Geology and Ground-Water Resources of Outagamie County Wisconsin

By E. F. LEROUX

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GEOLOGY AND GROUND-WATER RESOURCES OF OUTAGAMIE COUNTY, WISCONSIN

By E. F. LeRoux

ABSTRACT

Outagamie County is in east-central Wisconsin. It has no serious ground-water problem at present, but the county is important as a recharge area for the principal aquifers supplying water to Brown County and industrial Green Bay to the east.

The county is covered by glacial drift and lake deposits of the Wisconsin stage of glaciation. In the northwestern quarter of the county these deposits rest upon Precambrian crystalline rocks; throughout the remainder of the county they are underlain by sandstone, limestone, dolomite, and shale of Cambrian and Ordovician age. Where they are sufficiently thick, and where more productive formations are absent, glacial sand and gravel are an important source of ground water. The major sources, however, are the St. Peter sandstone, of Ordovician age, and the sandstones of the Upper Cambrian series. The Precambrian crystalline rocks, which underlie all the county, yield little or no water to wells.

The regional dip of the Paleozoic bedrocks is 25 to 30 feet per mile eastward and southeastward. There are no major folds, but the thickness of each geologic unit may change from place to place because of predepositional or postdepositional erosion. There is no conclusive evidence of major faulting in the area.

Ground water in Outagamie County occurs under both water-table (unconfined) and artesian (confined) conditions. The source of the ground water is precipitation which falls on the surface and percolates downward into the underlying permeable materials. Regional movement of ground water in the eastern third of the county is controlled by the bedrock structure, and the discharge is toward the east and south. Throughout the rest of the county the movement of water is controlled mainly by bedrock and surface topography, and the water moves toward the streams and bedrock valleys.

Water-level fluctuations follow definite patterns. Where the effects of pumping are at a minimum, water levels reach a high in April or May, decline through the summer months owing to natural discharge, and lack of recharge, and do not begin to recover until after the ground thaws in the spring. In areas of heavy pumping where this pattern is distorted, the lowest water levels occur in the early fall and recoveries begin in October or November after the period of heaviest pumping.

Pumpage in the county was estimated to be about 9.0 million gallons per day (mgd) in 1951 and 1952. Nearly half of this was for industrial, commercial, and public-supply use along the Fox River. Wells, most of which are drilled by the cable-tool method, range in diameter from 3 to 16 inches and in depth from 10 or 20 feet to 804 feet. In the alluvium and glacial drift 1¼- to 2½-inch driven wells are common.

Pumping tests were made to determine the hydraulic characteristics of the aquifers at Seymour, Appleton, and Hortonville. The average coefficient of transmissibility at Seymour is about 18,000 gpd per foot; at Appleton it is about 19,000 gpd per foot. The coefficients of storage are 0.00022 and 0.00015 at Seymour and Appleton, respectively. Movement of ground water out of the county, assuming an average transmissibility of 18,000 gpd per foot, was calculated to be more than 10 mgd toward the southeast.

The ground water differs greatly in chemical quality from well to well, but it is generally a very hard calcium magnesium bicarbonate water, some of it high in iron. To aid in determining the source of well waters, 22 chemical analyses were plotted on a logarithmic diagram to obtain characteristic patterns for waters from several geologic sources.

INTRODUCTION

PURPOSE AND SCOPE

The study of ground-water conditions in Outagamie County described in this report was made by the U. S. Geological Survey in cooperation with the University of Wisconsin. The report includes a discussion of the geology of the area, the occurrence of ground water, the hydrologic properties of the aquifers, and the chemical quality of the water. Hydrologically the county is important as a recharge area for the principal aquifers underlying Brown County and Green Bay to the east. The present study is, in part, supplemental to the investigation of Brown County published as U. S. Geological Survey Water-Supply Paper 1190. There is no serious ground-water problem at present in Outagamie County, and this report is presented as a compilation and summary of available data for use in conjunction with the expected expansion of agriculture and industry in the county.

METHOD OF INVESTIGATION

A canvass of wells and systematic collection of other data were begun in 1951 by W. C. Walton. The investigation was continued and expanded in 1952 and 1953 by V. T. McCauley. The geology was mapped and the fieldwork was completed by the author in 1954. The work was done under the general direction of A. N. Sayre, chief of the Ground Water Branch of the U. S. Geological Survey, and under the immediate supervision of W. J. Drescher, district engineer.

Water levels in several wells have been measured at intervals since 1947 as a part of a Statewide program, and an automatic water-level recorder has been in operation on well Ou 2 since December 1946. A continuing program of water-level measurements was begun in 1952. In April 1949 a pumping test was made at Seymour to determine the hydrologic properties of the water-bearing material at that location. This was followed by a test at Hortonville in 1953 and another in Appleton in 1954. The results of these tests were used to estimate rates of movement of ground water and to predict trends of the water levels in relation to pumping.

Reconnaissance geologic mapping of the county was done on Wisconsin Land Inventory maps at a scale of about 1 inch to the mile; most of the county has not been topographically mapped. Field mapping was based on examination of outcrops and land forms. Subsurface control is from drillers' logs and from logs based on examination of drill cuttings by F. T. Thwaites of the Wisconsin Geological Survey.

ACKNOWLEDGMENTS

The success and value of a study such as this depend in large part on the cooperation and assistance of local persons. The willing cooperation of well owners, well drillers, civil officials, and private citizens is greatly appreciated. The pumping tests would not have been possible without the cooperation of Walter Muehle, superintendent of the Seymour Water Department; Arthur Dunn, Hortonville water superintendent; Walter Schroder, president of the Fox Valley Canning Co.; and W. Segar of the Badger Consolidated Cooperative Dairy.

The author wishes especially to thank F. T. Thwaites, Wisconsin Geological Survey, for the use of his field notes and G. F. Hanson, State Geologist, for his review of the report.

Members of the Bureau of Sanitary Engineering, Wisconsin State Board of Health, contributed greatly to the report by giving access to files of well records and pumpage data. Chemical analysis of water samples, which were collected by members of the U. S. Geological Survey, was made by chemists of the Wisconsin State Laboratory of Hygiene.

PREVIOUS REPORTS

Martin (1932) presents a fairly complete list of early reports on the geology of Wisconsin. Reports by Chamberlin (1877), Weidman and Schultz (1915), and Thwaites (1943) contain much information pertinent to the geology and ground-water resources of Outagamie County. A soil survey by Whitson and others (1921) and a discussion of the geography of the Fox River valley by Whitbeck (1915) provide additional historical and geographical information.

DESCRIPTION OF THE AREA

LOCATION AND EXTENT

Outagamie County is in east-central Wisconsin, north of Lake Winnebago and southwest of Green Bay, between latitudes 44°14′ and 44°36′ N. and longitudes 88°11′ and 88°44′ W. (pl. 1). The county is rectangular, about 27 miles long, east-west, and 24 miles wide; it has an area of about 646 square miles. Appleton (1950 pop. 34,010) is the principal city and the county seat.

CULTURE

In 1950 the county's population was 81,722. About 61 percent of the population lives in the urban areas along the Fox River, about 20 percent on farms, and about 19 percent in villages.

More than 90 percent of the land was in farms in 1949. The farms are small, averaging about 109 acres as compared with 138 acres for the State. Seventy-eight percent are classed by the U. S. Census as dairy farms, and 89 percent of the farm income is from livestock and livestock products. The county ranks 7th in milk production (412,500,000 lbs. in 1953) and 13th in cheese production (15,587,000 lbs. in 1953) in the State.

Industrial growth has been due almost entirely to the abundant water and power furnished by the Fox River. The world's first hydroelectric central station started operation in Appleton in 1882, and electricity has played an important role in industrial development since that time. The principal industries are associated with food processing, and knitting, and the manufacture and processing of paper, wood products, metal products, and machinery. Closely associated with the growth and development of the area is Lawrence College, at Appleton, founded in 1847, 10 years before the city was incorporated.

TOPOGRAPHY

Only small, isolated areas in Outagamie County have been covered by adequate topographic mapping. The well altitudes and rock-outcrop altitudes used in this report were obtained with an aneroid altimeter using U. S. Coast and Geodetic Survey and U. S. Geological Survey bench marks for control. The highest altitude obtained by this method is 1,015 feet above mean sea level at the top of a drumlin along the north edge of sec. 33, T. 22 N., R. 16 E., about 3.5 miles east of Hortonville. This hill is probably the highest point in the county, although several other drumlins near Hortonville reach altitudes of more than 1,000 feet. The lowest measured well altitude (Ou 43) is 620 feet above mean sea level in Kaukauna. However, the lowest point in the county is about 600 feet where the Fox River enters Brown County, about 4.5 miles northeast of Kaukauna.

The county may conveniently be divided into three topographic units. The flat northwestern quarter, bounded on the south and east by the escarpment of the cuesta formed by rocks of the Prairie du Chien group, is covered by glacial-lake deposits and Recent flood-plain deposits. Along both sides of the Fox River is another area of relatively flat but well-drained land, formed by glacial-lake deposits. The remainder of the county is a gently rolling countryside of drumlins, moraines, and occasional small scarps and cliffs of bedrock exposed through thin glacial drift.

DRAINAGE

Essentially all of Outagamie County, except for the land drained by Duck Creek, is included within the Fox River drainage basin.

From the northern boundary of the county, near Leeman, the Wolf River flows parallel to the escarpment formed by the Prairie du Chien group southward through Shiocton to a point about 3 miles northeast of Hortonville, where it turns abruptly to the west and flows through New London. It is joined at Shiocton by the Shioc River, which drains the area north and west of Seymour, and at New London by the Embarrass River, which drains the extreme northwestern part of the county. The drainage basin of the Wolf River above New London has an area of about 2,240 square miles, about 400 square miles being in Outagamie County. The average daily discharge at New London is 1,793 cubic feet per second (cfs) (Paulsen and others, 1952). The Wolf River is a slow-moving, meandering stream as it traverses the flat, poorly drained northwestern quarter of the county. The gradient from Shawano, 47 miles upstream, to New London averages only about 0.8 foot per mile (Smith, 1908). From New London the river flows southwestward through Waupaca County and into Winnebago County, where it joins the Fox River, which flows into Lake Winnebago at Oshkosh.

The lower Fox River leaves the northwest corner of Lake Winnebago at Neenah-Menasha, about 5 river miles south of Appleton. In its 35-mile course to Green Bay it falls about 4.8 feet per mile (Smith, 1908). However, most of this fall is over rapids in the reach from Appleton to Kaukauna, where it drops nearly 10 feet per mile. At Rapide Croche Dam, about 12 miles downstream from Appleton, the average discharge is 4,242 cfs (Paulsen and others, 1952) from a drainage area of 6,150 square miles.

The remainder of the county is drained by Duck Creek, which flows generally south from Seymour, about 6.5 miles north of Little Chute, it turns abruptly to the northeast and flows between two prominent ridges out of the county and, 17 or 18 miles farther northeast, into Green Bay.

CLIMATE

The climate of Outagamie County is characterized by mild, humid summers and rather long, severe winters. The growing season averages 163 days at Appleton, 151 days at New London, and 134 days about 27 miles north of New London at Shawano. Four months of the year, December through March, have an average temperature below 32° F; the 5 months from May through September are generally free from frost (fig. 1). Average monthly temperatures range from a high of 70.9° F in July to a low of 16.2° F in January. The mean annual temperature is 43.6° F, which is 0.2° F above the annual mean for the

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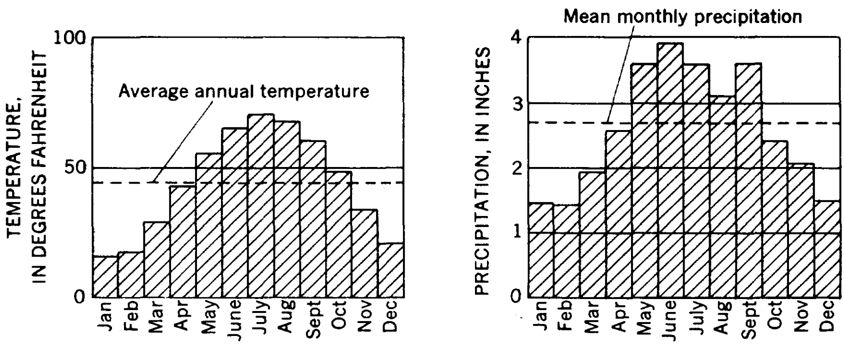

FIGURE 1.—Average monthly temperature and precipitation, Outagamie County, Wis. (Appleton, Green Bay, New London)

entire State. The average annual precipitation, including snow in the winter months, is 31.25 inches. The average ranges from 3.93 inches in June to 1.42 inches in February. Fortunately for agriculture, about 57 percent of the yearly precipitation falls during the growing season, May through September.

GEOLOGIC UNITS AND THEIR WATER-BEARING PROPERTIES

With the exception of the Precambrian granite, all the rock units discussed in the report and shown in table 1 are exposed at the surface in Outagamie County. The map showing bedrock geology (pl. 2) is based on the State geologic map (Bean, 1949). Modifications and changes were made in accordance with field observations and drillers' logs collected during the investigation.

PRECAMBRIAN ROCKS

The crystalline rocks of Precambrian age, which underlie all of Outagamie County, have been encountered in a number of wells throughout the area. They are usually reported to be pink, red, or gray coarse-grained granite or granite gneiss, which may or may not be weathered through the first several feet. Thwaites (1931) suggests that much of the weathered zone of kaolinitic clay, where present, may not be a product of subaerial weathering, but rather a product of alteration of the crystalline rocks by acidic ground water from the overlying sandstone. This theory is supported by the fact that some well drillers report a nongradational contact between the weathered zone and the overlying sandstone. No Precambrian rocks are exposed in Outagamie County. However, a prominent northwest-trending hill in Waupaca County, about 3 miles south-southwest of New London, is composed entirely of a moderate pink coarse- to medium-grained biotite granite intersected by numerous quartz veins.

TABLE 1.—*Description and water-bearing characteristics of geologic units in Outagamie County, Wis.*

System	Geologic unit	Maximum depth to top (feet)[1]	Maximum thickness (feet)[1]	Description: Drill cuttings [2]	Description: Outcrop observations [3]	Water-bearing characteristics
Quaternary.	Recent river and swamp deposits.	0	?	------------------------------------	Silt, sand, and peat.	Not determined.
	Pleistocene deposits.	?	510	Glacial drift, mostly till; sand, clay, silt, gravel, boulders.	Glacial drift, mostly till, and lake clay. Moderate-red to dark-yellowish-orange silty clay; sand, gravel, silt, boulders.	Good yields where sufficiently thick. Flowing wells and seepage springs common. Only source of ground-water supply in northwest part of county.
Ordovician.	Maquoketa shale.	7	209	Shale, blue, dolomitic, calcareous; thin beds of shaly blue-gray dolomite.	Shale, light-bluish-gray, thin-bedded. Thin beds of dolomite.	Yields very small quantities of highly mineralized water to a few domestic and stock wells.
	Galena dolomite and Platteville formation, undifferentiated.	216	211	Dolomite, sandy, gray to bluish-gray. Sandstone, fine-to medium-grained, gray; usually near base of formation.	Dolomite, thin-bedded to blocky and massive. Greenish-gray to yellowish-gray; sandy, silty, oolitic in places.	Yields small amounts of water along bedding planes and from sandy zones.
	St. Peter sandstone.	424	171	Sandstone, fine- to coarse-grained, pink, gray, and white; some chert. Thin layers of sandy gray and red shale.	Sandstone, fine- to coarse-grained, well-rounded, soft, friable; banded pale-reddish-brown and grayish-orange, occasionally white.	Good yields, but limited by presence of shale and relatively small thickness of formation.
	Prairie du Chien group.	490+	235+	Dolomite, gray, pink, and red, commonly sandy and shaly; layers of chert. Sandstone, fine- to medium-grained, white. Shale, red and green.	Dolomite, usually massive, yellowish-gray; chert layers common. Occasional sandy and shaly zones.	Small quantities of water obtained from cracks and sandy zones.
Cambrian.	Upper Cambrian series.	490+	458+	Sandstone, very fine to coarse-grained; pink, white, gray, and red; occasionally shaly and dolomitic. Dolomite, soft, sandy, with red and greenish-gray dolomitic siltstone.	Sandstone, very fine to coarse-grained, well-rounded; interbedded soft, hard, and friable; pale yellowish-orange and white to medium-gray. Some pyrite.	Yields large amounts of water, especially from the lower portion which is less dolomitic.
Pre-cambrian.		800		Granite, pink, gray, and red; weathered at the top.	Granite, coarse- to medium-grained, moderate-pink, biotitic. (Crops out in Waupaca County.)	Essentially impermeable. May yield some water from weathered and creviced zone.

[1] Based on well logs. [2] By F. T. Thwaites. [3] By E. F. LeRoux.

The crystalline rocks yield little or no water to wells. A very small amount might be obtained from cracks in the rock or from the weathered zone, but drilling usually ceases shortly after reaching granite.

PALEOZOIC ROCKS

CAMBRIAN SYSTEM

Upper Cambrian series.—Sandstones of Late Cambrian age (Dresbach sandstone, Franconia sandstone, and Trempealeu formation) are the principal source of water for industrial and public-supply wells in Outagamie County. They supply water to Seymour and Hortonville and to all the cities along the Fox River below Appleton. They are exposed in several places at the foot of the escarpment of the Prairie du Chien group (pl. 2) and in the Mosquito Hills, about 1½ miles east of New London. In outcrops the sandstones are very fine to coarse grained, ranging from pale yellowish orange to medium gray and white. Hard, well-cemented layers are interbedded with soft, friable layers. Some beds stand up well to weathering; others crumble and disintegrate rapidly. In drillers' logs (table 10) the section is reported as shaly, silty, and dolomitic in the upper part, grading into a fine- to medium-grained sandstone at the base.

A sample taken from an outcrop in the SE¼NE¼ sec. 4, T. 22 N., R. 15 E., had a remarkably symmetrical distribution of grain sizes (J. Lopez, written communication). The histogram in figure 2 shows

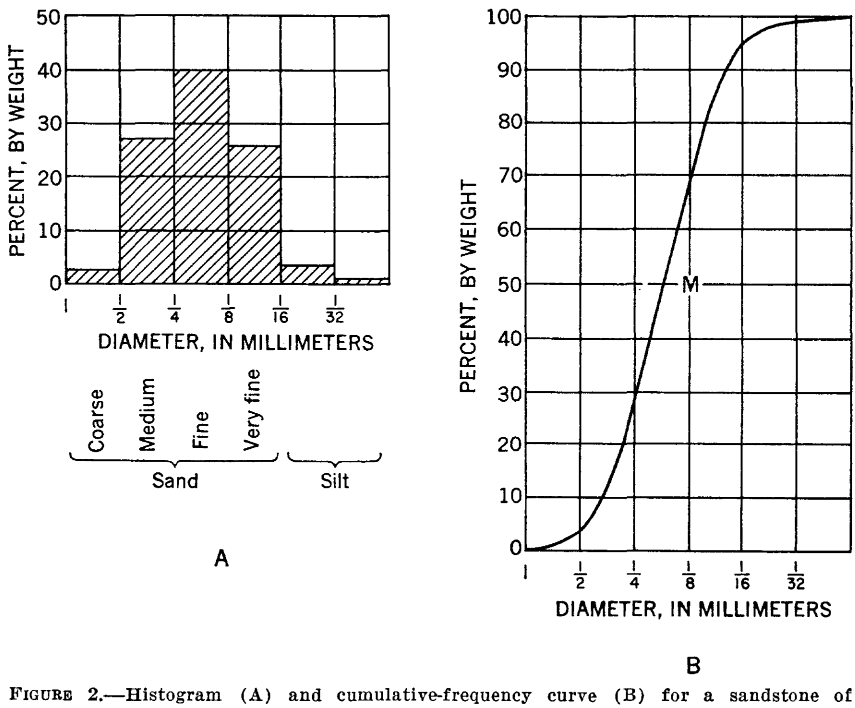

FIGURE 2.—Histogram (A) and cumulative-frequency curve (B) for a sandstone of Cambrian age, Outagamie County, Wis.

that about 40 percent of the grains were in the fine-sand range, the remainder being divided almost equally between the larger and the smaller sizes. The cumulative-frequency curve shows that the mean grain size is about $3/16$ mm (fine grained); it gives also a more exact picture of the gradation between grain size units in the sample.

