

ISWS/BUU60(23)/78

BULLETIN 60-23

STATE OF ILLINOIS

DEPARTMENT OF REGISTRATION AND EDUCATION



*Public Groundwater Supplies  
in Henderson County*

by DOROTHY M. WOLLER and ELLIS W. SANDERSON

ILLINOIS STATE WATER SURVEY

URBANA

1978

# PUBLIC GROUNDWATER SUPPLIES IN HENDERSON COUNTY

by Dorothy M. Woller and Ellis W. Sanderson

## Introduction

This publication presents all available information on production wells used for public groundwater supplies in Henderson County. Bulletin 60, which is divided by county into separate publications, supersedes Bulletin 40 and its Supplements 1 and 2.

The definition of public water supply as contained in the Environmental Protection Act of 1970 was used to determine those water systems and wells to be included. Systems and wells described furnish water for drinking or general domestic use in: 1) incorporated municipalities; 2) unincorporated communities where 10 or more separate lots or properties are being served or are intended to be served; 3) state-owned parks and memorials; and 4) state-owned educational, charitable, or penal institutions.

This report includes separate descriptions for groundwater supplies of 6 municipalities and 1 state park in Henderson County. These are preceded by brief summaries of the groundwater geology of the county and the development of groundwater sources for public use. An explanation of the format used in the descriptions is also given.

Acknowledgments. This report was prepared under the general direction of Dr. William C. Ackermann, Chief of the Illinois State Water Survey, and Richard J. Schicht, Head of the Hydrology Section. Mrs. J. L. Ivens and Mrs. P. A. Motherway edited the manuscript, Mrs. Marilyn J. Innes typed the camera-copy, John W. Brother, Jr., supervised the preparation of the illustrations, and Karen L. Kunz assisted in the final preparation of the manuscript. The chemical analyses, unless otherwise stated, were made by personnel of the Water Survey Chemistry Section under the supervision of Laurel M. Henley. The analyses made by personnel of the Illinois Environmental Protection Agency were under the supervision of Ira M. Markwood. Thanks are due M. L. Sargent of the Illinois State Geological Survey who prepared the generalized column of rock stratigraphic units and aquifers and, with R. D. Brower, reviewed the geological information in the manuscript. Grateful acknowledgment also is given to consulting engineers, well drillers, water superintendents, and municipal officials who have provided valuable information used in this report.

## Groundwater Geology

The geology of Henderson County is described generally in Illinois State Geological Survey Circular 222, *Groundwater Geology in Western Illinois, North Part*; Circular 383, *The Sangamon Arch*; and Report of Investigation 221, *Ground-Water Geology of the Rock Island, Monmouth, Galesburg, and Kewanee Area, Illinois*. The following brief discussion of geologic conditions in the county is taken largely from these publications. More detailed information on the geology in this portion of the state can be provided by the State Geological Survey which is located on the University of Illinois campus, Urbana.

Glacial drift deposits form the present land surface in Henderson County and vary greatly in thickness and water-yielding character. Thick extensive deposits of sand and

gravel are present in the bottomlands of the Mississippi River where the fill is from 50 to as much as 200 ft thick in a partially buried preglacial bedrock valley. These permeable sand and gravel deposits are suitable for development of high capacity wells for municipal, industrial, and irrigation uses. Sand and gravel deposits also may be associated with buried tributary bedrock valleys at the north edge of the county, east of Oquawka, and northwest of Stronghurst.

The glacial drift deposits in the upland areas of the county are generally less than 50 ft thick and consist principally of tight glacial till. These materials are extensively dissected by tributaries of the Mississippi River and water-bearing sand and gravel deposits rarely are encountered.

Beneath the glacial drift deposits, the upper bedrock

surface consists principally of beds of limestone and shale. Rock formations underlying Henderson County range in geologic age from Pennsylvanian to Precambrian (upper units shown on generalized stratigraphic sequence in figure 1).

Pennsylvanian-age rocks underlie the glacial drift in an area of about 45 square miles at the southeast corner of the county. These rocks have a maximum thickness of about 90 ft at the southeast corner and thin to a featheredge northward and westward due to erosion. These rocks consist principally of shale with some interbedded siltstone and are not regarded as water yielding in this area.

The Burlington-Keokuk Limestone (Mississippian age) is the upper bedrock unit beneath most of the upland areas of the county except in the southeast where it is overlain by Pennsylvanian and in the northern part where it has been eroded away exposing the underlying Kinderhookian and Upper Devonian Shale Series, the New Albany Group. The Burlington-Keokuk is exposed at land surface in some of the creek valleys but is usually at a depth of about 25 to more than 100 ft on the upland between the valleys. It ranges in thickness from 0 to 175 ft. The yield capability of the Burlington-Keokuk depends on the number, size, and degree of interconnection of water-filled cracks and crevices within the rock that are intersected by the well bore. Quantities of water adequate for domestic and farm use usually can be obtained and, locally, supplies for small communities may be available for development.

The New Albany Shale Group (Mississippian-Devonian age) underlies the Burlington-Keokuk and separates it from deeper water-yielding units. This unit underlies the Mississippi River bottomland deposits south of Oquawka, is exposed along the valley bluff north of Oquawka, and is the upper bedrock unit in the deep tributary bedrock valley at the north edge of the county. It ranges in thickness from 0 to about 290 ft. The New Albany is not water yielding.

The Silurian-Devonian (Hunton Megagroup) limestone and dolomite occur below the New Albany Shale Group and underlie the glacial drift in the Mississippi River bottomlands in northwestern Henderson County and the deep tributary bedrock valley near the north edge of the county. The depth to the top of the Silurian-Devonian units varies greatly. They are about 200 ft deep in the north, about 450 ft in the vicinity of Biggsville, about 300 to 350 ft around Stronghurst and Media, and about 600 ft at the southeast corner of the county. Their thicknesses range from about 250 ft in the northeast corner to about 75 ft north and east of Stronghurst to about 150 ft in the southern part of the county. Water from these limestone and dolomite units is obtained from cracks and crevices in the rock that are intersected by the well bore.

The Maquoketa Shale Group (Ordovician age) underlies the Silurian-Devonian aquifer and consists primarily of non-water-bearing shales. It is about 50 to 220 ft thick and sep-

arates the Silurian-Devonian aquifer from deeper water-yielding units.

Below the Maquoketa Group there is a thick sequence of hydrologically connected rock units that are referred to as the Cambrian-Ordovician aquifer system. This aquifer system consists in downward order of the Galena-Platteville Dolomite Groups, Glenwood-St. Peter Sandstone, Eminence-Potosi Dolomite, Franconia Formation, and Ironton-Galesville Sandstone. Water supply wells in Henderson County have not penetrated below the Glenwood-St. Peter Sandstone.

The Galena-Platteville Dolomite Groups (Ordovician age) lie at depths (in the upland areas) of more than 600 ft in the northern part of the county, about 750 ft in the central area around Biggsville, less than 500 ft near Stronghurst, and about 800 ft in the southeast corner of the county. It has a relatively uniform thickness of about 290 ft. Water from this unit is also obtained from cracks and crevices intersected by the well bore. Moderate quantities of water (50 to 200 gpm) usually are obtained, but the water is highly mineralized.

The Glenwood-St. Peter Sandstone (Ordovician age) lies below the Galena-Platteville at depths (in the upland areas) of about 900 ft in the north, less than 800 ft in the southeast near Stronghurst, and about 1050 ft in the central region near Biggsville and the southern part of the county. The limited data available suggest the aquifer is about 150 ft thick in Henderson County. The Glenwood-St. Peter is one of the more reliable aquifers in this part of Illinois and is capable of yielding moderate quantities of water. The water is highly mineralized in this area.

### **Groundwater Development for Public Use**

Groundwater is used as a source for 7 public water supply systems serving Biggsville, Delabar State Park, Galesburg (Knox County), Media, Oquawka, Raritan, and Stronghurst. The locations of these supplies are shown in figure 2 (except Galesburg).

Unconsolidated sand and gravel deposits associated with the Mississippi River bottomlands are tapped as a source of water by the wells for Delabar State Park, Galesburg, and Oquawka. There are presently 6 supply wells and 1 collector well finished in sand and gravel at depths of 50 to 134.7 ft. The collector well can be pumped at a rate of about 13,000 gpm and yields of the other wells range from 25 to 1780 gpm depending primarily upon the type of well constructed and the permeability, thickness, and areal extent of the sand and gravel aquifer tapped by each well. Production from these wells in 1977 was estimated to be about 6,660,000 gpd. Analyses of water from these wells indicate that the iron content ranges from 0.0 to 2.8 mg/l and the hardness from 184 to 284 mg/l. Water for Delabar State Park is not treated. Water for Galesburg is chlorinated, fluoridated, a polyelectrolyte added to aid coagulation, and filtered. Water for Oquawka is chlorinated and fluoridated.

| SYSTEM        | SERIES        | GROUP OR FORMATION                  | AQUIFER            | LOG                | THICKNESS (FT) | GENERALIZED DESCRIPTION   |
|---------------|---------------|-------------------------------------|--------------------|--------------------|----------------|---|
| QUATERNARY    | PLEISTOCENE   |                                     | Sands and Gravels  |                    | 0-200          | Till, gravel, sand, silt, peat, loess   |
| PENNSYLVANIAN |               |                                     |                    |                    | 0-90           | Shale, sandstone, clay, limestone, coal   |
| MISSISSIPPIAN | VALMEYERAN    | Burlington-Keokuk                   |                    |                    | 0-175          | Limestone, white to brown, very cherty, fossiliferous, dolomitic                |
|               | KINDERHOOKIAN | New Albany                          |                    |                    | 0-290          | Shale, green to brown, pyritic, Sporangites, little sandstone and dolomite      |
| DEVONIAN      | UPPER         |                                     |                    |                    |                |   |
|               | MIDDLE        | HUNTON<br>Cedar Valley-Wapsipinicon | Silurian-Devonian  |                    | 100-170        | Limestone and dolomite, silty, cherty, fine gray to buff, part slightly pyritic |
| SILURIAN      | NIAGARAN      |                                     |                    | Racine-Marcus      |                | 0-75  |
|               | ALEXANDRIAN   |                                     |                    |                    | 0-20           | Dolomite, dense to vesicular, silty and sandy in lower part                     |
| ORDOVICIAN    | CINCINNATIAN  | Maquoketa                           |                    |                    | 50-220         | Shale, dolomitic, green to gray, some dolomite                                  |
|               | CHAMPLAINIAN  | Galena                              | Galena-Platteville |                    | 230-240        | Dolomite and limestone, medium-grained, cherty in lower part                    |
|               |               | Platteville                         |                    |                    | 40-50          | Dolomite, fine-grained, cherty  |
|               |               | Glenwood-St. Peter                  |                    | Glenwood-St. Peter |                | 150±  |

Figure 1. Generalized geological column of rock formations in Henderson County  
(Prepared by M. L. Sargent, Illinois State Geological Survey)

The Burlington-Keokuk Limestone is tapped as a source of water by the wells for Media and Stronghurst. Biggsville Well No. 1 and Raritan Well No. 1 are open to the Burlington-Keokuk as well as to deeper aquifer units. There are presently 3 production wells ranging in depth from 65 to 70 ft open only to the Burlington-Keokuk. They reportedly are pumped at rates of 80 to 120 gpm. Production from these wells in 1977 was estimated to be about 85,000 gpd. Analyses of water indicate that the iron content ranges from about 0.0 to 4.0 mg/l and the hardness from 248 to 358 mg/l. Water for Media is fluoridated and water for Stronghurst is aerated, filtered, chlorinated, and fluoridated.

