.L.*, hydraulic grade line, shows the elevation to which water from the lower stratum would rise while pumping.

Figure 3 shows three types of wells, *A* and *B* as in figures 1 and 2, and *C*, a well into the same water-bearing strata penetrated by *B*,

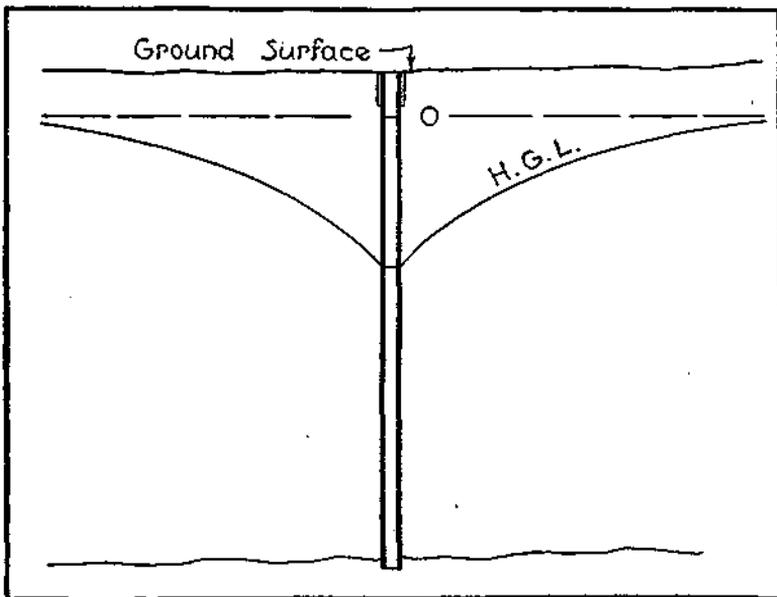


FIG. 1

but with no water cased out. A great majority of our deep wells secure water from more than one stratum as shown at *C*. With water standing at different levels in wells *A* and *B*, all water pumped from well *C* will be from the stratum from which water rises the higher, until the water level is drawn down below the depth at which it stands in either *A* or *B*. Then, with increased pumping, water will be drawn from both strata and the rate of lowering with increased pumping may be a little less or very much less than before.

Drilling and pumping from additional wells in an area may change

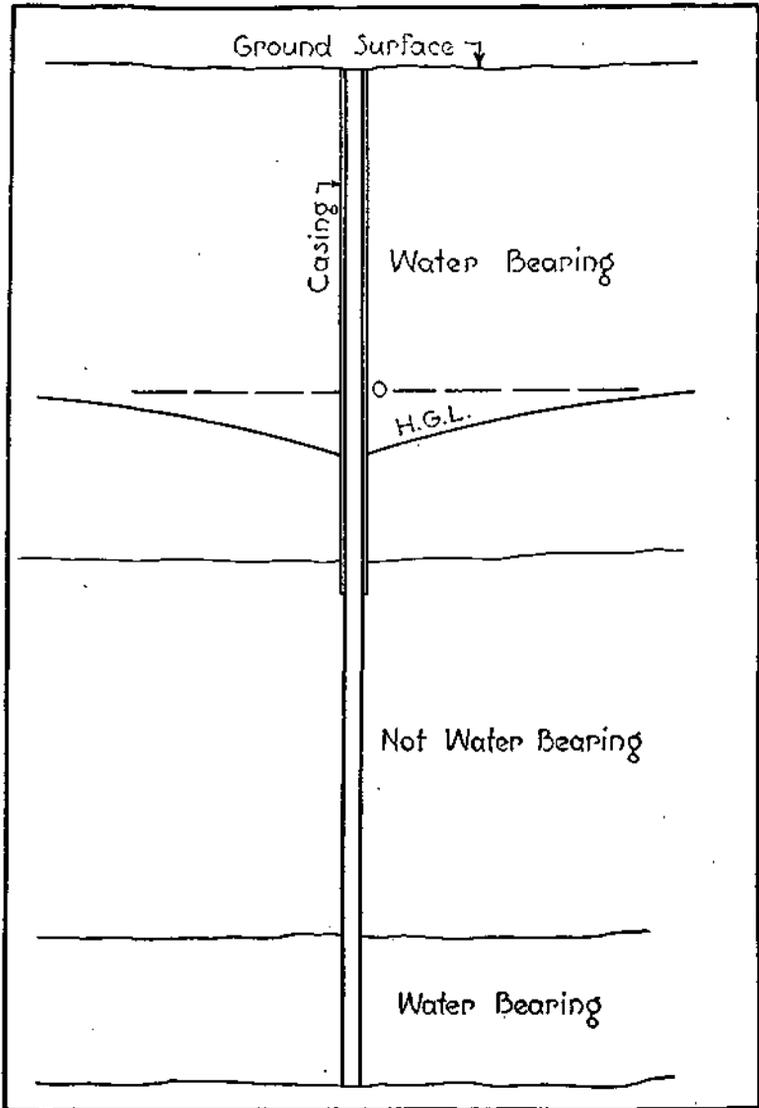


FIG. 2

conditions on account of the quantity of water pumped greatly exceeding the capacity of strata which had supplied all or nearly all demands.