Although the Upper Cambrian series is the most important aquifer in Outagamie County, a comparison of specific capacities and yield factors (tables 2 and 3) shows the St. Peter sandstone to have a much higher permeability. The specific capacity of a well (yield per unit of drawdown, generally expressed as gallons per minute per foot of drawdown) is an indication of both the water-yielding capacity of wells and the relative transmissibility of the water-bearing materials they penetrate. The yield factor (Poland and others) is an indication of the relative permeability of the water-bearing material. It is expressed as gallons per minute per foot of drawdown per 100 feet of aquifer penetrated. The specific capacity and yield factor of a well are representative of the water-bearing material within the area of influence of the well. In tests of short duration the area of influence is relatively small. As the well continues to pump, the area of influence expands and the specific capacity and yield factor may change, owing to changes in the character of the water-bearing material sampled by the expanding cone of influence. For this reason, comparisons between tests of equal length are the most consistent.

Table 2 summarizes the available data on specific capacity and yield factor for 16 wells. Wells Ou 19, 23, and 280 in Appleton have almost identical yield factors, as do the two wells in Seymour. The lower yield factors for the wells in Kimberly, Little Chute, and Kaukauna indicate lower permeability. Drillers' logs of these wells show that the water-bearing material is finer grained and contains more silt and siltstone than that penetrated by the wells in Appleton. The relatively high yield factors of the remaining wells may be due to their location near the outcrop area or may reflect the smaller dicharge and shorter duration of the tests.

ORDOVICIAN SYSTEM

Prairie du Chien group.—The Prairie du Chien group of Ordovician age, the Lower Magnesian of early reports, is composed of the Oneota dolomite, the New Richmond sandstone, and the Shakopee dolomite (Thwaites, 1923), but it was not subdivided in this investigation. It is best exhibited in the prominent escarpment which forms the southern and eastern boundaries of the flat northwestern quarter of Outagamie County. It is exposed also in many active quarries where rock is obtained for use as road material. An interesting feature of several of these quarries (that in the SE¼SE¼ sec. 17, T. 24 N., R. 17 E., for example) is the domelike structure that is revealed.

These domes are quite characteristic of the Prairie du Chien group. They are composed of concentric layers over a core of brecciated dolomite (Chamberlain, 1883).

TABLE 2.—*Specific capacity and yield factor of wells in the Upper Cambrian series*

Well no. Ou—	Specific capacity ([a])	Yield factor ([b])	Length of test (hrs)	Average discharge (gpm)	Thickness of aquifer penetrated (ft)	Location	Well diameter (in.)
1	7.4	2.7	24	421	[c] 276	Seymour	10
10	8.6	2.8	24	310	305	do	12
19	8.7	5.4		165	160	Appleton	8
23	13	5.7	18	550	229	do	10
33	15	5.4	24	310	282	Hortonville	
34	5.5	1.4	6	887	407	Kimberly	12
35	3.6	.9		524	420	do	12
37	5.0	1.3		497	382	Little Chute	12
46	5.0	1.5	30	340	123	Kaukauna	10
47	2.7	2.3		234	117	do	10
168	7.1	12	4	250	59	Black Creek (5 miles south)	8
200	1.4	13	4	7	11	Dale	4
269	12	12	4	35	97	Black Creek (3 miles south)	6
272	5.0	8.3	4	30	60	Shiocton (4 miles south)	6
273	.9	1.6	4	20	[d] 58	do	6
280	29	5.8	10	1,200	[e] 500	Appleton	15

[a] Gallons per minute per foot of drawdown.

[b] $\frac{\text{Specific capacity} \times 100}{\text{Thickness of aquifer penetrated (feet)}}$.

[c] Includes 65 feet of St. Peter sandstone which contributes water to the well.

[d] Includes 40 feet of hard, non-water-bearing sandstone. If this is not included the yield factor becomes 5.0.

[e] Includes 70 feet of St. Peter sandstone which contributes water to the well.

The weathered surface of the rock is pale brown to pale yellowish brown; fresh surfaces are yellowish gray. Sandy and shaly zones and layers of chert are exposed in some outcrops. Thwaites (1923) states that the presence of oolitic chert is a reliable marker of the Prairie du Chien group, as it has never been found in adjacent dolomite formations. In drillers' logs the rock is described as gray, pink, or red dolomite that is often sandy or shaly. Lenses of fine- to medium-grained white sandstone are found throughout the section, as are thin layers of red or green shale.

The dolomite is dense, and water is transmitted through vertical fractures and along bedding planes and solution channels. The sandstone lenses also supply some water to wells, but the unit as a whole is not as productive as the overlying and underlying sandstone units. However, many domestic and stock wells obtain a small but adequate supply from the Prairie du Chien. Well Ou 278 was pumped at 12 gallons per minute for 2 hours, the water level lowering 2 feet. In a comparable test, well Ou 15, which taps both the Platteville formation and Galena dolomite and the Prairie du Chien group, yielded 150 gallons per minute but with a drawdown of 150 feet.

St. Peter sandstone.—The St. Peter sandstone of Ordovician age crops out at the base of escarpments topped by the Platteville formation and Galena dolomite or is buried by Pleistocene and Recent deposits in low, swampy areas. It is a soft, friable sandstone that usually weathers to a pale reddish brown. Fresh surfaces show a reddish-brown and grayish-orange banding and occasional zones of pure white sand. The well-rounded grains range in size from fine to coarse and appear well sorted. The drill cuttings are described as fine- to coarse-grained pink, gray, and white sandstone with some chert. Thin layers of sandy gray and red shale are disseminated throughout the section but usually are more common near the base.

The St. Peter sandstone is an important supplier of water to stock and domestic wells but it is absent in most wells in the industrial area along the Fox River. Table 3 shows that the relatively slight importance of the St. Peter as an aquifer in Outagamie County is a reflection of the thinness of the sandstone. Yield factors of 3 of the 4 wells tapping the St. Peter are considerably higher than those of wells tapping the Upper Cambrian series (table 2), showing that, were the St. Peter sandstone as thick and extensive as the Upper Cambrian series, it would easily surpass that series as an aquifer. The short duration of the tests cited in table 3 may account, in part, for the high yield factors, but similar tests of wells in the Upper Cambrian series do not give comparably high figures.

TABLE 3.—*Specific capacity aid yield factor of wells in the St. Peter sandstone*

Well no. Ou—	Specific capacity [1]	Yield factor [2]	Length of test (hrs)	Average discharge (gpm)	Thickness of aquifer penetrated (ft)	Location	Well diameter (in.)
76	10	50	4	10	20	Seymour (2 miles east)	6
85	4.0	33	4	8	12	Appleton (4 miles northwest)	6
91	2.9	145	2	20	2	Hortonville (5 miles southeast)	6
201	6.0	9.1	1	30	66	Seymour (1 mile southwest)	5

[1] Gallons per minute per foot of drawdown.

[2] $\frac{\text{Specific capacity} \times 100}{\text{Thickness of aquifer penetrated (feet)}}$.

Platteville formation and Galena dolomite.—No attempt was made to differentiate the Platteville formation and the Galena dolomite. The Decorah formation could not be recognized. The unit crops out in many small scarps and is exposed in quarries and stream beds throughout the eastern portion of the county. Many of the older quarries have been abandoned but several large ones are still supplying rock. The Fox River has cut through the overlying glacial drift to the Platteville and Galena unit throughout its reach in Outagamie County, and Duck Creek exposes the formation in several places (pl. 2).

As seen in outcrops, the weathered surface of the rock is usually grayish orange; fresh surfaces range from greenish gray to yellowish gray. Numerous sandy or silty zones weather rapidly, allowing blocks of the more crystalline rock to break off along vertical fractures and slump or fall from the scarps. Other outcrops reveal a series of thin beds with very thin shaly partings between the dolomite layers. In drill cuttings the Platteville and Galena section is recognized by its predominantly gray to bluish-gray color, and there may be as much as 20 feet of fine- to medium-grained gray sandstone (Ou 19) near the base of the unit.

The Platteville and Galena formations contribute water to many domestic and stock wells in the county. At least 2 schools (Ou 279, Ou 285) and 1 industrial plant (Ou 38) rely entirely on this unit for their water supplies. Yields are generally small, and drawdowns are excessive in most of the wells. Some domestic and stock wells that penetrate almost the full thickness of the Platteville and Galena are reported to "pump dry" after a short period of pumping. The presence of recoverable water is evidence that the formation is not an ideal confining bed and that it probably transmits some water to recharge the underlying formations where their head is below that of the Platteville and Galena. Drescher (1953) states that where the Platteville and Galena formations are overlain by the more impervious Maquoketa shale it is of little importance as an aquifer. This indicates that the water moves downward through cracks and solution openings more easily than along the nearly horizontal bedding planes.

Maquoketa shale.—The Maquoketa shale underlies the glacial drift in an area of about 1 square mile in the extreme southeastern corner of Outagamie County. It is a light bluish-gray thin-bedded shale with thin layers of dolomite. In well logs it is described as a blue calcareous or dolomitic shale with some layers of shaly blue or gray dolomite. The shale acts as an effective confining bed for the underlying formations and yields little or no water to wells. It has been reported, however, that well Ou 48 obtains its water entirely from the Maquoketa shale.

CENOZOIC ROCKS

QUATERNARY SYSTEM

Pleistocene deposits.—Glacial deposits of the Wisconsin stage, which cover Outagamie County, consist of lake deposits and glacial drift. The lake deposits are exposed at or near the surface over most of the western two-thirds of the county but are covered by ground moraine of the Valders Substage (Thwaites, 1943) in the eastern part. They consist of layers of silt and clay deposited in deep portions of Lake Oshkosh (Thwaites, 1943), zones of fine-to medium sand deposited in shallow water, and beach sand and gravel laid down around the edge of the lake. The glacial drift in Outagamie County includes both stratified and unstratified deposits. Ground moraine, terminal moraines, and drumlins are composed of unsorted and unstratified material left by the glacier and not reworked by water. Eskers formed by swiftly flowing subglacial streams and consisting of roughly stratified sand and gravel are usually somewhat distorted by slump and covered by unstratified till left by the melting ice sheet. More or less irregular bodies of sorted sand and gravel are found in places within the body of the drift.

Pleistocene deposits are the only water source for wells in the northwest quarter of the county. They furnish adequate supplies to domestic and farm wells and for several public-supply systems. New London is supplied by three wells in drift and alluvium, and the village of Black Creek is supplied by a single well (Ou 71), pumping as much as 170,000 gallons per day from 43 feet of coarse gravel and sand. The specific capacity of the well is 18 gpm per foot of drawdown and the yield factor (p. 9) is 42. In a discussion of Pleistocene deposits the term yield factor has a very limited significance because of the rapid change in character of the water-bearing material. For example, well Ou 169 has a yield factor of only 3.3, yet it penetrates 21 feet of what appears to be the same kind of sand and gravel as that tapped by Ou 71 about half a mile away.

In the southern and eastern parts of the county most of the wells obtain water from the consolidated rocks, and the unconsolidated Pleistocene deposits are cased out to prevent caving. However, many wells obtain sufficient water for domestic and farm use from small, discontinuous sand and gravel lenses, confined in the Pleistocene clay. Because of the discontinuity of the Pleistocene beds, the artesian systems developed locally are small and unrelated, each resulting from recharge on nearby high ground.

Thwaites (1943) has published a detailed study of the Pleistocene geology of part of northeastern Wisconsin. It includes all of Outagamie County except the small portion south of the Fox River.

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Recent deposits.—The Recent deposits consist mostly of silt and very fine sand deposited on the flood plains of the Wolf, Embarrass, and Shioc Rivers. They include also about 55,000 acres of peat (Whitson and others, 1921), which is continually forming in the swamps and marshes. Areas of peat are scattered throughout the county but are most extensive in the western half. The peat deposits in a given swamp are usually thickest near the center, where they sometimes extend to depths of more than 10 feet below the surface.

The thickness of the Recent river deposits in the northwestern quarter of the county is not known. Riverbanks here are low, and flooding of the adjacent lands during high water is quite common. The very fine sand and silt deposited at these times are not important as a source of ground water.

BEDROCK STRUCTURE

The regional bedrock structure is one of gentle dips to the east and southeast (pl. 3). The rocks in Brown County dip at about 30 to 35 feet per mile about S. 70° E. (Drescher, 1953). In eastern Outagamie County the dip, determined from well logs and altitudes, is 25 to 30 feet per mile S. 60° E. The few well logs available for wells in the southwestern quarter of the county indicate that the direction of dip there may be nearly S. 45° E.

Because of the nature of their deposition and subsequent erosion, there is a great range in the thickness of most of the geologic units. The Precambrian floor is an uneven surface that slopes generally 20 to 30 feet per mile toward the east and south. Lying unconformably upon this crystalline floor, the Upper Cambrian series fills in the depressions and covers the areas of low relief, producing a relatively flat inclined plane. The base of the Prairie du Chien group is relatively flat, but its upper surface is described by Chamberlin (1877) as being highly undulating and billowy. The origin of the undulations or domes is uncertain. They have been attributed to Cryptozoön reefs, tectonic deformation, subaerial erosion, and compaction of sediments. The presence of brecciated material within the domes, however, indicates that they were formed after deposition of the original sediments.

The St. Peter sandstone was deposited on the undulating surface of the Prairie du Chien group. It fills in the low areas and generally covers the domes, again producing a relatively even surface. However, where the relief of the Prairie du Chien is unusually great, the sandstone is missing from the high areas and the Platteville and Galena formations rest directly upon the dolomite of the Prairie du Chien group (geologic sections *A–A′* and *D–D′*). This may be the situation in the areas 6 miles west of Freedom and about 6 miles west of Appleton where the boundaries of the St. Peter sandstone are shown as dashed lines on the geologic map (pl. 2). Field observations in these areas indicate that the formation is absent, and it is not encountered in wells immediately to the east. Except where they have been acted upon by glacial and preglacial erosion, the Platteville and Galena formations have a more uniform thickness than any of the other geologic units. The unit has an even upper surface and rests upon a similar surface formed by the St. Peter sandstone and the Prairie du Chien group.

A west-trending fault along the Wolf River and Bear Creek has been reported by Chamberlin (1877) and others. The only evidence of a fault observed during this investigation is the peculiar right-angle turn in the Wolf River northeast of Hortonville and the straight-line effect caused by Bear Creek coming in from the east. Such a straight-line effect, however, is often the only surface expression of a fault and is sufficient reason for further investigation. The fault is not evident in geologic section D–D′ (pl. 3), which shows only a flattening of the apparent dip probably caused by a change in trend of the line of section (see geologic map, pl. 2). The movement of ground water in the area does not appear to be controlled by a fault (pl. 5), and there is no definite indication of a fault on the bedrock-surface map (pl. 4).

No other major faults or anomalies in structure have been found. The odd bedrock pattern in the vicinity of Seymour (pl. 2) is due not to structure but rather to the preglacial valley that heads in that area.

BEDROCK TOPOGRAPHY

In an area where the glacial drift is an important aquifier, it is necessary to define the buried surface of the consolidated rocks. A map showing contours on the bedrock surface may reveal preglacial valleys and depressions that have no surface expression. These valleys and depressions have been filled with glacial debris which may constitute an additional source of ground water.

The bedrock-contour map (pl. 4) was constructed from data obtained in drillers' logs and from field observations of quarries and other outcrops and surface topography. The altitudes are from aneroid-altimeter traverses using U. S. Coast and Geodetic Survey and U. S. Geological Survey bench marks as control. The lack of sufficient surface and subsurface control, the irregularity of the bedrock surface, and the variable thickness of the drift all tend to limit the accuracy of a map of this type. However, the general character and the dominant features of the buried surface are probably as shown on the map.

The outstanding feature of the preglacial landscape is the large buried valley which may be traced from near Seymour to Shiocton.

It is quite narrow and reaches a depth of 512 feet below the land surface at Black Creek. Although the valley may have been deepened and modified by ice advances, it was probably formed by a pre-Pleistocene stream flowing southwestward and emptying into the ancestral Wolf River at Shiocton. Two smaller valleys to the north also seem to terminate along the course of the present Wolf River, which flows southward to a point about 3 miles northeast of Hortonville where it is joined by a deep, narrow valley from the east. The straight-line effect caused by this confluence has been discussed in the section on bedrock structure. The fact that the present-day streams conform so well to the preglacial drainage pattern is due to the thinness of the drift in much of the county. Although the old channels are buried beneath hundreds of feet of sediments, the streams are still controlled by the same bedrock configurations etched out by their ancestors.

Other prominent features of the old surface are the Mosquito Hills about 1½ miles east of New London. They are preglacial erosional remnants of the Upper Cambrian series which were modified by the advancing ice. A cut-and-fill terrace, which may be an early stream terrace or a wave-cut bench from the time of Lake Oshkosh (Thwaites, 1943), was observed on the west side of the mounds.

The bedrock-topography map used in conjunction with land-surface altitudes shows that the glacial drift is thickest in the buried valleys and in the general area north and west of the Prairie du Chien escarpment. The bedrock surface in the remainder of the county is relatively flat, with no evidence of any great thickness of drift except in drumlins and eskers.

GEOLOGIC HISTORY

The Precambrian rocks that underlie all of Outagamie County were formed during the earliest geologic era. In Wisconsin these rocks consist of igneous rocks, as well as of sedimentary rocks that have been altered by heat and pressure. The Precambrian landscape was rugged and mountainous; even after long periods of exposure to the elements it was still dominated by many hills and ridges.

After the close of the Precambrian the area was covered by a sea into which layer after layer of sediment was deposited. The sea was not stationary, and alternating layers of sandstone, limestone, and shale were deposited as the water advanced and retreated. At times the sea retreated entirely, leaving the deposits exposed to subaerial erosion and continental deposition. From the time of final retreat of the sea until the advent of the Pleistocene glaciers, the rocks were subjected to weathering and erosion. It was during this interval that the bedrock valleys (pl. 4) were cut by the ancestral Wolf River and its tributaries.

Modification of the land surface during Pleistocene glaciation was accomplished more by deposition than by erosion. The valleys were filled, moraines were built up, and new drainage patterns were formed. As the ice front withdrew from its last major advance, much of Outagamie County was again covered by fresh water, of a glacial lake (Thwaites, 1943). Lake sediments were deposited, and then the water withdrew, leaving the land surface much as it appears today. Little erosion has taken place, and deposition has been restricted to flood-plain deposits of silt and sand along the streams and to organic deposits in lakes and swamps.