Deeper lying bedrock aquifer units are tapped for water supply at Biggsville, Raritan, and Stronghurst (Well No. 1). In these wells various combinations of Devonian, Silurian, and Ordovician age aquifer units are open to the hole with each contributing a portion of the water withdrawn. Water obtained from many of these bedrock aquifer units in Henderson County is highly mineralized with one or more mineral constituents exceeding the primary or secondary standards of the USEPA Interim Drinking Water Regulations. Fluoride, sulfate, chloride, and the total mineral content are among the constituents that may be greater than the allowable or recommended limit. Sufficient data are not available to

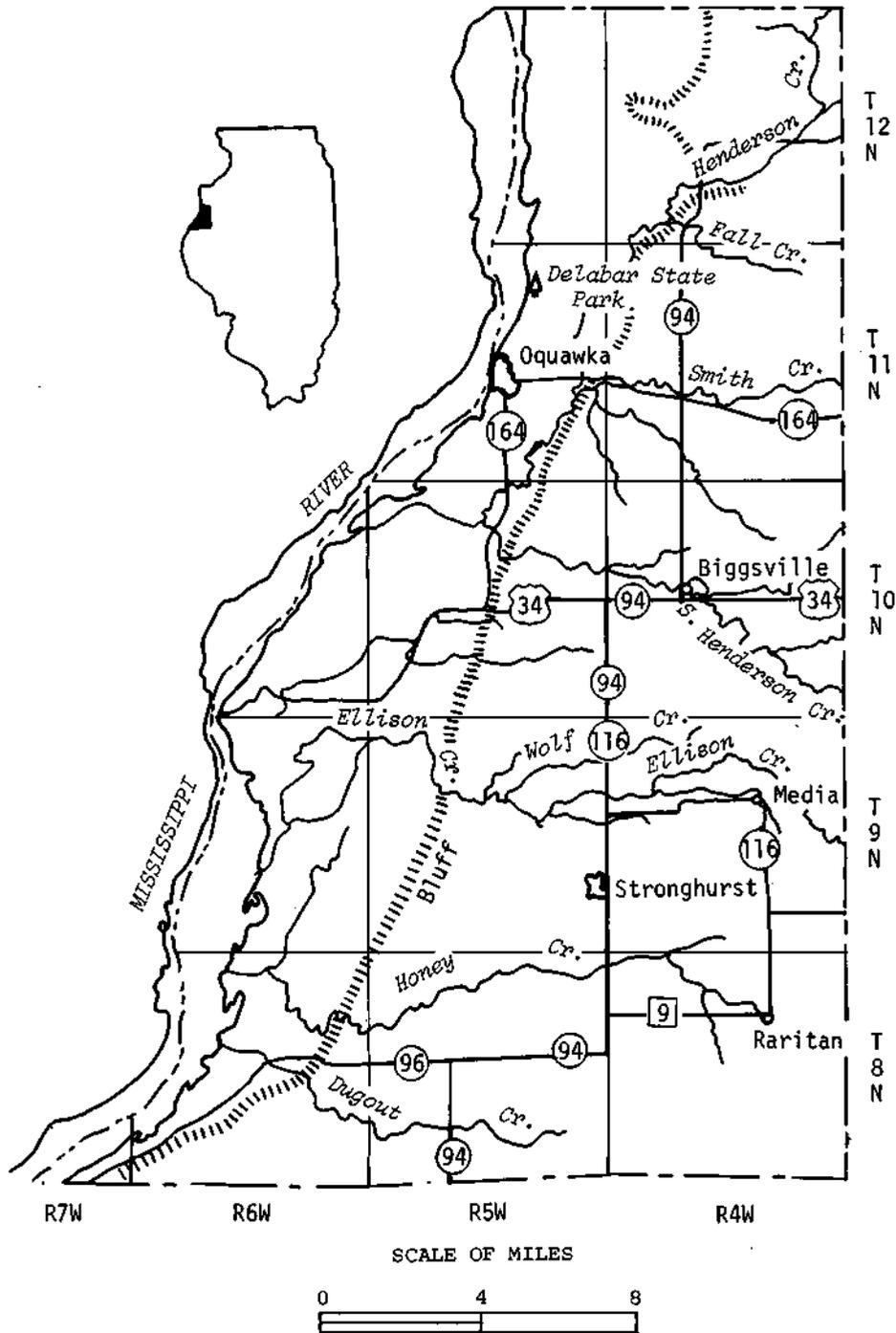


Figure 2. Location of public groundwater supplies (except Galesburg) in Henderson County

determine the specific aquifer unit that contributes water with the greatest concentrations of each mineral.

The Devonian limestone is open to the hole in Biggsville Well No. 1 and Raritan Well No. 1, but no wells tap only this aquifer unit.

The Galena-Platteville dolomite is tapped by Well No. 2

at Biggsville and is the deepest unit open to the hole in Biggsville Well No. 1 and Raritan Well No. 1. These wells range in depth from 891 to 964 ft and are pumped at rates of 50 to 250 gpm. The Glenwood-St. Peter Sandstone is tapped by Well No. 1 at Stronghurst. This well is 1009 ft deep and is only used on an emergency basis. It can be pumped

at a rate of about 112 gpm. Production in 1977 from these four wells was estimated to be about 32,000 gpd. Analyses of water indicate that the iron content ranges from 0.5 to 4.0 mg/l, sodium from 189 to 544 mg/l, fluoride from 2.4 to 5.5 mg/l, chlorides from 195 to 310 mg/l, sulfates from 650 to 1720 mg/l, hardness from 454 to 1065 mg/l and the total dissolved minerals from 1054 to 2971 mg/l. Water at Biggsville and Raritan is chlorinated.

Total public water supply pumpage in Henderson County for 1977 was about 6,777,000 gpd. Estimated pumpage from municipal wells tapping sand and gravel was about 98.3 percent of this total (6,660,000 gpd), wells tapping the Burlington-Keokuk aquifer yielded about 1.2 percent (85,000 gpd), and the remaining 0.5 percent (32,000 gpd) was pumped from wells finished in the Galena-Platteville dolomite or the Glenwood-St. Peter Sandstone.

### Format

In this publication the descriptions of public groundwater supplies are presented in alphabetical order by place name.

At the beginning of each description the U. S. Census of population for 1970 is given for incorporated places.

The number of services and quantity of water distributed at each supply are given where available for the earliest and the latest reported values.

Individual production wells for each supply are described in the order of their construction. The description for each well includes the *aquifer or aquifers tapped, date drilled, depth, driller, legal location, elevation in feet above mean sea level, log, construction features, yield, pumping equipment, and chemical analyses.*

When available, sample study logs prepared by the Illinois State Geological Survey are presented. When these are not available, drillers logs are used as reported. Commonly used drillers terms such as clay, silt, or pebbly clay generally are synonymous with the glacial tills tabulated by the State Geological Survey. Similarly, limestones or dolomites re-

ported by drillers usually are carbonate rocks which in most of Illinois are dolomitic in composition. When stating the bedrock aquifers tapped by a well, the sample study log provided by the State Geological Survey and the drillers casing record are used to determine the geohydrologic units open to the hole. If only a drillers log is available and the geohydrologic units cannot be readily determined, only the principal rock type as described by the driller is given (dolomite, sandstone, etc.).

The screen sizes given in this publication are for continuous slot type screens unless stated otherwise. Slot sizes given indicate the width of the slot openings in thousandths of an inch. For example, a 20 slot screen has slot openings 0.020 in. wide and a 100 slot screen has slots 0.100 in. wide. Approximate equivalent slot openings for other types of screens are given in parentheses after the screen description.

### Abbreviations Used

|             |                            |
|-------------|----------------------------|
| ft.....     | foot (feet)                |
| gpd.....    | gallons per day            |
| gpm.....    | gallons per minute         |
| hp.....     | horsepower                 |
| hr.....     | hour(s)                    |
| ID.....     | inside diameter            |
| in.....     | inch(es)                   |
| Lab.....    | laboratory                 |
| lb.....     | pound(s)                   |
| me/l.....   | milliequivalents per liter |
| mgd.....    | million gallons per day    |
| mg/l.....   | milligrams per liter       |
| min.....    | minute(s)                  |
| No.(s)..... | number(s)                  |
| OD.....     | outside diameter           |
| pc/l.....   | picocuries per liter       |
| R.....      | range                      |
| rpm.....    | revolutions per minute     |
| T.....      | township                   |
| TDH.....    | total dynamic head         |

## BIGGSVILLE

The village of Biggsville (391) installed a public water supply in 1903. One well (No. 2) is in use and another well (No. 1) is available for emergency use. In 1949 there were 65 services, very few metered; the estimated average daily pumpage was 8000 gpd. In 1976 there were 120 services, none metered. The water is chlorinated.

Initially, a 2-in. diameter well, located near the center of the village, was drilled to a depth of 193 ft. This well was abandoned prior to 1946.

A second well, 4 in. in diameter, was drilled in 1914 to a depth of 192 ft. The well was located one block east of the business district in the SE quarter of the NW quarter of the SW quarter of Section 16, T10N, R4W. In 1921 the non-pumping water level was reported to be 40 ft below land surface. This well was abandoned prior to 1946.

WELL NO. 1, open to the Burlington-Keokuk Limestone, the Devonian limestone, and the Galena-Platteville dolomite, was completed in 1936 to a depth of 891 ft by Ellis Jones, Burlington, Iowa. This well is available for emergency use. The well is located in a park 100 ft west of the Biggsville Township High School, approximately 250 ft N and 250 ft W of the SE corner of Section 17, T10N, R4W. The land surface elevation at the well is approximately 680 ft.

A sample study log of Well No. 1 furnished by the State Geological Survey follows:

| <i>Strata</i>                         | <i>Thickness<br/>(ft)</i> | <i>Depth<br/>(ft)</i> |
|---------------------------------------|---------------------------|-----------------------|
| <b>PLEISTOCENE SERIES</b>             |                           |                       |
| Loess and glacial till                | 57                        | 57                    |
| <b>MISSISSIPPIAN SYSTEM</b>           |                           |                       |
| Burlington-Keokuk Limestone           | 143                       | 200                   |
| <b>MISSISSIPPIAN-DEVONIAN SYSTEMS</b> |                           |                       |
| New Albany Group                      |                           |                       |
| Shale                                 | 260                       | 460                   |
| <b>DEVONIAN SYSTEM</b>                |                           |                       |
| Cedar Valley Limestone                |                           |                       |
| Limestone, dolomite at top            | 100                       | 560                   |
| Shale and dolomite                    | 7                         | 567                   |
| Dolomite                              | 13                        | 580                   |
| <b>ORDOVICIAN SYSTEM</b>              |                           |                       |
| Maquoketa Group                       |                           |                       |
| Shale, some dolomite                  | 180                       | 760                   |
| Galena Group                          |                           |                       |
| Dolomite                              | 131                       | 891                   |

An 8-in. diameter hole was drilled to a depth of 775 ft and finished 6.2 in. in diameter from 775 to 891 ft. The well is cased with 8-in. ID pipe from land surface to a depth of 65 ft.

Upon completion, the nonpumping water level was reported to be 130 ft below land surface.

In 1944, after a 2 to 3-day idle period, the nonpumping water level was reported to be 65 ft below the top of the well.

In June 1954, the well reportedly produced 140 gpm for 4 hr with a drawdown of 16 ft from a nonpumping water level of 153 ft.

The pumping equipment presently installed is a Red Jacket submersible pump rated at 250 gpm, and powered by a 15-hp Red Jacket electric motor.

A mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. B104422) of a sample collected October 30, 1973, after pumping for 1 hr, showed the water to have a hardness of 709 mg/l, total dissolved minerals of 2287 mg/l, and an iron content of 1.2 mg/l.

WELL NO. 2, open to the Galena-Platteville dolomite, was completed in October 1971 to a depth of 950 ft by Charles L. Jennings, New London, Iowa. The well is located about 50 ft west of Well No. 1, approximately 250 ft N and 300 ft W of the SE corner of Section 17, T10N, R4W. The land surface elevation at the well is approximately 680 ft.

A drillers log of Well No. 2 follows:

| <i>Strata</i>      | <i>Thickness<br/>(ft)</i> | <i>Depth<br/>(ft)</i> |
|--------------------|---------------------------|-----------------------|
| Drift              | 40                        | 40                    |
| Limestone          | 140                       | 180                   |
| Shale              | 270                       | 450                   |
| Devonian limestone | 130                       | 580                   |
| Shale              | 175                       | 755                   |
| Galena limestone   | 195                       | 950                   |

The following mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. B20509) is for a water sample from the well collected in November 1976, after 1 hr of pumping at 120 gpm.

| WELL NO. 2, LABORATORY NO. B20509 |                 |             |             |                                    |                  |             |
|-----------------------------------|-----------------|-------------|-------------|------------------------------------|------------------|-------------|
|                                   |                 | <i>mg/l</i> | <i>me/l</i> |                                    | <i>mg/l</i>      | <i>me/l</i> |
| Iron                              | Fe              | 1.8         |             | Silica                             | SiO <sub>2</sub> | 9.7         |
| Manganese                         | Mn              | 0.02        |             | Fluoride                           | F                | 3.9         |
| Ammonium                          | NH <sub>4</sub> | 2.1         | 0.12        | Boron                              | B                | 1.8         |
| Sodium                            | Na              | 432         | 18.79       | Nitrate                            | NO <sub>3</sub>  | 0.0         |
| Potassium                         | K               | 14.8        | 0.38        | Chloride                           | Cl               | 200         |
| Calcium                           | Ca              | 169         | 8.43        | Sulfate                            | SO <sub>4</sub>  | 1100        |
| Magnesium                         | Mg              | 69          | 6.68        | Alkalinity (as CaCO <sub>3</sub> ) |                  | 224         |
| Arsenic                           | As              | 0.00        |             | Hardness (as CaCO <sub>3</sub> )   |                  | 708         |
| Barium                            | Ba              | 0.1         |             |                                    |                  | 14.16       |
| Copper                            | Cu              | 0.02        |             | Total dissolved minerals           |                  | 2252        |
| Cadmium                           | Cd              | 0.00        |             |                                    |                  |             |
| Chromium                          | Cr              | 0.00        |             |                                    |                  |             |
| Lead                              | Pb              | 0.00        |             |                                    |                  |             |
| Mercury                           | Hg              | 0.0001      |             |                                    |                  |             |
| Nickel                            | Ni              | 0.0         |             |                                    |                  |             |
| Selenium                          | Se              | 0.00        |             |                                    |                  |             |
| Silver                            | Ag              | 0.00        |             |                                    |                  |             |
| Cyanide                           | CN              | 0.00        |             |                                    |                  |             |
| Zinc                              | Zn              | 0.4         |             | pH (as rec'd)                      |                  | 7.5         |

A 12-in. diameter hole was drilled to a depth of 40 ft, reduced to 10 in. between 40 and 771 ft, and finished 8 in. in diameter from 771 to 950 ft. The well is cased with 10-in. steel pipe from 1 ft above land surface to a depth of 100 ft and 8-in. steel pipe from 1 ft above land surface to a depth of 900 ft. The annulus between the casings is filled with cement grout.

Upon completion, the well reportedly produced 200 gpm for 6 hr with a drawdown of 250 ft from a nonpumping water level of 120 ft below land surface.

The pumping equipment presently installed is a Red Jacket submersible pump set at 320 ft, rated at 250 gpm, and powered by a 15-hp Red Jacket electric motor.

