CIRCULAR 191

ILLINOIS STATE GEOLOGICAL SURVEY

URBANA

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WATER WELLS FOR FARM SUPPLY IN CENTRAL AND EASTERN ILLINOIS

A Preliminary Report on Geologic Conditions

BY

JOHN W. FOSTER and LIDIA F. SELKREGG

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WATER WELLS FOR FARM SUPPLY IN CENTRAL AND EASTERN ILLINOIS

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ABSTRACT

Groundwater possibilities for farm supply in central and eastern Illinois range from very poor to excellent. This report is designed to show in a general way the geologic control of the availability of groundwater in this area and to suggest the best ways to obtain it under prevailing conditions. The accompanying map shows areas that appear to have water-yielding formations suitable for good farm wells and those with unfavorable geologic conditions for small drilled wells. Generally, poor possibilities are due to thin glacial drift, scarce water-yielding sands, or tight bedrock. It is hoped that this report will improve understanding of the occurrence of groundwater, demonstrate the geologic control of groundwater supplies, and encourage landowners to require fundamental records from well drillers.

INTRODUCTION

Water in the earth - groundwater - is a geologic resource. When we tap water from a well, we are not mining this resource, as we do coal, oil, and fluorspar: we merely borrow it from nature. Groundwater is a renewable resource, like forests and grasslands. Nature normally takes care of the return of water to the place from which it was removed. Whether groundwater is available or not is largely a matter of natural conditions that were determined thousands of years ago and which in most places cannot be changed by man. Where good, abundant groundwater can be obtained by drilling today, it could have been obtained ages ago. Where groundwater is difficult to find today, it would probably have been difficult to find in Grandfather's time and centuries before that. Prehistoric man would probably have found essentially the same geologic conditions, if he had had the tools with which to drill 5000 years ago.

One of the primary requirements of an area in attracting new industries is abundant water. Farms and communities, however, are settled and their residents must do the best they can with existing natural conditions. The State Geological Survey is cooperating with the extension services of the Agricultural Engineering Department, University of Illinois, in a program toward water supply improvement on the farms of Illinois. The region covered by this report is Agricultural Extension District 3. The accompanying map, plate 1, shows the twenty-two counties included in District 3.

GEOLOGY OF THE REGION

The landscape of central and eastern Illinois is not ancient in a geologic sense, like the Missouri and Illinois Ozarks and the grasslands of Kentucky. The fresh, young land surface has been reworked by glacial ice sheets, which several times overrode this part of Illinois and changed its face. Great volumes of earth debris have filled the ancient river valleys and covered the ancient hills until none remains to be seen. Loose, unconsolidated glacial debris is known to geologists as glacial drift. It consists partly of water-bearing sands and gravels and partly of tight pebbly clay and silt (till). In some places the drift is so thin that outcrops of bedrock, mostly shale, can be seen along the sides of the valleys, such as near Danville. In other places the drift is so thick that wells 400 feet deep fail to penetrate the top of the shale. Areas near Paxton, Rantoul, Mahomet, Monticello, and Clinton have unusually thick glacial drift, which fills an ancient deep valley that once drained the land as far east as the Blue Ridge Mountains into the old course of the Mississippi River.

The prairies of central and eastern Illinois show the work of glaciers everywhere. Boulders from Wisconsin, Michigan, and Canada are common. Long winding ridges cross the countryside. These moraines, as they are called, were caused by the dumping of particularly large amounts of debris along the front of the melting ice mass. Smooth rock surfaces in some limestone quarries show long, straight scratches carved by pebbles at the base of moving ice.

Below the glacial drift and extending to depths of several thousand feet are layers upon layers of firm rocks such as shale, coal, limestone, and sandstone. These formations lie more or less like flat pages in a large book. They generally extend horizontally for scores of miles, deformed in places by warps and gentle folds. Only in parts of Coles, Douglas, Champaign, Ford, McLean, and Livingston counties are the bedrock formations known to slope more than a few feet to the mile.

Under the layered rocks, some 4000 to 8000 feet deep, and extending to unknown and unexplored depths are the very hard "basement" granite and similar rocks. These are the rocks that rise to the land surface in the St. Francois Mountains of Missouri and in central and northern Wisconsin, where they have escaped burial through the eons of time, or where they have been uncovered by erosion of the layered rocks.

WHERE IS WATER IN THE EARTH?