GROUND WATER

SOURCE AND MOVEMENT

The piezometric surface of a water-bearing formation, or aquifer, may be defined as that surface represented by the water level in wells or other large openings. If the water is not confined by impermeable material, the piezometric surface is called the water table. Under artesian conditions the water is confined under pressure by relatively impermeable material, and the piezometric surface is above the top of the aquifer. Ground water occurs under both artesian and water-table conditions in Outagamie County. Water-table conditions prevail locally in bodies of clean sand or gravel, and in limestone and dolomite where the water moves freely through cracks and solution openings that are connected with the atmosphere. Artesian water occurs locally, confined by layers of silt or clay, in the glacial drift and is the source of many springs and flowing wells. It occurs also throughout the bedrock aquifers wherever it is confined by relatively impermeable dolomite and shale. The confining material is not totally impermeable, and there is much slow leakage through the beds, so that over a long period of time the water may be considered as a single water body rather than several water bodies.

The direction of movement of ground water is illustrated by the piezometric map (pl. 5), which was constructed from water-level measurements made in 91 wells during April 1954. The wells do not represent any one aquifer, as most wells are cased only through the drift, and the leaky-artesian conditions that prevail in much of the county make it impossible to assign a water level to a specific aquifer without a driller's log and casing record of the well. The contour lines represent points of equal altitude on the piezometric surface. Because water flows down the hydraulic gradient, the direction of movement at any given point can be determined. Natural movement is controlled by discharge, recharge, topography, and geologic structure. It is altered by local pumping and by recharge from man-made reservoirs. In the eastern third of Outagamie County the water flows southeastward. The direction of flow is the result of natural discharge into the Fox River, of recharge from the large area to the west, of municipal and industrial pumping along the Fox River from Lake Winnebago to Green Bay, and of the eastward dip of the bedrock. Industrial and municipal pumping has increased the gradient and hence the volume of water moving toward the areas of discharge, but it has not greatly changed the direction of ground-water movement. An increase in gradient at any given place may also be due to a decrease in permeability of the water-bearing material or to a local increase in recharge.

The quantity of water moving out of the county to the southeast was computed by applying Darcy's law to the area between the 780- and 700-foot contours running northeast from Appleton. From Darcy's law it follows that the quantity of water discharged in a unit of time (Q) is equal to the product of the average permeability of the material (P), the hydraulic gradient (I), and the cross-sectional area through which the water moves (A). It may be written in the form $Q=TIL$, where T is the transmissibility and L is the length of the section perpendicular to the direction of flow. An approximate T of 18,000 gpd per foot was obtained from pumping tests at Seymour and Appleton. L is the average length of the contours between the limiting flow lines *A–B* and *C–D* (pl. 5). The gradient, I, is averaged as the quotient of the area between the contours divided by the average length of the contours. Table 4 summarizes the data and results of the computations.

TABLE 4.—*Calculated movement of water to the southeast in Outagamie County, Wis.*

Contour interval (feet)	*T* (gpd per foot)	*I* (foot per foot)	*L* (miles)	*Q* (mgd)
780–740	18,000	0.0036	29.6	10.1
740–700	18,000	.0040	27.7	10.5

The amount of water moving southeastward is more than 10 mgd. Of this, about 4.5 mgd is pumped from wells along the Fox River from Appleton to Kaukauna. A large quantity is discharged naturally into the river, and the remainder flows downvalley toward the city of Green Bay, where the pumpage is estimated to average about 12.5 mgd.

Throughout the remainder of Outagamie County ground-water movement is controlled mainly by surface and bedrock topography. The water flows outward from the high areas toward lower ground, where it may come to the surface through seeps and springs. The large bedrock valley near Seymour influences ground-water movement in the central part of the county. Water moves toward the valley from both sides and then westward toward the Wolf River. The number and distribution of control wells in the northwestern part of the county did not justify the drawing of piezometric contours in this area. The water here is in glacial drift, and, except in a few places where it is confined by impermeable layers, it exists under water-table conditions. The gradient appears to be quite flat, the water moving toward the Wolf and Embarrass Rivers.

The source of the ground water is precipitation. Recharge to the Paleozoic rocks takes place by percolation through the glacial drift into the subjacent sandstones or dolomites and thence downward into the deeper lying formations. The best opportunities for recharge are in areas where the sandstones crop out or are covered only by permeable glacial deposits. The piezometric map shows that where a stream influences ground-water movement the flow is usually toward the stream, indicating that water is entering rather than leaving the stream.

In areas of local recharge, the seasonal distribution of rainfall and seasonal changes in temperature have a pronounced effect on water levels. Rainfall on a recharge area may add water to the ground-water body; it also reduces the demand for ground water, thus tending to maintain natural conditions. High temperatures create a greater demand for water and a consequent lowering of water levels. High temperatures also increase the rates of evaporation and transpiration, thus reducing the amount of water available for recharge.

WATER LEVELS

Periodic water-level measurements (table 5, figs. 3 and 4) were made in 27 wells during the investigation. In addition, a continuous water-

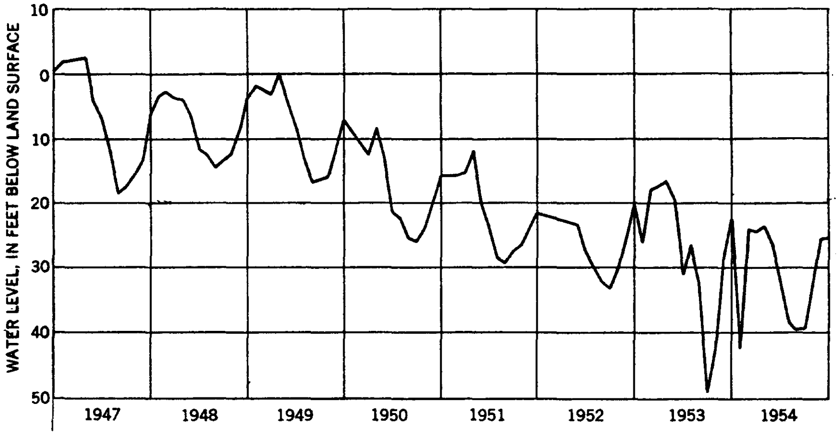

FIGURE 3.—Water level in well Ou 2, Kaukauna, Wis.

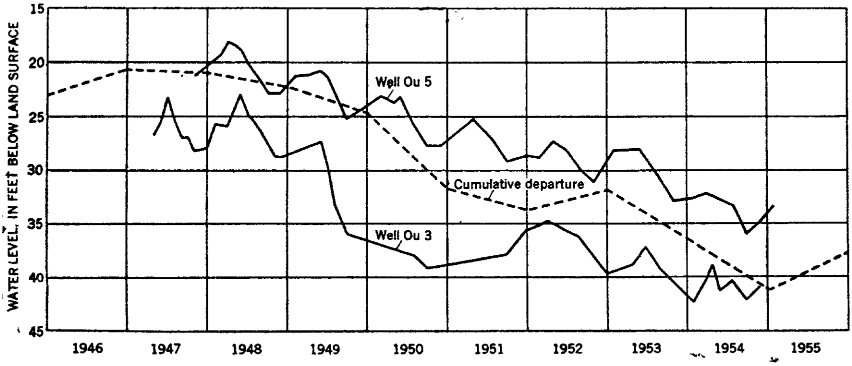

FIGURE 4.—Water levels in two wells and cumulative departure from normal precipitation since 1947–55, Outagamie County, Wis.

level recorder has been in operation on well Ou 2 since December 1946. More than 90 wells were measured in April 1954 for use in construction of the piezometric map (pl. 5).

Fluctuations caused by pumping from a water-table aquifer represent actual removal of water from the aquifer and usually are relatively small. In an artesian aquifer the fluctuations caused by pumping are relatively rapid and large, as they represent mostly changes in pressure within the system. Evaporation of water directly from the ground-water body and evaporation from plants (transpiration) are effective when the ground-water body is at or near the land surface. Barometric and other pressure effects on water levels are most pronounced in wells tapping confined water. Atmospheric pressure is transmitted through the well to the elastic artesian aquifer, and the well acts as a water barometer.

Fluctuations in water level may be grouped into three categories: short-term (ranging from a few seconds or minutes to several days); seasonal; and long-term. Nearly instantaneous fluctuations may be the result of loading of the aquifer by railroad trains, of earthquakes, of pumping from wells, etc. Diurnal or semidiurnal fluctuations may be caused by pumping, diurnal barometric changes, earth tides, or evaporation and transportation. Weekly fluctuations may occur as a result of a decrease in industrial and municipal pumping on weekends.

Table 5.—*Water levels in wells in Outagamie County, Wis.*

[Measurements in feet below land-surface datum]

Well Ou 19

Date	Depth to water	Date	Depth to water	Date	Depth to water
July 19, 1951	38.00	Dec. 4, 1952	29.00	May 5, 1954	33.98
Aug. 21	39.00	Jan. 29, 1953	28.31	July 8	38.32
Dec. 6	34.00	Apr. 9	27.98	Sept. 10	40.02
Feb. 8, 1952	30.00	June 5	30.73	Nov. 18	34.32
Apr. 11	30.00	Aug. 7	41.03	Mar. 16, 1955	29.35
June 13	34.00	Oct. 16	37.65		
Aug. 14	42.00	Jan. 8, 1954	30.41		
Oct. 10	35.00	Mar. 4	30.35		

Well Ou 24

Date	Depth to water	Date	Depth to water	Date	Depth to water
July 25, 1951	77.95	Oct. 10, 1952	74.64	Mar. 4, 1954	70.25
Sept. 21	77.03	Dec. 5	68.76	May 5	72.06
Dec. 6	72.98	Jan. 29, 1953	67.55	Sept. 10	79.44
Feb. 8, 1952	68.69	Apr. 9	66.58	Mar. 16, 1955	70.74
Apr. 10	67.93	Oct. 16	77.54		
Aug. 14	75.59	Jan. 8, 1954	68.75		

Well Ou 29

Date	Depth to water	Date	Depth to water	Date	Depth to water
July 27, 1951	56.96	Dec. 5, 1952	57.18	Mar. 4, 1954	58.61
Sept. 21	57.36	Jan. 29, 1953	57.43	May 5	57.78
Feb. 8, 1952	56.16	Apr. 9	56.20	July 8	57.50
Apr. 17	59.64	June 5	54.88	Sept. 10	58.04
June 13	55.83	Aug. 7	56.81	Nov. 18	55.69
Aug. 14	55.33	Oct. 16	58.30	Mar. 16, 1955	57.10
Oct. 10	57.31	Jan. 8, 1954	58.14		

Well Ou 41

Date	Depth to water	Date	Depth to water	Date	Depth to water
June 25, 1952	71.76	Sept. 4, 1953	77.14	July 30, 1954	75.40
Dec. 9	71.89	Jan. 7, 1954	72.83	Sept. 22	76.03
Mar. 23, 1953	72.20	Mar. 3	72.88		
May 26	72.02	Apr. 26	74.05		

Well Ou 59

Date	Depth to water	Date	Depth to water	Date	Depth to water
Aug. 6, 1952	71.80	Aug. 13, 1953	73.12	July 30, 1954	69.31
Dec. 9	71.89	Jan. 7, 1954	72.81	Sept. 22	70.76
Mar. 23, 1953	71.91	Mar. 3	73.07	Nov. 18	72.82
May 26	72.79	Apr. 28	73.18		

Well Ou 65

Date	Depth to water	Date	Depth to water	Date	Depth to water
Aug. 27, 1952	32.10	Aug. 2, 1953	32.97	July 29, 1954	34.04
Dec. 9	33.48	Jan. 7, 1954	34.51	Sept. 22	35.03
Mar. 23, 1953	33.80	Mar. 4	34.77	Nov. 17	35.08
May 26	32.91	Apr. 28	35.01		

Well Ou 70

Date	Depth to water	Date	Depth to water	Date	Depth to water
Aug. 28, 1952	81.22	May 26, 1953	80.21	July 30, 1954	83.53
Dec. 9	82.38	Aug. 13	81.67	Sept. 22	84.01
Mar. 23, 1953	82.65	Jan. 7, 1954	83.59	Nov. 17	81.84

Well Ou 74

Date	Depth to water	Date	Depth to water	Date	Depth to water
Sept. 9, 1952	0.41	July 16, 1953	[a] 1.96	Nov. 18, 1954	Flowing.
Dec. 10	[a] 1.48	July 30, 1954	0.21		
Mar. 24, 1953	[a] 1.61	Sept. 21	0.37		

[a] Feet above land-surface datum.

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TABLE 5.—*Water levels in wells in Outagamie County, Wis.*—Continued

Well Ou 82

Date	Depth to water	Date	Depth to water	Date	Depth to water
Sept. 11, 1952	43.89	May 26, 1953	40.65	Apr. 27, 1954	44.31
Dec. 10	44.39	Aug. 13	43.74		
Mar. 24, 1953	42.32	Mar. 4, 1954	46.34		

Well Ou 87

Date	Depth to water	Date	Depth to water	Date	Depth to water
Oct. 2, 1952	7.97	Aug. 13, 1953	8.63	July 30, 1954	11.93
Dec. 9	11.53	Jan. 7, 1954	14.95	Sept. 21	12.20
Mar. 23, 1953	3.86	Mar. 4	12.54	Nov. 27	6.88
May 26	5.55	Apr. 27	9.86		

Well Ou 95

Date	Depth to water	Date	Depth to water	Date	Depth to water
Nov. 6, 1952	8.23	Aug. 13, 1953	9.24	July 30, 1954	8.76
Dec. 10	7.05	Jan. 8, 1954	10.24	Sept. 21	9.05
Mar. 24, 1953	6.46	Mar. 4	8.11	Nov. 17	7.50
May 26	7.00	Apr. 27	9.38		

Well Ou 105

Date	Depth to water	Date	Depth to water	Date	Depth to water
May 28, 1953	2.31	Mar. 4, 1954	6.28	Sept. 21, 1954	6.51
Aug. 13	4.73	Apr. 27	5.12	Nov. 17	3.15
Jan. 8, 1954	6.38	July 29	5.88		

Well Ou 121

Date	Depth to water	Date	Depth to water	Date	Depth to water
June 25, 1953	24.85	Mar. 4, 1954	24.54	Sept. 22, 1954	24.55
Aug. 2	22.93	Apr. 28	24.54	Nov. 17	21.71
Jan. 7, 1954	24.22	July 29	24.95		

Well Ou 125

Date	Depth to water	Date	Depth to water	Date	Depth to water
June 25, 1953	32.41	Mar. 4, 1954	34.12	Sept. 22, 1954	35.50
Aug. 2	32.42	Apr. 28	33.38	Nov. 17	33.08
Jan. 7, 1954	34.54	July 29	33.82		

Well Ou 136

Date	Depth to water	Date	Depth to water	Date	Depth to water
June 26, 1953	12.69	Mar. 4, 1954	13.34	Apr. 28, 1954	11.68

Well Ou 152

Date	Depth to water	Date	Depth to water	Date	Depth to water
July 1, 1953	7.26	Mar. 4, 1954	11.14	Sept. 22, 1954	9.35
Aug. 13	7.79	Apr. 29	10.50	Nov. 17	7.02
Jan. 7, 1954	10.19	July 29	8.82		

Well Ou 155

Date	Depth to water	Date	Depth to water	Date	Depth to water
July 1, 1953	1.44	Mar. 4, 1954	3.17	Nov. 17, 1954	1.03
Aug. 13	1.74	July 29	2.10		
Jan. 7, 1954	3.02	Sept. 21	1.84		

Well Ou 169

Date	Depth to water	Date	Depth to water	Date	Depth to water
July 13, 1953	12.29	Mar. 4, 1954	13.78	Sept. 21, 1954	13.50
Aug. 13	11.88	Apr. 29	13.74	Nov. 17	10.59
Jan. 7, 1954	13.04	July 29	12.91		

Well Ou 170

Date	Depth to water	Date	Depth to water	Date	Depth to water
July 13, 1953	6.72	Mar. 4, 1954	9.82	Nov. 17, 1954	5.94
Aug. 13	7.43	July 29	7.38		
Jan. 8, 1954	8.76	Sept. 21	7.90		

TABLE 5.—*Water levels in wells in Outagamie County, Wis.*—Continued

Well Ou 179

Date	Depth to water	Date	Depth to water	Date	Depth to water
July 14, 1953	8.01	Mar. 4, 1954	9.35	Nov. 17, 1954	7.86
Sept. 4	8.27	July 29	8.58		
Jan. 8, 1954	9.16	Sept. 21	8.84		

Well Ou 203

Date	Depth to water	Date	Depth to water	Date	Depth to water
July 22, 1953	58.09	Mar. 4, 1954	58.37	Sept. 22, 1954	57.49
Jan. 7, 1954	58.26	July 29	45.34	Nov. 17	34.77

Well Ou 217

Date	Depth to water	Date	Depth to water	Date	Depth to water
July 23, 1953	7.89	Mar. 4, 1954	6.00	Nov. 17, 1954	5.98
Sept. 4	7.94	July 29	7.22		
Jan. 8, 1954	6.30	Sept. 21	7.29		

Well Ou 238

Date	Depth to water	Date	Depth to water	Date	Depth to water
Sept. 1, 1953	8.42	Apr. 27, 1954	6.37	Nov. 17, 1954	5.43
Jan. 8, 1954	6.74	July 30	6.44		
Mar. 4	7.11	Sept. 21	6.68		

Well Ou 246

Date	Depth to water	Date	Depth to water	Date	Depth to water
Sept. 3, 1953	4.47	July 29, 1954	4.63	Nov. 17, 1954	2.51
Jan. 8, 1954	4.60	Sept. 21	4.01		

Well Ou 258

Date	Depth to water	Date	Depth to water	Date	Depth to water
Oct. 14, 1953	7.15	Apr. 27, 1954	4.80	Nov. 17, 1954	2.93
Jan. 8, 1954	8.41	July 30	4.89		
Mar. 4	6.89	Sept. 21	5.64		

Seasonal fluctuations are due to seasonal variations in pumping, evaporation and transpiration, and recharge. Normally, water levels decline through the summer as a result of reduced recharge (due to increased evaporation and transpiration) and of drainage into streams. The decline continues through the winter months when the ground is frozen and recharge is at a minimum. Recharge is greatest in the spring, owing to snow melt and spring rains. In southeastern Outagamie County the pattern is distorted by pumping along the Fox River. Hydrographs (figs. 3 and 4) show that the lowest water levels occur in the early fall at the end of the period of heaviest industrial and municipal pumping. Recovery is rapid, and a nearly stable condition is reached early the following year. The water level in well Ou 3, which of the three wells illustrated is that least affected by pumping, follows more closely the natural influences of recharge and discharge. It continues to decline during the winter and reaches its maximum recovery in April or May.

Long-term trends in water levels are the result of precipitation and temperature cycles or of pumping trends. About 8 years of records are available for wells Ou 2, 3, and 5 (figs. 3 and 4). All three wells are affected by increased pumping at Green Bay and along the Fox River, and all three hydrographs show a downward trend during the period of record. However, the cumulative-departure curve for precipitation in Outagamie County also shows a downward trend during this period. The curve follows quite closely the trend of the hydrographs, indicating that the precipitation cycle has a definite influence on water levels. The effects of precipitation and temperature cycles on water levels are accentuated by corresponding pumping cycles; for example, high temperatures and lack of precipitation, which reduce recharge and cause water levels to decline, usually result in increased pumping, which has a similar effect. Wells Ou 2 and 5 are deep wells near the area of maximum withdrawal and relatively far from the recharge area. Here the effect of pumping is at a maximum and the effect of fluctuations in precipitation are minimized. Well Ou 3 is a shallow well located near the outcrop area, where water levels are influenced by precipitation cycles. This influence is shown by the trend of the hydrograph, which follows very closely the cumulative-departure curve for precipitation. The well is west of the recharge boundary, determined by Drescher (1953), for the Green Bay area and should not be greatly affected by withdrawals at Green Bay.