## DELABAR STATE PARK

Delabar State Park, located two miles north of Oquawka, installed a public water supply in 1961. One well (No. 4) is in use. The water is not treated.

WELL NO. 1, finished in sand and gravel, was completed in 1960 to a depth of 40 ft. This well was abandoned and sealed in 1977. The well was located in the camping area, approximately 2400 ft S and 150 ft E of the NW corner of Section 11, T11N, R5W. The land surface elevation at the well is approximately 565 ft.

Casing and screen data are not available.

A mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. B20507) of a sample collected November 17, 1976, after pumping for 5 min, showed the water to have a hardness of 185 mg/l, total dissolved minerals of 231 mg/l, a nitrate content of 48 mg/l, and an iron content of 1.4 mg/l.

WELL NO. 2, finished in sand and gravel, was completed in 1961 to a depth of 40 ft. This well was abandoned and sealed in 1977. The well was located at the pavilion, approximately 1800 ft N and 300 ft W of the SE corner of Section 10, T11N, R5W. The land surface elevation at the well is approximately 570 ft.

Casing and screen data are not available.

A mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. B20506) of a sample collected November 17, 1976, after pumping for 10 min, showed the water to have a hardness of 182 mg/l, total dissolved minerals of 274 mg/l, a nitrate content of 70 mg/l, and an iron content of 0.5 mg/l.

WELL NO. 3, finished in sand and gravel, was completed in 1960 to a depth of 60 ft. This well was abandoned and sealed in 1977. The well was located at the custodian's house near the north border of the park, approximately 1150 ft S and 400 ft E of the NW corner of Section 11, T11N, R5W. The land surface elevation at the well is approximately 560 ft.

Casing and screen data are not available.

The following mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. B20501) is for a water sample from the well collected November 17, 1976, after 5 min of pumping.

### WELL NO. 3, LABORATORY NO. B20501

|           |                 | mg/l   | me/l |                                   | mg/l             | me/l     |
|-----------|-----------------|--------|------|-----------------------------------|------------------|----------|
| Iron      | Fe              | 0.0    |      | Silica                            | SiO <sub>2</sub> | 27.5     |
| Manganese | Mn              | 0.00   |      | Fluoride                          | F                | 0.2 0.01 |
| Ammonium  | NH <sub>4</sub> | 0.0    |      | Boron                             | B                | 0.2      |
| Sodium    | Na              | 3      | 0.13 | Nitrate                           | NO <sub>3</sub>  | 79 1.27  |
| Potassium | K               | 0.9    | 0.02 | Chloride                          | Cl               | 15 0.42  |
| Calcium   | Ca              | 46     | 2.30 | Sulfate                           | SO <sub>4</sub>  | 8.6 0.18 |
| Magnesium | Mg              | 12     | 0.99 | Alkalinity(as CaCO <sub>3</sub> ) |                  | 74 1.48  |
| Arsenic   | As              | 0.00   |      |                                   |                  |          |
| Barium    | Ba              | 0.1    |      | Hardness (as CaCO <sub>3</sub> )  |                  | 164 3.28 |
| Copper    | Cu              | 0.07   |      |                                   |                  |          |
| Cadmium   | Cd              | 0.00   |      | Total dissolved                   |                  |          |
| Chromium  | Cr              | 0.00   |      | minerals                          |                  | 252      |
| Lead      | Pb              | 0.00   |      |                                   |                  |          |
| Mercury   | Hg              | 0.0001 |      |                                   |                  |          |
| Nickel    | Ni              | 0.0    |      |                                   |                  |          |
| Selenium  | Se              | 0.00   |      |                                   |                  |          |
| Silver    | Ag              | 0.00   |      |                                   |                  |          |
| Cyanide   | CN              | 0.00   |      |                                   |                  |          |
| Zinc      | Zn              | 0.3    |      | pH (as rec'd)                     |                  | 7.9      |

WELL NO. 4, finished in sand and gravel, was completed in September 1977 to a depth of 126 ft by the Burlington Well Drilling Service, Burlington, Iowa. The well is located about 300 ft east and 20 ft north of Well No. 3, approximately 1130 ft S and 700 ft E of the NW corner of Section 11, T11N, R5W. The land surface elevation at the well is approximately 560 ft.

A drillers log of Well No. 4 follows:

| Strata                        | Thickness (ft) | Depth (ft) |
|-------------------------------|----------------|------------|
| Sand                          | 40             | 40         |
| Coarse sand with yellow clay  | 34             | 74         |
| Fine sand with blue mud       | 20             | 94         |
| Sand and gravel with blue mud | 21             | 115        |
| Some gravel                   | 8              | 120        |
| Very coarse sand and gravel   | 6              | 126        |

An 8-in. diameter hole was drilled to a depth of 126 ft. The well is cased with 7-in. pipe from about 2 ft above land surface to a depth of 120 ft and equipped with 5 ft of 6-in. No. 30 slot Johnson stainless steel screen. A 5-in. diameter pipe extends 6 ft above the top of the screen.

Upon completion, the well reportedly produced 25 gpm for 4 hr with a drawdown of 28 ft from a nonpumping water level of 37 ft. Pumping was continued for 4 hr at a rate of 50 gpm with a drawdown of 63 ft.

The pumping equipment presently installed is a Red Jacket submersible pump (Model No. 8DC) set at about 105 ft, rated at 28 gpm, and powered by a 2-hp Red Jacket electric motor.

The following mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. B24654) is for a water sample from the well collected December 8, 1977.

WELL NO. 4, LABORATORY NO. B24654

|           |                 | mg/l   | me/l |                                    |                  | mg/l | me/l |
|-----------|-----------------|--------|------|------------------------------------|------------------|------|------|
| Iron      | Fe              | 2.8    |      | Silica                             | SiO <sub>2</sub> | 19   |      |
| Manganese | Mn              | 0.79   |      | Fluoride                           | F                | 0.2  | 0.01 |
| Ammonium  | NH <sub>4</sub> | 0.3    | 0.02 | Boron                              | B                | 0.1  |      |
| Sodium    | Na              | 7      | 0.30 | Nitrate                            | NO <sub>3</sub>  | 0.0  | 0.00 |
| Potassium | K               | 2.4    | 0.06 | Chloride                           | Cl               | 4.2  | 0.12 |
| Calcium   | Ca              | 62     | 3.09 | Sulfate                            | SO <sub>4</sub>  | 30   | 0.62 |
| Magnesium | Mg              | 25     | 2.06 | Alkalinity (as CaCO <sub>3</sub> ) |                  | 240  | 4.80 |
| Arsenic   | As              | 0.00   |      | Hardness (as CaCO <sub>3</sub> )   |                  | 262  | 5.24 |
| Barium    | Ba              | 0.1    |      | Total dissolved minerals           |                  | 288  |      |
| Copper    | Cu              | 0.09   |      |                                    |                  |      |      |
| Cadmium   | Cd              | 0.00   |      |                                    |                  |      |      |
| Chromium  | Cr              | 0.0    |      |                                    |                  |      |      |
| Lead      | Pb              | 0.02   |      |                                    |                  |      |      |
| Mercury   | Hg              | 0.0000 |      |                                    |                  |      |      |
| Nickel    | Ni              | 0.0    |      |                                    |                  |      |      |
| Selenium  | Se              | 0.00   |      |                                    |                  |      |      |
| Silver    | Ag              | 0.00   |      |                                    |                  |      |      |
| Cyanide   | CN              | 0.00   |      |                                    |                  |      |      |
| Zinc      | Zn              | 1.6    |      | pH (as rec'd)                      |                  | 7.6  |      |

**GALESBURG**

The city of Galesburg (36,290) installed a public water supply in 1890. Although the city is located in Knox County, the last four wells constructed are located in this county. Four wells (Collector No. 1, and Well Nos. 74-1, 74-2, and 74-3) are in use and three wells (Henderson St. Well Nos. 1 and 2, and Florence Ave. well) are available for emergency use. This city also furnishes water to East Galesburg and the Galesburg Mental Health Center (State Hospital). In 1952 the average and maximum daily pumpages were 1,150,000 and 1,400,000 gpd, respectively. In 1977 there were 12,775 services, all metered (including East Galesburg and the Galesburg Mental Health Center); the average and maximum daily pumpages were 6,500,000 and 8,000,000 gpd, respectively. The water is chlorinated, fluoridated, and then pumped to the treatment plant in Galesburg where it is fed a polyelectrolyte coagulant aid (Nalcolyte 110-A) and filtered.

Initially, water was obtained from a series of driven wells 70 to 80 ft deep located along the bank of Cedar Creek near the old waterworks building in the city of Galesburg. Additional wells were drilled as needed until there were about 80. In 1911, with five 8-in. wells and one 10-in. well in use, all about 70 ft deep, the nonpumping water level was reported to be 45 to 50 ft below land surface. The wells were equipped with Cook strainers about 20 ft long with 1/16-in. openings. By 1921, continuous sand problems caused the ultimate abandonment of these wells.

Two wells were drilled in the same vicinity as the driven wells in January and September 1896 to depths of 1226 and 1250 ft, respectively. In 1906 another well was drilled to a depth of 775 ft in the same location of the city. Non-pumping water levels were reported to be 100 ft below land surface in 1911 and 180 ft in 1920. In 1921, it was reported that these deep wells were not being used because their operation was not economical compared with the operation of three wells that were drilled in 1917 and 1919. The deep wells were abandoned prior to 1929.

A drillers log of the 1226-ft deep well follows:

| Strata                 | Thickness (ft) | Depth (ft) |
|------------------------|----------------|------------|
| Black top soil         | 4              | 4          |
| Blue clay              | 8              | 12         |
| Fine sand              | 13             | 25         |
| Sand                   | 13             | 38         |
| Coal                   | 2              | 40         |
| Coarse sand and gravel | 45             | 85         |
| Fire clay              | 5              | 90         |
| Sandstone              | 15             | 105        |
| Shale mixed with sand  | 27             | 132        |
| Sandstone              | 6              | 138        |
| Fire clay              | 4              | 142        |
| Black shale            | 8              | 150        |
| White shale            | 15             | 165        |
| Brown shale            | 10             | 175        |
| Soapstone              | 15             | 190        |
| Black soapstone        | 10             | 200        |
| Limestone and flint    | 15             | 215        |
| Slate                  | 15             | 230        |
| Yellow shale           | 115            | 345        |

| <i>Strata (continued)</i>      | <i>Thickness (ft)</i> | <i>Depth (ft)</i> |
|--------------------------------|-----------------------|-------------------|
| Limestone                      | 80                    | 425               |
| White limestone                | 25                    | 450               |
| Sandstone                      | 110                   | 560               |
| Shale, soapstone and limestone | 90                    | 650               |
| Limestone                      | 25                    | 675               |
| Black limestone                | 85                    | 760               |
| Trenton limestone              | 300                   | 1060              |
| St. Peter sandstone            | 166                   | 1226              |

A large-diameter well, 9 ft in diameter, was constructed in 1914 to a depth of about 80 ft. The well was cased with 6-ft diameter steel pipe to a depth of 60 ft followed by two concentric perforated pipes, with an 18-in. space between which was filled with gravel. This well was abandoned in 1920.

CENTRAL FIRE STATION WELL (also known as Bradley Well No. 1), open to the Glenwood-St. Peter Sandstone, was completed in December 1917 to a depth of 1252 ft by city employees. This well was abandoned prior to 1952 and has been sealed. The well was located at the Central Fire Station on the east side of Cherry St. south of Simmons St., approximately 500 ft S and 1280 ft W of the NE corner of Section 15, T11N, R1E, Knox County. The land surface elevation at the well is 772.78 ft.

