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CIRCULAR 198

GROUNDWATER POSSIBILITIES IN NORTHEASTERN ILLINOIS

A Preliminary Geologic Report

BY

R. E. BERGSTROM, J. W. FOSTER, LIDIA F. SELKREGG, and W. A. PRYOR

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1955

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ABSTRACT

Groundwater possibilities for domestic, municipal, and industrial supplies in northeastern Illinois range from poor to excellent. This report summarizes the geologic conditions controlling the availability of groundwater and suggests ways to obtain it under the prevailing conditions. Maps are presented which show: 1) groundwater possibilities from sand and gravel deposits, 2) groundwater possibilities in shallow bedrock, and 3) depth to the Galesville sandstone, the principal water-yielding formation for industrial and municipal groundwater in northeastern Illinois.

INTRODUCTION

Water that occurs in the earth and that is tapped with varying success by farm, municipal, and industrial wells is one of our most valuable natural resources. In some areas it is readily available for all purposes - from small domestic supplies to great industrial or municipal supplies - whereas in other areas even a little groundwater is difficult to obtain in wells.

The basic conditions that control the availability of water in the earth (groundwater) are natural and fixed. Skillful well design, construction, and management are extremely important factors in obtaining satisfactory amounts of groundwater, but these factors apply at any potential well site only if natural geologic conditions favor the type of supply desired. For example, even the most elaborate and careful well construction does not obtain a groundwater supply for a large city at a site where all the earth formations to great depths are dense, tight materials which do not allow water to flow into the well.

Northeastern Illinois has geologic conditions that make it one of the most favorable areas in the State for obtaining groundwater. Farm supplies from shallow sources are readily available in much of the area. Municipal and industrial supplies are widely available from deep sources and are also locally available from shallow sources.

The purpose of this report is to provide general information on the availability of groundwater in nine counties: Cook, DuPage, Grundy, Kane, Kankakee, Kendall, Lake, McHenry, and Will. This region has an area of some 5000 square miles and a population of over 5,250,000. It includes densely populated and industrialized sections, such as Cook County, and sparsely populated agricultural districts. Evaluation of the groundwater possibilities within the region, therefore, has taken into consideration both domestic and large-scale demands.

This report is based on a study of the nine counties by six members of the Groundwater Division of the Illinois State Geological Survey: Robert E. Bergstrom, Merlyn B. Buhle, John W. Foster, James E. Hackett, Wayne A. Pryor, and Lidia F. Selkregg. It is the second of a series prepared to assist in water-supply improvement on the farms of Illinois.* The Geological Survey is cooperating in this program with the extension services of the Agricultural Engineering Department, University of Illinois. The region covered here is Agricultural Extension District 1, eastern part. We hope this report will improve the general understanding of groundwater occurrence and assist in the procurement of suitable groundwater supplies.

The authors are happy to acknowledge the generous assistance given in this study by many drilling contractors of northeastern Illinois and by members of the State Water Survey, particularly W. B. Millis of Chicago.

GEOLOGY OF THE REGION

The main features of the northeastern Illinois landscape were developed during the geologically recent past, when great continental glaciers covered much of northern United States. From centers of snow accumulation in Canada, these vast ice sheets advanced southward, as well as in other directions. They scraped the land surface over which they moved, picked up and transported rock debris, and deposited most of the debris at the melting outer borders of the ice.

The glacial deposits, called drift, form an irregular surface blanket that covers the solid layered bedrock in northeastern Illinois. In excavations, such as quarries and road cuts, and in deeply eroded stream valleys, the drift mantle has been removed and the underlying bedrock exposed. In most of the area drilling penetrates varying thicknesses of unconsolidated glacial material before striking bedrock. Not only the deposits themselves but the form of some of the deposits were produced by glacial processes. For example, the prominent ridges that parallel Lake Michigan in McHenry, Lake, Kane, Cook, DuPage, and Will counties are thick accumulations of mixed clay, silt, sand, pebbles, and boulders heaped up along the front of a melting glacier. These ridges are called moraines. Cook, Grundy, and Kankakee counties contain wide flat areas which were the sites of shallow glacial lakes. Some valleys of northeastern Illinois have broad sand and gravel flats which were built up by large streams fed by the melting glaciers.

Because the great glaciations of the Ice Age occurred quite recently in geologic time, the landscape of northeastern Illinois is actually fairly young. An older landscape - carved in the bedrock largely before the glaciers advanced

* The first report, Water Wells for Farm Supply in Central and Eastern Illinois, by John W. Foster and Lidia F. Selkregg, has been issued by the Illinois State Geological Survey as Circular 192, and is available free of charge from the Survey in Urbana.

into the area - would be found if the mantle of drift were stripped away. Despite its burial beneath glacial deposits which locally attain a thickness of several hundred feet, the bedrock surface is not entirely beyond our range of study. Thousands of water wells drilled through the glacial drift into the bedrock provide detailed information on the bedrock topography. The bedrock surface has hills and valleys just as the land surface does. Some surface valleys coincide with valleys in the bedrock, but in areas of very thick drift the surface and buried valleys may not correspond.

In contrast to the complex, heterogeneous glacial deposits, the bedrock formations present a more orderly picture. They consist of layers of limestone, shale, and sandstone arranged one upon the other like the pages of a thick book. Although they are firm, dense rocks now, they were originally deposited as loose sediments in shallow seas which invaded the continent. They were buried and hardened into solid rock during the several hundred million years after the seas had retreated from northeastern Illinois. The rocks were later gently tilted from their original horizonal position, so that today they dip southeastward 10 to 15 feet per mile. The tilted beds are cut by the erosion surface beneath the glacial drift, producing rudely parallel belts that trend approximately north-south. In McHenry, Lake, Cook, DuPage, Will, and Kankakee counties, a limestone-like rock, called dolomite, underlies the glacial drift, whereas to the west bands of older shale and sandstone lie directly beneath the drift.

Beneath the 3000 or 4000 feet of layered rocks is ancient crystalline rock which forms the basement. The crystalline rock is mainly granite as shown by a few very deep wells in Illinois. Crystalline basement rock is at the surface today in the St. Francois Mountains of Missouri and the Black Hills of South Dakota where there has been marked uplift and deep erosion of the overlying stratified rock.

WATER IN THE EARTH

Water that occurs in the ground and comes to the surface in springs and wells has long been regarded as somewhat mysterious. The details of its occurrence, source, quantity, quality, temperature, pressure, and movement are complex, but the general principles pertaining to groundwater are relatively simple and well understood.

Water falling on or flowing over the ground seeps through openings between loose particles of the soil and percolates downward. Below a certain depth, all openings in the loose surface material (such as glacial drift) and in the underlying bedrock are filled with water. This water occurs in pores between grains and in rock crevices, and not in streams or lakes (except only locally in limestone caves). Because rainfall continually contributes to or replenishes the supply, groundwater is a renewable resource.

The upper surface of the water-saturated zone is called the water table. Its position is shown by the depth at which water stands in shallow wells, borings, and excavations. It roughly parallels the surface topography, rising under the uplands and intersecting the ground surface along perennial streams, lakes, and swamps.