USE

Withdrawal of ground water in Outagamie County in 1951 and 1952 is estimated to have averaged about 9.0 mgd. Industrial, commercial, and public-supply pumping along the Fox River accounts for 48 percent of the total. The city of Appleton and the paper mills use Fox River water, but pumping by other industries and businesses in the Appleton area amounts to about 1.7 mgd. The cities of Kaukauna, Little Chute, Kimberly, and Combined Locks use ground water at the rate of 2.6 mgd for all purposes. Pumpage in the remainder of the county, estimated to be about 4.6 mgd, is predominantly for domestic and general farm use. The estimate is based on pumpage figures supplied by the villages and on an estimated average consumption of 40 gallons per day (gpd) per person for rural areas, 35 gpd per cow for milk cows and associated dairy servicing, 12 gpd for cattle and horses, and smaller amounts for other animals.

WELLS

The locations of the 287 wells visited during the investigation are shown on plate 1. The data assembled for each well are listed in table 6. Wells are numbered consecutively in the order visited and prefixed by the letters Ou to show that they are in Outagamie County.

TABLE 6.—*Records of wells in Outagamie County, Wis.*

[Qa, Recent alluvium and Pleistocene deposits; Om, Maquoketa shale; Ogp, Galena dolomite, and Platteville formation; Osp, St. Peter sandstone; Opc, Prairie du Chien group; Ꞓs, Upper Cambrian series; AC, Air conditioning; Des, Destroyed; Dom, Domestic; Ind, Industrial; PS, Public supply; RR, Railroad; S, Stock; Un, Unused]

Well No. Ou—	Location	Owner	Year drilled	Altitude of land surface (feet)	Depth of well (feet)	Depth of casing (feet)	Diameter of casing (inches)	Principal aquifer			Water level		Use
								Geologic unit	Depth to top (feet)	Thickness penetrated (feet)	Below land surface (feet)	Date of measurement	
1	NW¼SW¼ sec. 28, T. 24 N., R. 18 E.	City of Seymour	1934	788	406	202	12-10	Ꞓs	195	211			PS.
2	NE¼SW¼ sec. 24, T. 21 N., R. 18 E.	City of Kaukauna	1909	645	798	208	12	Ꞓs	368	410	+1.84	Dec. 4, 1946	Un.
3	SE¼NE¼ sec. 2, T. 23 N., R. 18 E.	William Vanden Huefel	1942	790	110	35	5	Osp	55	50	26.67	Apr. 16, 1947	S.
4	SE¼NW¼ sec. 5, T. 21 N., R. 18 E.	Marvin Murphy			400±		8				32.25	May 14, 1947	Un.
5	SW¼SE¼ sec. 4, T. 21 N., R. 19 E.	Kaukauna Water and Electric.	1929	660	408	69	6	Osp	237	171	21.19	Oct. 30, 1947	Dom.
6	NW¼NW¼ sec. 16, T. 24 N., R. 19 E.	Wisconsin State Reformatory.		776	192	82	6	Osp	178	14			PS.
7	NE¼NW¼ sec. 33, T. 24 N., R. 18 E.	Seymour Canning Co	1910	796	235		6				32.80	December 1952.	Un.
8	NE¼NW¼ sec. 33, T. 24 N., R. 18 E.	do	1929	796	350	193	12	Ꞓs	220	130			Ind.
9	NW¼NW¼ sec. 33, T. 24 N., R. 18 E.	Green Bay and Western Railroad Co.		791									Un.
10	NE¼NE¼ sec. 32, T. 24 N., R. 18 E.	City of Seymour	1947	788	500	270	10	Ꞓs	195	305			PS.
11	NE¼SE¼ sec. 29, T. 24 N., R. 18 E.	Outagamie County		790	140		5				18.23	Apr. 18, 1949	PS.
12	NE¼SW¼ sec. 35, T. 24 N., R. 18 E.	John Vander Zanden					4				41.23	Oct. 5, 1949	Un.
13	SW¼SE¼ sec. 26, T. 21 N., R. 17 E.	Fox River Paper Corp	1900?		250±		6						Un.
14	**NW¼SE¼ sec. 26,** T. 21 N., R. 17 E.	do	1900?		250±		6						Un.
15	NW¼NE¼ sec. 36, T. 21 N., R. 17 E.	Institute of Paper Chemistry.	1942	765	249	71	10	Ogp, Opc.	68	181	129	July 18 1951	AC.
16	NW¼NE¼ sec. 35, T. 21 N., R. 17 E.	Appleton Machine Co	1900?		100±		4						Ind.
17	SW¼SW¼ sec. 26, T. 21 N., R. 17 E.	Geo. Walters Brewery	1900?										Ind.
18	SW¼SW¼ sec. 26, T. 21 N., R. 17 E.	do	1948	790	520		8-6				96	July 19, 1951	Ind.

TABLE 6.—*Records of wells in Outagamie County, Wis.*—Continued

Well No. Ou—	Location	Owner	Year drilled	Altitude of land surface (feet)	Depth of well (feet)	Depth of casing (feet)	Diameter of casing (inches)	Principal aquifer			Water level		Use
								Geologic unit	Depth to top (feet)	Thickness penetrated (feet)	Below land surface (feet)	Date of measurement	
19	SE¼SW¼ sec. 35, T. 21 N., R. 17 E.	Wisconsin-Michigan Power Co.	1946	728	450	54	8	Ꞓs	290	160	38	July 19, 1951	Un.
20	NW¼NW¼ sec. 23, T. 21 N., R. 17 E.	North Star Locker Plant	1947	830	410	100	6	Ꞓs	345	65			Ind.
21	SW¼SW¼ sec. 26, T. 21 N., R. 17 E.	Outagamie County	1941	777	433	215	8	Ꞓs	340	93	96.67	July 20, 1951	AC.
22	NW¼NW¼ sec. 34, T. 21 N., R. 17 E.	Consolidated Badger Coop Dairy.	1946	806	528	128	10	Ꞓs	315	213			Ind.
23	NW¼NW¼ sec. 34, T. 21 N., R. 17 E.	do	1949	806	538	130	10	Ꞓs	309	229			Ind.
24	NW¼NW¼ sec. 25, T. 21 N., R. 17 E.	Appleton Coated Paper Co.	1928	763	501	244	12	Ꞓs	344	157	77.95	July 25, 1951	Un.
25	NW¼NE¼ sec. 29, T. 21 N., R. 17 E.	Valley Locker Co.	1947	781	312	65	6	Ꞓs	205	107			Ind.
26	SE¼SE¼ sec. 20, T. 21 N., R. 17 E.	Outagamie County Hospital	1950	754	662	158	10	Ꞓs	225	437	43.47	July 26, 1950	PS.
27	SE¼SE¼ sec. 20, T. 21 N., R. 17 E.	do	1890		700±								PS.
28	SW¼NE¼ sec. 26, T. 21 N., R. 17 E.	Tuttle Paper Press Co.			250±	103	5						PS.
29	NE¼SE¼ sec. 15, T. 21 N., R. 17 E.	Highland Memorial Park	1935	839	300±						56.96	July 27, 1951	
30	SE¼SE¼ sec. 22, T. 21 N., R. 17 E.	Fox River Valley Knitting Co.	1902		360		5						Ind.
31	SE¼SW¼ sec. 23, T. 21 N., R. 17 E.	G. M. Hahn	1948	798	368		6	Osp	350	18			AC.
32	NW¼SE¼ sec. 26, T. 21 N., R. 17 E.	Conway Hotel			700±		6	Ꞓs					PS.
33	NW¼SE¼ sec. 35, T. 22 N., R. 15 E.	City of Hortonville	1946	772	340			Ꞓs	58	282	17.5	June 23, 1952	PS.
34	NW¼SW¼ sec. 21, T. 21 N., R. 18 E.	Village of Kimberly	1924	717	661	119	12	Ꞓs	350	407			PS.
35	NE¼NW¼ sec. 28, T. 21 N., R. 18 E.	do	1939	731	804	148	12	Ꞓs	380	420			PS.
36	SW¼SW¼ sec. 22, T. 21 N., R. 18 E.	Village of Little Chute	1923	679	734	102	12	Ꞓs	345	385	41.1	June 24, 1952	PS.
37	NW¼NE¼ sec. 21, T. 21 N., R. 18 E.	do	1948	731	772	153	12	Ꞓs	390	382			PS.

38	NE¼NW¼ sec. 21, T. 21 N., R. 18 E.	Little Chute Bottling Co.	1950		68	58	8	Ogp	58	10			Ind.
39	NW¼SW¼ sec. 21, T. 21 N., R. 18 E.	Kimberly-Clark Paper Co.			711	29	8	€s	349	415			Ind.
40	NW¼NW¼ sec. 27, T. 21 N., R. 18 E.	Combined Locks Paper Co.	1925	665	227	65	6	Ogp	65	146			PS.
41	SW¼NW¼ sec. 31, T. 21 N., R. 19 E.	Peter Loderbauer	1927	735	581	141	6	€s	466	115	71.76	June 25, 1952	Dom, S.
42	SW¼NE¼ sec. 24, T. 21 N., R. 18 E.	Thilmany Pulp & Paper Co.	1934	660	714		16–14	€s	356	358			Ind.
43	SE¼NE¼ sec. 24, T. 21 N., R. 18 E.	do	1941	620	332	101	10	Osp	170	90			Ind.
44	NE¼SW¼ sec. 24, T. 21 N., R. 18 E.	City of Kaukauna	1921	648	726	34	15½	€s	340	386			PS.
45	SW¼SW¼ sec. 24, T. 21 N., R. 18 E.	do	1935	642	733	121	16	€s	370	363			PS.
46	SE¼SE¼ sec. 23, T. 21 N., R. 18 E.	do	1945	720	570	159	10	€s	445	125			PS.
47	NW¼NW¼ sec. 25, T. 21 N., R. 18 E.	do	1945	704	557	135	10	€s	440	117			PS.
48	SE¼NE¼ sec. 28, T. 21 N., R. 19 E.	Leo Schmidt	1949	784	91	28	6	Om	28	63	9.67	Aug. 5, 1952	Dom, S.
49	SE¼SE¼ sec. 21, T. 21 N., R. 19 E.	R. Vanderloop	1950	704	370	130	6				73.33	Aug. 5, 1952	S.
50	NE¼NE¼ sec. 32, T. 21 N., R. 19 E.	Louis Mischler	1921	729	152	100	6				76.72	Aug. 6, 1952	Dom, S.
51	SW¼NW¼ sec. 21, T. 21 N., R. 19 E.	Frank Nytes	1900?	693	102		4				44.95	Aug. 6, 1952	Dom, S.
52	NE¼SE¼ sec. 9, T. 21 N., R. 19 E.	Peter Feldkamp		658			3				58.08	Aug. 6, 1952	Dom, S.
53	NE¼NE¼ sec. 12, T. 21 N., R. 17 E.	Robert Van Handel	1950	770			6				27.54	Aug. 7, 1952	Dom.
54	NE¼NW¼ sec. 16, T. 21 N., R. 18 E.	William Van Grall	1948	728	171	100	8–6				55.01	Aug. 7, 1952	Dom, S.
55	SW¼NW¼ sec. 3, T. 21 N., R. 18 E.	Alois Jansen		729			4				29.02	Aug. 8, 1952	Dom, S.
56	NE¼NE¼ sec. 3, T. 21 N., R. 16 E.	St. Mary's Congregation	1938	915	659	29	6	€s	201	458			Un.
57	NE¼SE¼ sec. 3, T. 21 N., R. 16 E.	Henry Griesbach		890							52.37	Aug. 7, 1952	Dom, S.
58	SE¼SE¼ sec. 35, T. 22 N., R. 17 E.	Delmar Schmeichel	1951	841	174	40±	6				59.47	Nov. 6, 1952	Dom.
59	NW¼NE¼ sec. 17, T. 21 N., R. 19 E.	Richard Lamers		673	96±		4				71.80	Aug. 6, 1952	Dom, S.
60	NE¼NE¼ sec. 28, T. 22 N., R. 18 E.	George Diedrick	1941	737	120		4	Ogp	90	30	26.05	Aug. 8, 1952	Dom, S.
61	NW¼NW¼ sec. 13, T. 21 N., R. 18 E.	Lester Besaw	1947	715			6				53.69	Aug. 26, 1952	Dom, S.
62	SW¼NW¼ sec. 13, T. 21 N., R. 18 E.	Ben Pahl		723			6				60.31	Aug. 26, 1952	Dom.
63	SE¼SW¼ sec. 25, T. 22 N., R. 18 E.	William Walsh		171	90		6				35.69	Aug. 26, 1952	Dom, S.

TABLE 6.—*Records of wells in Outagamie County, Wis.*—Continued

Well No. Ou—	Location	Owner	Year drilled	Altitude of land surface (feet)	Depth of well (feet)	Depth of casing (feet)	Diameter of casing (inches)	Principal aquifer: Geologic unit	Principal aquifer: Depth to top (feet)	Principal aquifer: Thickness penetrated (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Use
64	NW¼NW¼ sec. 14, T. 22 N., R. 18 E.	Herbert Van Wychen		759			6				24.68	Aug. 27, 1952	Dom.
65	SW¼NW¼ sec. 18, T. 22 N., R. 19 E.	Mark Kerkhoff	1950	735	52	32±	6				32.10	Aug. 27, 1952	Dom, S.
66	NW¼NW¼ sec. 16, T. 22 N., R. 19 E.	Pete Kieffer		700			6				41.05	Aug. 27, 1952	Dom, S.
67	SE¼NE¼ sec. 29, T. 22 N., R. 19 E.	Joe Mennen		697	320		6				52.52	Aug. 27, 1952	Dom, S.
68	NW¼NW¼ sec. 5, T. 21 N., R. 19 E.	Robert Van Delou		710	96?		4				79.38	Aug. 27, 1952	Dom, S.
69	SE¼SE¼ sec. 2, T. 21 N., R. 18 E.	Austin Diedrich		711	72		4	Ogp			28.82	Aug. 27, 1952	Dom, S.
70	SW¼NW¼ sec. 18, T. 22 N., R. 18 E.	Orville Krabbe		856	136		4				81.22	Aug. 28, 1952	Dom, S.
71	SE¼SW¼ sec. 9, T. 23 N., R. 17 E.	Village of Black Creek	1941	789	158	130	10	Qa	115	40	21	Sept. 8, 1952	PS.
72	SE¼SW¼ sec. 7, T. 22 N., R. 15 E.	New London Utilities					4						PS.
73	SE¼SW¼ sec. 7, T. 22 N., R. 15 E.	do			76	46	24						PS.
74	SW¼NE¼ sec. 29, T. 23 N., R. 16 E.	Shiocton Produce Co	1947	766	411		6				.41	Sept. 9, 1952	Ind.
75	SW¼NE¼ sec. 29, T. 23 N., R. 16 E.	Shiocton Kraut Co	1929?	765	295		6				5.31	Sept. 9, 1952	Ind.
76	NW¼NE¼ sec. 35, T. 24 N., R. 18 E.	John Vander Zanden	1952	796	89	38	8-6	Osp	69	20	15.12	Sept. 10, 1952	Dom, S.
77	NE¼NE¼ sec. 21, T. 23 N., R. 18 E.	N. Van Handel		802	68		4				39.98	Sept. 10, 1952	Dom, S.
78	SW¼SW¼ sec. 9, T. 22 N., R. 18 E.	Jerry Geenen		820	160	5	6				22.48	Sept. 10, 1952	Dom.
79	SW¼SE¼ sec. 35, T. 22 N., R. 15 E.	Fox Valley Canning Co		794	335±		10	Ꞓs	60	275			Ind.
80	SW¼SE¼ sec. 35, T. 22 N., R. 15 E.	do		793	210±		6	Ꞓs			3.64	Dec. 10, 1952	Ind.
81	SE¼SE¼ sec. 35, T. 22 N., R. 15 E.	R. E. Schweb		801	108		6	Ꞓs					Ind.
82	SE¼SE¼ sec. 2, T. 21 N., R. 15 E.	American Telephone & Telegraph.	1930	845	134	83	4½	Ꞓs	80	54	43.89	Sept. 11, 1952	Ind.

83	NW¼NE¼ sec. 29, T. 22 N., R. 15 E.	Fox Valley Canning Co		748			2½						Un.
84	NW¼NE¼ sec. 32, T. 21 N., R. 17 E.	Fred Yelg	1951	773	102	43	6	Osp	90	12	20.71	Oct. 1, 1952	Dom.
85	SE¼NE¼ sec. 18, T. 21 N., R. 17 E.	Charles Milbauer	1951	825	112	41	6	Osp	100	12	24.16	Oct. 1, 1952	Dom, S.
86	NW¼SE¼ sec. 26, T. 21 N., R. 17 E.	Rio Theater	1931	769	514	95		Ꞓs	350	164			AC.
87	NW¼NE¼ sec. 19, T. 22 N., R. 17 E.	Peter Williamson	1951	796	96	30	6	Ꞓs	80	16	7.97	Oct. 2, 1952	Dom, S.
88	NE¼NE¼ sec. 5, T. 21 N., R. 15 E.	Franklin Gruetzmacher	1950	896	159	67	6	Ꞓs	110	49	56.43	Nov. 5, 1952	Dom, S.
89	SE¼NW¼ sec. 15, T. 21 N., R. 15 E.	Don Sell		874	104+		4				38.90	Nov. 5, 1952	Dom, S.
90	NE¼NW¼ sec. 25, T. 21 N., R. 15 E.	Emil Tullock	1948	826	116		6				28.01	Nov. 5, 1952	Dom.
91	SW¼SW¼ sec. 14, T. 21 N., R. 16 E.	Virginia Findley	1952	826	91	73	6	Ꞓs	89	3	18.04	Nov. 6, 1952	Dom.
92	NW¼NW¼ sec. 5, T. 21 N., R. 17 E.	H. F. McCarthy		848			4				77.19	Nov. 6, 1952	Dom, S.
93	SW¼NE¼ sec. 33, T. 22 N., R. 17 E.	Landwehr & Hackel Gravel Co.	1951	813	124	40	8				19.43	Dec. 11, 1952	Ind.
94	SW¼SE¼ sec. 31, T. 22 N., R. 16 E.	Elmer Collar		885	135	66	6	Ꞓs	120	15	43.2	Nov. 6, 1952	Dom.
95	NE¼NW¼ sec. 20, T. 22 N., R. 16 E.	John Ross	1952	777	112	111	6	Qa	100	12	8.23	Nov. 6, 1952	Un.
96	SW¼NW¼ sec. 27, T. 22 N., R. 16 E.	Vernon Kern		863	100±		4				49.12	Nov. 6, 1952	Dom, S.
97	SE¼SE¼ sec. 8, T. 23 N., R. 17 E.	Borden Condensed Milk Co	1918	788	484			Qa	2	510			Un.
98	SW¼NW¼ sec. 33, T. 21 N., R. 19 E.	Mike Weiss	1926	796	490	10	8-6	Osp	424	66			Dom.
99	NW¼SW¼ sec. 6, T. 21 N., R. 19 E.	George Lambie	1927	709	311½	90	6	Ogp, Opc	90	222			Dom.
100	NE¼NW¼ sec. 33, T. 21 N., R. 19 E.	Henry Mischler	1924	790	486	49	6	Osp	415	71	31.08	May 26, 1953	Dom.
101	SE¼NE¼ sec. 31, T. 23 N., R. 17 E.	Outagamie County	1925	827	305		10	Ꞓs	91	214			Des.
102	NW¼SW¼ sec. 23, T. 21 N., R. 18 E.	Riverview Sanatorium	1935	667	302	100	8	Ogp	25	190			PS.
103	SW¼NW¼ sec. 29, T. 21 N., R. 19 E.	Eleanor Hansen	1952	742	370		6				83.02	May 26, 1953	Dom.
104	NW¼SW¼ sec. 32, T. 21 N., R. 17 E.	William Martin	1949	767	49	33½	4	Osp	42	7			Dom.
105	NE¼SW¼ sec. 29, T. 21 N., R. 16 E.	Serto Balliet		776	142		6	Ꞓs	128	14	2.81	May 28, 1953	Dom.
106	NW¼NW¼ sec. 36, T. 21 N., R. 15 E.	E. J. Winkler	1951	838	138		6	Ꞓs	126	12	64.50	May 28, 1953	Dom, S.
107	NW¼NW¼ sec. 33, T. 22 N., R. 16 E.			963	180	65	6	Ꞓs	165	15			Dom, S.
108	NW¼NW¼ sec. 26, T. 21 N., R. 16 E.	V. Leppla	1943	900±	265	148	4						Dom, S.