A partial sample study log of the Central Fire Station well furnished by the State Geological Survey follows:

| <i>Strata</i>  | <i>Thickness (ft)</i> | <i>Depth (ft)</i> |
|--|-----------------------|-------------------|
| <b>PLEISTOCENE SERIES</b>                                    |                       |                   |
| Till, pebbly and sandy                                       | at                    | 54                |
| Sand, quartz grains, with a piece of coal                    | at                    | 96                |
| Sand and gravel  | at                    | 98                |
| <b>PENNSYLVANIAN SYSTEM</b>                                  |                       |                   |
| Coal and black sandy shale                                   | at                    | 110               |
| Shale, gray, with fine sand                                  | at                    | 215               |
| Shale and fine sand, gray                                    | at                    | 260               |
| <b>DEVONIAN SYSTEM</b>                                       |                       |                   |
| Limestone, gray, shaly                                       | 5                     | 410               |
| Interval   | 5                     | 415               |
| Limestone, like last   | 6                     | 420               |
| Limestone, gray, with a little sand                          | 5                     | 425               |
| Limestone, gray, fine grained                                | 10                    | 435               |
| Limestone, light brownish gray, fine grained                 | 25                    | 460               |
| <b>SILURIAN SYSTEM</b>                                       |                       |                   |
| Limestone, like last, mixed with dolomite, light gray        | 5                     | 465               |
| Limestone, light to drab, crystalline                        | 39                    | 504               |
| Limestone, gray  | 11                    | 515               |
| Limestone, gray, subcrystalline                              | 5                     | 520               |
| Limestone, light gray, subcrystalline, partly dolomitic      | 5                     | 525               |
| Dolomite, gray   | 50                    | 575               |
| <b>ORDOVICIAN SYSTEM</b>                                     |                       |                   |
| <b>Maquoketa Group</b>                                       |                       |                   |
| Dolomite, gray, w/lt some chert                              | 5                     | 580               |
| Shale, greenish gray   | 29                    | 609               |
| Shale, light gray  | 57                    | 666               |
| Limestone, shaly, dolomitic, subcrystalline                  | 14                    | 680               |
| Shale, gray  | 5                     | 685               |
| <b>Galena-Platteville Groups</b>                             |                       |                   |
| Limestone, dolomitic, subcrystalline                         | 6                     | 691               |
| Limestone, gray and drab, partly dolomitic                   | 17                    | 708               |
| Shale, gray, calcareous                                      | 10                    | 718               |
| Limestone, gray to drab dolomitic, fine grained, show action | 62                    | 780               |
| Dolomite, gray, crystalline                                  | 6                     | 786               |

| <i>Strata (continued)</i>                         | <i>Thickness (ft)</i> | <i>Depth (ft)</i> |
|---|-----------------------|-------------------|
| Limestone, gray, dolomitic, show HCl action       | 206                   | 992               |
| Limestone, dolomitic with some chert              | 5                     | 997               |
| Limestone, dolomitic, gray                        | 83                    | 1080              |
| Limestone, dolomitic, gray with some sand         | 10                    | 1090              |
| <b>Glenwood-St. Peter Sandstone</b>               |                       |                   |
| Sand, quartz, in clean rounded grains             | 10                    | 1100              |
| Sand, like the last with some dolomite from above | 6                     | 1106              |
| Sand, yellowish, in rounded grains                | 46                    | 1152              |
| Sandstone with gray dolomite cement               | at                    | 1180              |
| Sandstone, like last                              | 5                     | 1185              |
| Sandstone, with gray (light) dolomitic cement     | 20                    | 1205              |
| Sandstone, with gray dolomite cement              | 35                    | 1240              |
| Sandstone, in clean rounded quartz grains         | 12                    | 1252              |

The well was cased with 24-in. heavy steel pipe from land surface to a depth of 40 ft, 20-in. heavy steel pipe from 40 ft to a depth of 146 ft, 16-in. heavy steel pipe from 146 ft to a depth of 276 ft, 12-in. heavy steel pipe from 276 ft to a depth of 626 ft, and 10-in. wrought iron pipe from 626 ft to a depth of 1087 ft. Below the casing, the hole was 10 in. in diameter to the bottom.

The well was shot with two 200-lb charges of 100 per-cent gelatin and then cleaned out.

In 1921, it was reported that after pumping at a rate of 450 gpm, the drawdown was 118 ft from a nonpumping water level of 186 ft below land surface.

A mineral analysis of a sample (Lab. No. 99153) collected February 11, 1944, after pumping for 30 min at 210 to 225 gpm, showed the water to have a hardness of 501 mg/l, total dissolved minerals of 1885 mg/l, and an iron content of 0.6 mg/l.

BROOKS ST. WELL (also known as Bradley Well No. 2), open to the Cambrian-Ordovician aquifer except for the Galena-Platteville dolomite and the Glenwood-St. Peter Sandstone, was constructed in 1919 to a depth of 1245 ft by city employees and deepened in July 1944 to a reported depth of 2450 ft by the Thorpe Well Drilling Co., Des Moines, Iowa. This well is not in use. The well is located at the southeast corner of Brooks St. and Churchill Ave., approximately 2325 ft S and 900 ft E of the NW corner of Section 14, T11N, R1E, Knox County. The land surface elevation at the well is 782.7 ft.

An interpreted drillers log of the Brooks St. well furnished by the State Geological Survey follows:

| <i>Strata</i>                            | <i>Thickness (ft)</i> | <i>Depth (ft)</i> |
|--|-----------------------|-------------------|
| <b>PLEISTOCENE SERIES</b>                |                       |                   |
| <b>Glacial drift</b>                     |                       |                   |
| Till and clay, yellow to gray            | 20                    | 20                |
| Sand and gravel                          | 32                    | 52                |
| <b>PENNSYLVANIAN SYSTEM</b>              |                       |                   |
| Shale, light gray                        | 68                    | 120               |
| Shale, dark gray, calcareous             | 15                    | 135               |
| Shale, light gray, w/lt coal             | 5                     | 140               |
| Sandstone, gray, reddish                 | 20                    | 160               |
| Sandstone, calcareous, gray; shale, gray | 9                     | 169               |
| Limestone, sandy, gray; shale, sandy     | 9                     | 178               |
| Shale, black; limestone, dark            | 12                    | 190               |

| <i>Strata (continued)</i>                    | <i>Thickness<br/>(ft)</i> | <i>Depth<br/>(ft)</i> | <i>Strata (continued)</i>               | <i>Thickness<br/>(ft)</i> | <i>Depth<br/>(ft)</i> |
|--|---------------------------|-----------------------|---|---------------------------|-----------------------|
| Coal; underclay                              | 5                         | 195                   | "Sandstone, dolomitic"                  | 50                        | 2290                  |
| Shale, black; limestone, black               | 20                        | 215                   | Sandstone, slightly dolomitic, buff     | 55                        | 2345                  |
| Shale, gray to brown                         | 35                        | 250                   | Sandstone, buff; thin dolomite beds     | 50                        | 2395                  |
| Shale, sandy, gray                           | 5                         | 255                   | Sandstone, buff                         | 20                        | 2415                  |
| Sandstone, brown; little shale               | 15                        | 270                   | "Sandstone"                             | 21                        | 2436                  |
| <b>MISSISSIPPIAN-DEVONIAN SYSTEMS</b>        |                           |                       | <b>Eau Claire Formation</b>             |                           |                       |
| New Albany Group                             |                           |                       | "Sand; some green, red, and gray shale" | 14                        | 2450                  |
| Shale, gray to brown, sporangites            | 60                        | 330                   |   |                           |                       |
| <b>DEVONIAN SYSTEM</b>                       |                           |                       |   |                           |                       |
| Cedar Valley-Wapsipinicon Limestone          |                           |                       |   |                           |                       |
| Limestone, and dolomite, partly cherty       | 75                        | 405                   |   |                           |                       |
| Limestone, gray, fine                        | 60                        | 465                   |   |                           |                       |
| <b>SILURIAN SYSTEM</b>                       |                           |                       |   |                           |                       |
| Dolomite, gray; little shale, green          | 20                        | 485                   |   |                           |                       |
| <b>ORDOVICIAN SYSTEM</b>                     |                           |                       |   |                           |                       |
| Maquoketa Group                              |                           |                       |   |                           |                       |
| Shale, gray; dolomite, sandy                 | 10                        | 495                   |   |                           |                       |
| Dolomite, slightly cherty, gray              | 75                        | 570                   |   |                           |                       |
| Shale, gray                                  | 5                         | 575                   |   |                           |                       |
| Dolomite, gray                               | 15                        | 590                   |   |                           |                       |
| Shale, calcareous, gray                      | 10                        | 600                   |   |                           |                       |
| Dolomite, shaly, gray                        | 10                        | 610                   |   |                           |                       |
| Shale, gray to green                         | 15                        | 625                   |   |                           |                       |
| Dolomite, brown                              | 5                         | 630                   |   |                           |                       |
| Shale, calcareous, gray to brown             | 15                        | 645                   |   |                           |                       |
| Dolomite, shaly, gray                        | 10                        | 655                   |   |                           |                       |
| <b>Galena-Platteville Groups</b>             |                           |                       |   |                           |                       |
| Dolomite, gray                               | 285                       | 940                   |   |                           |                       |
| Dolomite, cherty, gray                       | 25                        | 965                   |   |                           |                       |
| Dolomite, gray                               | 95                        | 1060                  |   |                           |                       |
| Dolomite, sandy, gray                        | 5                         | 1065                  |   |                           |                       |
| <b>Glenwood-St. Peter Sandstone</b>          |                           |                       |   |                           |                       |
| Sandstone, clean                             | 165                       | 1230                  |   |                           |                       |
| No record                                    | 22                        | 1252                  |   |                           |                       |
| <b>Shakopee Dolomite</b>                     |                           |                       |   |                           |                       |
| "Dolomite, argillaceous in part"             | 222                       | 1474                  |   |                           |                       |
| <b>New Richmond Sandstone</b>                |                           |                       |   |                           |                       |
| "Sandstone, cherty, dolomitic"               | 46                        | 1520                  |   |                           |                       |
| Dolomite, sandy, cherty; sandstone           | 15                        | 1535                  |   |                           |                       |
| <b>Oneota Dolomite</b>                       |                           |                       |   |                           |                       |
| "Dolomite"                                   | 15                        | 1550                  |   |                           |                       |
| Dolomite, cherty, white; sandstone           | 5                         | 1555                  |   |                           |                       |
| "Dolomite, with interbedded sandstone"       | 25                        | 1580                  |   |                           |                       |
| Dolomite, cherty, white; sandstone           | 5                         | 1585                  |   |                           |                       |
| "Dolomite, cherty"                           | 15                        | 1600                  |   |                           |                       |
| Dolomite, white                              | 10                        | 1610                  |   |                           |                       |
| "Dolomite, cherty, sandy at base"            | 55                        | 1665                  |   |                           |                       |
| Dolomite, very cherty, white; quartz         | 5                         | 1670                  |   |                           |                       |
| "Dolomite, cherty, sandy"                    | 25                        | 1695                  |   |                           |                       |
| Dolomite, buff, pink                         | 10                        | 1705                  |   |                           |                       |
| "Dolomite, cherty, silty"                    | 30                        | 1735                  |   |                           |                       |
| Dolomite, cherty, sandy, shaly, buff         | 15                        | 1750                  |   |                           |                       |
| Chert, dolomitic, oolitic                    | 5                         | 1755                  |   |                           |                       |
| "Dolomite, sandy; interbedded sandstone"     | 15                        | 1770                  |   |                           |                       |
| Dolomite, sandy, cherty (oolitic), buff      | 5                         | 1775                  |   |                           |                       |
| Dolomite sandy; sandstone                    | 18                        | 1793                  |   |                           |                       |
| <b>CAMBRIAN SYSTEM</b>                       |                           |                       |   |                           |                       |
| <b>Eminence-Potosi Dolomite</b>              |                           |                       |   |                           |                       |
| Dolomite, sandy, glauconitic                 | 17                        | 1810                  |   |                           |                       |
| "Crevice"                                    | 5                         | 1815                  |   |                           |                       |
| Dolomite, sandy, cherty, glauconitic; quartz | 5                         | 1820                  |   |                           |                       |
| "Dolomite"                                   | 30                        | 1850                  |   |                           |                       |
| Dolomite, sandy, glauconitic                 | 20                        | 1870                  |   |                           |                       |
| "Dolomite; crevice at base"                  | 10                        | 1880                  |   |                           |                       |
| Dolomite, gray, pink; quartz                 | 20                        | 1900                  |   |                           |                       |
| "Dolomite; crevices"                         | 20                        | 1920                  |   |                           |                       |
| Dolomite, glauconitic, buff; quartz          | 40                        | 1960                  |   |                           |                       |
| Same; thin sandstone beds                    | 20                        | 1980                  |   |                           |                       |
| Dolomite, sandy, glauconitic, buff; quartz   | 25                        | 2005                  |   |                           |                       |
| "Dolomite"                                   | 10                        | 2015                  |   |                           |                       |
| Dolomite, sandy, glauconitic, buff, pink     | 40                        | 2055                  |   |                           |                       |
| "Dolomite"                                   | 11                        | 2066                  |   |                           |                       |
| <b>Franconia Formation</b>                   |                           |                       |   |                           |                       |
| "Dolomite, sandy, glauconitic"               | 9                         | 2075                  |   |                           |                       |
| Dolomite, very glauconitic and sandy; shale  | 90                        | 2165                  |   |                           |                       |
| Sandstone, white, coarse, incoherent         | 20                        | 2185                  |   |                           |                       |
| Dolomite, as above; shale                    | 55                        | 2240                  |   |                           |                       |
| <b>Ironton-Galesville Sandstone</b>          |                           |                       |   |                           |                       |

Originally, the well was cased with 20-in. pipe from land surface to a depth of 52 ft, 16-in. OD pipe from land surface to a depth of 360 ft (cemented in), and 15-in. OD pipe from 360 ft to a depth of 610 ft. Below the casing, the hole was finished 14 in. in diameter to a depth of 1245 ft. During deepening in 1944, the well was cased with 12-in. wrought iron pipe from land surface to a depth of 319.7 ft, 10-in. wrought iron pipe from 319.7 ft to a depth of 569.2 ft, and 8-in. drive pipe from land surface to a depth of 1259.5 ft (the top 522 ft was cut off and removed). Below the casing, the hole was finished 8 in. in diameter to the bottom. The annulus between the old 16- and the new 12-in. casings and between the old 14- and the new 10-in. casings is filled with cement grout.

A production test was conducted by the driller on March 8, 1919. After pumping at a rate of 650 gpm, the drawdown was 157 ft from a nonpumping water level of 190 ft below land surface.

In November 1943, a 1.5-in. airpipe broke causing air and water to rise outside the eductor pipe and flood the station. The Thorpe Well Drilling Co. removed the pump and the nonpumping water level was reported to be 253 ft below the top of the 16-in. casing. It was observed that at a depth of 60 ft, considerable water was entering the well through holes in the casing. The holes may have been made when the well was first constructed in order to take advantage of the water found at that depth. In 1944 the driller deepened the well to 2450 ft and installed new casings.

After the well was deepened, a production test was conducted by the State Water Survey on July 14, 1944. After 8.4 hr of pumping at rates of 512 to 519 gpm, the final drawdown was 19 ft from a nonpumping water level of 258 ft below land surface. One min after pumping was stopped, full recovery was observed.