Water from the saturated zone is not everywhere available for withdrawal by wells, as this is controlled by the details of the local geology. A bed of clay may contain a large volume of water per cubic foot but hold the water so tightly that a well drilled into it may be "dry." On the other hand, a bed of pea gravel may contain less water per cubic foot than the clay, but the water in the gravel is not held and can move quite readily between the grains and into a well bore. As the well is pumped, more water flows in.

The problem involved in obtaining a groundwater supply, therefore, is to strike a "formation" that will transmit its water to the well bore. Most drilled wells that are "dry" are unsuccessful not because of lack of water in the rocks but because water-yielding (permeable) formations are not present.

A special word should be said about the geology of artesian wells. Water that occurs in some of the deep permeable sandstone formations underlying northeastern Illinois comes from rainfall, which enters these rocks some distance away, where they are close to the surface. Because relatively water-tight formations occur above the deep sandstones in northeastern Illinois, the water in the deep beds behaves somewhat differently from that in beds at shallower depths. It is under natural pressure and therefore may rise several hundred feet in a well that penetrates a deep sandstone. We call these wells artesian wells. In the days before the water from the deep sandstones was heavily exploited by industries and cities, some artesian wells flowed without pumping.

WATER-YIELDING FORMATIONS

The most important water-yielding deposits in the glacial drift above the bedrock are beds of clean, loose sand and gravel. They range from thin discontinuous streaks to extensive beds tens of feet thick. Drilled wells are usually productive where the sand and gravel is a few feet or more thick and water-bearing. Where only thin streaks of sand and gravel are present in otherwise tight glacial drift, large-diameter dug wells are generally the only way of obtaining groundwater from the shallow drift.

The grain size (texture) of sand and gravel deposits is extremely important in determining their water-yielding properties. Good water-yielding sands are coarser than sugar and nearly all the grains are the same size. The percentage of clay and silt in sand and gravel deposits should be low because this fine material occupies the spaces between the larger grains and slows water movement. Few natural deposits have the uniform coarse textures that are ideal; however, a skillful drilling contractor, familiar with sand and gravel well construction, can by proper design and development often make a satisfactory well in formations that are fine-grained or not uniformly sorted, or in formations that contain some clay and silt.

Much of the bedrock beneath the glacial drift in northeastern Illinois is a limestone-like rock called dolomite. Groundwater in limestone and dolomite occurs in fractures and in channels dissolved out of the rock. The success of a water well drilled in limestone or dolomite, therefore, depends upon the well bore actually penetrating water-filled joints and channels.

The thick dolomite in much of northeastern Illinois is well creviced and fractured, particularly in the upper part, so that it is an important source of groundwater. The dolomite is especially good for groundwater at the many places where it is overlain by drift containing substantial sand and gravel deposits. On the other hand, where the drift is tight and non-water-yielding, the underlying dolomite is also commonly "tight." Some drilling contractors substantially improve the performance of limestone and dolomite wells in the area by enlarging existing joints and channels with hydrochloric acid, which dissolves part of the rock with which it comes in contact.

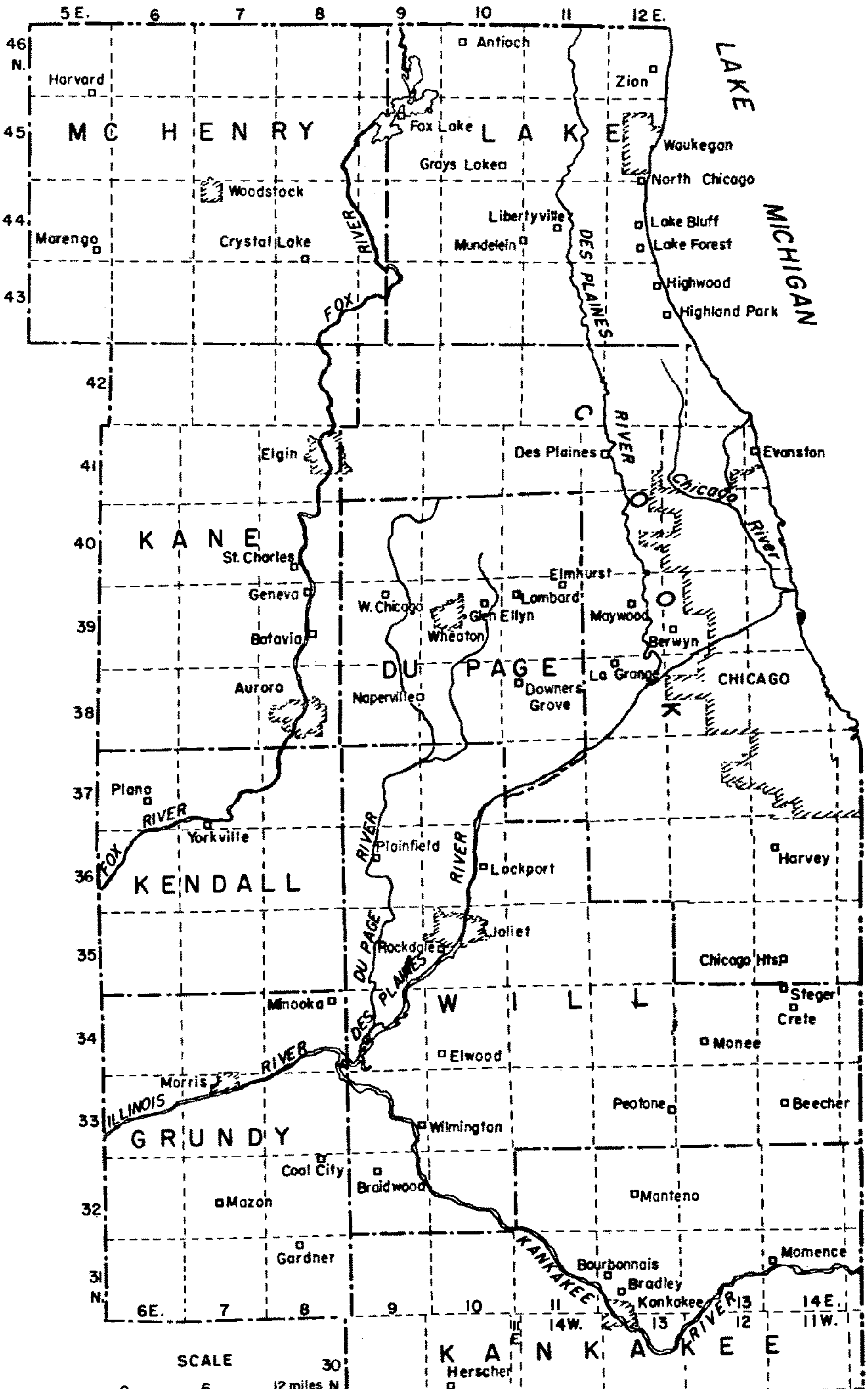
Another important water-yielding rock of northeastern Illinois is sandstone. It occurs at a depth of several hundred feet and more throughout the area. In southwestern Kendall County an important water-yielding sandstone lies just beneath the glacial drift.