The upper few thousand feet of the earth is soaked with water almost everywhere. Water fills the crevices and the pores - it is not found as underground streams or lakes (except locally in limestone caves). But water is not everywhere available to man. A water-soaked bed of clay is likely to contain more water per cubic foot than a bed of water-bearing sand suitable for a well. The trick is to get water to move into a well. Many formations, such as clay or shale, are too "tight" to allow the movement of water, even though the pores in the material are filled with water.

Thus when a driller bores into the earth for a water supply he is not looking for water, but rather a permeable formation which will release its water to an open bore hole. He may end with a "dry" hole - dry because the material will not yield its water.

How are we situated in central and eastern Illinois with regard to water-yielding formations? Some areas contain water-yielding deposits of great promise, not only for plentiful domestic and farm supply but for irrigation, industrial, and municipal supply. In other areas there is a scarcity of good water-yielding formations at reasonable depths and the quality of the water at greater depths is poor.

WATER-YIELDING FORMATIONS

The great majority of successful drilled wells in central and eastern Illinois obtain groundwater from beds of loose sand and gravel that are in the unconsolidated glacial drift that covers solid bedrock. Competent well drillers familiar with the construction of wells in sand and gravel beds can recognize a suitable water-yielding deposit. Some beds may be as thin as one or two feet, yet are satisfactory for farm wells constructed with care.

Water-yielding sands are generally coarser than sugar and do not contain a large percentage of silt and clay. One way to estimate their worth as a source of groundwater is to heap a shovelful of the wet material on the ground and pat it with the hand. If water comes to the surface of the pile and does not disappear in a few seconds, the formation probably contains more silt and clay than is ordinarily desirable for a good yield of groundwater.

It is well to remember that the coarseness of the sand is no more significant than the uniformity of the size of the individual grains. Ideal water-yielding formations have grains that are all about the same size.

In parts of the region drilled wells penetrate solid bedrock and tap groundwater from sandstone or from open cracks in limestone and firm shale. On plate 1 these areas are distinguished by patterns from the areas of sand and gravel possibilities. In northern Livingston County the St. Peter sandstone has proved a satisfactory source of groundwater at depths of 500 to 800 feet.

In many places where the glacial drift does not reveal water-yielding sand and gravel, drillers bore 50 to 150 feet into solid bedrock in the hope of finding a thin sandstone or a crack in firm shale or in limestone. Except in those areas where bedrock is known to be favorable for drilling, as shown on the map, rock borings are venturous. They are frequently justified as a last resort. Chances of success in shallow bedrock outside known favorable rock areas probably range from fifty-fifty or better in parts of Edgar County to less than one in five in some western areas, such as Sangamon County.

UNUSUALLY FAVORABLE CONDITIONS

An area is considered geologically favorable for drilled wells if satisfactory small wells can be constructed, without regard to depth. The favorable areas have been drawn on plate 1 without regard to the depth of the par-