The pumping equipment presently installed consists of a 100-hp U. S. electric motor (No. 337616), a 9.5-in., 10-stage American Well Works turbine pump (No. 69921) set at 350 ft, rated at 545 gpm at about 350 ft head, and has 350 ft of 6-in. column pipe. A 20-ft section of 6-in. suction pipe is attached to the pump intake. The well is equipped with 350 ft of airline.

A partial analysis of a sample (Lab. No. 105558) collected February 15, 1946, after pumping for 6.1 hr, showed the water to have a hardness of 318 mg/l, total dissolved minerals of 1352 mg/l, and an iron content of 1.6 mg/l.

HENDERSON ST. WELL NO. 1 (also known as Potsdam

Well No. 1), open to the Cambrian-Ordovician aquifer except for the Galena-Platteville dolomite and the Glenwood-St. Peter Sandstone, was completed in July 1919 to a depth of 2414 ft by S. B. Geiger, Chicago. This well is available for emergency use. The well is located about 200 ft south of the waterworks pumping station and 550 ft west of Henderson St., approximately 540 ft S and 640 ft W of the NE corner of Section 16, T11N, R1E, Knox County. The land surface elevation at the well is approximately 760 ft.

A sample study log of Henderson St. Well No. 1 furnished by the State Geological Survey follows:

| <i>Strata</i>  | <i>Thickness (ft)</i> | <i>Depth (ft)</i> |
|--|-----------------------|-------------------|
| <b>PLEISTOCENE SERIES</b>  |                       |                   |
| No samples   | 50                    | 50                |
| Sand, brownish gray, medium grained, calcareous below                              | 10                    | 60                |
| No samples   | 20                    | 80                |
| Sand, brownish gray, fine to coarse, calcareous                                    | 5                     | 85                |
| No samples   | 10                    | 95                |
| <b>PENNSYLVANIAN SYSTEM</b>  |                       |                   |
| Shale, calcareous, medium gray, silty  | 50                    | 145               |
| Coal; and shale, medium gray, sandy  | 5                     | 150               |
| Shale, medium gray   | 20                    | 170               |
| No samples   | 20                    | 190               |
| Coal; and fire clay, light gray, soft  | 10                    | 200               |
| Shale, dark gray, soft   | 5                     | 205               |
| No samples   | 25                    | 230               |
| Shale, slightly calcareous, brown, sandy   | 5                     | 235               |
| No samples   | 10                    | 245               |
| <b>MISSISSIPPIAN-DEVONIAN SYSTEMS</b>  |                       |                   |
| New Albany Group   |                       |                   |
| Shale, light gray and brown, smooth  | 20                    | 265               |
| Shale, brown and gray, slightly gritty, with sporangites huronense fossils         | 55                    | 320               |
| <b>DEVONIAN SYSTEM</b>   |                       |                   |
| Cedar Valley-Wapsipinicon Limestone  |                       |                   |
| Limestone, argillaceous, light brownish gray, fossiliferous                        | 5                     | 325               |
| No samples   | 105                   | 430               |
| <b>SILURIAN SYSTEM</b>   |                       |                   |
| Niagaran Series  |                       |                   |
| Chert, white and gray, oolitic and banded, some weathered                          | 5                     | 435               |
| No samples   | 10                    | 445               |
| Dolomite, light gray, powdered   | 5                     | 450               |
| No samples   | 350                   | 800               |
| <b>ORDOVICIAN SYSTEM</b>   |                       |                   |
| Galena-Platteville Groups  |                       |                   |
| Dolomite, brown, finely crystalline; lower 10 ft sandy                             | 255                   | 1055              |
| Glenwood-St. Peter Sandstone   |                       |                   |
| Sandstone, white, fine to medium   | 135                   | 1190              |
| Chert pebbles, white and buff, dense, oolitic, and porous; with sandstone          | 35                    | 1225              |
| Shale, green, sandy  | 5                     | 1230              |
| Prairie du Chien Group   |                       |                   |
| Dolomite, gray, buff and pink, with cherty and sandy layers                        | 205                   | 1435              |
| Dolomite, light brown, with whitish chert  | 50                    | 1485              |
| Sandstone, dolomitic, very fine to medium (New Richmond?)                          | 15                    | 1500              |
| Dolomite, cherty, light gray to white  | 225                   | 1725              |
| Dolomite, cherty, white, sandy; with sandstone, white, fine                        | 10                    | 1735              |
| <b>CAMBRIAN SYSTEM</b>   |                       |                   |
| Eminence-Potosi Dolomite   |                       |                   |
| Dolomite, light gray and pink, very fine grained                                   | 285                   | 2020              |
| Dolomite, light brownish gray, glauconitic   | 10                    | 2030              |
| Franconia Formation  |                       |                   |
| Sandstone, very dolomitic, gray with greenish tint, glauconitic, very fine grained | 130                   | 2160              |

| <i>Strata (continued)</i>   | <i>Thickness (ft)</i> | <i>Depth (ft)</i> |
|---|-----------------------|-------------------|
| Dolomite, sandy, gray, scattered glauconite                         | 30                    | 2190              |
| Sandstone, dolomitic, gray, glauconitic, becoming coarser at bottom | 25                    | 2215              |
| Shale, yellow green, powdered and mixed with sand                   | 20                    | 2235              |
| Ironton-Galesville Sandstone  |                       |                   |
| Sandstone, white to yellow, fine to medium, loosely cemented        | 70                    | 2305              |
| Interval not studied  | 109                   | 2414              |

A 26-in. diameter hole was drilled to a depth of 573 ft, reduced to 16 in. between 573 and 1225 ft, reduced to 12 in. between 1225 and 2100 ft, reduced to 11 in. between 2100 and 2175 ft, and finished 10 in. in diameter from 2175 to 2414 ft. The well is cased with 26-in. OD drive pipe from land surface to a depth of 125 ft, 22-in. OD pipe from land surface to a depth of 201.3 ft, and 16-in. OD pipe from 201.3 ft to a depth of 1225 ft.

Nonpumping water levels below the pump base plate were reported as follows: 156 ft in 1919; 205.5 ft in March 1936; 245.1 ft on October 18, 1939; and 247.5 ft on July 21, 1945.

The pumping equipment presently installed is a 12-in., 14-stage American Well Works turbine pump (No. 51235) rated at 1000 gpm, and powered by a 150-hp 1160 rpm Westinghouse electric motor (No. 4649281). A 20-ft section of 6-in. suction pipe is attached to the pump intake.

A mineral analysis of a sample (Lab. No. 105243) collected January 9, 1946, showed the water to have a hardness of 229 mg/l, total dissolved minerals of 1026 mg/l, and an iron content of 0.3 mg/l.

HENDERSON ST. WELL NO. 2 (also known as Potsdam Well No. 2), open to the Cambrian-Ordovician aquifer except for the Galena-Platteville dolomite, the Glenwood-St. Peter Sandstone, and the Shakopee Dolomite, was completed in June 1928 to a depth of 2408 ft by the Phillips Bros., Des Moines, Iowa. This well is available for emergency use. The well is located on the west side of Henderson St. about 500 ft east of the waterworks station, approximately 390 ft S and 140 ft W of the NE corner of Section 16, T11N, R1E, Knox County. The land surface elevation at the well is 756.3 ft.

A summary sample study log of Henderson St. Well No. 2 furnished by the State Geological Survey follows:

| <i>Strata</i>                         | <i>Thickness (ft)</i> | <i>Depth (ft)</i> |
|---------------------------------------|-----------------------|-------------------|
| <b>PLEISTOCENE SERIES</b>             |                       |                   |
| Glacial drift                         |                       |                   |
| Soil and till                         | 20                    | 20                |
| Sand, yellow                          | 55                    | 75                |
| Till, gray                            | 10                    | 85                |
| <b>PENNSYLVANIAN SYSTEM</b>           |                       |                   |
| Shale, black                          | 5                     | 90                |
| Coal                                  | 5                     | 95                |
| Shale, gray to black                  | 135                   | 230               |
| <b>MISSISSIPPIAN-DEVONIAN SYSTEMS</b> |                       |                   |
| New Albany Group                      |                       |                   |
| <b>DEVONIAN SYSTEM</b>                |                       |                   |
| Cedar Valley-Wapsipinicon Limestone   | 90                    | 445               |
| <b>SILURIAN SYSTEM</b>                |                       |                   |

| <i>Strata (continued)</i>                       | <i>Thickness (ft)</i> | <i>Depth (ft)</i> |
|---|-----------------------|-------------------|
| <b>Niagaran and Alexandrian Dolomite Series</b> | <b>125</b>            | <b>570</b>        |
| <b>ORDOVICIAN SYSTEM</b>                        |                       |                   |
| Maquoketa Shale Group                           | 200                   | 770               |
| Galena-Platteville Dolomite Groups              | 300                   | 1070              |
| Glenwood-St. Peter Sandstone                    |                       |                   |
| Sandstone                                       | 135                   | 1205              |
| Shale, weak                                     | 5                     | 1210              |
| Shakopee Dolomite                               | 270                   | 1480              |
| New Richmond Sandstone                          | 40                    | 1520              |
| Oneota Dolomite                                 | 255                   | 1775              |
| No samples                                      | 40                    | 1815              |
| <b>CAMBRIAN SYSTEM</b>                          |                       |                   |
| Eminence-Potosi Dolomite                        | 205                   | 2020              |
| Franconia Formation                             |                       |                   |
| Dolomite, sandstone and shale                   | 195                   | 2215              |
| Ironton-Galesville Sandstone                    | 120                   | 2335              |
| Eau Claire Formation                            |                       |                   |
| Some sandstone, dolomite, and shale             | 73                    | 2408              |

The well is cased with 22-in. OD pipe from land surface to a depth of 412 ft and 14-in. OD pipe from 406 ft to a depth of 1479 ft. Below the casing, the hole was finished 12 in. in diameter to the bottom.

Upon completion, the well reportedly produced 1600 gpm with a drawdown of 57 ft from a nonpumping water level of 197 ft below the base plate.

In June 1933, after pumping at a rate of 1580 gpm, the drawdown was 39.1 ft from a nonpumping water level of 202.5 ft below the base plate.

Nonpumping water levels below the base plate were reported to be 211 ft in May 1936 and 222 ft in February 1940.

In June 1944, the well reportedly produced 1000 gpm with a drawdown of 74.3+ ft from a nonpumping water level of 230.9 ft below the base plate.

The pumping equipment presently installed is a 20-in., 4-stage American Well Works turbine pump (No. 52059) rated at 1200 gpm, and powered by a 200-hp 1176 rpm Westinghouse electric motor (No. 154C3947). A 20-ft section of 10-in. suction pipe is attached to the pump intake.

A mineral analysis of a sample (Lab. No. 105245) collected January 9, 1946, showed the water to have a hardness of 227 mg/l, total dissolved minerals of 1086 mg/l, and an iron content of 0.1 mg/l.

In May and June 1944, during a critical water shortage, the city leased an 80-ft deep well from the Western Illinois Ice Co. The well was located on the south side of the Atchison, Topeka, and Santa Fe RR Co. right of way and 500 ft west of Main St., approximately 300 ft S and 1125 ft E of the NW corner of Section 15, T11N, R1E, Knox County. The well was reported to be 16 ft in diameter and cased with 15-ft diameter concrete pipe to a depth of 80 ft. On June 4, 1944, after pumping continuously at a rate of 400 gpm, there was very little drawdown from a nonpumping water level of 15 ft below land surface.

FLORENCE AVE. WELL, open to the Devonian limestone and the Cambrian-Ordovician aquifer except for the Glenwood-St. Peter Sandstone, was completed in June 1944

to a depth of 2473 ft by the Thorpe Well Drilling Co., Des Moines, Iowa. This well is available for emergency use. The well is located 500 ft west of Florence Ave. and 160 ft south of Walsh St., approximately 2500 ft N and 1500 ft E of the SW corner of Section 2, T11N, R1E, Knox County. The land surface elevation at the well is approximately 786 ft. A sample study log of the Florence Ave. well furnished by the State Geological Survey follows:

| <i>Strata</i>   | <i>Thickness (ft)</i> | <i>Depth (ft)</i> |
|---|-----------------------|-------------------|
| <b>PLEISTOCENE SERIES</b>                                 |                       |                   |
| Soil, silt, and till                                      | 25                    | 25                |
| Gravel, sand and silt                                     | 9                     | 34                |
| Till  | 41                    | 75                |
| Sand and gravel   | 7                     | 82                |
| <b>PENNSYLVANIAN SYSTEM</b>                               |                       |                   |
| Shale, thin siltstone, limestone and coal beds            | 256                   | 338               |
| <b>MISSISSIPPIAN-DEVONIAN SYSTEMS</b>                     |                       |                   |
| New Albany Group  |                       |                   |
| Shale, thin sandstone bed                                 | 40                    | 378               |
| <b>DEVONIAN SYSTEM</b>                                    |                       |                   |
| Cedar Valley Limestone                                    | 80                    | 458               |
| Wapsipinicon Limestone                                    | 32                    | 490               |
| <b>SILURIAN SYSTEM</b>                                    |                       |                   |
| Niagaran-Alexandrian Series                               |                       |                   |
| Siltstone and dolomite                                    | 64                    | 554               |
| Dolomite  | 68                    | 622               |
| <b>ORDOVICIAN SYSTEM</b>                                  |                       |                   |
| Maquoketa Group   |                       |                   |
| Shale, some dolomite                                      | 198                   | 820               |
| Galena-Platteville Dolomite Groups                        | 295                   | 1115              |
| Glenwood-St. Peter Sandstone                              |                       |                   |
| Sandstone, dolomite and shale                             | 5                     | 1120              |
| Sandstone, incoherent                                     | 143                   | 1263              |
| Shale and chert   | 10                    | 1273              |
| Shakopee Dolomite, some shale and thin sandstone beds     | 232                   | 1505              |
| New Richmond Sandstone, dolomitic                         | 80                    | 1585              |
| Oneota Dolomite, some thin sandstone and shale beds       | 267                   | 1852              |
| <b>CAMBRIAN SYSTEM</b>                                    |                       |                   |
| Eminence-Potosi Dolomite                                  | 231                   | 2083              |
| Franconia Formation, dolomite, sandstone, thin shale bed  | 187                   | 2270              |
| Ironton-Galesville Sandstone, partly dolomitic            | 120                   | 2390              |
| Eau Claire Formation, sandstone, shale, thin dolomite bed | 83                    | 2473              |

A 24-in. diameter hole was drilled to a depth of 410 ft, reduced to 23 in. between 410 and 843 ft, reduced to 18 in. between 843 and 1285 ft, and finished 12 in. in diameter from 1285 to 2473 ft. The well is cased with 24-in. OD pipe from land surface to a depth of 410 ft, 16-in. OD liner pipe from 477.2 ft to a depth of 843.3 ft, and 12-in. ID liner pipe from 1031.5 ft to a depth of 1285.1 ft.