Water occurs in sandstone between the sand grains, just as it does in loose sand deposits. Therefore, the size and uniformity of the grains is extremely important. Sandstone also contains variable amounts of cement, which binds the grains together. The amount of cement is another factor that affects the water yield. Tightly cemented sandstones are not good formations for water unless they are well jointed or fractured, like limestones.

The deep sandstones of northeastern Illinois - the Galesville sandstone in particular - and the shallower St. Peter sandstone are good groundwater sources because they are uniform in texture and loosely cemented. Less satisfactory for groundwater are the fine-grained tightly cemented near-surface sandstones of the Pennsylvanian system ("Coal Measures") in Grundy County.

SUMMARY OF GROUNDWATER POSSIBILITIES BY COUNTIES

This evaluation of groundwater possibilities for domestic, municipal, and industrial purposes is based upon geologic information in the files of the Illinois State Geological Survey and helpful suggestions by drilling contractors. The county discussions summarize possibilities in (1) sand and gravel, (2) shallow bedrock, and (3) deep sandstones. They may be used in conjunction with figures 2, 3, and 4. Figure 1 is an index map of northeastern Illinois.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WILL
GRUNDY
KANKAKEE
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Harvard
Zion
Fox Lake
Waukegan
Grays Lake
North Chicago
Woodstock
Libertyville
Lake Bluff
Marengo
Crystal Lake
Mundelein
Lake Forest
Highwood
Highland Park
FOX RIVER
DES PLAINES RIVER
Elgin
Des Plaines
Evanston
Chicago River
St. Charles
Elmhurst
Geneva
W. Chicago
Lombard
Maywood
Glen Ellyn
Batavia
Wheaton
Berwyn
La Grange
CHICAGO
Aurora
Naperville
Downers Grove
Plano
Yorkville
Plainfield
Harvey
Lockport
Joliet
Rockdale
Chicago Hts
DU PAGE RIVER
Steger
Crete
Minooka
Monee
Elwood
ILLINOIS RIVER
Morris
Peotone
Beecher
Wilmington
Coal City
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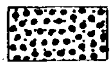
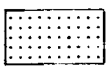
Fig. 1.

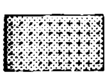
POSSIBILITIES FOR WELLS IN SAND AND GRAVEL



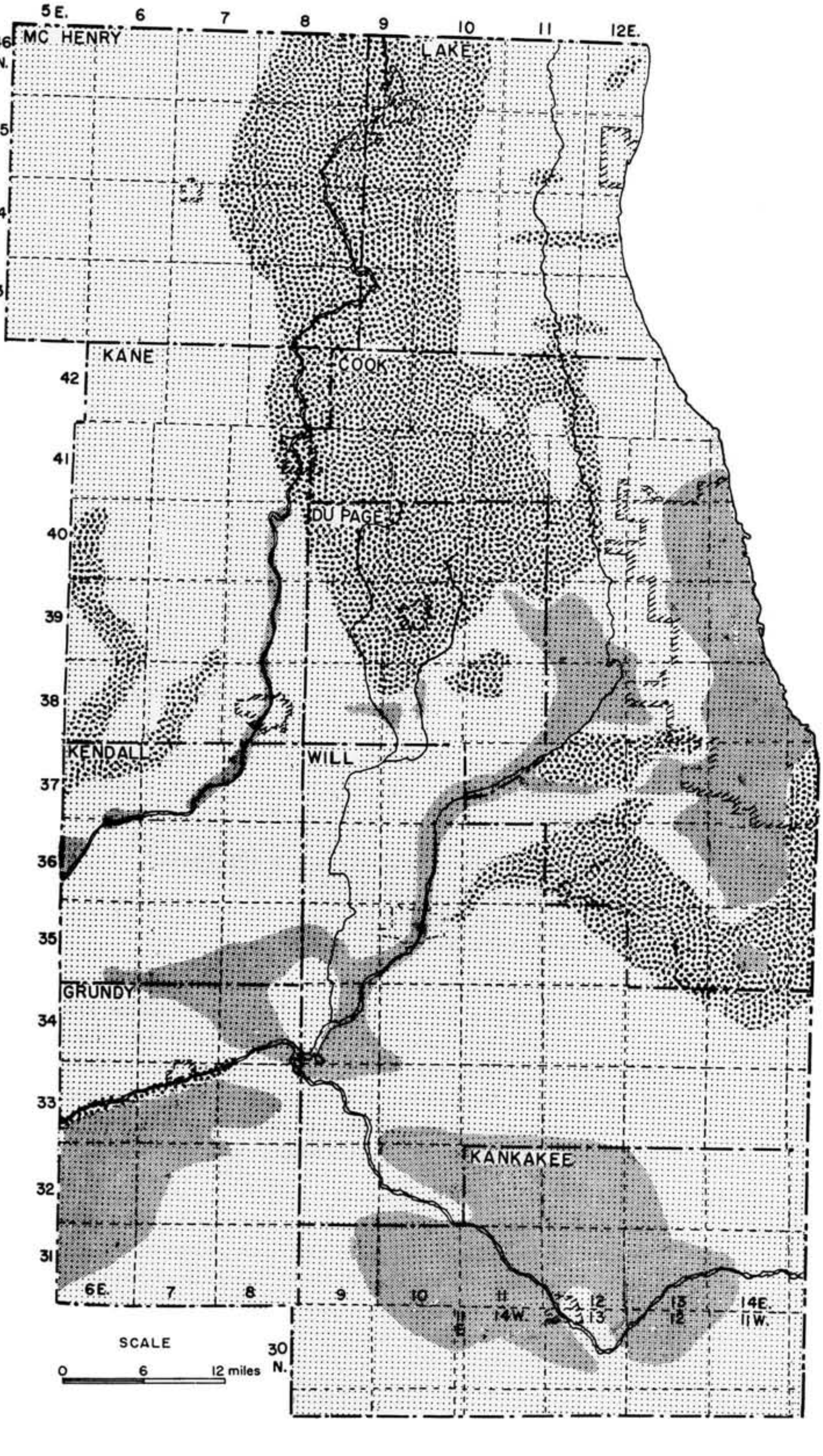
Best possibilities for the occurrence of water-bearing sand and gravel within the glacial drift. Groundwater for domestic and farm supply generally is obtainable in this area from small-diameter drilled wells completed in sand and gravel. The wells range in depth from 35 to over 200 feet, depending upon depth of water-yielding formation. Possibilities for municipal or industrial wells completed above bedrock are good to excellent, although some test drilling probably is necessary to locate the best formation and site for the construction of a high-capacity well.