TABLE 6.—*Records of wells in Outagamie County, Wis.*—Continued

Well No. Ou—	Location	Owner	Year drilled	Altitude of land surface (feet)	Depth of well (feet)	Depth of casing (feet)	Diameter of casing (inches)	Principal aquifer			Water level		Use
								Geologic unit	Depth to top (feet)	Thickness penetrated (feet)	Below land surface (feet)	Date of measurement	
109	NE¼NW¼ sec. 25, T. 21 N., R. 15 E	E. L. Lippert	1950	829			6	€s			39.66	May 29, 1953	Dom.
110	NE¼SE¼ sec. 34, T. 21 N., R. 16 E.	Elmer H. Schroeder		918	98		6				76.76	May 29, 1953	Dom, S.
111	NE¼NE¼ sec. 32, T. 22 N., R. 18 E.	Richard Van Schyndel	1951	752	305	35	6	Osp	240	10	32.90	May 13, 1953	Dom, S.
112	NE¼NE¼ sec. 13, T. 21 N., R. 17 E.	Jacob Behle	1953	756	120	59	6				36.16	June 23, 1953	
113	NE¼SE¼ sec. 27, T. 21 N., R. 16 E.	Clem Gitter		905	200+		4				64.82	June 23, 1953	Dom, S.
114	SW¼NW¼ sec. 25, T. 22 N., R. 16 E.	Evangelical Lutheran Church.	1944	884	134	30	6–5	€s	60	74	84.37	June 23, 1953	Dom, PS.
115	SW¼SW¼ sec. 30, T. 22 N., R. 18 E.	George Bohl	1949	854	304	96	6	Ogp, Opc	96	208			Dom, S.
116	SE¼NE¼ sec. 36, T. 22 N., R. 17 E.	Harry Brockmann		880	8	8	60				3.34	June 24, 1953	Dom, S.
117	SE¼SE¼ sec. 6, T. 22 N., R. 18 E.	Roy M. Riessenweber	1942	794	130	63	5	Osp	96	34			Dom.
118	NW¼SE¼ sec. 21, T. 23 N., R. 17 E.	Arron Riehl	1942	841	80	57	5	Opc	57	23			Dom, S.
119	SE¼SE¼ sec. 18, T. 24 N., R. 17 E.	Lawrence Dudek	1942	777	137	137	4½	Qa	137				Dom, S.
120	NE¼NW¼ sec. 12, T. 22 N., R. 16 E.	Mrs. Geo. Laird	1945	824	99	99	4	Qa	88	11			Dom.
121	NW¼NW¼ sec. 14, T. 22 N., R. 18 E.	Arnold Hooyman and Joe Heckel.	1942	756	83	53	5	Osp	53	30	24.85	June 25, 1953	Dom.
122	NW¼SE¼ sec. 6, T. 22 N., R. 19 E.	Marvin Murphy	1944	727	67	47	5	Ogp	47	20	3.60	June 25, 1953	S.
123	NW¼NE¼ sec. 1, T. 22 N., R. 18 E.	Norman Austin	1948	767	113	96	6	Osp	100	13	60.76	June 25, 1953	Dom, S.
124	SW¼NW¼ sec. 29, T. 23 N., R. 19 E.	Melvin Van Den Berg		725	120	58	6	Osp	107	13			Dom.
125	SE¼NE¼ sec. 30, T. 23 N., R. 19 E.	Immaculate Conception Mission.	1953	729	122	65½	6				32.41	June 25, 1953	PS.
126	SE¼NW¼ sec. 20, T. 23 N., R. 19 E.	Chester Smith		733	92	92	6	Qa	90	2	48.12	June 25, 1953	Dom, S.
127	SE¼NE¼ sec. 7, T. 23 N., R. 19 E.	John Van Boxtle	1945	762	144	48	6	Osp	100	44	41.51	June 25, 1953	Dom, S.

128	NW¼NW¼ sec. 7, T. 23 N., R. 19 E.	Bernard Van de Vort	1945	766	73	28	6	Ogp	28	45			Dom, S.
129	NE¼SE¼ sec. 12, T. 23 N., R. 18 E.	Wm. and John Van Boxtle	1949	767	141	30	6	Osp	115	26			Dom
130	SE¼SE¼ sec. 33, T. 24 N., R. 18 E.	Claud Schamberg	1945	825	104	58	6	Osp	58	46			Dom, S.
131	NE¼NE¼ sec. 5, T. 23 N., R. 18 E.	Robert Schultz	1943	839	64	64	8-5	Osp	28	36			Ind.
132	SW¼SE¼ sec. 9, T. 23 N., R. 18 E.	Winfred Cleereman	1945	819	82	34	6	Osp	48	34			Dom, S.
133	SW¼SW¼ sec. 5, T. 23 N., R. 18 E.	Lawrence Barclay	1944	853	80	14½	6	Osp	46	34			Dom, S.
134	SE¼SW¼ sec. 30, T. 24 N., R. 18 E.	Evert McBain	1944	777	119	119	6	Qa	44	75			Dom, S.
135	SE¼SW¼ sec. 20, T. 24 N., R. 18 E.	Earl Court	1944	830	153	21	5	Opc	17	136			Dom, S.
136	NW¼SW¼ sec. 20, T. 24 N., R. 18 E.	Hugo Baehler	1944	861	41	19	6	Opc	29	12	12.69	June 26, 1953	Dom, S.
137	NW¼NW¼ sec. 21, T. 24 N., R. 18 E.	Fenton Gardner	1945	848	130	14	6	Osp	35	75			Dom, S.
138	SW¼NW¼ sec. 21, T. 24 N., R. 18 E.	Roger Gardner	1945	807	140	110	6	Opc	110	30			Dom, S.
139	SE¼SE¼ sec. 1, T. 23 N., R. 17 E.	Frank Kirzek	1952		8	8	48	Qa	6	2			Dom, S.
140	SE¼SE¼ sec. 1, T. 23 N., R. 17 E.	do	1944	796	41	34½	6	Osp	32	9	.82	June 26, 1953	Un.
141	SE¼NE¼ sec. 23, T. 24 N., R. 18 E.	George Lindsley	1944	803	168	75	6	Ogp	75	93			Dom, S.
142	NW¼SW¼ sec. 30, T. 24 N., R. 19 E.	Andrew Schmidt	1946	791	105	21	6	Osp	76	29			S.
143	NW¼SW¼ sec. 30, T. 24 N., R. 19 E.	do	1915±	791	20	20	48				8.10	June 30, 1953	Dom.
144	NW¼NE¼ sec. 13, T. 24 N., R. 18 E.	Elmer Ashman	1945	803	102	35	6	Ogp	35	67	13.54	June 30, 1953	Dom.
145	SE¼SE¼ sec. 6, T. 24 N., R. 19 E.	Harlin Schmidt	1943	777	66	33	6	Ogp	33	33	11.50	June 30, 1953	Dom, S.
146	NE¼NE¼ sec. 15, T. 24 N., R. 18 E.	Kranzusch Bros	1953	829	212	62	6	Ogp, Opc	62	150	76.88	June 30, 1953	Un.
147	NE¼NE¼ sec. 15, T. 24 N., R. 18 E.	do	1931		20		42	Qa					Dom, S.
148	SE¼SE¼ sec. 8, T. 24 N., R. 18 E.	Herbert Krahn	1946	884	102	16	6	Osp	80	22			Dom, S.
149	SE¼SE¼ sec. 7, T. 24 N., R. 18 E.	Leonard Montie	1944	891	90	18	6	Osp	53	37			Dom, S.
150	SE¼SW¼ sec. 15, T. 24 N., R. 17 E.	Chester Gritt	1945	838	47	45	5	Opc	45	2			Dom, S.
151	SE¼NE¼ sec. 20, T. 24 N., R. 18 E.	Ray Elsen	1945	812	36	36	6	Qa	35				Dom.
152	SW¼SE¼ sec. 12, T. 23 N., R. 17 E.	Corbin Graunke	1943	793	85½	85	5				7.26	July 1, 1953	Un.
153	NE¼SW¼ sec. 2, T. 23 N., R. 17 E.	Lambert Sanderfoot		783	18½	18	48				9.70	July 1, 1953	Dom, S.

TABLE 6.—*Records of wells in Outagamie County, Wis.*—Continued

Well No. Ou—	Location	Owner	Year drilled	Altitude of land surface (feet)	Depth of well (feet)	Depth of casing (feet)	Diameter of casing (inches)	Principal aquifer: Geologic unit	Principal aquifer: Depth to top (feet)	Principal aquifer: Thickness penetrated (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Use
154	SW¼NW¼ sec. 30, T. 24 N., R. 17 E.	George Van Eperen	1945	775	113	113	5	Qa	113				Dom, S.
155	NE¼NE¼ sec. 7, T. 23 N., R. 17 E.	Albert Theobald	1925±	769	43	43	2	Qa	43		1.44	July 1, 1953	Un.
156	SE¼NE¼ sec. 31, T. 23 N., R. 17 E.	Hollis Reineck		827	40		4				13.44	July 1, 1953	Ind.
157	NE¼NW¼ sec. 10, T. 22 N., R. 17 E.	Clarence A. Pennings		803	36	20±	5	Opc	20	16	16.11	July 1, 1953	Dom, S.
158	SW¼SW¼ sec. 14, T. 22 N., R. 17 E.	Walter H. Wieckert	1890	864	198		4				102.50	July 1, 1953	Dom, S.
159	NW¼NE¼ sec. 20, T. 21 N., R. 16 E.	Clarence, Harvey, and Stanley Jameson.	1940	806	102	96±	6	Qa			13.96	July 2, 1953	Dom, S.
160	SW¼SW¼ sec. 13, T. 21 N., R. 15 E.	Richard Blunenberg		860	30	30	36	Qa			18.21	July 2, 1953	Dom, S.
161	SW¼SW¼ sec. 13, T. 21 N., R. 15 E.	do		848	12		12	Qa			10.44	July 2, 1953	S.
162	SW¼SW¼ sec. 18, T. 21 N., R. 15 E.	Wilson Grunwald		873	98		4				37.53	July 2, 1953	Dom, S.
163	SW¼SW¼ sec. 6, T. 23 N., R. 18 E.	Ed. Wendt	1944	820	54	19½	6	Osp	10	44			Dom, S.
164	SE¼SW¼ sec. 18, T. 24 N., R. 17 E.	Byron Scott											Dom, S.
165	NE¼SW¼ sec. 10, T. 21 N., R. 17 E.	Clifford Weber	1953	795	39	39	6	Ogp	25	14			Dom.
166	SW¼SW¼ sec. 26, T. 22 N., R. 17 E.	Leroy Giger		820	95	70	6	Ogp	70	25			Dom.
167	SE¼SE¼ sec. 5, T. 22 N., R. 17 E.	Center Valley Coop	1936	819	225	73	6	Ꞓs	125	100			Ind.
168	NE¼NE¼ sec. 8, T. 22 N., R. 17 E.	do	1936	824	196	68	8	Ꞓs	137	59			Ind.
169	SE¼SE¼ sec. 8, T. 23 N., R. 17 E.	Outagamie Producer's Coop.	1942	781	163	143	8	Qa	142	21	12.29	July 13, 1953	Un.
170	NE¼SW¼ sec. 8, T. 24 N., R. 17 E.	Nichols Paper Products		798	131	78	6	Ꞓs	78	53	6.72	July 13, 1953	Un.
171	NE¼SW¼ sec. 18, T. 24 N., R. 17 E.	Lloyd Scott	1949	784	71	54	6	Ꞓs	54	17			Dom.
172	NE¼SW¼ sec. 8, T. 24 N., R. 17 E.	Claude Hansche	1950	798	131	78	6	Ꞓs	78	53			PS.

173	NW¼NE¼ sec. 3, T. 24 N., R. 18 E.	Leonard Colling	1949	867	85	40	6	Ogp					Dom.
174	SE¼NE¼ sec. 4, T. 24 N., R. 18 E	Robert Thies	1951	861	230		6	Ogp	90	140	76.25	Apr. 28, 1954	Dom, S.
175	NW¼NE¼ sec. 5, T. 24 N., R. 17 E.	Ed Kemp	1941	795	151		6	Qa	141	10			Dom, S.
176	NE¼NW¼ sec. 5, T. 24 N., R. 17 E.	J. Ciesielczyk	1951	804	242	236	6	Ꞓs	235	7			Dom, S.
177	NW¼NE¼ sec. 9, T. 24 N., R. 16 E.	Leeman School	1952	797	102	70	6	Ꞓs	68	34			PS.
178	SW¼NE¼ sec. 9, T. 24 N., R. 16 E.	Lewis Reese		799	67		4				11.42	July 14, 1953	Dom, S.
179	SW¼NE¼ sec. 9, T. 24 N., R. 16 E.	Richard Reese		797	140		6				8.01	July 14, 1953	Un.
180	NW¼SW¼ sec. 22, T. 24 N., R. 16 E.	Oakland School	1930	772	137	137	4½	Qa					PS.
181	SE¼SE¼ sec. 7, T. 23 N., R. 17 E.	A. E. Gritt	1938	796	246	246	4½	Qa	246		19.36	July 14, 1953	Un.
182	SE¼SE¼ sec. 7, T. 23 N., R. 17 E.	do	1938	796	72	72	4	Qa	72		30.10	July 14, 1953	Dom, S.
183	NE¼NE¼ sec. 25, T. 24 N., R. 17 E.	Elmer Winters	1942	791	97	97	4½	Qa	40	57	.91	July 15, 1953	S.
184	SW¼NE¼ sec. 27, T. 24 N., R. 17 E.	Robert Mielke		817	143	42	5	Ꞓs	60	83			Dom.
185	NE¼NE¼ sec. 34, T. 24 N., R. 17 E.	Clarence Hurkman		777	739		8				4.00	July 15, 1953	Ind.
186	NW¼SW¼ sec. 28, T. 24 N., R. 17 E.	Carl Mauthe		780	285		10	Ꞓs			12.98	July 15, 1953	Dom.
187	NW¼SW¼ sec. 1, T. 23 N., R. 16 E.	Joe Weber		770	181	171	6	Ꞓs	169	12	1.52	July 15, 1953	Dom, S.
188	SE¼SW¼ sec. 24, T. 24 N., R. 16 E.	John Tiekler	1941	779	103	103	4½	Qa	103		2.25	July 15, 1953	Dom, S.
189	SE¼NE¼ sec. 14, T. 24 N., R. 17 E.	Elmer Mueller		834	51		6				10.95	July 15, 1953	Dom, S.
190	SW¼NW¼ sec. 16, T. 23 N., R. 17 E.	Leo Gauss	1943	811	337	270	6	Qa					
191	SE¼NE¼ sec. 17, T. 23 N., R. 17 E.	Linder Peterson	1943		57	57	6	Qa			12.01	July 16, 1953	Dom, S.
192	SW¼SE¼ sec. 15, T. 23 N., R. 17 E.	Herman Seitz	1915	810	84	60	4	Opc	60	60	17.31	July 16, 1953	Dom, S.
193	SW¼NW¼ sec. 15, T. 23 N., R. 17 E.	Henry Dieterrich	1941	812	154	100?	5	Qa	150	4			Dom, S.
194	NE¼NW¼ sec. 10, T. 22 N., R. 16 E.	Clifford Schlintz	1950	816	80	80	5	Qa			22.80	July 16, 1953	Dom, S.
195	NW¼NE¼ sec. 9, T. 22 N., R. 16 E.	Ellington School	1952	841	175		4	Ꞓs	122	53	38.48	July 16, 1953	PS
196	SW¼NE¼ sec. 4, T. 22 N., R. 16 E.	Carlton Schlintz	1949	913	148	10	6	Ꞓs	61	87	69.77	July 16, 1953	Dom, S.
197	NW¼NW¼ sec. 35, T. 23 N., R. 16 E.	Joe Conrad	1941	796	100	90	4½	Ꞓs	88	12			S.
198	NW¼NW¼ sec. 22, T. 23 N., R. 16 E.	Clinton Mack	1914	767	190		4	Qa			2.46	July 16, 1953	Dom, S.