The hole was dynamited in two series of shots. The first series of 9 shots (125 lb each) was spaced between depths of 2278 and 2392 ft, and the second series of 5 shots (175 lb each) was spaced between depths of 2293 and 2402 ft.

A production test was conducted on June 2-4, 1944, by representatives of the driller and the State Water Survey. After 8.9 hr of pumping at rates of 470 to 483 gpm, the drawdown was 83 ft from a nonpumping water level of 255 ft below the top of the 24-in casing. Pumping was continued for 6.2 hr at rates ranging from 718 to 558 gpm with a maxi-

imum drawdown of 121 ft. After a 2.2-hr shutdown, pumping was resumed for 5.8 hr at rates of 773 to 700 gpm with a drawdown of 136 ft. After a 45-min shutdown, pumping was resumed for 11 hr at rates of 718 to 700 gpm with a drawdown of 140 ft. After another 5.5-hr shutdown, pumping was resumed for 10.6 hr at rates ranging from 800 to 718 gpm with a drawdown of 155 ft. After a 40-min shutdown, the well was pumped for 7.8 hr at rates ranging from 663 to 635 gpm with a final drawdown of 130 ft.

In November 1955, the nonpumping water level was reported to be 300 ft below land surface.

The pumping equipment presently installed is an 11-in., 9-stage American Well Works turbine pump (No. 68796) rated at 1000 gpm at about 466 ft head, and powered by a 150-hp 1770 rpm U. S. electric motor (Serial No. 326809). A 20-ft section of 10-in. suction pipe is attached to the pump intake.

The following mineral analysis (Lab. No. 105246) is for a water sample from the well collected January 9, 1946, after 10 days of pumping at 650 gpm.

**FLORENCE AVE. WELL, LABORATORY NO. 105246**

|           | mg/l            | me/l        |                                    | mg/l             | me/l        |
|-----------|-----------------|-------------|------------------------------------|------------------|-------------|
| Iron      | Fe              | 0.5         | Silica                             | SiO <sub>2</sub> | 10.5        |
| Manganese | Mn              | 0.0         | Fluoride                           | F                | 3.0 0.16    |
| Ammonium  | NH <sub>4</sub> | 1.3 0.07    | Nitrate                            | NO <sub>3</sub>  | 1.2 0.02    |
| Sodium    | Na              | 382.5 16.64 | Chloride                           | Cl               | 215.0 6.06  |
| Calcium   | Ca              | 68.1 3.40   | Sulfate                            | SO <sub>4</sub>  | 558.9 11.62 |
| Magnesium | Mg              | 26.2 2.16   | Alkalinity (as CaCO <sub>3</sub> ) |                  | 228 4.56    |
|           |                 |             | Hardness (as CaCO <sub>3</sub> )   |                  | 279 5.58    |
| Turbidity | Tr              |             |                                    |                  |             |
| Color     | Tr              |             |                                    |                  |             |
| Odor      | 0               |             | Total dissolved minerals           |                  | 1399        |
| Temp.     | 68.2F           | (reported)  |                                    |                  |             |

FOURTH ST. WELL, open to the Devonian limestone, the Silurian dolomite, the Cambrian-Ordovician aquifer (except for the Glenwood-St. Peter Sandstone), and the Elmhurst-Mt. Simon aquifer, was completed in 1950 to a depth of 2750 ft (plugged back to 2645 ft) by the Thorpe Well Drilling Co., Des Moines, Iowa. This well has not been used since 1966 and has been abandoned and capped. The well is located about 350 ft west and 50 ft north of the intersection of Fourth and Henderson Sts., approximately 590 ft N and 350 ft W of the SE corner of Section 16, T11N, R1E, Knox County. The land surface elevation at the well is approximately 775 ft.

A drillers log of Well No. 5 follows:

| Strata         | Thickness (ft) | Depth (ft) |
|----------------|----------------|------------|
| Drift          | 96             | 96         |
| Shale          | 19             | 115        |
| Slate and coal | 2              | 117        |
| Shale          | 57             | 174        |
| Coal           | 2              | 176        |

| Strata (continued)                 | Thickness (ft) | Depth (ft) |
|------------------------------------|----------------|------------|
| Shale                              | 48             | 224        |
| Limestone, sandy                   | 14             | 238        |
| Shale                              | 159            | 397        |
| Limestone                          | 250            | 647        |
| Shale                              | 48             | 695        |
| Limestone                          | 19             | 714        |
| Shale                              | 7              | 721        |
| Limestone                          | 78             | 799        |
| Shale                              | 6              | 805        |
| Limestone                          | 5              | 810        |
| Shale                              | 5              | 815        |
| Limestone                          | 6              | 821        |
| Limestone, shale streaks           | 5              | 826        |
| Limestone                          | 266            | 1092       |
| Sandstone (St. Peter)              | 135            | 1227       |
| Shale                              | 8              | 1235       |
| Dolomite                           | 128            | 1363       |
| Shale                              | 3              | 1366       |
| Dolomite                           | 699            | 2065       |
| Dolomite, shale streaks            | 120            | 2185       |
| Dolomite, hard                     | 40             | 2225       |
| Dolomite, shale streaks            | 30             | 2255       |
| Sandstone (Galesville)             | 120            | 2375       |
| Dolomite, hard                     | 30             | 2405       |
| Dolomite, sandy with shale streaks | 60             | 2465       |
| Dolomite, hard                     | 63             | 2528       |
| Shale, brown                       | 8              | 2536       |
| Dolomite, hard                     | 6              | 2542       |
| Shale, brown                       | 9              | 2551       |
| Dolomite                           | 78             | 2629       |
| Dolomite, sandy                    | 21             | 2650       |
| Sandstone (Mt. Simon)              | 100            | 2750       |

A 32-in. diameter hole was drilled to a depth of 471 ft, reduced to 23 in. between 471 and 1260 ft, reduced to 19 in. between 1260 and 2525 ft, reduced to 15 in. between 2525 and 2637 ft, and finished 12 in. in diameter from 2637 to 2750 ft. The well is cased with 32-in. pipe from within a concrete base that extends 0.8 ft above the pumphouse floor to a depth of 106 ft, 24-in. pipe from land surface to a depth of 471 ft (cemented in), 20-in. pipe from 621 ft to a depth of 840 ft (cemented in) and from 1078 ft to a depth of 1260 ft, 16-in. pipe from 2382 ft to a depth of 2523 ft, and 12-in. perforated pipe from 2511 ft to a depth of 2637 ft.

A production test was conducted by the driller on September 6, 1950. After 5.8 hr of pumping at rates of 248 to 280 gpm, the drawdown was 104 ft from a nonpumping water level of 257 ft.

A production test was conducted by the driller on October 13-14, 1950. After 1.7 hr of pumping at rates of 500 to 485 gpm, the drawdown was 88.0 ft from a nonpumping water level of 259.0 ft. Pumping was continued for 55 min at a rate of 585 gpm with a drawdown of 109.0 ft. Pumping was continued for 4.2 hr at rates of 725 to 750 gpm with a drawdown of 139.5 ft. Pumping was continued for 2 hr at rates of 886 to 850 gpm with a drawdown of 166.0 ft. After an additional 12.5 hr of pumping at rates ranging from 1030 to 1134 gpm, the final drawdown was 218.5 ft.

After a permanent pump had been installed, a production test was conducted on September 20, 1951, by representatives of the city, the pump contractor, and the State Water Survey. After 4.1 hr of pumping at rates ranging from 1001 to 776 gpm,

the final drawdown was 147 ft from a nonpumping water level of 271 ft.

A partial analysis of a sample (Lab. No. 147290) collected in August 1958, showed the water to have a hardness of 304 mg/l, total dissolved minerals of 1601 mg/l, and an iron content of 0.8 mg/l. Hydrogen sulfide was apparent when a previous sample was collected.

Prior to the construction of Collector Well No. 1, more than 35 test holes were drilled in 1956 and 1957 by the Layne-Western Co., Aurora, and The Ranney Co., Westerville, Ohio, in the Mississippi River valley near Oquawka in Henderson County.

COLLECTOR WELL NO. 1, finished in sand and gravel, was completed in February 1958 by The Ranney Co., Westerville, Ohio. This well was placed in service in May 1959. The collector well is located about 30.5 miles west of Galesburg south of Oquawka about 50 ft from the Mississippi River bank, approximately 750 ft S and 175 ft W of the NE corner of Section 28, T11N, R5W, Henderson County. The land surface elevation at the well is approximately 530 ft.

A drillers log of Collector Well No. 1 follows:

| Strata                             | Thickness (ft) | Depth (ft) |
|------------------------------------|----------------|------------|
| Fill                               | 6              | 6          |
| Brown sandy clay                   | 10             | 16         |
| Fine sand, silt                    | 13             | 29         |
| Fine sand, scattered gravel        | 10             | 39         |
| Medium pea gravel, fine sand, silt | 13             | 52         |
| Very fine sand, silt               | 13             | 65         |
| Medium pea gravel, fine sand, silt | 33             | 98         |

The reinforced concrete caisson (13 ft ID by 16 ft OD) was constructed from about 11.2 ft above land surface to a depth of 97 ft. Nine 12-in. diameter perforated steel pipe laterals project radially toward the river from the collector at a depth of 90 ft below land surface. The total length of the laterals is 1800 ft distributed as shown in the following table.

| Lateral | Length (ft) |
|---------|-------------|
| 1       | 108         |
| 2       | 216         |
| 3       | 232         |
| 4       | 168         |
| 5       | 236         |
| 6       | 232         |
| 7       | 200         |
| 8       | 208         |
| 9       | 200         |

In 1971, the nonpumping water level was reported to be 13 ft.

A production test using seven observation wells was conducted February 4-8, 1958, using two pumps giving a combined rate of 5752 gpm. After 86.6 hr of pumping at a rate

of 5752 gpm, the drawdown was 15.61 ft from a nonpumping water level of 13.27 ft below the top of the collector.

The pumping equipment presently installed consists of two 24-in. Byron Jackson turbine pumps (Type KXL), each rated at 5000 gpm at about 400 ft TDH, and powered by a 600-hp Westinghouse electric motor, and one Byron Jackson pump rated at 3000 gpm, and powered by a 300-hp U. S. electric motor.

The following mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. B01371) is for a water sample from the well collected July 8, 1975, after 20 hr of pumping at 5200 gpm.

COLLECTOR WELL NO. 1, LABORATORY NO. B01371

|           | mg/l            | me/l   |                                    | mg/l             | me/l |
|-----------|-----------------|--------|------------------------------------|------------------|------|
| Iron      | Fe              | 1.6    | Silica                             | SiO <sub>2</sub> | 19   |
| Manganese | Mn              | 0.35   | Fluoride                           | F                | 0.3  |
| Ammonium  | NH <sub>4</sub> | 0.04   | Boron                              | B                | 0.1  |
| Sodium    | Na              | 6.2    | Nitrate                            | NO <sub>3</sub>  | 0.22 |
| Potassium | K               | 0.9    | Chloride                           | Cl               | 10   |
| Calcium   | Ca              | 60     | Sulfate                            | SO <sub>4</sub>  | 27   |
| Magnesium | Mg              | 18     | Alkalinity (as CaCO <sub>3</sub> ) |                  | 212  |
|           |                 |        | Hardness (as CaCO <sub>3</sub> )   |                  | 224  |
| Arsenic   | As              | 0.000  | Total dissolved minerals           |                  | 323  |
| Barium    | Ba              | 0.1    |                                    |                  |      |
| Copper    | Cu              | 0.00   | pH (as rec'd)                      |                  | 7.8  |
| Cadmium   | Cd              | 0.00   | Radioactivity                      |                  |      |
| Chromium  | Cr              | 0.00   | Alpha pc/l                         |                  | 0.4  |
| Lead      | Pb              | 0.00   | ± deviation                        |                  | 1.0  |
| Mercury   | Hg              | 0.0000 | Beta pc/l                          |                  | 1.4  |
| Nickel    | Ni              | 0.0    | ± deviation                        |                  | 1.5  |
| Selenium  | Se              | 0.000  |                                    |                  |      |
| Silver    | Ag              | 0.00   |                                    |                  |      |
| Cyanide   | CN              | 0.00   |                                    |                  |      |
| Zinc      | Zn              | 0.0    |                                    |                  |      |

WELL NO. 74-1, finished in sand and gravel, was completed in January 1975 to a depth of 101 ft by Luhr Bros., Inc., Columbia. The well is located about 550 ft southeast of Collector Well No. 1, approximately 1265 ft S and 25 ft E of the NW corner of Section 27, T11N, R5W, Henderson County. The land surface elevation at the well is approximately 530 ft.