Fair to good possibilities for the occurrence of water-bearing sand and gravel within the glacial drift. Groundwater for domestic and farm supply is obtainable locally in this area from small-diameter drilled wells in sand and gravel. The wells range in depth from 35 to about 100 feet. Water-yielding sand and gravel probably is absent at many locations, so wells generally are drilled through the glacial drift into bedrock. Possibilities for municipal or industrial wells are poor to fair. Extensive test drilling is likely to be necessary to locate deposits suitable for the construction of high-capacity wells in sand and gravel. Most high-capacity wells penetrate a bedrock aquifer.



Poorest possibilities for the occurrence of water-bearing sand and gravel within the glacial drift. Most wells obtain groundwater from bedrock below the glacial drift. Depth to bedrock generally is less than 50 feet. Shallow sands along the rivers are suitable locally for domestic and farm wells, but widespread thick sand and gravel beds generally are absent.



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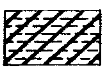
POSSIBILITIES FOR WELLS IN UPPER BEDROCK FORMATIONS

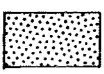
Dolomite lies directly beneath the glacial drift and yields groundwater at most locations through open crevices and channels. Most farm and domestic wells obtaining water from dolomite penetrate the rock 15 to 75 feet, depending upon the number and character of the water-yielding cracks. Industrial and municipal wells obtaining groundwater from dolomite generally penetrate 50 to 250 feet.

Dolomite lies directly beneath the glacial drift and generally has better-than-average water-yielding potential because of abundance of crevices and channels.

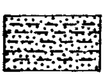
Dolomite lies directly beneath the glacial drift, but generally has less-than-average water-yielding potential.



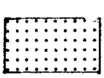
Shale or shaly dolomite bedrock is commonly found directly beneath the glacial drift. In some areas south of T. 38 N., it is necessary that wells in bedrock extend through 60 feet or more of non-water-yielding shale to penetrate water-yielding dolomite below. North of T. 37 N., particularly in Kane County, much dolomite is interbedded with the shale and may yield groundwater from open cracks.



Water-yielding St. Peter sandstone lies directly beneath the glacial drift and is suitable for small-diameter drilled wells.

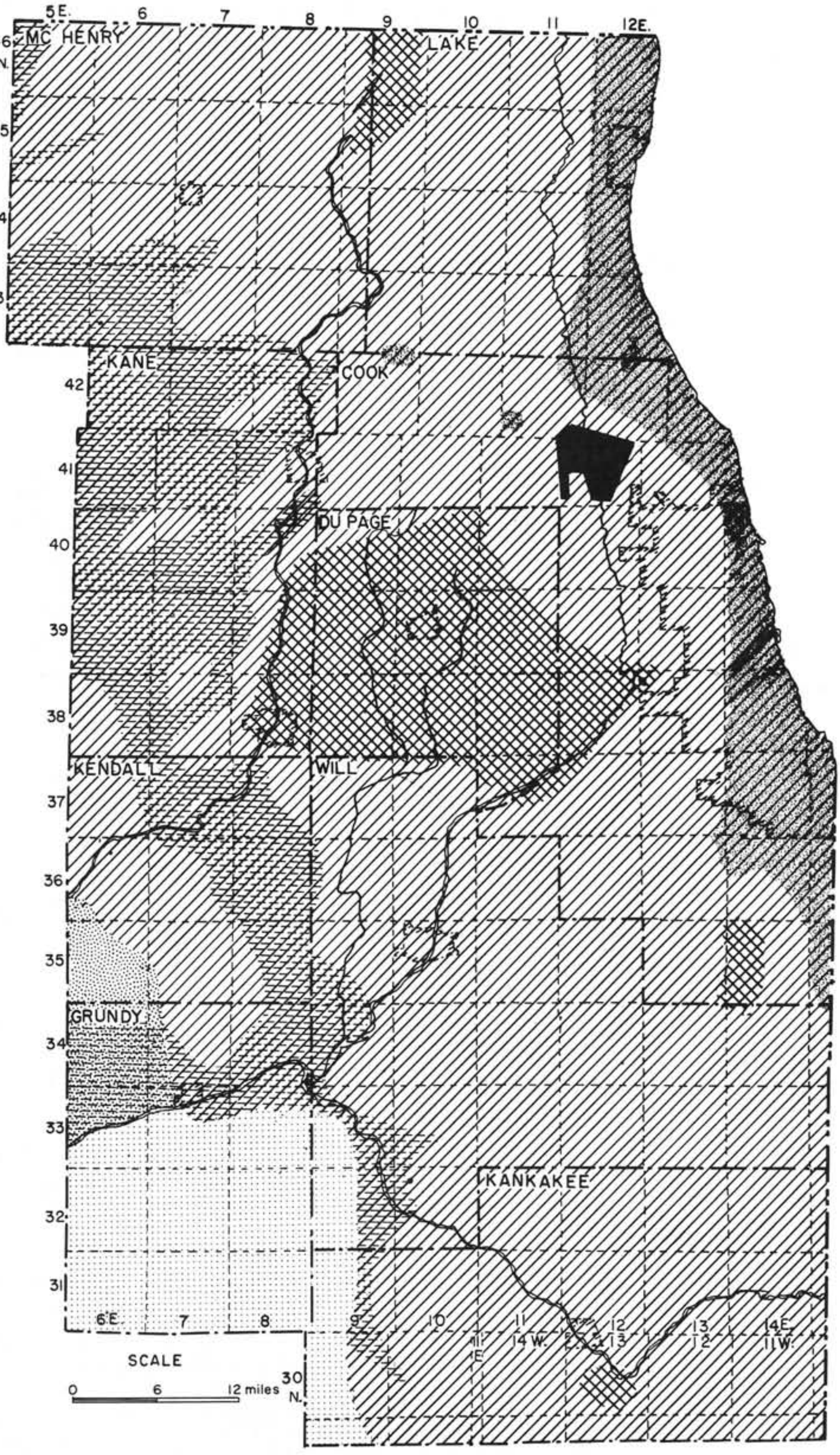


Shale bedrock, generally 35 to 100 feet thick, lies directly beneath the glacial drift. Most drilled wells penetrate through non-water-yielding shale into water-bearing sandstone below.



Pennsylvanian ("Coal Measures") bedrock lies directly beneath the glacial drift. The formations are mostly non-water-yielding shales, but sandstone beds occur locally (as around Verona, Carbon Hill, Braceville, Gardner, and South Wilmington) and are suitable for domestic and farm wells. Conditions in these rocks generally are unfavorable for high-capacity wells.