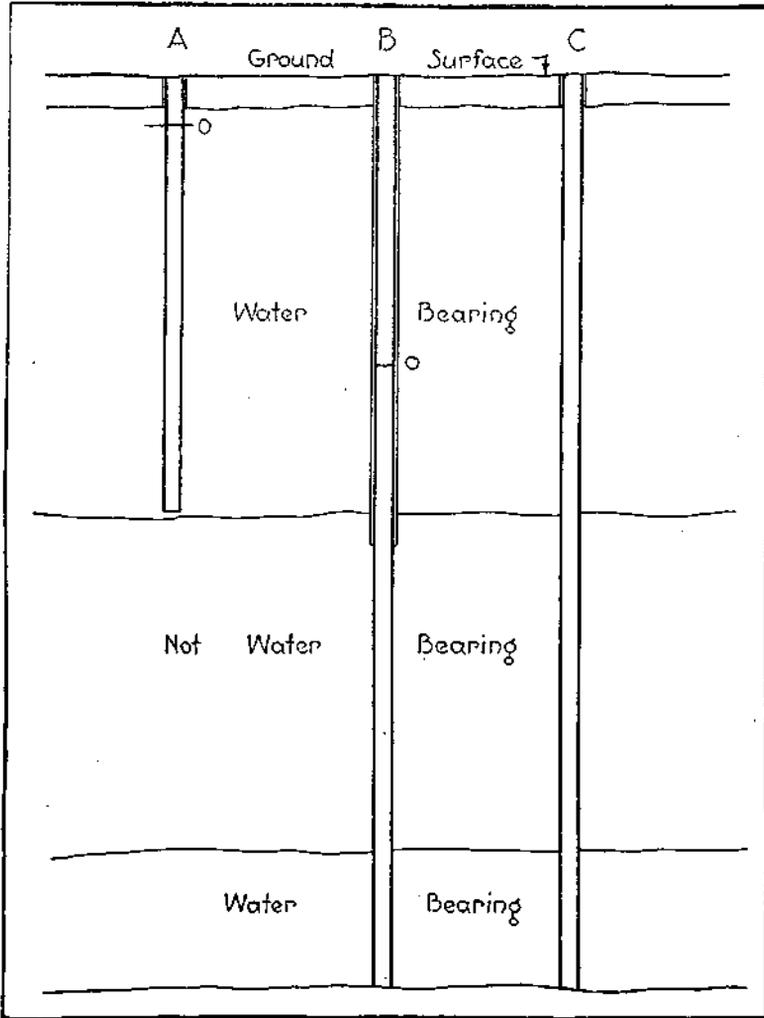


FIG. 3

The United States Geological Survey has developed a current meter to determine velocities at all depths in flowing wells, and thus determine the flow into or out of a well for each stratum.

A well in use for many years by the Village of Western Springs, a few miles west of Chicago, illustrates all three types of wells. The well was 2046 feet deep, was cased 1765 feet, to Mt. Simon sandstone, and was very large at the top, giving a well into Niagaran limestone outside of the deep casing. Pumping 110 gallons a minute from Mt. Simon sandstone lowered the water level inside the casing, 150 feet to a depth of 240 feet. Pumping large quantities from Niagaran limestone, outside the casing, lowered the water level a few feet. Shortly after the well was completed water both inside and outside the casing stood 15 feet below the ground surface and 600 gallons a minute could be pumped with a lowering not exceeding 6 feet. At least part of the casing was then out of commission, the well was of the type shown at C, and all water was from the upper part of the well.

Another illustration of change in conditions is at Lansing, a village southeast of Chicago near the Indiana State line, where a well was drilled to a depth of 1632 feet. When drilling in the lower part of the well the water level dropped 70 feet. Water from the upper part of the well then flowed into the well, downward, and out into lower strata. Water pumped from the well was from the upper part and had a hardness of 20 parts per million. With increasing demands, increased pumping, and draining of upper strata, the water level was lowered and part of the supply was secured from lower strata as shown by an increase in hardness of the supply to 650 parts per million.