TABLE 6.—*Records of wells in Outagamie County, Wis.*—Continued

Well No. Ou—	Location	Owner	Year drilled	Altitude of land surface (feet)	Depth of well (feet)	Depth of casing (feet)	Diameter of casing (inches)	Principal aquifer			Water level		Use
								Geologic unit	Depth to top (feet)	Thickness penetrated (feet)	Below land surface (feet)	Date of measurement	
199	NE¼NW¼ sec. 18, T. 23 N., R. 17 E.	W. G. Bishoff	1953	783	68	68	6	Qa	63	5	16.58	July 16, 1953	Dom, S.
200	NW¼NW¼ sec. 27, T. 21 N., R. 15 E.	Milo Hauk	1937	785	66	22	4	Ꞓs	55	11			Dom.
201	NE¼NE¼ sec. 6, T. 23 N., R. 18 E.	Joe Hein	1941	855	105	14	5	Osp	39	66			Dom, S.
202	NW¼NE¼ sec. 12, T. 23 N., R. 17 E.	Mrs. Rheinhold Miller	1944	785	114	114	6	Osp	96	18			Dom, S.
203	NW¼NW¼ sec. 8, T. 23 N., R. 18 E.	Mrs. Warren Barclay	1900±	864	95	15±	4	Osp			58.09	July 22, 1953	Un.
204	SW¼SW¼ sec. 17, T. 23 N., R. 18 E.	Charles Baumgartner	1949	811	127	89	6	Osp			15.14	July 22, 1953	Dom, S.
205	SW¼SW¼ sec. 28, T. 23 N., R. 18 E.	Golden Rule School		805	45		6				7.62	July 22, 1953	PS.
206	NE¼NE¼ sec. 32, T. 23 N., R. 18 E.	Carlton Sievert		808	40		4	Ogp	13	27	11.76	July 22, 1953	Un.
207	NE¼NW¼ sec. 32, T. 23, N., R. 18 E.	do	1952	824	200	31½	6	Osp			53.17	July 22, 1953	Dom, S.
208	SE¼SW¼ sec. 29, T. 23 N., R. 18 E.	Harvey Thomas	1952	805	81	20	6	Osp	42	39			
209	SW¼NW¼ sec. 35, T. 23 N., R. 18 E.	Louis Planert		758	156		6				17.99	July 22, 1953	Un.
210	SE¼NE¼ sec. 14, T. 23 N., R. 18 E.	Heitpas		774			6				17.87	July 22, 1953	S.
211	NE¼SE¼ sec. 8, T. 24 N., R. 18 E.	Tesch Bros		903	130		6	Ogp	90	40	48.04	July 23, 1953	Un.
212	NE¼NE¼ sec. 6, T. 24 N., R. 18 E.	Lawrence Grochowski		886	55		4				16.69	July 23, 1953	Un.
213	NW¼NE¼ sec. 6, T. 24 N., R. 18 E.	do		875	90		4				22.45	July 23, 1953	Dom, S.
214	NE¼NE¼ sec. 4, T. 24 N., R. 17 E.	Benny Banker		872			4	Opc			30.90	July 22, 1953	Dom, S.
215	NW¼NW¼ sec. 12, T. 24 N., R. 16 E.	Alvin Carpenter		792	78	78					6.20	July 23, 1953	Dom, S.
216	SW¼SW¼ sec. 23, T. 24 N., R. 16 E.	Louis Planert	1951	790			4				12.07	July 23, 1953	Dom, S.
217	SW¼SW¼ sec. 27, T. 24 N., R. 16 E.	George Gomm		775	45		3				7.89	July 23, 1953	Un.

218	SE¼NW¼ sec. 10, T. 23 N., R. 16 E.	Ralph E. Gehring	1951	771	254		4						
219	NW¼NW¼ sec. 35, T. 24 N., R. 17 E.	William Grunwaldt	1949	775	197	197	6	Qa					Dom.
220	NW¼SE¼ sec. 25, T. 24 N., R. 17 E.	Ernest Ossmann	1953	769	60	60	6	Qa			17.34	July 27, 1953	Un.
221	NE¼NE¼ sec. 4, T. 23 N., R. 19 E.	Sacred Heart Seminary		740							52	July 1953	PS.
222	SE¼SW¼ sec. 27, T. 24 N., R. 16 E.	Jack Newland		770	268			Ꞓs	238	30			
223	NE¼NE¼ sec. 9, T. 24 N., R. 19 E.	L'Onnaye School		760±									PS.
224	SE¼NW¼ sec. 18, T. 23 N., R. 17 E.	W. C. Bishoff	1953		37	32	6	Qa	32	5			
225	SW¼SW¼ sec. 17, T. 24 N., R. 16 E.	Michael McHugh		786	246	246	5	Qa	246		5.78	July 29, 1953	Dom, S.
226	SW¼NE¼ sec. 30, T. 24 N., R. 15 E.	Flanagan Bros. Inc	1936±										Ind.
227	NW¼NW¼ sec. 30, T. 24 N., R. 15 E.	Paul L. Downs	1948	857	106	101	4	Qa	90	16			Dom.
228	NE¼NW¼ sec. 30, T. 24 N., R. 15 E.	Bear Creek High School	1953	862	137	137	6	Qa					PS.
229	NE¼NW¼ sec. 30, T. 24 N., R. 15 E.	St. Mary's Congregation	1951	862	180	175	6	Qa	175	5	62.98	July 20, 1953	PS.
230	SW¼SW¼ sec. 28, T. 24 N., R. 15 E.	Herbert Poppe	1938	795	159	159	4	Qa	151	8			Dom.
231	SE¼SE¼ sec. 29, T. 24 N., R. 15 E.	do		789	100±						4.62	July 29, 1953	
232	NW¼SW¼ sec. 7, T. 23 N., R. 15 E.	Richard Thurk	1949	827	100	100	2	Qa	80	20			Dom, PS.
233	NE¼NE¼ sec. 4, T. 23 N., R. 15 E.	Edward Voss	1949	782	81	77	6	Qa	65	16			Dom, S.
234	SW¼NW¼ sec. 1, T. 23 N., R. 15 E.	Riverbend School		773	7½		36				4.82	July 30, 1953	PS.
235	NW¼SW¼ sec. 19, T. 22 N., R. 15 E.	Jess Lathrop	1895		195	195	4	Qa	189	8			Dom, S
236	SW¼SE¼ sec. 19, T. 22 N., R. 15 E.	Herbert Lathrop		784	45	45	2				1.01	Sept. 1, 1953	Un.
237	SW¼NE¼ sec. 17, T. 22 N., R. 15 E.	Franklin Runge		773	33+		2½				4.69	Sept. 1, 1953	Dom.
238	SW¼NW¼ sec. 13, T. 22 N., R. 15 E.	Rankin		776	35+		4				8.42	Sept. 1, 1953	Un.
239	SW¼SE¼ sec. 6, T. 23 N., R. 15 E.	Clover Blossom School	1953	809	111	111	2½	Qa					PS.
240	SW¼SE¼ sec. 6, T. 23 N., R. 15 E.	do		808	81½	81½	2½	Qa			10.53	Sept. 2, 1953	Un.
241	SW¼SE¼ sec. 29, T. 23 N., R. 15 E.	Pribbernow Bros		809	45+		6				30.27	Sept. 3, 1953	S.
242	NW¼NE¼ sec. 29, T. 23 N., R. 15 E.	Stanley Ziemer		802	25	25	2	Qa			11.41	Sept. 3, 1953	Un.
243	SW¼SE¼ sec. 16, T. 23 N., R. 15 E.	Anthony Young		769							5.31	Sept. 3, 1953	Dom, S.

TABLE 6.—*Records of wells in Outagamie County, Wis.*—Continued

Well No. Ou—	Location	Owner	Year drilled	Altitude of land surface (feet)	Depth of well (feet)	Depth of casing (feet)	Diameter of casing (inches)	Principal aquifer			Water level		Use
								Geologic unit	Depth to top (feet)	Thickness penetrated (feet)	Below land surface (feet)	Date of measurement	
244	NW¼SE¼ sec. 17, T. 24 N., R. 15 E.	W. T. Nielson		795	16		24	Qa			12.35	Sept. 3, 1953	Un.
245	SW¼NW¼ sec. 9, T. 24 N., R. 15 E.	Owen Nielson		789	14		36	Qa			8.07	Sept. 3, 1953	Dom, S.
246	SE¼SE¼ sec. 6, T. 24 N., R. 15 E.	E. Meidam	1908	798	50		4				4.47	Sept. 3, 1953	Dom. S.
247	NE¼SE¼ sec. 18, T. 24 N., R. 15 E.	L. Meidam		793			4				3.80	Sept. 3, 1953	Dom, S.
248	SW¼SE¼ sec. 35, T. 22 N., R. 15 E.	Fox Valley Canning Co.		789	82		6				16.1	July 21, 1953	Ind.
249	NW¼SE¼ sec. 35, T. 22 N., R. 15 E.	Dr. F. W. Cousineau		778	61		4						Dom.
250	SW¼SE¼ sec. 35, T. 22 N., R. 15 E.	Fox Valley Canning Co.		789	180						8.87	July 21, 1953	Un.
251	SE¼SW¼ sec. 35, T. 22 N., R. 15 E.	Claire Poole		820	58		4				31	Oct. 19, 1953	Un.
252	SW¼SE¼ sec. 35, T. 22 N., R. 15 E.	Melvin Buesing		790	56		4				2.24	July 23, 1953	Un.
253	SW¼SW¼ sec. 27, T. 21 N., R. 17 E.	Stokely-Van Camp	1934	802	480	141	12	€s	307	173			Ind.
254	NE¼NW¼ sec. 34, T. 21 N., R. 17 E.	Appleton Wood Products Co.	1917	803	147		4				67.99	Sept. 30, 1953	Un.
255	NE¼NW¼ sec. 34, T. 21 N., R. 17 E.	Wisconsin Distributing Co.		802	300						78.55	Sept. 30, 1953	Ind.
256	SW¼SW¼ sec. 27, T. 21 N., R. 17 E.	City of Appleton	1900	803	96						78.88	Sept. 30, 1953	Un
257	SE¼NE¼ sec. 8, T. 24 N., R. 15 E.	Harvey Borg	1949	794	103	98	5				8.82	Oct. 8, 1953	Dom, S.
258	NW¼NW¼ sec. 32, T. 21 N., R. 16 E.			770	17		4				7.15	Oct. 14, 1953	Un.
259	NE¼NW¼ sec. 10, T. 22 N., R. 17 E.	Clarence Pennings	1954	813	135	36	6	Opc	34	101	20.69	Apr. 23, 1954	Dom, S.
260	NW¼NW¼ sec. 8, T. 23 N., R. 17 E.	Albert Stephani		769	20	20	2	Qa					Un.
261	SW¼SE¼ sec. 29, T. 24 N., R. 15 E.	Clover Lawn School District 1.		791				Qa			6.29	July 29, 1954	PS.
262	SE¼SW¼ sec. 29, T. 23 N., R. 15 E.	Golden Hill School Joint District 2.		813			4				38.66	July 28, 1954	PS.

263	SW¼NW¼ sec. 24, T. 22 N., R. 16 E.	Carl Timm	1953	776	342	172	6	€s	180	162			Dom.
264	NE¼NE¼ sec. 5, T. 22 N., R. 16 E.	Harold Conradt		803									Dom.
265	SW¼SE¼ sec. 32, T. 23 N., R. 16 E.	do		770			4				Flowing	Sept. 1, 1954	Un.
266	NW¼SW¼ sec. 17, T. 22 N., R. 16 E.			768			2				Flowing	Sept. 1, 1954	S.
267	NW¼SW¼ sec. 13, T. 22 N., R. 16 E.	Edw. Halloran	1953	800	100	100	6	Qa	96	4			S.
268	SW¼SW¼ sec. 29, T. 23 N., R. 17 E.	Black Creek School District 4.	1942	827	56	30	4½						Un.
269	SW¼SW¼ sec. 29, T. 23 N., R. 17 E.	Black Creek School District 4.	1953	827	43	43	6	€s	61	97			PS.
270	SE¼NW¼ sec. 9, T. 21 N., R. 15 E.	Unused School		839			4				17.17	Sept. 2, 1954	Un.
271	SE¼NW¼ sec. 13, T. 22 N., R. 16 E.	John McCandless	1938	799	84	37	4½	€s	37	47	9.01	Oct. 7, 1954	Dom.
272	SE¼NW¼ sec. 17, T. 22 N., R. 16 E.	Wm. Cummings	1954	806	125	65	6	€s	65	60	34.31	Oct. 7, 1954	Dom, S.
273	SW¼NE¼, sec. 17, T. 22 N., R. 16 E.	Peter Wied	1954	834	85	43	6	€s	27	58			Dom.
274	SW¼SW¼ sec. 27, T. 24 N., R. 18 E.	Seymour Creamery	1947±	802	235	96		Ogp, Opc.	96	139			Ind.
275	SW¼SW¼ sec. 8, T. 22 N., R. 16 E.	T. L. Knapstein	1952±	760±	205	140	3	Qa	140	65	Flowing	Oct. 8, 1954	Dom.
276	SE¼SW¼ sec. 20, T. 24 N., R. 17 E.	Wm. Marcks	1954	780	150±		6	€s	130	20			Dom.
277	NW¼SW¼ sec. 28, T. 24 N., R. 17 E.			780	91			€s	280	220			Oil test.
278	SE¼NE¼ sec. 11, T. 24 N., R. 17 E.	School District	1941	862	91	38	4½	Opc	427	64			PS.
279	NE¼NE¼ sec. 1, T. 24 N., R. 18 E.	County Line School	1946	804	63	40	6	Ogp	38	25			PS.
280	SW¼SW¼ sec. 27, T. 21 N., R. 17 E.	Stokely-Van Camp	1954	804	745	152	16	€s	315	428			Ind.
281	NE¼NE¼ sec. 31, T. 24 N., R. 18 E.	Crystal Spring School		776	80		4½	Qa					PS.
282	NW¼NE¼ sec. 31, T. 24 N., R. 18 E.	K. Kollath		776	130	80	4½	Qa					Dom, S.
283	SW¼NW¼ sec. 24, T. 22 N., R. 17 E.	A. Techlin	1942	861	355	168	5	€s	258	97			Dom, S.
284	SW¼SW¼ sec. 8, T. 24 N., R. 19 E.			771	70±		6				12.39	Nov. 18, 1954	S.
285	NE¼NW¼ sec. 7, T. 21 N., R. 17 E.	School District 9	1954	852	154	42	6	Ogp	42	112			PS.
286	SW¼NE¼ sec. 33, T. 23 N., R. 16 E.	W. Williams	1902	820	102	77	4	€s	77	25			
287	SW¼NW¼ sec. 3, T. 23 N., R. 15 E.			783	200±			Qa	40	160+			

Drilled wells range in diameter from 3 to 16 inches, depending upon the size and type of pump to be used and the yield required. Those ending in consolidated rock are usually cased only through the drift; those penetrating just the drift use perforated casing or screen to keep the hole open and to allow water to enter the well. Some wells ending in coarse sand or gravel are cased with unperforated pipe, and water enters through the open bottom of the casing.

When a relatively small quantity of water is needed for stock or domestic use, a well may be driven into sandy deposits of the glacial drift or lake sediments. Such wells are usually 1¼ to 2½ inches in diameter and have a well point or a length of slotted pipe near the bottom. The driven well is best suited to the sandy areas in the northwestern quarter of the county.

A few dug wells are still in use for domestic and stock supplies, but most of them have been replaced by drilled or driven wells. The dug wells are 3 to 5 feet in diameter and as much as 30 feet deep. They have been dug by hand or by power shovel and are lined with stone to prevent caving. The material penetrated must be firm and must stand without caving, so the wells are usually dug through clay to the top of a more permeable underlying bed.

Twenty-four of the wells visited exceed 500 feet in depth. Of these, 20 are industrial or municipal wells along the Fox River. The deepest well visited is Ou 35, drilled for the Village of Kimberly and ending in granite at 804 feet. The average depth of the 257 wells whose depth is known is 195 feet, the median depth of the same wells is 127 feet—that is, 128 wells are less than and 128 wells are more than 127 feet deep.

SPRINGS

A spring is the discharge of ground water, under hydrostatic pressure, at the land surface or into lakes and streams. There are many different types of springs, but the two most common in Outagamie County may be classed as seepage and contact springs. Seepage springs represent an outcrop of the water table and may disappear during periods of water-table decline. They are most numerous in the low, marshy areas along the Wolf and Embarrass Rivers, where there is a considerable amount of effluent seepage. Although most marshy areas are the result of effluent ground-water seepage, in most places the seepage is not concentrated enough to be classed as a spring.

Contact springs occur when the contact between a permeable and an impermeable formation is exposed at the surface. Along the Fox River, ground water percolates downward through the glacial drift to the top of the less permeable Platteville formation, where some of the water moves laterally toward the river and issues as springs along the sides of the valley. At the base of the escarpment of Prairie du

Chien rocks between Hortonville and New London the process is reversed. Here artesian water rising in the permeable sandstone of Cambrian age is partly retarded by the overlying dolomite of the Prairie du Chien group and flows to the surface along the contact near the base of the scarp.

Weidman and Schultz report that springs were a common source of water supply in the county at the time of their report (1915), but now few are in use.

PUMPING TESTS

Determination of the hydraulic characteristics of an aquifer is essential in predicting the effects of withdrawal of water from it. The term coefficient of transmissibility is used to designate the amount of water, in gallons, that will pass in 1 day across a vertical strip of the aquifer, 1 foot wide and extending the full thickness of the aquifer, under a unit hydraulic gradient. The coefficient of storage of an aquifer is the volume of water it releases from or takes into storage per unit surface area of the aquifer per unit change in the component of head normal to that surface.

The most reliable short-term method of determining the hydraulic characteristics of an aquifer is to apply the nonequilibrium formula of Theis (1935) to observations of the amount and rate of change in the piezometric surface at or near a discharging well.

The nonequilibrium formula is:

$$s = \frac{114.6\,Q}{T} W(u)$$

where

$$W(u) = \int_u^\infty \frac{e^{-u}du}{u} = -0.577216 - \log_e u + u - \frac{u^2}{2\cdot 2!} + \frac{u^3}{3\cdot 3!} - \frac{u^4}{4\cdot 4!} \cdots$$

and

$$u = \frac{1.87 r^2 S}{Tt}$$

where s = drawdown, in feet, at observation well
Q = discharge, in gallons per minute
T = coefficient of transmissibility, in gpd/ft
r = distance, in feet, from observation well to pumped well
S = coefficient of storage
t = time, in days, since pumping started

To develop the formula it was assumed that the aquifer is infinite in extent and confined between impermeable beds, that it transmits water equally in all directions and releases water from storage instantaneously with a decline in artesian head, and that its hydraulic characteristics do not change. It is recognized that these are ideal conditions which are never completely satisfied in nature, but in many areas they are substantially satisfied.

SEYMOUR TESTS

The pumping tests at Seymour in April 1949 consisted of pumping wells that tap sandstone of Cambrian age and observing the effects produced on the piezometric surface. Water-level measurements were made with a steel tape in wells Ou 10 and 11 and with an air line in well Ou 1. Well Ou 7 was equipped with a water-stage recorder which made a continuous record of the water level in the well. The hydrographs (pl. 6) show the decline and recovery of water levels in three observation wells and the drawdown and recovery in the pumped well. Distances between wells are given in table 7, and computed values of the coefficients of transmissibility and storage are listed in table 8.

TABLE 7.—*Distances, in feet, between pumped well and observation wells used during pumping tests at Seymour, Wis.*

Pumped well	Observation well		
	Ou 7	Ou 10	Ou 11
Ou 1	2,890	1,595	368
Ou 10	2,390		1,875

TABLE 8.—*Coefficients of transmissibility and storage at Seymour, Wis., Apr. 18–22, 1949*

Pumped well Ou—	Observation well Ou—	Coefficient of transmissibility (gpd/ft)	Coefficient of storage	Duration of test (hours)
1 on		24,000		17½
	7	18,000	0.0002	17
	10	17,000	.0002	17
	11	[a] 15,000	[a] .0027	17
1 off		15,000		26
	7	19,000	.0002	19
	10	16,000	.0002	19
	11	[a] 21,000	[a] .0022	19
10 on		17,000		21½
	1	17,000	.0003	21½
	7	16,000	.0002	21½
	11	[a] 24,000	[a] .0010	21½
10 off		16,000		14
	1	18,000	.0003	12
	7	18,000	.0002	10½
	11	[a] 53,000	[a] .0014	12
Average		18,000	.0002	

[a] Not figured in average because well is shallow and penetrates a zone separated from principal aquifer by a shaly horizon.

Wells Ou 1 and 10 are deep wells which penetrate more than 200 feet of the sandstone. Well Ou 7 is drilled about 15 feet into the sandstone, and well Ou 11 is a shallow well which may be separated from the sandstone by several feet of shale. The shallow penetration of wells Ou 7 and 11 is reflected in their hydrographs, which show a relatively narrow range of fluctuations during the tests. For example, the water level in well Ou 11 was lowered less than 8 feet when well Ou 1 was pumped, whereas the water level in well Ou 10, at a much greater distance from the pumping well, was lowered nearly 6 feet during the same period. The small irregularities in the hydrograph of well Ou 7 were caused by the pumping of a shallow well nearby.