Des Plaines faulted area. Bedrock formations are broken and displaced, so the usual sequence of formations rarely is found. Upper bedrock generally consists of tight shale more than 400 feet thick in some places. There are possibilities of high-capacity wells in deep sandstone, but shallow sand and gravel should be investigated first.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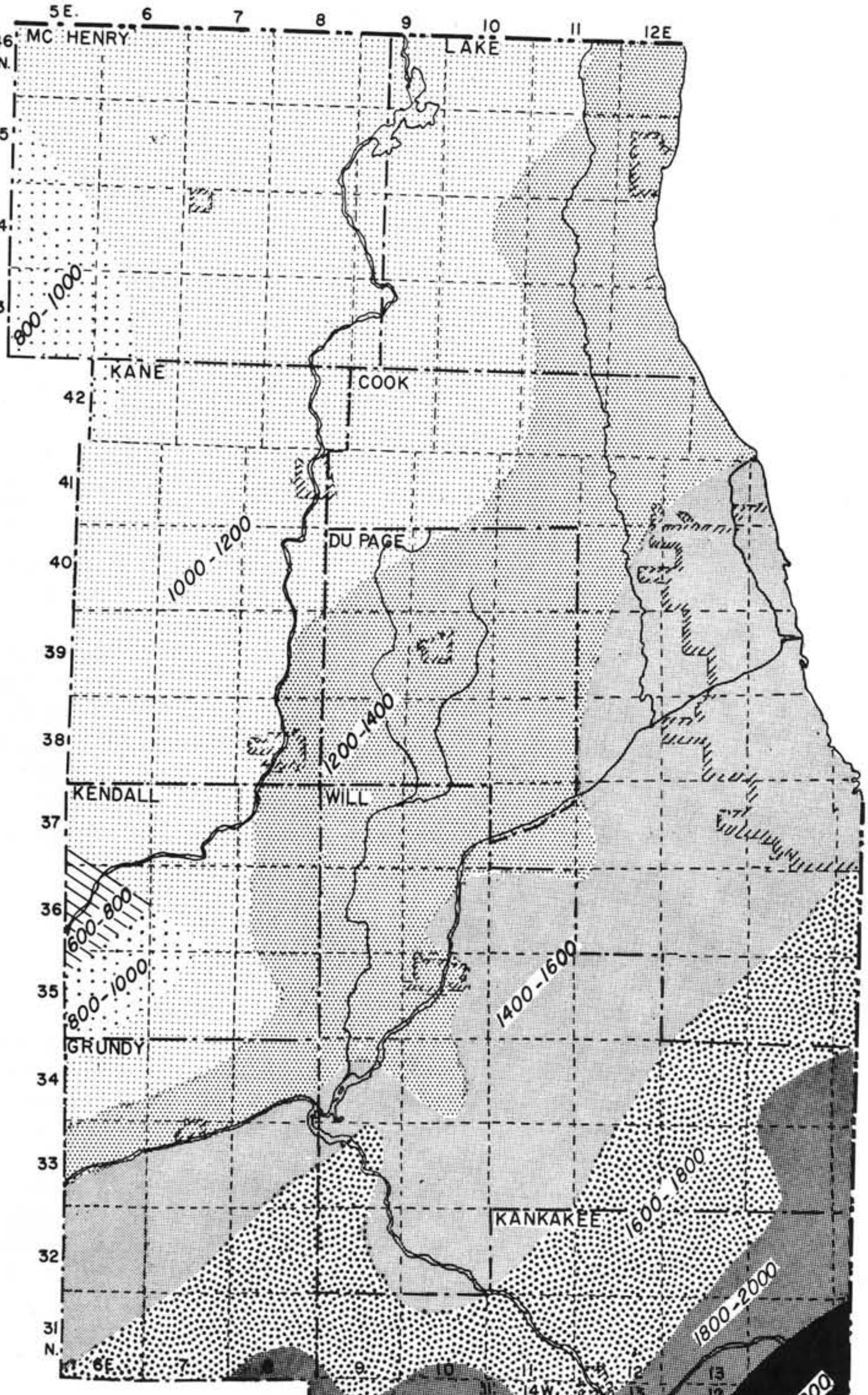
DEPTHS TO TOP OF THE GALESVILLE SANDSTONE

The Galesville sandstone extends throughout northeastern Illinois. Its average thickness is approximately 135 to 160 feet. Like other bedrock formations in the region, the sandstone dips southeastward. Its depth increases from about 600 feet in western Kendall County to over 2200 feet in southeastern Kankakee County.

Hundreds of industrial and municipal water wells obtain water from the Galesville sandstone, considered the best bedrock aquifer in Illinois because of its consistent permeability and thickness. Many deep wells also obtain part of their yield from the shallower St. Peter sandstone and Trempeauleau dolomite and from the deeper Mt. Simon sandstone. To the south, the groundwater possibilities of the Galesville sandstone are controlled by water quality, which becomes poorer with depth, particularly south of the Illinois River and in Kankakee and southern Will counties.



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COOK COUNTY

Groundwater possibilities in sand and gravel beds in Cook County are best in the upland areas in the northwestern, south-central, and southern parts of the county. These water-yielding deposits are principally sand and fine to coarse gravel, which are in some places as much as 100 feet thick. They occur mainly in the lower half of the glacial drift. Best possibilities for industrial and municipal supplies of water in sand and gravel are near Elgin, Bartlett, Arlington Heights, and Orland Park; also locally elsewhere.

In central Cook County and along the Des Plaines River southwest of Summit, the glacial drift is thin and sand and gravel deposits are correspondingly thin or are absent. Here shallow sand deposits are mainly fine-grained or silty, and virtually all drilled wells penetrate solid bedrock for groundwater supplies.

The Chicago Plain lies generally east of Homewood, Oak Forest, Evergreen Park, Justice, LaGrange, Bellwood, Niles, and Northfield. This lowland is underlain by silts and clays deposited on the floor of ancient Lake Chicago. Water-bearing sands are extremely scarce in the lake beds. The surface of the Chicago Plain is marked with more-or-less continuous ancient beach ridges and spits of clean sand, for example, the Glenwood Beach running southeastward from Glenwood and the Wilmette spit fanning south-southwestward from Wilmette. The sands of these features are generally too thin to be suitable for water wells, but locally the sands extend to depths of 25 to 30 feet and are water-bearing in the lower part. A narrow band of beach sand along the present Lake Michigan shore yields groundwater to sand-point wells in scattered places.

The common source of groundwater for domestic wells in Cook County is in the upper part of the dolomitic bedrock, lying immediately below the drift. Beneath the silts and clays of the Chicago Plain in the eastern part of Cook County, the dolomitic bedrock is relatively tight and locally not water-yielding. Areas where the shallow dolomite is particularly favorable for water wells are in the western half of T.35 N., R. 14 E., near Chicago Heights, and in parts of Ts.38 and 39 N., R. 12 E., near LaGrange.

Cook County is underlain by deeply buried sandstone, a reliable source of municipal and industrial water supplies. The Galesville sandstone ranges in depth from 1000 feet in northwestern Cook County to 1800 feet in the extreme southeastern part. Most municipal and major industrial water supplies in the county are obtained from this aquifer.

In north-central Cook County, in the vicinity of Des Plaines, bedrock formations have been severely broken and displaced, or faulted (fig. 3). Uncommonly great thicknesses of shale are encountered locally within the Des Plaines faulted area, and dolomite formations may be thin or absent. Groundwater possibilities in dolomite are therefore poorer here than they are in most of Cook County.