The only reason for lowering of water levels discussed above is increase in rate of pumping. An attempt has been made to show that with increased pumping the lowering may be slight between certain limits of yield and may be great between other limits, depending upon the relative yields and water levels in various strata penetrated by a well.

A lowering of water level may be due in part to other causes. A lowering of level giving reduced pressure in a stratum may release gases from the water, causing a readjustment in dissolved mineral matters and a deposit of part of them, thus increasing friction loss and adding to the lowering if the yield is maintained. Deposits are found on equipment taken from some wells. It is claimed that blasting has restored yields of wells by removing deposits.

Growths on walls of wells and in the strata are given as a possible cause of decrease in yield or lowering of level to obtain the same yield.

Mechanical clogging of strata with fine sand or other material may add greatly to friction losses and thus to lowering of water level.

Compression of water-bearing strata is given by Oscar E. Meinzer and Herbert A. Hard as an explanation of lowering of water level.<sup>4</sup> A reduction of pressure in a stratum is equivalent, in some respects to increased pressure on the stratum. Increased pressure gives compression which reduces the voids in the stratum. Yields from wells in the past, greater than present yields with higher water levels than present levels, can then be explained, as part of the yields were of water in storage in the vicinity of the wells. This explains a lag in adjustment of water levels with changes in yields. Compression will also have a direct effect on the increase in friction loss.

Conditions in various states in regard to water level recessions due to the causes mentioned or possibly other causes, will be given by the persons whose names appear on the program. I shall give a few facts in regard to conditions in Illinois.

#### CONDITIONS IN ILLINOIS

The water levels in deep wells in northern Illinois have receded considerably. A large part of the lowering is due to increased pumping and an effort has been made to determine the quantity of water pumped from wells penetrating the lower water-bearing strata, including St. Peter sandstone and all lower strata. This is given for several areas and the Chicago suburban area is here considered as area in Illinois from Lake Michigan along the Wisconsin State line to Fox River; southward including Elgin, Aurora, and Morris; southeastward to include Kankakee; eastward to the Indiana State line; and north to the lake. Reasonably accurate data have been secured in this area by H. L. White of the State Water Survey Division. Data of municipal supplies outside of this area have been secured from Bulletin 21, issued by that survey, and from city and village officials. Few data are readily available in regard to industrial use of water from deep wells outside of Chicago and the suburban area, and this has been assumed at between 2,500,000 and 7,500,000. Quantities pumped per day for areas given are as follows:

	<i>million gallons per day</i>
Stock yards area in Chicago .....	.10
City of Chicago .....	.15
Cook County.....	.30
Chicago and suburban area .....	.50
State of Illinois .....	.70 to 75

\* United States Geological Survey, Water Supply Paper 520.

180 total

The largest yields are from wells into Cambrian sandstones. They supply about 95 per cent of the quantity given for Chicago and suburban area and probably 85 per cent of the quantity given for the state. Water levels given will be for wells into Cambrian sandstone.

The lowering of water level in the stock yards area is shown in figure 4. The curve, to 1915, is copied from State Geological Survey Bulletin 34. Water stood at the ground surface in 1889 and at a depth of 212 feet in 1914. The bulletin gives the quantity of water pumped per day in the latter year as 13,450,200 gallons in the stock yards and 30,100,000 gallons in Chicago. Since that date nearly all wells formerly in use at breweries have been abandoned and many other wells have been abandoned on account of increasing costs of

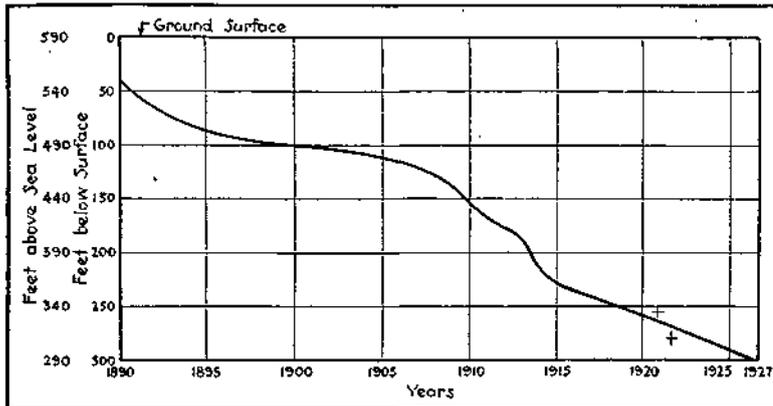


FIG. 4

pumping from greater depths and superior quality of the city supply. Some wells have been drilled and nearly all of the wells now in use are pumped almost continuously at a high rate, many yielding 1,000 gallons a minute or more. The quantity pumped in the suburbs has increased very rapidly.