APPLETON TEST

In March 1954 a test was made in Appleton, using well Ou 22 as the pumped well and well Ou 253 as an observation well. The wells are 1,115 feet apart and both are open in the St. Peter sandstone, the dolomite of the Prairie du Chien group, and the underlying sandstone of Cambrian age. The average coefficient of transmissibility obtained from the drawdown and recovery tests is about 19,000 gpd per foot. The average coefficient of storage for the two tests is about 0.00015. The coefficients are based on measurements in only one observation well and may not be representative. However, they are in close agreement with values obtained in the Seymour tests, and the specific capacities of the wells are similar to those of other wells in the Appleton area.

HORTONVILLE TESTS

In Hortonville, pumping tests were made in October 1953 using wells Ou 33 and 80 as pumped wells and Ou 81 and 248–252 as observation wells. The pumped wells tap sandstone of Cambrian age which lies immediately below the glacial drift in this area.

Values obtained for the coefficient of transmissibility (T) range from about 27,000 to about 75,000 gpd per foot and average about 43,000 gpd. Values of the coefficient of storage (S) range from about 0.00006 to about 0.0009 and average about 0.0004. The wide range in T and S values, which is attributed to local recharge and the fact that some of the observation wells may terminate in the glacial drift, make it impossible to apply the values to a prediction of interference or water-level trends.

QUALITY

Chemical analyses of 37 samples of ground water from Outagamie County are listed in table 9. The chemical quality of the water differs greatly from well to well. For example, the mean hardness is about 385 ppm (median 300 ppm), but the range in hardness is from 1,200 ppm to 58 ppm. Although the water generally is very hard, the dissolved-solids content averages about 540 ppm (median about 350 ppm); a limit of 500 ppm is recommended by the U. S. Public Health Service (1946) for drinking and culinary water. The sulfate concentration ranges from 815 ppm to less than 1 ppm and averages about 169 ppm (median 30 ppm). The limit suggested by the Public Health Service for sulfate is 250 ppm. High iron content is a problem in many wells. A concentration of 27 ppm is reported in well Ou 56. However, in 34 analyses listed in table 9 the range is from 4.0 ppm to 0.0 ppm and the average is about 0.8 ppm (median 0.4 ppm). The median is 0.1 ppm above the limit set by the Public Health Service for iron, or iron and manganese together.

TABLE 9.—*Chemical analyses of ground water in Outagamie County, Wis.*

[Results in parts per million except pH; analyses by Wisconsin State Board of Health]

Well No. Ou—	Date of collection	Dissolved solids	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Hardness as $CaCO_3$	pH
1	1935	221	1.4	--	--	193	8	5	--	150	--
2	[a] 1911	1,350	--	272	21	--	604	12	--	765	--
	1935	1,460	.4	--	--	209	815	15	--	970	--
10	Aug. 7, 1946	328	1.2	69	30	373	20	2.5	0.2	285	7.4
17	([a])	647	--	158	31	--	296	7.1	--	522	--
26	1946	310	.8	70	27	331	30	3.5	.5	265	7.4
33	Mar. 11, 1949	346	.0	73	34	423	3.0	2.0	.1	320	7.4
34	1935	480	.3	--	--	376	122	10	--	450	--
36	do	475	.5	--	--	293	152	8.0	--	380	--
44	do	960	--	--	--	224	481	10	--	620	--
	Mar. 6, 1946	1,040	.3	261	16	212	560	11	2.0	585	7.3
45	do	1,220	.4	312	16	222	660	14	2.0	670	7.3
46	Sept. 30, 1946	590	.2	135	20	257	245	12	1.9	385	7.4
47	do	548	.2	125	16	245	210	12	2.0	300	7.4
48	Apr. 8, 1954	1,670	1.8	362	68	456	725	28	1.0	1,200	7.1
54	do	354	.1	65	19	183	108	5.5	1.9	244	7.8
65	Apr. 23, 1954	1,020	.5	171	64	449	330	8.0	1.2	732	7.3
71	Feb. 16, 1950	180	.0	20	17	190	11	4.0	.2	120	7.7
72	1935	246	.2	--	--	268	22	8	--	260	--
73	do	279	.4	--	--	309	16	3	--	250	--
74	Apr. 23, 1954	302	.2	31	26	232	16	2.0	.2	176	8.1
85	Mar. 25, 1954	368	1.2	58	43	381	24	14	.1	341	7.6
87	do	370	.0	68	36	327	24	6.0	<.1	322	7.6
91	do	300	.6	34	40	320	12	3.5	.2	270	7.9
103	Apr. 8, 1954	1,010	.4	142	29	78	500	41	1.4	475	7.7
105	Mar. 25, 1954	290	4.0	56	34	356	2.5	2.0	.2	288	7.8
111	Apr. 8, 1954	298	.4	41	30	307	13	5.5	.7	235	7.7
114	do	520	1.6	87	44	417	49	44	<.1	403	7.4
125	Apr. 23, 1954	218	.1	31	20	217	22	2.0	.9	164	7.8
133	do	352	4.0	68	30	325	33	1.5	.1	299	7.3
138	do	288	1.6	56	29	320	7.0	1.5	.4	262	7.7
159	Apr. 8, 1954	258	.3	29	36	278	21	3.0	.2	236	8.0
165	Mar. 25, 1954	362	.6	53	39	412	2.0	2.5	.4	330	7.8
187	Apr. 23, 1954	196	.0	16	4.8	120	47	10	.6	58	8.3
196	do	630	1.2	98	50	400	73	35	<.1	472	7.4
259	do	296	1.0	26	41	354	.0	3.0	.3	268	7.7
260	do	238	.1	29	25	264	.5	2.0	.4	181	8.0

[a] Weidman, Samuel, and Schultz, A. R., 1915, p. 493.

Information on the chemical character of ground water is important to all users of this valuable resource. It is also an important tool for use by the hydrologist interested in the source and movement of water. A table of analyses, such as table 9, presents the available data but the form is not readily adaptable for interpretive work. In the past, several illustrative methods have been used to show the similarity or dissimilarity of various waters. These methods include the bar graph, the pie diagram, the trilinear plot, and others, each of which has advantages and disadvantages. R. C. Vorhis of the U. S. Geological Survey has suggested for interpretive work the use of a logarithmic diagram (Schoeller, 1935) adopted by the French hydrogeologists in Tunisia, Algeria, and French Morocco. The diagram consists of vertical logarithmic scales for constituents and properties, and the graph is a series of straight-line segments connecting the values plotted for each analysis (pl. 7). The similarity or difference of two analyses is readily apparent from a comparison of their graphs.

Logarithmic graphs for 22 analyses are shown on plate 7. They are grouped by geologic source to show that the source is the predominant factor in determining the pattern of the graph. The form of the graphs in diagram *A* is distinctive and is characteristic for wells that tap all the Paleozoic formations below the Maquoketa shale. Water from the Maquoketa shale is similar to, but more highly mineralized than, water from the Platteville and Galena formations (diagram *B*). Water from rocks of the Upper Cambrian series (diagram *C*) is generally characterized by a low chloride and sulfate content. Well Ou 10, which does not fit this pattern, is an old well cased through the Prairie du Chien. However, the graph for Ou 10 closely resembles those of diagram *D*, indicating that water from the Prairie du Chien must be entering the well through a defective casing, raising the sulfate content of the water sampled. The patterns of diagrams *D* and *E* are noticeably alike. They represent water from similar material but of a different age.

The graphs for well Ou 114 (diagram *C*), Ou 196 (diagram *D*), and Ou 85 (diagram *E*) are anomalous because of an abnormally high chloride content. This is attributed to their location near poorly drained, marshy areas where the chloride concentration of the water is increased by surface evaporation of the stagnant water. The pattern of diagram *F*, representing water from Pleistocene deposits, is somewhat similar to that of diagrams *D* and *E*, except for the nearly straight line formed by the calcium-magnesium-hardness plot.

The logarithmic diagram has been useful in the study of the geology and ground water of Outagamie County. Although a limited number of analyses were made and plotted, a definite tendency toward characteristic patterns for the various sources of water was evident. Where other evidence was inconclusive, comparisons of water-analysis graphs helped in determining the source and movement of water and in establishing geologic boundaries.

CONCLUSIONS

More than three-fourths of Outagamie County is underlain by thick beds of sandstone of Cambrian age which supply most of the water to industrial and public-supply wells along the Fox River. Consolidated rocks of the St. Peter sandstone, Platteville formation and Galena dolonite, and Prairie du Chien group and unconsolidated deposits of Pleistocene age are tapped by many domestic and farm wells and probably could be developed to a much greater extent. An especially promising reservoir is the buried preglacial valley that heads near Seymour.

Recharge occurs throughout most of the county but is greatest in areas where the sandstones are at or near the surface. Practically all recharge is from local precipitation. Ground-water discharge occurs naturally by flow from contact and seepage springs; by diffused seepage into swamps, from which it is evaporated and transpired, and into streams; and by underflow to the south and east.

Ground-water pumpage along the Fox River in Outagamie County was about 4.3 mgd in 1952. There is no evidence of overdraft at present, but additional pumping tests should be made to determine the acquifer characteristics in localities other than the few already tested, to enable prediction of water-level trends and interference that would result from additional development.

WELL LOGS

Tables 10 and 11 contain selected logs of wells drilled in Outagamie County. The descriptions and stratigraphic correlations in table 10 are by F. T. Thwaites of the Wisconsin Geological Survey from his examination of drill cuttings from each well. In table 11, descriptions of the material penetrated are those of the driller and stratigraphic correlations are by the author.

Logs of 337 wells were collected from several sources during the investigation. Of these, 161 were located in the field, 49 logs were used in construction of the geologic sections, and 45 logs are published in tables 10 and 11. Essentially all drilling in the county is by the cable-tool method. This method, when used by experienced drillers facilities accurate logging of wells.

TABLE 10.—*Materials penetrated by wells in Outagamie County, Wis.*

[Interpretation by F. T. Thwaites, Wisconsin Geological Survey, on basis of examination of drill cuttings]

Well Ou 2, NE¼SW¼ sec. 24, T. 21 N., R. 18 E.

	Thickness (feet)	Depth (feet)
Galena Dolomite and Platteville formation:		
Limestone	170	170
St. Peter sandstone:		
Dolomite, light-gray	3	173
Sandstone, medium- to fine-grained, gray, dolomitic	13	186
Sandstone, fine-grained; pebbles, pink; chert, white	14	200
Prairie du Chien group:		
Dolomite, light-gray; some shale, green	42	242
Sandstone, medium-grained, white; chert, white; shale, green	11	253
Dolomite, light-gray; some chert, white	115	368
Upper Cambrian series:		
Sandstone, fine-grained, light-gray; shale, red, dolomitic	12	380
Dolomite, dark-red	23	403
Sandstone, medium-gray; some pink and red, dolomitic	105	508
Sandstone, medium-grained, white	177	685
Sandstone, medium-grained, white, some red, dolomitic	15	700
Sandstone, medium- to fine-grained, white	78	778
Precambrian:		
Granite, red and gray	20½	798½

Well Ou 5, SW¼SE¼ sec. 4, T. 21 N., R. 19 E.

	Thickness (feet)	Depth (feet)
Glacial drift:		
No samples	66	66
Galena dolomite and Platteville formation:		
Dolomite, gray	29	95
Dolomite, gray; some bluish-gray	15	110
Dolomite, light bluish-gray	5	115
Dolomite, gray and blue	24	139
Dolomite, blue; some gray	6	145
Dolomite, light and dark-gray	20	165
Dolomite, light-gray	5	170
Dolomite, dark-blue; some gray	17	187
Dolomite, gray	45	232
Dolomite, gray, very sandy	5	237
St. Peter sandstone:		
Sandstone, coarse- to medium-grained, gray	11	248
Sandstone, medium-grained, white	58	295
Sandstone, medium-grained, white and pink	17	312
Sandstone, medium-grained, white	21	333
Sandstone, medium- to fine-grained, very light gray	50	383
Sandstone, medium-grained, coarse, white	5	388
Sandstone, medium-grained, white	20	408

Well Ou 19, NE¼NW¼ sec. 35, T. 21 N., R. 17 E.

	Thickness (feet)	Depth (feet)
Glacial drift:		
No samples	24	24
Galena dolomite and Platteville formation:		
Dolomite, blue-gray and gray	16	40
Dolomite, light-gray; chert, white	10	50
Dolomite, light-gray	30	80
Sandstone, fine- to medium-grained, light-gray, dolomitic; dolomite, very light gray	20	100
Prairie du Chien group:		
Dolomite, light-gray, sandy	10	110
Dolomite, light-gray	30	140
Dolomite, light-gray; sandstone, medium-to fine-grained, light-gray	5	145
Dolomite, light-gray	15	160
Dolomite, light-gray; chert, white	55	215
Dolomite, light-gray	60	275
Sandstone, fine- to medium-grained, light-gray, pink, dolomitic; chert	15	290
Upper Cambrian series:		
Sandstone, fine-grained, pink, dolomitic	10	300
Dolomite, sandy, red, gray, glauconitic	15	315
Sandstone, fine-grained, gray, red, dolomitic, glauconitic	10	325
Sandstone, medium- to fine-grained, light-gray, dolomitic; shale, red	45	370
Sandstone, medium- to fine-grained, light-gray, dolomitic	20	390
Sandstone, very fine to medium-grained, light-gray, dolomitic	15	405
Sandstone, coarse- to fine-grained, light-gray, dolomitic	15	420
Sandstone, fine- to medium-coarse-grained, light-gray	30	450

TABLE 10.—*Materials penetrated by wells in Outagamie County, Wis.*—Continued

Well Ou 23, NW¼NW¼ sec. 34, T. 21 N., R. 17 E.

	Thickness (feet)	Depth (feet)
Glacial drift:		
Till, red	18	18
Clay, red, dolomitic	30	48
Clay, red, sandy, dolomitic	6	54
No sample	5	59
Till, stony, gray	20	79
Gravel, fine, very stony	10	89
Sand and gravel	5	94
Gravel, stony	5	99
Galena dolomite and Platteville formation:		
Dolomite, light-gray, broken	10	109
Dolomite, light blue-gray; some light gray	10	119
Sandstone, medium-grained, light-gray, very dolomitic	5	124
No sample	5	129
Prairie du Chien group:		
Dolomite, sandy, light-gray	10	139
Dolomite, light-gray	75	214
No sample	5	219
Dolomite, light-gray; chert, white	20	239
Dolomite, light-gray	35	274
Dolomite, light-gray; shale, red	15	289
Dolomite, light-gray, gray, pink	10	299
Dolomite, gray; chert, gray, oolitic	5	304
No sample	5	309
Upper Cambrian series:		
Dolomite, sandy, light-gray, pink, glauconitic	15	324
Dolomite, sandy, dark-red	15	339
Sandstone, fine-grained, pink	21	360
Sandstone, fine- to medium-grained, light-gray, dolomitic, glauconitic	15	375
Sandstone, medium- to fine-grained, light-gray, dolomitic	35	410
Sandstone, fine-grained, light-gray, dolomitic	35	445
Siltstone, gray to light-gray, dolomitic	10	455
Sandstone, fine- to coarse-grained, light-gray, dolomitic	15	470
Sandstone, medium- to fine-grained, white, slightly dolomitic	68	538

Well Ou 24, NW¼NW¼ sec. 25, T. 21 N., R. 17 E.

	Thickness (feet)	Depth (feet)
Glacial drift:		
No samples	111	111
Galena dolomite and Platteville formation:		
Dolomite, gray	11	122
Dolomite, gray; blue spots	21	143
Dolomite, very light gray, sandy, pyritic	5	148
Prairie du Chien group:		
Dolomite, gray, blue spots, pyritic	5	153
Dolomite, gray, blue spots, sandy	10	163
Dolomite, very light gray and gray, sandy	15	178
Dolomite, light-gray	46	224
Dolomite, gray, greenish-gray, sandy, cherty	12	236
Dolomite, light-gray; some white chert	19	255
Dolomite, light-gray	53	308
Dolomite, light-gray, greenish-gray, red	5	313
Dolomite, light-gray	21	334
Dolomite, red, sandy; chert, pink, oolitic	10	344
Upper Cambrian series:		
Sandstone, medium-grained, pinkish-gray, dolomitic	10	354
Sandstone, medium-grained, light-gray, dolomitic	8	362
Sandstone, very fine grained, red, very dolomitic	15	377
Sandstone, fine-grained, gray, very dolomitic, glauconitic	28	405
Sandstone, medium- to coarse-grained, gray, dolomitic	36	441
Sandstone, medium-grained, white, slightly dolomitic	20	461
Sandstone, medium- to fine-grained, light-gray, dolomitic	17	478
Shale, gray, very sandy, dolomitic	16	494
Sandstone, medium- to coarse-grained, gray, dolomitic	7	501

Well Ou 26, SE¼SE¼ sec. 20, T. 21 N., R. 17 E.

	Thickness (feet)	Depth (feet)
Glacial drift:		
Clay	25	25
Till, gray, dolomitic	10	35
Gravel, fine; much silt	10	45
Galena dolomite and Platteville formation:		
Dolomite, gray, light-gray; some blue specks	20	65
Dolomite as above; sandstone, medium- to fine-grained, light-gray, dolomitic	10	75

TABLE 10.—*Materials penetrated by wells in Outagamie County, Wis.*—Continued

Well Ou 26, SE¼SE¼ sec. 20, T. 21 N., R. 17 E.—Continued

	Thickness (feet)	Depth (feet)
Prairie du Chien group:		
Dolomite, light-gray	30	105
Dolomite, light-gray; chert, white, oolitic	15	120
Dolomite, light-gray, sandy; chert, white	10	130
Dolomite, light-gray	20	150
Dolomite, light-gray; some chert, white	15	165
Dolomite, light-gray	45	210
Dolomite, light-gray; some sand	10	220
Dolomite, pink, light-gray; chert, gray, oolitic	5	225
Upper Cambrian series:		
Sandstone, fine-grained, silty, purple, very dolomitic	20	245
Sandstone, fine-grained, red, dolomitic	10	255
Sandstone, fine-grained, silty, pink, green-gray, dolomitic, glauconitic	25	280
Sandstone, fine- to medium-grained, light-gray to pink, dolomitic	40	320
Sandstone, medium- to fine-grained, light-gray	5	325
Sandstone, fine- to medium-grained, light-gray, dolomitic	20	345
Siltstone, light-gray, dolomitic	5	350
Sandstone, fine-grained, silty, light-gray, dolomitic	15	365
Sandstone, fine-grained, gray, dolomitic, glauconitic	10	375
Sandstone, coarse- to fine-grained, light-gray, dolomitic	10	385
Sandstone, medium- to fine-grained, light-gray	175	560
Sandstone, fine- to medium-grained, light-pink; some light gray, dolomitic	50	610
Sandstone, medium- to fine-grained, light-gray	15	625
Sandstone, fine- to medium-grained, light-gray, part dolomitic	37	662

Well Ou 33, NW¼SE¼ sec. 35, T. 22 N., R. 15 E.