DUPAGE COUNTY

Thick glacial drift containing water-yielding sand and gravel deposits overlies the dolomite in DuPage County. The most favorable areas for sand and gravel wells are north of Naperville. Within this area, good to excellent domestic wells probably can be made in the drift. Aside from domestic supplies, it appears that water-yielding sand and gravel deposits worth industrial and municipal consideration might be found by testing. Along the Des Plaines River, along the East and West Branches of the DuPage River in T. 38 N., and at Elmhurst the glacial drift is thin and generally unfavorable for sand and gravel wells.

Bedrock in the county offers excellent possibilities for domestic, municipal, and industrial water supplies. The dolomite beneath the drift contains abundant water-filled crevices. Excellent wells have been constructed in the dolomite at Lombard, Glen Ellyn, Villa Park, Wheaton, Naperville, and along the Des Plaines River.

The deep sandstones, Galesville and Mt. Simon, are penetrated for industrial and municipal groundwater supplies throughout the county. The top of the Galesville is at depths of 1200 to 1400 feet; the top of the Mt. Simon is some 450 to 500 feet deeper.

GRUNDY COUNTY

Groundwater possibilities in sand and gravel in Grundy County are best along the Illinois River west of the mouth of Kankakee River. The water-yielding deposits are mainly medium to coarse sand, with some fine gravel, less than 65 feet deep in the bottomlands along the river. They are not confined to the valley but extend southward for a mile or more beneath the uplands along the valley southwest of Morris. At Morris, the valley flat south of the river appears to have possibilities for industrial supplies of groundwater from sand and gravel.

On the uplands north and south of the Illinois River, sand and gravel deposits in the glacial drift are small, scattered, and shallow. Most drilled wells penetrate bedrock for groundwater supplies. North, northeast, and east of Morris, the most dependable groundwater source for domestic wells is dolomite and limestone between depths of 75 and 225 feet. West and northwest of Morris most wells obtain water from the St. Peter sandstone at depths of 150 to 300 feet.

South of the Illinois River, the relatively tight Pennsylvanian rocks underlie the glacial drift. The principal water-yielding formations for domestic wells around Verona, Carbon Hill, Braceville, Gardner, and South Wilmington are tight sandstones less than 150 feet from land surface, though shallow sand and gravel deposits are present around Braceville and Coal City. A few higher-capacity wells are completed in the dolomite below the Pennsylvanian or in the St. Peter sandstone at a depth of over 600 feet.

KANE COUNTY

With the exception of the Fox River Valley south of Elgin, where bedrock is exposed or very close to the surface, Kane County contains thick glacial drift in which domestic groundwater supplies from sand and gravel are readily available. Drift 200 feet and more thick is widespread, particularly along Marengo Ridge and to the east. It is probable that sand and gravel deposits suitable for some industrial supplies are present. Partially buried bedrock valleys in the southern part of the county contain especially promising sand and gravel deposits, but these have not been tested beyond the requirements for farm wells.

Groundwater also is available from dolomite below the glacial drift. East of the Fox River this dolomite is well creviced and is a dependable source of groundwater. West of the river the dolomite is part of a shale and dolomite formation (Maquoketa) which is generally cased or lined in deep sandstone wells. Dolomite makes up the main part of the Maquoketa formation in Kane County, however, and it is an important groundwater source for farm supplies.

Major groundwater supplies are available from deep sandstones. The top of the Galesville is encountered at depths ranging from less than 1000 feet in the northwestern corner of the county to about 1300 feet at Aurora. The St. Peter sandstone, which is locally a source of industrial and municipal groundwater supplies, attains a thickness of 507 feet at Geneva and 305 feet at Batavia.

KANKAKEE COUNTY

Virtually all wells east of Herscher obtain groundwater from open cracks and crevices in dolomite that lies just beneath the glacial drift. Farm wells generally penetrate 25 to 75 feet into solid rock, whereas wells of higher capacity may penetrate the entire thickness of dolomite to depths of over 250 feet.

Throughout a large area in central Kankakee County, extending from Union Hill eastward to Momence and from the Will County line southward to Aroma Park, water-bearing sand and gravel suitable for drilled wells is scarce. In the neighborhood of the Kankakee River east of Kankakee, shallow sands found locally are suitable for sand-point wells. Elsewhere in the county the glacial drift contains scattered water-bearing deposits of sand and gravel above the bedrock.

Conditions are least favorable for good wells near the western edge of the county, as at Reddick, where water-bearing sands may be difficult to find and where most of the 100 feet or more of shale directly below the glacial drift is non-water-yielding.

Deep water-bearing sandstone occurs throughout Kankakee County. The top of the Galesville sandstone is about 1600 feet deep in the northwest, about 2200 feet deep in the southeast. Water in the Galesville and deeper formations may be of poor quality, particularly where the Galesville sandstone is deeper than about 1800 feet.

KENDALL COUNTY

Domestic and farm supplies of groundwater are locally obtained from sand and gravel beds throughout most of the county. The poorest possibilities for water-bearing sand and gravel are along the Fox River, where bedrock is exposed at many places, and in the southeastern part of the county, particularly east of Lisbon, where the glacial drift is thin and sands are scarce. The best area for possible high-capacity wells in sand and gravel is northwest of Plano, where the glacial drift is generally more than 75 feet thick and where favorable sand and gravel deposits probably are present.

Wells in bedrock below glacial drift are numerous. The character of the rock varies markedly in the county. In most areas north and east of Yorkville and east of Platteville, thick shale beds occur below the drift. The shale may be non-water-yielding; therefore penetration of 125 to 300 feet into dolomite below the shale is often necessary. South of Newark and west of Lisbon, in the southwestern part of the county, wells generally penetrate St. Peter sandstone directly below the drift. This sandstone is suitable for domestic and farm wells, and locally for wells of higher capacity. Elsewhere in the county, dolomite lies below glacial drift and yields groundwater from open cracks and crevices.

Deep water-bearing sandstone occurs throughout the county. Near Millington, in the extreme west, the top of the Galesville sandstone is about 600 feet deep. Along the eastern edge of the county the Galesville sandstone is as deep as 1300 feet.

LAKE COUNTY

Thick water-bearing sand and gravel beds are widespread in western Lake County, particularly west of Lake Villa, Round Lake, and Lake Zurich. Here the glacial drift is generally over 200 feet thick. Fifty to 100 feet of water-bearing sand and gravel are found locally and thicknesses of 20 feet are common. The deposits are suitable over wide areas as farm and domestic groundwater sources and for industrial-municipal wells at many places. Some water-yielding sand and gravel is less than 50 feet beneath the surface, but other deposits are as deep as 250 feet.

In the eastern two-thirds of the county, groundwater supplies can be obtained locally from sand and gravel, but the possibilities of finding very favorable deposits are generally poorer than in the west. Along the Lake Michigan shore, shallow beach sands are possible water sources.

Dolomite that may yield groundwater from open cracks and crevices lies directly below the glacial drift throughout the county. Virtually all farm and domestic wells drilled below the drift obtain groundwater from the dolomite, penetrating it for 20 to 100 feet. Because of abundant open cracks, the dolomite is considered a particularly favorable water source for high-capacity wells in parts of Ts. 45 and 46 N., R. 9 E. The dolomite is reported to be poorly creviced or "tight" in a belt along the Lake Michigan shore, which extends westward for three to seven miles. The possibilities for high-capacity wells in the dolomite are poorest in this belt.