Recent information in regard to levels at the stock yards is principally from Armour and Company and was secured with the assistance of G. B. Mulloy and others. The water level in one well, last month, when the pump had been idle one day, was 300 feet below the ground surface, about 290 feet above sea level. When pumping 800 gallons a minute the depth to water was close to 340 feet, as a hole was found in the suction line at that depth and other equipment in good repair in other wells discharged more water.

Within 6 miles of the stock yards, on land not more than 10 feet higher, excepting to the south and southeast where practically no deep wells are in use and we have no record, depths to water when not pumping are reported as about 300 feet, some a little more, some less. At a plant of the Corn Products Refining Company, 8 miles west and south, where land is at about the same elevation, the depth to water when pumping 2,300,000 gallons a day from a group of wells, is 340 feet.

In wells at May wood, about 10 miles west and 5 miles north of the stock yards, in an area where the quantity of water pumped has increased rapidly, the water level was approximately 555 feet above sea level in 1907 and 375 feet above in 1927.

North and northwest of the stock yards more than 7 miles little water is pumped from deep wells. At Park Ridge, 15 miles northwest, the water level was 565 feet above sea level in 1914 and 67 feet lower, or about 500 feet above sea level in 1927.

At North Chicago, 35 miles north, wells now flow several feet above the lake level, about 590 feet above sea level.

At Rockford the water level was about 740 feet above sea level in 1885, 720 feet above in 1891, 707 feet in 1910, 697 feet in 1919, and approximately 690 feet in new wells in 1923.

At Galena, close to the northwest corner of the State, it was reported in 1886, when a well 1547 feet was drilled, that the flow was 500 gallons a minute and that water would rise to 84 feet above the ground surface, 694 feet above sea level. In 1896 water would rise to 32 feet above the ground surface. After repairing the well the pressure at the top, in 1925, with small flow through a waste valve, was 32 feet. Another well of practically the same depth, 8 inches in diameter, located 130 feet from the older well, had been completed in 1921. When pumps were not operating there was a small flow from the two wells through a blow-off valve and a pressure gauge on the pump suction registered 36 feet. When pumping from the two wells at a rate of 750 gallons a minute the pressure at the top of the wells was 8 feet, indicating that, with zero pressure at the top, a flow close to 500 gallons per minute per well could be obtained, for a short time at least.

Analysis of the causes of the recession of the water level in this state would be difficult. The majority of the wells in use pierce several water-bearing strata and have little casing, so the quantity of water pumped from each stratum is not known. Many wells more

than 1800 feet deep in the western suburbs of Chicago yield several hundred gallons a minute, of which a large part is from the upper 300 or 400 feet of the wells, as shown by low temperatures. A well at Western Springs has been given as an example.

With increased demands, wells have been drilled deeper or replaced by deeper wells into lower water-bearing strata, so that conditions are not directly comparable with conditions of ten years ago. However, practically all water pumped in the stock yards district is, and for many years has been, from wells about 1600 feet deep.

A large part of all water pumped is from Cambrian sandstone, as has been noted, but there are several water-bearing sandstones in the Cambrian system and many of the wells at one location are drilled into lower strata than are wells at other places nearby. For example, at Aurora, 35 miles west of Chicago, wells are drilled more than 1000 feet into the Cambrian system, while wells in use at the stock yards are drilled about 200 feet into this system.

About the only conclusion that can be drawn at this time seems to be that the water level lowering depends in large part directly upon the quantity of water pumped and that part of the change is due to some of the other factors which have been given as possible causes. The great lowering near Chicago may be due in part to compression of strata.

In the vicinity of Chicago, where the greatest quantity of well water is used, much of the water is now from wells drilled as deep as can be drilled without securing salty water, and the water level has receded until some wells have been abandoned, so it may be that conditions will be more uniform during the next few years and additional information can be obtained.

**State Water Survey Bulletin No. 21**

**PUBLIC GROUND-WATER SUPPLIES  
IN ILLINOIS**

By G. C. Habermeyer

This bulletin contains valuable information concerning the quality and quantity of public water supplies obtained from underground sources. The history of the supply system in each community is given, together with detailed descriptions of wells, pumping equipment, reservoirs, distributing mains, etc. The quality of the water is shown in most cases by a laboratory report of a mineral analysis, supplemented by notes on the hardness of the water, its alkalinity, temperature, taste, and its action on plumbing fixtures, meters, pumps, etc. Data on the yields of wells and changes in the water level are given wherever such facts could be obtained. Municipalities having public water supplies are mapped, with symbols to indicate the nature of the source of each supply.

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*Price \$1.00*

STATE WATER SURVEY DIVISION  
URBANA, ILLINOIS