	Thickness (feet)	Depth (feet)
Glacial drift:		
Soil, black, on gray silt	7	7
Till, pink, dolomitic	8	15
Till, gray, dolomitic	4	19
Clay, red, dolomitic	17	36
Sand, medium, silty, gray, dolomitic; flow	1	37
Gravel and red clay mixed	3	40
Gravel, coarse, stony	14	54
Gravel; pebbles; siltstone, red, gray, dolomitic	4	58
Upper Cambrian series:		
Siltstone, red, gray, dolomitic, glauconitic	11	69
Sandstone, fine- to medium-grained, red, dolomitic, glauconitic	21	90
Sandstone, fine- to medium-grained, pink, dolomitic	8	98
Sandstone, medium- to fine-grained, light-gray	6	104
Sandstone, medium- to coarse-grained, light-gray	30	134
Sandstone, medium- to fine-grained, light-gray	38	172
Sandstone, fine- to coarse-grained, pink, dolomitic	18	190
Sandstone, medium- to fine-grained; some coarse, white	150	340

Well Ou 36, SW¼SW¼ sec. 22, T. 21 N., R. 18 E.

	Thickness (feet)	Depth (feet)
Glacial drift:		
Clay	5	5
Galena dolomite and Platteville formation:		
Dolomite, light brown-gray	5	10
Dolomite, brown-gray, blue specks	5	15
Dolomite, gray, blue specks	50	65
Dolomite, gray, some blue-gray	25	90
Dolomite, blue, mottled blue and gray	11	101
Dolomite, light-gray	7	108
Dolomite, light and dark-gray	6	114
Dolomite, light, dark-gray; some chert, white	25	139
Dolomite, blue, gray	12	151
Prairie du Chien group:		
Sandstone, medium- to coarse-grained, gray, very dolomitic; chert, white; shale, green	13	164
Sandstone, medium-fine-grained, gray, very dolomitic, hard	25	189
Dolomite, gray, sandy, pyritic; chert, white	11	200
Dolomite, light-gray, pyritic; shale, dark-gray	15	215
Dolomite, light-gray, sandy; chert, oolitic	14	229
Sandstone, fine-grained, white, dolomitic; chert, white	8	237
Dolomite, gray; sandstone, fine-grained, gray; chert, oolitic	5	242
Dolomite, gray; chert, white	25	267
Dolomite, gray	36	303
Dolomite, gray; chert, white	5	308
Dolomite, gray	11	319
Dolomite, banded purple-gray, sandy, glauconitic	10	329
Sandstone, very fine grained, gray, very dolomitic	6	335
Dolomite, gray, pink, sandy	10	345

TABLE 10.—*Materials penetrated by wells in Outagamie County, Wis.*—Continued

Well Ou 36, SW¼SW¼ sec. 22, T. 21 N., R. 18 E.—Continued

	Thickness (feet)	Depth (feet)
Upper Cambrian series:		
Sandstone, very fine grained, pink, dolomitic; dolomite, gray	14	359
Sandstone, fine-grained, light-gray, dolomitic	10	369
Sandstone, medium- to very fine grained, pink, dolomitic	5	374
Sandstone, fine-grained, dark pink, dolomitic, glauconitic	8	382
Sandstone, fine-grained, dark-gray, dolomitic, glauconitic	5	387
Sandstone, fine-grained, silty, green, dolomitic	27	414
Sandstone, medium- to fine-grained, gray, white	7	421
Sandstone, very fine to fine-graine , dark-gray, dolomitic	29	450
Sandstone, fine-grained, gray, dolomitic	15	465
Sandstone, fine- to medium-grained, gray, dolomitic	20	485
Sandstone, medium- to fine-grained, gray, silty	5	490
Sandstone, fine- to medium-grained, silty, light-gray	15	505
Sandstone, medium- to fine-grained, silty, gray	25	530
Sandstone, fine- to medium-grained, light-gray	10	540
Sandstone, very fine to fine-grained, light-gray	15	555
Sandstone, fine- to medium-grained, light-gray	65	620
Sandstone, medium- to fine-grained, light-gray	10	630
Sandstone, fine- to medium-grained, light-gray	20	650
Sandstone, medium- to fine-grained, light-pink-gray	10	660
Sandstone, fine-grained, silty, pink	15	675
Sandstone, fine-grained, light-gray	20	695
Sandstone, medium- to fine-grained, light-gray	30	725
Sandstone, fine- to medium-grained, light-gray	5	730
Precambrian:		
Granite, light-pink	4	734

Well Ou 71, SE¼SW¼ sec. 9, T. 23 N., R. 17 E.

	Thickness (feet)	Depth (feet)
Glacial drift:		
Clay, red, dolomitic	80	80
Clay, gray, dolomitic	35	115
Gravel, coarse, pebbles to over ½-inch, stony	40	155
Sand, coarse, gray	3	158

Well Ou 82, SE¼NE¼ sec. 2, T. 21 N., R. 15 E.

	Thickness (feet)	Depth (feet)
Glacial drift:		
Till, red, dolomitic	8	8
Till, light pinkish-gray, dolomitic	72	80
Upper Cambrian series:		
Dolomite, very sandy, pink, red; shale, red	14	94
Sandstone, medium-grained, light-gray, pink, dolomitic, glauconitic	6	100
Sandstone, medium-grained, white	20	120
Sandstone, medium-grained, white; some yellow gray, dolomitic	14	134

Well Ou 97, SE¼SE¼ sec. 8, T. 23 N., R. 17 E.

	Thickness (feet)	Depth (feet)
Glacial drift:		
Surface soil	2	2
Clay, red	50	52
"Pack sand" and "quicksand"	38	90
"Sand-pan" and "quicksand"	20	110
"Gumbo" clay, red	20	130
"Gumbo" clay, black	38	168
"Hardpan"	100	268
"Pack sand"	2	270
Sand, coarse	8	278
"Hardpan"	25	303
"Hardpan" and "bedrock"	28	331
Sand	2	333
"Bedrock"	12	345
Sand, coarse; some water: "pack sand"	5	350
Gravel, very coarse; "hardpan"	5	355
Sand, very coarse; some water	10	365
"Hardpan," blue and gray	5	370
Gravel, coarse, and "hardpan," gray	10	380
"Bedrock" and gravel	5	385
Sand, rock and gravel; layers of mud	10	395
Gravel and rock, streaks of clay, dry, red; gravel and sand	23	418
Gravel and sand, clay, dry, red and streaks of shale rock mixed	28	446
Rock	3	449
"Shale hardpan"	24	473
Streaks of rock and shale	11	484
No record	28	512
Precambrian:		
Granite, pink, gneissic	58	570

TABLE 10.—*Materials penetrated by wells in Outagamie County, Wis.*—Continued

Well Ou 101, SE¼NE¼ sec. 31, T. 23 N., R. 17 E.

	Thickness (feet)	Depth (feet)
Glacial drift:		
Gravel and sand	8½	8½
Prairie du Chien group:		
Dolomite, gray	5½	14
Dolomite, brownish-gray, sandy, pyritic	5	19
Dolomite, gray	31	50
Dolomite, pink and gray	30	80
Dolomite, gray, green, and pink; chert, white, oolitic	11	91
Upper Cambrian series:		
Sandstone, medium-grained, gray, dolomitic	8	99
Sandstone, very fine grained, pink, red and gray, dolomitic	19	118
Sandstone, very fine grained, red and gray, very dolomitic, hard	6	124
Dolomite, sandy, red, glauconitic	6	130
Sandstone, very fine grained, dark red, dolomitic, glauconitic	5	135
Sandstone, medium-grained, gray and pink, dolomitic	75	210
Sandstone, very fine grained, gray, dolomitic, some glauconite	5	215
Sandstone, medium-fine-grained, white, dolomitic, glauconitic	15	230
Sandstone, medium-to fine-grained, light-gray, dolomitic, hard	10	240
Sandstone, like above with streaks of gray dolomite	10	250
Sandstone, medium-to-fine-grained, white	25	275
Sandstone, medium-to-fine-grained, white, streaks of pink dolomite	20	295
Sandstone, fine-to-coarse-grained, white	10	305

Well Ou 102, NW¼SW¼ sec. 23, T. 21 N., R. 18 E.

	Thickness (feet)	Depth (feet)
Glacial drift:		
Till, red, dolomitic	10	10
Clay, gray, dolomitic	10	20
Till, gray, dolomitic	5	25
Galena dolomite and Platteville formation:		
Dolomite, gray	30	55
Dolomite, light-gray	30	85
Dolomite, light-gray and gray	20	105
Dolomite, blue-gray	20	125
No samples	20	145
Dolomite, light-gray	10	155
Dolomite, gray and light-gray	40	195
Dolomite, light-gray; much sand	20	215
Prairie du Chien group:		
Dolomite, light-gray, green spots	20	235
Dolomite, light-gray	10	245
Dolomite, light-gray; chert, dense and oolitic, red and gray; sandstone, fine-grained, white, very dolomitic	40	285
Dolomite, light-gray	17	302

Well Ou 280, NW¼NW¼ sec. 34, T. 21 N., R. 17 E.

	Thickness (feet)	Depth (feet)
Glacial drift:		
Sand, fine, gray-pink, weathered	5	5
Till, pink, dolomitic	80	85
Gravel, fine, stony	5	90
Till, light yellow-gray	5	95
Galena dolomite and Platteville formation:		
Dolomite, light-gray; some light blue-gray	10	105
Sandstone, medium-to fine-grained, light-gray, dolomitic	10	115
St. Peter sandstone:		
Sandstone, fine-to medium-grained, very light gray	20	135
Chert, gray, pink-gray	5	140
Shale, red; chert, green-gray, pink	5	145
Chert, gray, yellow-gray, pink-gray; quartzite, fine-grained, light-gray	40	185
Prairie du Chien group:		
Dolomite, very light gray	30	215
Dolomite, light-gray to very light gray	20	235
Dolomite, light-gray	40	275
Dolomite, light-gray, pink, some sand	5	280
Dolomite, very light gray, light-gray	30	310
Dolomite, very light gray, sandy; chert, gray, oolitic	5	315
Upper Cambrian series:		
Sandstone, very fine-grained, very light gray, dolomitic	10	325
Sandstone, very fine grained to silty, orange-pink, dolomitic	5	330
Siltstone, red-brown, red, red-orange, green-gray, glauconitic, dolomitic; shale, gray-green	25	355
Sandstone, fine-grained, pale-red, dolomitic, glauconitic	5	360
Sandstone, fine-grained, light pink-gray, dolomitic, glauconitic	10	370
Sandstone, fine- to medium-grained, light-gray, dolomitic, some glauconite	65	435
Sandstone, fine-grained, light-gray, some glauconite	15	450
Siltstone, light medium-grained, gray, dolomitic, hard	5	455
Sandstone, fine- to coarse-grained, light-gray, dolomitic	10	465

TABLE 10.—*Materials penetrated by wells in Outagamie County, Wis.*—Continued

Well Ou 280, NW¼NW¼ sec. 34, T. 21 N., R. 17 E.—Continued

	Thickness (feet)	Depth (feet)
Upper Cambrian series—Continued		
Sandstone, fine- to medium-grained, very light gray	45	510
Sandstone, medium- to fine-grained, very light gray	5	515
Sandstone, fine- to medium-grained, very light gray	110	625
Sandstone, medium- to fine-grained, very light gray	5	630
Sandstone, fine- to medium-grained, very light gray	25	655
Sandstone, medium- to fine-grained, very light gray	5	660
Sandstone, very fine to medium-grained, very light gray	20	680
Sandstone, fine- to medium-grained, very light gray	10	690
Sandstone, very fine to medium-grained, very light gray	10	700
Sandstone, medium- to fine-grained, very light gray	5	705
Sandstone, fine- to medium-grained, very light gray	10	715
Sandstone, medium- to fine-grained, very light gray	5	720
Sandstone, fine- to medium-grained, very light gray	25	745

TABLE 11.—*Materials penetrated by wells in Outagamie County, Wis.*

Interpretation, by the author, of drillers' logs from the files of the Wisconsin State Board of Health]

Well Ou 104, NW¼SE¼ sec. 32, T. 21 N., R. 17 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Clay	10	10
Gravel	23½	33½
Galena dolomite and Platteville formation:		
Lime rock	8½	42
St. Peter sandstone:		
Sandstone	7	49

Well Ou 105, NE¼SW¼ sec. 29, T. 21 N., R. 16 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Gravel and sand	30	30
Sand and clay	12	42
Prairie du Chien group:		
Limestone	86	128
Upper Cambrian series:		
Sandstone	14	142

Well Ou 106, NW¼SW¼ sec. 36, T. 21 N., R. 15 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Sand and gravel	40	40
Prairie du Chien group:		
Limestone	86	126
Upper Cambrian series:		
Sandstone	12	138

Well Ou 107, NW¼NW¼ sec. 33, T. 22 N., R. 16 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Clay	10	10
Clay and sand	40	50
Sand	10	60
Hardpan	5	65
Prairie du Chien group:		
Limestone	100	165
Upper Cambrian series:		
Sandstone, red	15	180

Well Ou 111, NE¼NE¼ sec. 32, T. 22 N., R. 18 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Clay	34	34
Galena dolomite, Platteville formation, and Prairie du Chien group:		
Limestone	206	240
Sandstone	10	250
Limestone	55	305

TABLE 11.—*Materials penetrated by wells in Outagamie County, Wis.*—Continued

Well Ou 115, SW¼SW¼ sec. 30, T. 22 N., R. 18 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Clay	15	15
Sand and gravel	45	60
Hardpan and stones	30	90
Galena dolomite, Platteville formation, and Prairie du Chien group:		
Shell limestone	6	96
Limestone	208	304

Well Ou 117, SE¼SE¼ sec. 6, T. 22 N., R. 18 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Clay	40	40
Sand	17	57
Hardpan	16	73
Galena dolomite and Platteville formation:		
Hard rock	23	96
St. Peter sandstone:		
Sandstone	34	130

Well Ou 119, SE¼SE¼ sec. 18, T. 24 N., R. 17 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Soil and clay	28	28
Quicksand	40	68
Clay	49	117
Hardpan	20	137
Gravel		

Well Ou 124, SE¼NE¼ sec. 30, T. 23 N., R. 19 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Sand	20	20
Clay	6	26
Hardpan	16	42
Clay	16	58
Galena dolomite and Platteville formation:		
Limestone	42	100
St. Peter sandstone:		
Shale	2	102
Limestone	1	103
Shale	4	107
Sandstone	13	120

Well Ou 126, NW¼SW¼ sec. 20, T. 23 N., R. 19 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Sand	46	46
Clay	11	67
Hardpan	11	78
Clay	12	90
Gravel	2	92

Well Ou 152, SE¼SW¼ sec. 12, T. 23 N., R. 17 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Clay	42	42
Hardpan	4	46
Clay	10	56
Hardpan	29½	85½

Well Ou 154, SE¼NW¼ sec. 30, T. 24 N., R. 17 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Soil and sand	6	6
Clay	20	26
Quicksand	15	51
Clay	53	103
Hardpan	10	113
Sand and gravel	----------	----------

TABLE 11.—*Materials penetrated by wells in Outagamie County, Wis.*—Continued

Well Ou 163, SW¼SW¼ sec. 6, T. 23 N., R. 18 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Sand	10	10
St. Peter sandstone:		
Sandstone	44	54

Well Ou 167, SE¼SE¼ sec. 5, T. 22 N., R. 17 E.

Alluvium and drift:		
Soil and clay, red	50	50
Hardpan and gravel	23	73
Prairie du Chien group:		
Limestone	52	125
Upper Cambrian series:		
Sandstone	100	225

Well Ou 175, NW¼NE¼ sec. 5, T. 24 N., R. 17 E.

Alluvium and drift:		
Sand	15	15
Clay	25	40
Quicksand	30	70
Clay	60	130
Hardpan	11	141
Sand, coarse	10	151

Well Ou 177, NW¼NE¼ sec. 9, T. 24 N., R. 16 E.

Alluvium and drift:		
Overburden	68	68
Upper Cambrian series:		
Sandstone	34	102

Well Ou 188, SE¼SW¼ sec. 24, T. 24 N., R. 16 E.

Alluvium and drift:		
Soil, sandy	12	12
Clay, hard	65	77
Hardpan	26	103
Sand	------	------

Well Ou 193, SW¼NW¼ sec. 15, T. 23 N., R. 17 E.

Alluvium and drift:		
Clay	80	80
Sand	20	100
Hardpan	50	150
Gravel	4	154

Well Ou 197, NW¼NW¼ sec. 35, T. 23 N., R. 16 E.

Alluvium and drift:		
Soil	40	40
Hardpan	48	88
Upper Cambrian series:		
Sandstone	12	100

Well Ou 200, NW¼NW¼ sec. 26, T. 21 N., R. 15 E.

Alluvium and drift:		
Soil and clay	7	7
Prairie du Chien group:		
Shell rock	6	13
Limestone	42	55
Upper Cambrian series:		
Sandstone	11	66

TABLE 11.—*Materials penetrated by wells in Outagamie County, Wis.*—Continued

Well Ou 206, NE¼NE¼ sec. 32, T. 23 N., R. 18 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Soil	13	13
Galena dolomite and Platteville formation:		
Limestone	27	40

Well Ou 227, NW¼NW¼ sec. 30, T. 24 N., R. 15 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Clay	22	22
Sand and clay	68	90
Sand, fine	11	101
Sand, medium	5	106

Well Ou 230, SW¼SW¼ sec. 28, T. 24 N., R. 15 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Soil and clay, red	25	25
Quicksand	10	35
Clay, blue and stones	40	75
Sand	3	78
Clay, red; sand, stones	50	128
Clay, blue	23	151
Gravel	8	159

Well Ou 232, NW¼SW¼ sec. 7, T. 23 N., R. 15 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Sand	25	25
Clay	55	80
Sand and gravel	20	100

Well Ou 235, NW¼SW¼ sec. 19, T. 22 N., R. 15 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Sand	106	106
Clay	67	173
No record	7	180
Sand	9	189
Gravel	8	197

Well Ou 263, SW¼NW¼ sec. 24, T. 22 N., R. 16 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Clay	10	10
Sand and clay	20	30
Sand	60	90
Hardpan	20	110
Sand	62	172
Rock	8	180
Upper Cambrian series: Sandstone	162	342

Well Ou 272, SE¼NW¼ sec. 17, T. 22 N., R. 16 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Clay and stones	43	43
Sand	22	65
Upper Cambrian series:		
Sand rock	60	125

Well Ou 275, SW¼SW¼ sec. 8, T. 22 N., R. 16 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Clay, sand, gravel, and hardpan	205	205
Rock (could not drill farther)	----------	205

TABLE 11.—*Materials penetrated by wells in Outagamie County, Wis.*—Continued

Well Ou 279, NW¼NW¼ sec. 1, T. 24 N., R. 18 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Clay	16	16
Hardpan	14	30
Clay	8	38
Galena dolomite and Platteville formation:		
Limestone	25	63

Well Ou 283, SW¼NW¼ sec. 24, T. 22 N., R. 17 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Clay	35	35
Sand	60	95
Clay	28	123
Sand	60	183
Hardpan	5	188
Galena dolomite, Platteville formation, and Prairie du Chien group:		
Lime rock	70	258
Upper Cambrian series:		
Sandstone	97	355

Well Ou 285, NE¼NW¼ sec. 7, T. 21 N., R. 17 E.

	Thickness (feet)	Depth (feet)
Alluvium and drift:		
Soil	5	5
Clay	25	30
Hardpan	12	42
Galena dolomite and Platteville formation:		
Limestone, hard	88	130
Limestone, porous	24	154

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