Deep water-bearing sandstone occurs throughout Lake County. Depth to the top of the Galesville sandstone ranges from about 1100 feet in the northwest to 1350 feet in the southeast.

MCHENRY COUNTY

Groundwater possibilities in sand and gravel beds are good to excellent. Best areas for high-capacity wells in sand and gravel are in the eastern part, particularly east of Belden, Greenwood, Woodstock, Crystal Lake, and Algonquin. In this area the glacial drift that contains water-yielding deposits is generally over 175 feet thick. Sand and gravel beds are locally as much as 75 to 100 feet thick. Sand and gravel suitable as farm and domestic water sources are found in many places in the upper 75 feet of drift, but some of the deposits lie as deep as 200 feet.

In the western two-thirds of the county, groundwater supplies can be obtained locally from sand and gravel, but the possibilities of finding very favorable deposits are generally poorer than in the east. In the southwestern corner of the county the drift is less than 50 feet thick.

Groundwater generally can be obtained from open cracks and crevices in dolomite that lies directly below the glacial drift in most of the county. The dolomite is particularly well creviced along the Fox River north of McHenry and provides an excellent groundwater source. Shale beds are found below the drift along the western edge of the county and in T. 43 N., Rs. 5 and 6 E. Because shale is generally tight and non-water-yielding, it is often necessary to drill into the underlying dolomite.

Deep water-bearing sandstone occurs throughout McHenry County. Depth to the top of the Galesville sandstone ranges from about 800 feet in the southwest to about 1100 feet along the eastern edge of the county.

WILL COUNTY

Farm and domestic supplies of groundwater in most of Will County are obtainable with wells 50 to 150 feet deep. Many of these wells obtain groundwater from sand and gravel beds within the glacial drift. Some wells penetrate through the drift and obtain water from open cracks and crevices in dolomite. Along the Des Plaines River and in extreme southern Will County, the dolomite lies at or near the surface, so water-yielding sands and gravels are scarce. Best possibilities for high-capacity wells in sand and gravel are in parts of T. 36 N., R. 11 E., and T. 34 N., R. 14 E., where the drift is generally over 100 feet thick and where widespread sand and gravel beds are known.

West of the DuPage River and along the Kankakee River in southern Will County, thick shale beds occur below the glacial drift at most places. Where these shales are non-water-yielding, wells must be deepened to penetrate dolomite at depths of 150 to 300 feet. South of Braidwood, in extreme southwestern Will County, sandstone beds of the Pennsylvanian system lie beneath 10 to 50 feet of glacial drift. These sandstones yield water to a number of farm and domestic wells, but they are not considered suitable for high-capacity wells.

Deep water-bearing sandstone occurs throughout Will County. Top of the Galesville sandstone lies at a depth of about 1300 feet in the northwest and about 1900 feet in the extreme southeast. Where sandstone lies deeper than 1000 feet below sea level, as in southeastern Will County, consideration should be given to possible poor water quality.

PLANNING HIGH-CAPACITY WELLS

Most areas in northeastern Illinois are underlain by one or more formations favorable for the construction of high-capacity water wells. The key to successful well construction in the region lies not so much in where the wells are located but how carefully the wells are adapted to the geology and hydrology.

The best wells are generally those planned on the basis of all the geologic and hydrologic information that is obtainable.

The following log shows the sequence of formations that occur under most of the region. Well 1 of the Aluminum Company of America is more or less typical of deep sandstone wells.

Aluminum Company of America well 1 - W. P. Miller Artesian Well Co., driller, 1947; SE 1/4 sec. 17, T. 39 N., R. 12 E., Cook Co.; State Geological Survey sample set 16355; samples studied in 1950. Est. elev.: 632 ft. Casing schedule: 16 inch O.D., 0-22 1/2 ft.; 10 inch I.D., 0-500 ft.; 8 inch I.D., 983 1/2-1126 1/2 ft. Hole diameter: 18 inches, 0-22 1/2 ft.; 15 inches, 22 1/2-500 ft.; 10 inches, 500-1126 1/2 ft.; 8 inches, 1126 1/2-1495 ft. Static water level: 361 ft. (1947).

	Thickness (feet)	Depth (feet)
Pleistocene series		
Unconsolidated glacial drift	10	10
Silurian system		
Niagaran dolomite, yellowish gray	190	200
Alexandrian dolomite, whitish	45	245
Ordovician system		
Maquoketa shale and thin dolomite	225	470
Galena dolomite, yellowish brown	185	655
Decorah dolomite, sandy	15	670
Platteville dolomite, yellowish brown and gray	133	803
Glenwood-St. Peter sandstone, silty	202	1005
shale and chert	30	1035
Oneota-Gunter dolomite, sandy	80	1115
Cambrian system		
Trempealeau dolomite, yellowish gray and brown	75	1190
Franconia sandstone, shale and dolomite	105	1295
Ironton-Galesville sandstone	175	1470
Eau Claire shale and sandstone	25	1495

Sand and gravel wells

The first step in the planning of high-capacity water wells is an evaluation of the various water-yielding deposits or formations present. The possibility of sand and gravel beds above solid bedrock are worth early consideration. There is increasing interest in northern Illinois in the groundwater resources in sand and gravel deposits, because under good geologic conditions and good well construction these deposits yield more water to specific wells than any other type of aquifer. Other advantages of sand and gravel sources are generally shallower water levels, colder water, and in some places water of better bacterial quality. As water-bearing sand and gravel beds are scattered, exploratory test drilling is commonly required which has often discouraged the development of sand and gravel wells. It is often easier to design a deep rock well and to disregard the possibility of locating very favorable shallow water sources.

Figure 2 indicates the general possibilities of locating promising sand and gravel beds. In areas where conditions are favorable for the occurrence of sand and gravel deposits, it is good practice to test the glacial drift to the top of solid rock for the possible presence of water-yielding material. Such a test may find no suitable shallow water source, in which case a rock well may be necessary. A test that shows a promising sand and gravel bed should furnish basic information necessary for designing a high-capacity screened well. Test information should include a complete log of formations, samples of drill cuttings at five-foot intervals, drilling characteristics, and static water level. If rotary equipment is used for the test, data should include mud loss, mud weight, size of mud pit, and use of hydraulic "pull-down."

Bedrock wells

Many variable conditions affect the design of a good high-capacity well in bedrock in northeastern Illinois. These include (1) thickness, depth, and permeability of sandstones; (2) depth and crevicing of dolomites; (3) ability of formations to sustain open hole without casing or lining; (4) tendency of formations to yield silt or sand during heavy pumping; and (5) water quality and water-pressure potential.

The State Geological Survey can furnish basic information on the first four conditions for prospective well locations, although specific data depends on the availability of information from prior drilling. Much subsurface information is available in the Geological Survey files. The State Water Survey furnishes basic information on water quality, pressure potential of various formations, and yields of existing wells.