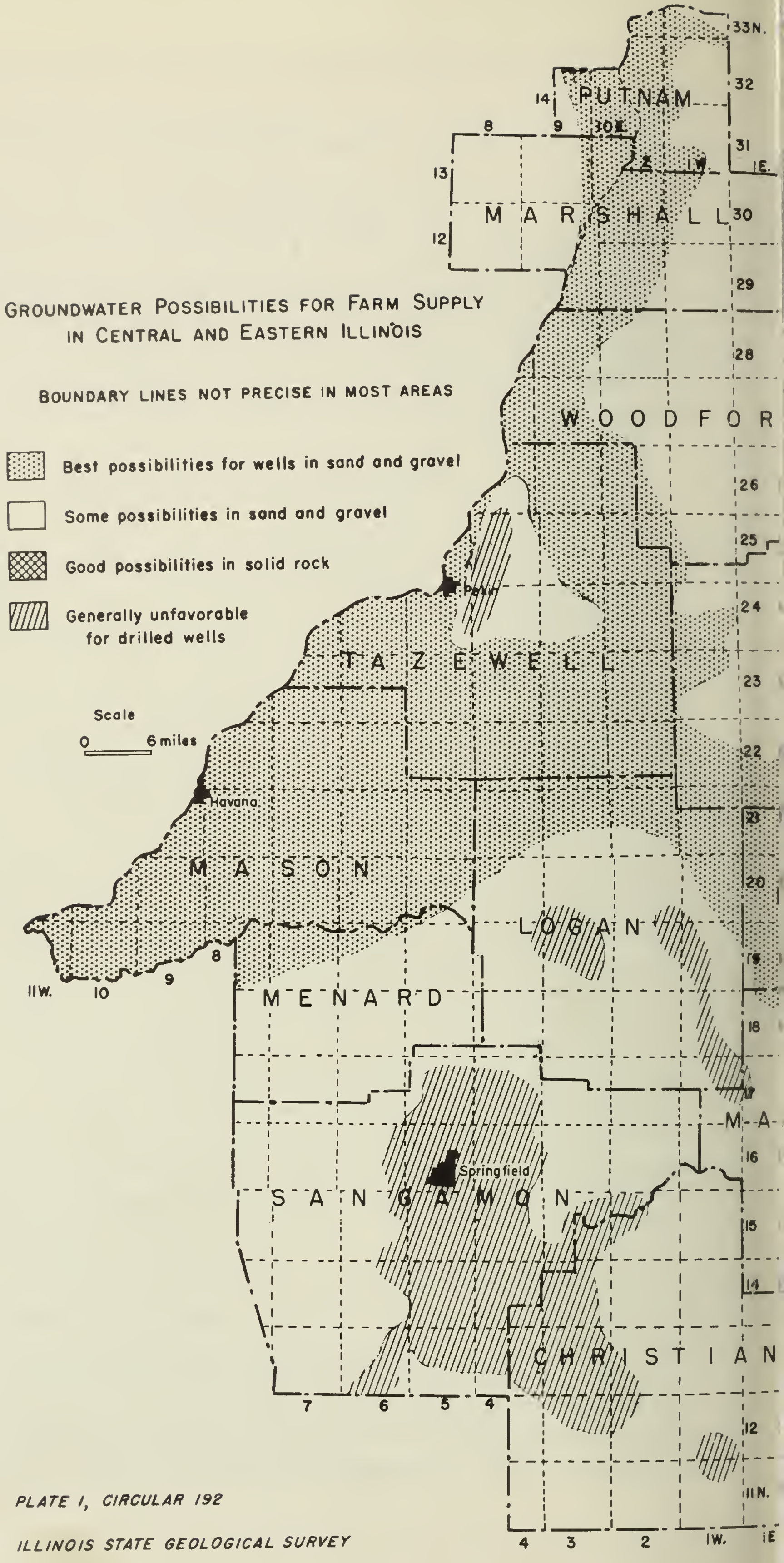

PLATE I, CIRCULAR 192

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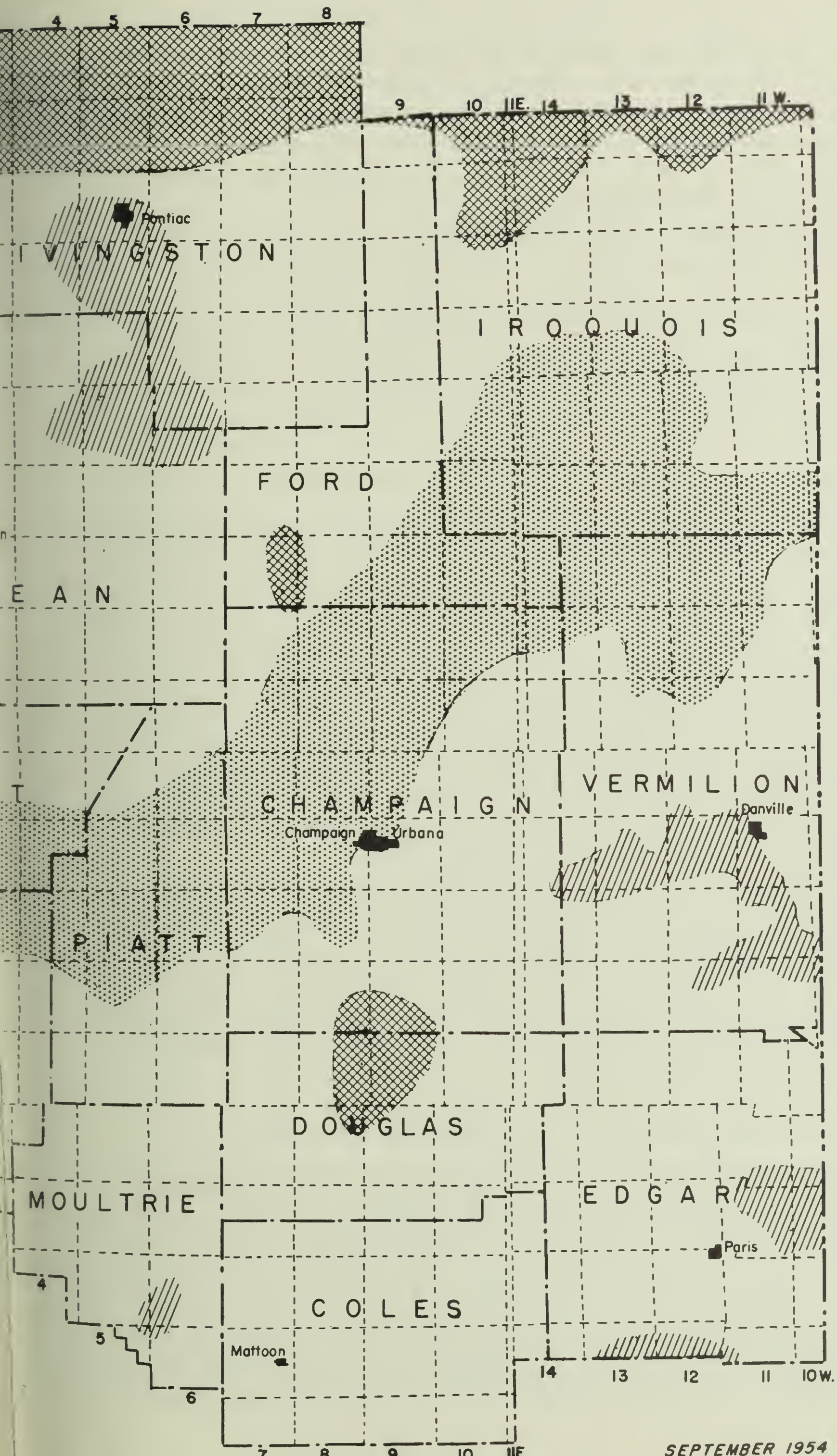

LIVINGSTON
Pontiac
IROQUOIS
FORD
McLEAN
CHAMPAIGN
Champaign
Urbana
VERMILION
Danville
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14 13 12 11 10 W.
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SEPTEMBER 1954

ticular water-yielding formation. It is possible, therefore, for an area to be geologically favorable but, from the point of view of the landowner, to be unfavorable because of excessive drilling cost. A water-bearing formation at 800 feet, such as the St. Peter sandstone at Long Point, Livingston County, may be too deep for one landowner yet be practicable for another.

Over a large part of the area indicated as geologically favorable, water-yielding formations can be tapped by wells less than 175 feet deep. Locally, however, wells may have to be drilled 200 to 250 feet deep; in northern Livinston County, more than 500 feet deep.

In some areas of central and eastern Illinois water-bearing sand and gravel deposits are abundant enough to have fair to excellent promise for major groundwater supplies, such as for irrigation. High-capacity wells, however, require careful planning before constuction and, in most places, preliminary drilling to prove the presence of a suitable formation and to guide the design of the permanent well. Suggestions in the matter of testing for water-bearing deposits can be obtained from the Geological Survey.

GENERALLY UNFAVORABLE CONDITIONS

Plate 1 shows the areas where geologic conditions are generally unfavorable for the constuction of small drilled wells of any depth. Unfavorable conditions are scarcity of water-yielding sands or gravels in the glacial drift and tight bedrock below the drift. In areas of this kind, the bedrock, in many places as shallow as 200 to 300 feet, contains water of unsatisfactory quality.

Drilling small test wells in these areas is often justified, despite the great risk of getting a "dry" hole, but penetration more than 150 feet into solid bedrock is discouraged because deeper drilling becomes progressively more venturous. The driller should be particularly watchful for thin seepage zones which, though perhaps not suitable for a small drilled well, could be tapped by a large tile well. A small unsuccessful test well can sometimes be an important guide to the construction of a large well.

Bottomlands of small valleys may have special importance in the areas where upland locations appear unfavorable for drilling. Many shallow sands in bottomlands have been found to be good sources of groundwater. They can be tapped either by drive points, drilled wells, or large tile wells. Many farmers pump water several hundred yards from such sources to the farmhouse. Testing for sands 20 to 30 feet deep can be done under some conditions with an extended soil auger.