A drillers log of Well No. 74-1 follows:

| Strata  | Thickness (ft) | Depth (ft) |
|---|----------------|------------|
| Clay, dark gray                                   | 10             | 10         |
| Sand, silty                                       | 5              | 15         |
| Sand, tan, medium                                 | 15             | 30         |
| Sand, very coarse with gravel to 3/4 in.          | 5              | 35         |
| Clay, dark gray                                   | 5              | 40         |
| Sand, dark gray with pea gravel                   | 45             | 85         |
| Sand, yellow medium with trace of pea gravel      | 10             | 95         |
| Sand, yellow very coarse with trace of pea gravel | 10             | 105        |

A 34-in. diameter hole was drilled to a depth of 101 ft. The well is cased with 16-in. steel pipe from 12 ft above land surface to a depth of 74.2 ft followed by 26.8 ft (30.5 ft overall length) of 16-in. No. 50 slot Johnson stainless steel screen. The annulus between the bore hole and the casing-

screen assembly is filled with concrete from 0 to 10 ft, with torpedo sand from 10 to 15.5 ft, and with No. 2 Northern gravel from 15.5 to 101 ft. For flood protection, the well is equipped with two corrugated steel pipes, 10 and 12 ft in diameter, extending from 11 ft above land surface to a depth of 4 ft and the annular space between the two corrugated pipes is filled with concrete.

A production test using two observation wells was conducted by the driller on January 20, 1975. After 4 hr of pumping at a rate of 1500 gpm, the final drawdown was 21.21 ft from a nonpumping water level of 10.30 ft below land surface. Fifteen min after pumping was stopped, the water level had recovered to 11.14 ft.

The pumping equipment presently installed is a Byron Jackson vertical turbine pump set at 75 ft, rated at 1780 gpm at about 445 ft head, and powered by a 350-hp General Electric motor (No. 6318P24).

A partial analysis of a sample (Lab. No. 197738) collected January 21, 1975, after pumping for 3.5 hr, showed the water to have a hardness of 226 mg/l, total dissolved minerals of 271 mg/l, and an iron content of 1.1 mg/l.

WELL NO. 74-2, finished in sand and gravel, was completed in January 1975 to a depth of 97 ft by Luhr Bros., Inc., Columbia. The well is located about 275 ft south of Well No. 74-1, approximately 1540 ft S and 10 ft W of the NE corner of Section 28, T11N, R5W, Henderson County. The land surface elevation at the well is approximately 530 ft.

A drillers log of Well No. 74-2 follows:

| <i>Strata</i>   | <i>Thickness (ft)</i> | <i>Depth (ft)</i> |
|---|-----------------------|-------------------|
| Blue silty clay   | 2                     | 2                 |
| Fine brown sand   | 9                     | 11                |
| Fine brown sand with dirty clay                                     | 2                     | 13                |
| Medium fine brown sand  | 17                    | 30                |
| Gray sand with some gravel and cobbles, gray clay layer 33 to 36 ft | 10                    | 40                |
| Dark gray sand, medium  | 36                    | 76                |
| Orange brown sand, coarse with gravel                               | 5                     | 81                |
| Orange brown sand, medium coarse with gravel                        | 5                     | 86                |
| Orange brown sand, very coarse with gravel                          | 7                     | 93                |
| Gray sand, very coarse with heavy cobbles                           | 12                    | 105               |

A 34-in. diameter hole was drilled to a depth of 97 ft. The well is cased with 16-in. steel pipe from 12 ft above land surface to a depth of 71.7 ft followed by 25.3 ft (30.5 ft overall length) of 16-in. No. 50 slot Johnson stainless steel screen. The annulus between the bore hole and the casing-screen assembly is filled with concrete from 0 to 10 ft, with torpedo sand from 10 to 11.5 ft, and with No. 2 Northern gravel from 11.5 to 97 ft. For flood protection, the well is equipped with two corrugated steel pipes, 10 and 12 ft in diameter, extending from 11 ft above land surface to a depth of 4 ft and the annular space between the two corrugated pipes is filled with concrete.

A production test using two observation wells was conducted by the driller on January 16, 1975. After 4 hr of

pumping at a rate of 1500 gpm, the final drawdown was 12.07 ft from a nonpumping water level of 9.91 ft below land surface. Fifteen min after pumping was stopped, the water level had recovered to 10.81 ft.

The pumping equipment presently installed is a Byron Jackson vertical turbine pump set at 75 ft, rated at 1780 gpm at about 445 ft head, and powered by a 350-hp General Electric motor (No. 6318P24).

A partial analysis of a sample (Lab. No. 197739) collected during the initial production test, after pumping for 3.5 hr, showed the water to have a hardness of 260 mg/l, total dissolved minerals of 308 mg/l, and an iron content of 0.5 mg/l.

WELL NO. 74-3, finished in sand and gravel, was completed in January 1975 to a depth of 102 ft by Luhr Bros., Inc., Columbia. The well is located about 275 ft south of Well No. 74-2, approximately 1815 ft S and 30 ft W of the NE corner of Section 28, T11N, R5W, Henderson County. The land surface elevation at the well is approximately 530 ft.

A drillers log of Well No. 74-3 follows:

| <i>Strata</i>   | <i>Thickness (ft)</i> | <i>Depth (ft)</i> |
|---|-----------------------|-------------------|
| Silty sand, brownish gray                                       | 15                    | 15                |
| Fine gray sand  | 5                     | 20                |
| Fine to medium brown sand with gravel (water bearing)           | 10                    | 30                |
| Coarse gray sand with gravel (water bearing)                    | 25                    | 55                |
| Medium gray sand with gravel (water bearing)                    | 5                     | 60                |
| Fine to medium gray sand, no gravel (water bearing)             | 10                    | 70                |
| Fine to medium gray sand with gravel (water bearing)            | 5                     | 75                |
| Fine gray sand  | 5                     | 80                |
| Fine to medium sand with gravel (water bearing)                 | 10                    | 90                |
| Coarse sand with gravel (water bearing)                         | 10                    | 100               |
| Medium coarse gray sand with very coarse gravel (water bearing) | 5                     | 105               |

A 34-in. diameter hole was drilled to a depth of 102 ft. The well is cased with 16-in. steel pipe from 12 ft above land surface to a depth of 74.5 ft followed by 27.5 ft (30.5 ft overall length) of 16-in. No. 50 slot Johnson stainless steel screen. The annulus between the bore hole and the casing-screen assembly is filled with concrete from 0 to 10 ft, with torpedo sand from 10 to 16.5 ft, and with No. 2 Northern gravel from 16.5 to 102 ft. For flood protection, the well is equipped with two corrugated steel pipes, 10 and 12 ft in diameter, extending from 11 ft above land surface to a depth of 4 ft and the annular space between the two corrugated pipes is filled with concrete.

A production test using two observation wells was conducted on January 22, 1975, by representatives of the driller, the city, the State Water Survey, and Casler, Houser & Hutchinson, Consulting Engineers. After 4 hr of pumping at rates of 1522 to 1493 gpm, the final drawdown was 12.34 ft from a nonpumping water level of 7.83 ft below land surface. Fifteen min after pumping was stopped, the water level had recovered to 8.70 ft.

The pumping equipment presently installed is a Byron Jackson vertical turbine pump set at 75 ft, rated at 1780 gpm at about 445 ft head, and powered by a 350-hp General Electric motor (No. 6318P24).

A partial analysis of a sample (Lab. No. 197740) collected during the initial production test, after pumping for 3.5 hr at 1500 gpm, showed the water to have a hardness of 236 mg/l,

total dissolved minerals of 276 mg/l, and an iron content of 0.2 mg/l.

Hydrologic analyses of the results of the production tests on Well Nos. 74-1, 2, and 3, indicated that the three-well system was capable of furnishing 8 mgd (1850 gpm per well) on a long-term basis.

## MEDIA

The village of Media (180) installed a public water supply in 1924. One well is in use. In 1950 there were 15 services. In 1976 there were 50 services, all metered; the estimated average and maximum daily pumpages were 12,000 and 15,000 gpd, respectively. The water is fluoridated.

WELL NO. 1, open to the Burlington-Keokuk Limestone, was constructed in 1925 to a depth of 65 ft by James Brewer, Stronghurst, and deepened in 1958 to a reported depth of 70 ft. The well is located about 100 ft east of East St. and 500 ft south of Route 116, approximately 1417 ft S and 1206 ft W of the NE corner of Section 15, T9N, R4W. The land surface elevation at the well is approximately 705 ft.

Originally, a 6-in. diameter hole was drilled to a depth of 30 ft and finished 5 in. in diameter from 30 to 65 ft. The well was then cased with 6-in. pipe from the bottom of a 6-ft deep well pit to a depth of 30 ft. In 1958 after the well was given to the village by Mr. Waldo Erickson, the well was rehabilitated. The well was reportedly deepened to 70 ft and cased with 6-in. pipe from 3 ft above land surface to a depth of 65 ft.

In October 1946, the well reportedly produced 15 gpm for 18 hr with very little drawdown from a nonpumping water level of about 30 ft below land surface.

The pumping equipment presently installed is a Red Jacket submersible pump rated at 80 gpm, and powered by a 5-hp Red Jacket electric motor.

The following mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. B21262) is for a water sample from the well collected November 22, 1976, after 30 min of pumping at 85 gpm.

| WELL NO. 1, LABORATORY NO. B21262 |                 |        |      |                                    |                         |
|-----------------------------------|-----------------|--------|------|------------------------------------|-------------------------|
|                                   |                 | mg/l   | me/l |                                    | mg/l me/l               |
| Iron                              | Fe              | 0.0    |      | Silica                             | SiO <sub>2</sub> 15     |
| Manganese                         | Mn              | 0.00   |      | Fluoride                           | F 0.3 0.02              |
| Ammonium                          | NH <sub>4</sub> | 0.00   |      | Boron                              | B 0.1                   |
| Sodium                            | Na              | 8      | 0.35 | Nitrate                            | NO <sub>3</sub> 34 0.55 |
| Potassium                         | K               | 0.3    | 0.01 | Chloride                           | Cl 12 0.34              |
| Calcium                           | Ca              | 64     | 3.19 | Sulfate                            | SO <sub>4</sub> 34 0.71 |
| Magnesium                         | Mg              | 29     | 2.39 | Alkalinity (as CaCO <sub>3</sub> ) | 206 4.12                |
| Arsenic                           | As              | 0.00   |      |                                    |                         |
| Barium                            | Ba              | 0.0    |      | Hardness (as CaCO <sub>3</sub> )   | 279 5.58                |
| Copper                            | Cu              | 0.00   |      |                                    |                         |
| Cadmium                           | Cd              | 0.00   |      | Total dissolved minerals           | 366                     |
| Chromium                          | Cr              | 0.00   |      |                                    |                         |
| Lead                              | Pb              | 0.00   |      |                                    |                         |
| Mercury                           | Hg              | 0.0001 |      |                                    |                         |
| Nickel                            | Ni              | 0.0    |      |                                    |                         |
| Selenium                          | Se              | 0.00   |      |                                    |                         |
| Silver                            | Ag              | 0.00   |      |                                    |                         |
| Cyanide                           | CN              | 0.00   |      |                                    |                         |
| Zinc                              | Zn              | 0.0    |      | pH (as rec'd)                      | 7.5                     |

## OQUAWKA

The village of Oquawka (1352) installed a public water supply in 1908. One well (No. 1) is in use and another well (No. 2) is available for emergency use. In 1951 there were 262 services, none metered; the estimated average and maximum daily pumpages were 40,000 and 60,000 gpd, respectively. In 1977 there were 700 services, 1.7 percent metered; the estimated average and maximum daily pumpages were 160,000 and 309,000 gpd, respectively. The water is chlorinated and fluoridated.

Water was initially obtained from a well driven in 1900

which was abandoned the following year, when 4 well points

were driven in sand and gravel at the foot of Warren St. near the Mississippi River, approximately 1300 ft S and 4400 ft W of the NE corner of Section 22, T11N, R5W. The land surface elevation at the well points is approximately 540 ft.

In 1915, eight well points were driven at the same location by Frank Boden, to replace the 4 well points. These 8 wells were spaced from 6 to 7 ft apart, 4 in each of two lines which were about at right angles to each other. Each well was cased with 2-in. galvanized pipe to a depth of 29 ft, the bottom 3 ft being perforated, and with 3 ft of No. 60 (0.010

in.) gauze screen inside the perforated pipe. In 1922, non-

pumping water levels were reported to be at a depth of 10 ft, but varied with the river stage. Between 1923 and 1927, these 8 well points were replaced by new points driven 10 ft deeper in an attempt to avoid rapid clogging. Additional well points were built after 1927, and in 1946 it was reported that water was being obtained from 14 well points. The well points were about 39 ft deep and were usually cased with 2-in. pipe to a depth of 36 ft followed by 3 ft of screen. A mineral analysis of a sample (Lab. No. 108142) collected from the well points on October 28, 1946, after pumping for 30 min at 200 gpm, showed the water to have a hardness of 223 mg/l, total dissolved minerals of 281 mg/l, and an iron content of 0.0 mg/l.