Wells completed in dolomite directly beneath glacial drift have surface casing seated in firm rock. There are strong possibilities of bacterial pollution where high-capacity wells obtain water from dolomite overlain by less than 35 feet of glacial drift.

Most deep sandstone wells in northeastern Illinois are cased through the Maquoketa shale into the top of the Galena dolomite, because many of the shale beds of the Maquoketa formation are too weak to sustain continuously an open hole. Lining also is desirable in the lower 30 to 50 feet of the St. Peter sandstone, particularly in the shale bed generally found between the sandstone and the dolomite of the Oneota formation. In McHenry County and vicinity, the lower St. Peter also contains weak cherty zones which require lining. No other shales or cherty zones above the Ironton-Galesville sandstone are sufficiently widespread to require plans for lining.

The pumping of fine sand and silt has been a problem in a number of deep sandstone wells in this region. The State Geological Survey has been called upon frequently to identify the source of the materials so that corrective measures may be taken. The most common sources of earth material pumped with water are (1) silt and clay from glacial drift, caused by a break in surface casing or by poorly seated casing; (2) silt and clay from open crevices in dolomite, which may be directly beneath the drift; and (3) silt and fine sand from the St. Peter, lower Franconia, Ironton, or Galesville formations.

A small amount of caving and pumping of earth material is probably unavoidable in high-capacity wells. However, attention to the following causes of excessive sand pumping should reduce the number and severity of sand-pumping problems: 1) drilling too small a hole in the Ironton-Galesville sandstone, which results in excessive velocities of water moving upward; 2) setting the pump at a level where turbulence in the vicinity of the pump bowls causes enlargement of the hole. Pump should be set opposite a firm dolomite or within a liner; 3) shooting the water-yielding sandstones with too much explosive and with too little regard for the condition of the sandstone. Sand probably caves readily from roofs of soft ledges which have been undercut by explosives. More uniform enlargement of the bore hole in the most permeable zones should decrease sand pumping.

PLANNING DOMESTIC AND FARM WELLS

Northeastern Illinois is the most favorable large region in the state for obtaining small private water supplies at minimum cost. Most private supplies are obtained from screened wells in sand and gravel or from unscreened (open hole) wells in dolomite below the drift. In western Kendall County, and locally in Grundy and Kane counties, private wells are drilled in firm sandstone.

Only in the southwestern part of Grundy County are geologic conditions in the bedrock locally unsuitable for small drilled wells. Most shallow bedrock formations in this area are tight shale. It is particularly important in such an area that wells be completed in water-bearing sand and gravel above rock wherever these permeable deposits can be located.

These suggestions should be helpful in planning private water supplies:

1. Select a driller who has constructed wells that have proved trouble-free for a period of years.
2. Encourage the driller to set a commercial well screen if the well is to be completed in sand and gravel. A properly selected and installed screen is the best guarantee against sand pumping. In a sand bed that is barely suitable for a water source, a carefully selected well screen is necessary for maximum yield.
3. The State Department of Public Health discourages the use of well pits on Grade A milk farms. Such pits are unduly expensive when they are properly constructed for good sanitation.
4. If a rock well is in creviced dolomite where the glacial drift above the dolomite is less than about 35 feet thick, the water should have periodic bacterial analyses. Wells in creviced rock are more subject to pollution than other types of drilled wells because there is no filtering action.
5. In most areas in northeastern Illinois, one location on a property is probably as good as another, so far as groundwater possibilities are concerned, so it is best to drill the well in a convenient place that has good surface drainage. In parts of Grundy County, however, it may be necessary to locate wells at some distance from the house, if water-bearing sand and gravel deposits cannot be located nearby.

ROLE OF THE DRILLING CONTRACTOR

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 basic construction 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 by the contractors 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 delivered to a new owner when the property changes hands. Copies of records will be available at the State Geological Survey if the driller provides them when the well is constructed.

2. It is desirable to construct the well so 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 and to make sure that surface waters drain away from the well.

4. Drillers should take special care to obtain the maximum amount of water from a poor formation in areas where groundwater conditions are unfavorable. 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 that 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 or open-bottom casing should be avoided except in very coarse sand and gravel beds where the ability of the well to yield water far exceeds the demand made.

6. The State Geological Survey files samples of drill cuttings received from drillers. It is particularly desirable in the case of school, industrial, and municipal well construction to save samples at regular five-foot intervals for the entire depth of the well. These samples may be sent express collect to the Survey, where they will be studied and placed in the permanent sample library. Information obtained from samples is vital in effective rehabilitation of old wells.

LARGE-DIAMETER WELLS

Large-diameter wells that are excavated by hand, or better yet, by power auger or bucket still have their place. In northeastern Illinois, however, where conditions are generally favorable for small drilled wells, the large well has never found wide use. They are best adapted to areas where formations are tight and cannot yield water readily to a pump. Such conditions are found locally in several parts of Grundy County and in extreme southwestern Will and extreme western Kankakee counties.

The chief advantage of a large well (say 2 to 5 feet in diameter) is that it can store large quantities of water. Short, intermittent pumping of a large 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 safe water supply: C. W. Klassen, Dept. of Public Health Circ. 14, 1951.

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

Chicago area water supply: A. M. Buswell, Max Suter, and H. E. Hudson, Jr., Illinois Water Survey Circ. 29, 1950.

Cisterns: Illinois Dept. Public Health Circ. 129, 1949.

Data on the ground waters of Lake County: Illinois Water Survey Circ. 17, 1935.

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

Geology of the Chicago region: J Harlen Bretz, Illinois Geol. Survey Bull. 65, Part I, General, 1939.

Public ground-water supplies in Illinois: compiled by Ross Hanson, Illinois Water Survey Bull. 40, 1950.

Rehabilitation of sandstone wells: W. B. Millis, Illinois Water Survey Circ. 23, 1946.

Significance of Pleistocene deposits in the groundwater resources of Illinois: J. W. Foster, Econ. Geol., v. 48, no. 7, Nov. 1953.

Stratigraphy and geologic structure of northern Illinois: F. T. Thwaites, Illinois Geol. Survey Rept. Inv. 13, 1927.

The artesian waters of northeastern Illinois: C. B. Anderson, Illinois Geol. Survey Bull. 34, 1919.

Water wells for farm supply in central and eastern Illinois: J. W. Foster and Lidia Selkregg, Illinois Geol. Survey Circ. 192, 1954.

Topographic maps are available for most of the area covered in this report. For the Chicago region these maps are on a scale of approximately 2 1/2 inches to the mile, and in the remainder of the area they are on a scale of 1 inch to the mile. They are printed by quadrangles and can be obtained from the Illinois State Geological Survey, Urbana, Illinois, or from the United States Geological Survey, Washington 25, D. C., for 20 cents each. Index maps showing topographic map coverage of the State are free.

Areal geologic maps, engraved in color on a scale of 2 1/2 inches to the mile are also available for the Chicago region. These can be obtained from the Illinois State Geological Survey for 15 cents each.

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