WHAT THE WELL DRILLER CAN DO FOR YOU

1. Every driller should provide his customer with an accurate log of the well at the time it is completed. In accordance with the mining laws of Illinois, a copy of the log should be sent to the State Geological Survey and to the State Water Survey. A good driller's log includes a description of the formations, information on the static water level and on the basic constuction of the well, such as length and size of well screen and size of casing, and an indication of the capacity of the well. As a service to drillers and property owners, log books may be obtained without charge from the Geological Survey.

Maintaining a permanent record of the construction of a water well is of great value to the property owner. This record should be kept with official property records and be delivered to a new owner in the event the property changes hands. Copies of records will always be available at the State Geological Survey, if the driller provides them when the well is constructed.

2. It is desirable, where possible, that the well be so constructed that the depth to water level can be measured with a tape or other device without removing pumping equipment.

3. The top of the well should be constructed to prevent surface pollution from entering the well or seeping downward around the casing. A good way to prevent downward seepage of surface water is to pour an envelope of concrete around the casing to a depth of several feet.

4. Drillers should exercise the care necessary to obtain the maximum amount of water from a poor formation. Whereas almost anyone can obtain a suitable yield from an excellent sand and gravel formation it takes a driller with experience and imagination to make the best use of a sand that is slow to respond to pumping.

5. Commercial well screens should be selected by the driller after a water-yielding bed has been penetrated and examined. The purpose of the well screen is not only to maintain an open hole and to admit water to the well but also to enable the driller to pull the fine portion of the formation through the screen and remove it from the well. This is called well "development," a process which requires that slot openings in the screen be carefully determined on the basis of the size of grains in the water-yielding bed. One objection to using slotted casing rather than commercial well screen is that the size of the slot openings rarely is appropriate for the particular formation. Use of slotted pipe should be discouraged except in coarse sand and gravel beds where the ability of the well to yield water far exceeds the demand to be made.

LARGE-DIAMETER WELLS

The construction of water wells to fit the geologic conditions at hand is the key to successful farm groundwater supplies. Large-diameter wells that are excavated by hand, or better yet, by power auger still have their place on the modern scene. Small drilled wells 4 to 8 inches in size are very popular because they are easy to make sanitary and they can penetrate to deep formations. But small wells store only small amounts of water in their casings and therefore need to be constructed in a formation that readily yields water to the demand of a pump. There are hundreds of farms in central and eastern Illinois where favorable water-yielding beds do not exist and small wells are impractical; on these farms large-diameter wells are often more satisfactory.

The chief advantage of a large well, say 2 to 5 feet in diameter, is that it can contain large quantities of water in storage. Short intermittent pumping of a large dug well does not require immediate release of water from the surrounding formation. The well can refill slowly over a period of many hours. Modern power equipment excavates large wells 50 to 100 feet or more in depth. Special sanitary precautions should be taken with large diameter wells (see Circular 14A, Illinois State Department of Public Health, Springfield).

SUGGESTIONS FOR FURTHER READING

A major buried valley in east-central Illinois and its regional relationships: Leland Horberg, Illinois Geol. Survey Rept. Inv. 106, 1945.

A safe water supply: C. W. Klassen, Dept. Public Health Circ. 14, 1951.

An integrated geophysical and geological investigation of aquifers in glacial drift near Champaign-Urbana, Illinois: John W. Foster and Merlyn B. Buhle, Illinois Geol. Survey Rept. Inv. 155, 1951.

Bedrock topography of Illinois: Leland Horberg, Illinois Geol. Survey Bull. 73, 1950.

Cisterns: Illinois Department of Public Health Circ. 129, 1949.

Disinfection of water: Illinois Department of Public Health Circ. 97, 1950.

Groundwater in the Peoria region: Leland Horberg, T. E. Larson, and Max Suter, Illinois Geol. Survey Bull. 75 (Illinois Water Survey Bull. 39), 1950.

Groundwater resources in Champaign County: H. F. Smith, Illinois Water Survey Rept. Inv. 6, 1950.

Major aquifers in glacial drift near Mattoon, Illinois: Leland Horberg, Illinois Geol. Survey Circ. 179, 1952.

Topographic maps (mostly on a scale of one inch to the mile) are available for most of Extension District III. They are printed by quadrangles and can be obtained from the Illinois State Geological Survey or from the United States Geological Survey, Washington 25, D.C., for 20 cents each. Index maps are free.

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