In 1950, eight new sand points were driven at the same location to a depth of about 39 ft. In 1952 these 8 were the only ones in use and in 1959 only 6 well points were in use. All of the sand points were disconnected from the system by 1968.

WELL NO. 1, finished in sand and gravel, was completed in September 1958 to a depth of 50 ft by the Schlicher Well Co., Donnellson, Iowa. The well is located near the intersection of First and Warren Sts., approximately 1580 ft S and 700 ft E of the NW corner of Section 22, T11N, R5W. The land surface elevation at the well is approximately 537 ft.

A drillers log of Well No. 1 follows:

| Strata                   | Thickness (ft) | Depth (ft) |
|--------------------------|----------------|------------|
| Cinders                  | 1.5            | 1.5        |
| Sandy clay               | 9              | 10.5       |
| Dirty sand               | 2.5            | 13         |
| Red clay                 | 2              | 15         |
| Sand                     | 5              | 20         |
| Fine sand with gray clay | 10.5           | 30.5       |
| Sand and gravel          | 20             | 50.5       |
| Clay; gray, and sandy    | 2.5            | 53         |

A 16-in. diameter hole was drilled to a depth of 25 ft and finished 12 in. in diameter from 25 to 53 ft. The well is cased with 16-in. pipe from 2 ft above land surface to a depth of 5.5 ft and 12-in. pipe from about 8.5 ft above land surface to a depth of 40 ft followed by 10 ft of 12-in. No. 30 slot Johnson Everdur screen. The annulus between the 16- and 12-in. casings and the 16-in. bore hole and 12-in. casing is cement grouted from 0 to 25 ft.

Upon completion, the driller reported that the well produced from 430 to 476 gpm for 12.2 hr with a drawdown of 28.7 ft from a nonpumping water level of 7.5 ft below land surface.

The pumping equipment presently installed is a Barnes submersible turbine pump (No. 37292-S-673) set at 38 ft, rated at 300 gpm at about 180 ft TDH, and powered by a 20-hp electric motor.

The following mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. B109955) is for a water sample from the well collected May 1, 1973, after 8 hr of pumping at 200 gpm.

WELL NO. 1, LABORATORY NO. B109955

|           |                 | mg/l   | me/l |                                    |                  | mg/l | me/l |
|-----------|-----------------|--------|------|------------------------------------|------------------|------|------|
| Iron      | Fe              | 0.08   | 0.00 | Silica                             | SiO <sub>2</sub> | 21.0 |      |
| Manganese | Mn              | 0.90   | 0.03 | Fluoride                           | F                | 0.10 | 0.00 |
| Ammonium  | NH <sub>4</sub> | 0.90   | 0.05 | Boron                              | B                | 0.1  |      |
| Sodium    | Na              | 9.00   | 0.39 | Nitrate                            | NO <sub>3</sub>  | 0.9  | 0.01 |
| Potassium | K               | 3.2    | 0.08 | Chloride                           | Cl               | 15.0 | 0.42 |
| Calcium   | Ca              | 56.0   | 2.79 | Sulfate                            | SO <sub>4</sub>  | 39.0 | 0.81 |
| Magnesium | Mg              | 21.0   | 1.73 | Alkalinity (as CaCO <sub>3</sub> ) |                  | 182  | 3.64 |
|           |                 |        |      | Hardness (as CaCO <sub>3</sub> )   |                  | 226  | 4.52 |
| Arsenic   | As              | 0.00   |      | Total dissolved minerals           |                  | 305  |      |
| Barium    | Ba              | 0.0    |      |                                    |                  |      |      |
| Copper    | Cu              | 0.00   |      | pH (as rec'd)                      |                  | 7.9  |      |
| Cadmium   | Cd              | 0.00   |      | Radioactivity                      |                  |      |      |
| Chromium  | Cr              | 0.00   |      | Alpha pc/l                         |                  | 1.4  |      |
| Lead      | Pb              | 0.00   |      | ± deviation                        |                  | 1.6  |      |
| Mercury   | Hg              | 0.0000 |      | Beta pc/l                          |                  | 8.1  |      |
| Nickel    | Ni              | 0.0    |      | ± deviation                        |                  | 1.7  |      |
| Selenium  | Se              | 0.00   |      |                                    |                  |      |      |
| Silver    | Ag              | 0.00   |      |                                    |                  |      |      |
| Zinc      | Zn              | 0.36   |      |                                    |                  |      |      |

WELL NO. 2, finished in sand and gravel, was completed in February 1970 to a depth of 134.7 ft by the Schlicher Well Co., Donnellson, Iowa. This well is available for emergency use. The well is located between Second and Third Sts. on Green St., approximately 2100 ft S and 2200 ft W of the NE corner of Section 15, T11N, R5W. The land surface elevation at the well is approximately 562 ft.

A drillers log of Well No. 2 follows:

| Strata   | Thickness (ft) | Depth (ft) |
|--|----------------|------------|
| Brown medium to coarse sand  | 30             | 30         |
| Brown medium to coarse sand with small gravel                                    | 5              | 35         |
| Brown coarse sand with gravel  | 35             | 70         |
| Grayish brown coarse sand with gravel, black coal, and some clay binder          | 5              | 75         |
| Yellow fine to medium sand with iron deposit                                     | 5              | 80         |
| Yellow medium to coarse sand with gravel   | 10             | 90         |
| Grayish brown medium to fine sand with black coal particles                      | 5              | 95         |
| Grayish brown fine sand with black coal particles                                | 5              | 100        |
| Grayish brown medium to coarse sand with black coal, and organic material (wood) | 5              | 105        |
| Brown medium to coarse sand with some gravel                                     | 5              | 110        |
| Brown medium to coarse sand with gravel and some clay binder                     | 4              | 114        |
| Grayish brown medium to coarse sand with gravel                                  | 21             | 135        |

A 16-in. diameter hole was drilled to a depth of 92.2 ft and finished 8 in. in diameter from 92.2 to 135 ft. The well is cased with 16-in. pipe from land surface to a depth of 90.5 ft and 12-in. pipe from 4 ft above land surface to a depth of 92.2 ft followed by 42.5 ft (45 ft overall length) of 8-in. Johnson Everdur screen. The screened section from top to bottom consists of 5 ft of No. 14 slot, 13 ft of No. 7 slot, 10 ft of No. 16 slot, 5 ft of No. 25 slot, 7 ft of No. 30 slot, and 5 ft of No. 25 slot. The annulus between the casings is cement grouted from 0 to 88.2 ft.

Upon completion, the well reportedly produced 400 gpm for 2 hr with a drawdown of 37 ft from a nonpumping water level of 34 ft below the pump base.

In September 1972, after 90 hr of pumping at a rate of

440 gpm, the drawdown was 34 ft from a nonpumping water level of 35 ft below the pump base.

The pumping equipment presently installed is a 10-in., 6-stage Layne vertical centrifugal pump (No. 65036) set at 85 ft, rated at 500 gpm at about 315 ft TDH, and powered by a 50-hp 1750 rpm U. S. Holloshaft electric motor.

A partial analysis of a sample (Lab. No. 196090) collected June 24, 1974, after pumping for 30 min, showed the water to have a hardness of 284 mg/l, total dissolved minerals of 306 mg/l, and an iron content of 2.4 mg/l.

A test well was constructed in 1973 to a depth of 76 ft by the Schlicher Well Co., Donnellson, Iowa.

## RARITAN

The village of Raritan (206) installed a public water supply in 1965. One well is in use. In 1976 there were 96 services, 96 percent metered; the estimated average and maximum daily pumpages were 8000 and 15,000 gpd, respectively. The water is chlorinated.

Prior to the installation of a public water supply, a test well was drilled on the north edge of the village in November 1963 to a depth of 82 ft by Charles Measley, Plymouth. It was cased with 8-in. pipe from 0.5 ft above land surface to a depth of 64 ft and 7-in. pipe from 62 ft to a depth of 82 ft. A production test was conducted by the State Water Survey on February 26, 1964. After 1.7 hr of pumping at a rate of 16 gpm, the drawdown was 27.68 ft from a non-pumping water level of 29.80 ft below land surface. On the basis of the production test data, it was estimated that this test well would yield 6 gpm (8640 gpd) on a long-term basis.

WELL NO. 1, open to the Burlington-Keokuk Limestone, Devonian limestone, and the Galena-Platteville dolomite, was completed in December 1964 to a depth of 964 ft by the Bushnell Drilling Co., Plymouth. The well is located on the north edge of the village at the base of the elevated tank at the site of the test well, approximately 250 ft N and 650 ft E of the SW corner of Section 11, T8N, R4W. The land surface elevation at the well is approximately 760 ft.

A drillers log of Well No. 1 follows:

| Strata                 | Thickness (ft) | Depth (ft) |
|------------------------|----------------|------------|
| Top soil and clay      | 30             | 30         |
| Gray mud               | 25             | 55         |
| Sand (fine)            | 9              | 64         |
| Sandstone              | 6              | 70         |
| Black shale            | 7              | 77         |
| Limestone (Burlington) | 143            | 220        |
| Shale                  | 244            | 464        |
| Lime (Devonian)        | 110            | 574        |
| Shale (Maquoketa)      | 139            | 713        |
| Lime (gray)            | 25             | 738        |
| Lime (brown dolomite)  | 226            | 964        |

A 10-in. diameter hole was drilled to a depth of 470 ft, reduced to 8 in. between 470 and 724 ft, and finished 6 in.

in diameter from 724 to 964 ft. The well is cased with 10-in. pipe from 1 ft above land surface to a depth of 90 ft (cemented in), 8-in. pipe from 215 ft to a depth of 470 ft, and 6.6-in. ID pipe from 504 ft to a depth of 724 ft.

A production test was conducted by the State Water Survey on December 15, 1964. After 4 hr of pumping at a rate of 60 gpm, the drawdown was 7.5 ft from a non-pumping water level of 240.5 ft below land surface. Fifteen min after pumping was stopped, the water level had recovered to 240.8 ft. On the basis of the production test data, it was estimated that this well would yield 50 gpm (72,000 gpd) on a long-term basis.

The pumping equipment presently installed consists of a 7½hp Red Jacket electric motor, an 8-stage Red Jacket submersible pump (Model No. 756U4-8L6) set at 315 ft, rated at 50 gpm at about 350 ft TDH, and has 315 ft of 3-in. column pipe. The well is equipped with 315 ft of airline.

The following mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. B21263) is for a water sample from the well collected November 22, 1976, after 2 hr of pumping at 60 gpm.

### WELL NO. 1, LABORATORY NO. B21263

|           | mg/l            | me/l      |                                    | mg/l             | me/l      |
|-----------|-----------------|-----------|------------------------------------|------------------|-----------|
| Iron      | Fe              | 0.7       | Silica                             | SiO <sub>2</sub> | 11        |
| Manganese | Mn              | 0.02      | Fluoride                           | F                | 3.2 0.17  |
| Ammonium  | NH <sub>4</sub> | 1.5 0.08  | Boron                              | B                | 1.6       |
| Sodium    | Na              | 380 16.53 | Nitrate                            | NO <sub>3</sub>  | 0.4 0.01  |
| Potassium | K               | 13.8 0.35 | Chloride                           | Cl               | 210 5.92  |
| Calcium   | Ca              | 110 5.49  | Sulfate                            | SO <sub>4</sub>  | 750 15.60 |
| Magnesium | Mg              | 50 4.12   | Alkalinity (as CaCO <sub>3</sub> ) |                  | 232 4.64  |
| Arsenic   | As              | 0.00      |                                    |                  |           |
| Barium    | Ba              | 0.1       | Hardness (as CaCO <sub>3</sub> )   |                  | 481 9.62  |
| Copper    | Cu              | 0.00      |                                    |                  |           |
| Cadmium   | Cd              | 0.00      | Total dissolved minerals           |                  | 1732      |
| Chromium  | Cr              | 0.00      |                                    |                  |           |
| Lead      | Pb              | 0.00      |                                    |                  |           |
| Mercury   | Hg              | 0.0001    |                                    |                  |           |
| Nickel    | Ni              | 0.0       |                                    |                  |           |
| Selenium  | Se              | 0.00      |                                    |                  |           |
| Silver    | Ag              | 0.00      |                                    |                  |           |
| Cyanide   | CN              | 0.00      |                                    |                  |           |
| Zinc      | Zn              | 0.0       | pH (as rec'd)                      |                  | 7.4       |

## STRONGHURST

The village of Stronghurst (836) installed a public water supply in 1915. Two wells (Nos. 3 and 4) are in use and another well (No. 1) is available for emergency use. In 1950 there were 250 services; the average and maximum daily pumpages were 36,000 and 44,000 gpd, respectively. In 1976 there were 381 services, all metered; the estimated average and maximum daily pumpages were 73,000 and 115,000gpd, respectively. The water is aerated, filtered, chlorinated, and fluoridated.

WELL NO. 1, open to the Glenwood-St. Peter Sandstone, was completed in June 1915 to a depth of 1009 ft by the Sewell Well Co., St. Louis, Mo. This well is available for emergency use. The well is located on lot 11, block 7 in the fire station near the elevated tank, approximately 2150 ft S and 300 ft W of the NE corner of Section 25, T9N, R5W. The land surface elevation at the well is approximately 685 ft.

A drillers log of Well No. 1 follows:

| <i>Strata</i>       | <i>Thickness<br/>(ft)</i> | <i>Depth<br/>(ft)</i> |
|---------------------|---------------------------|-----------------------|
| Soil and clay       | 30                        | 30                    |
| Blue clay           | 95                        | 125                   |
| Gas bearing sand    | 5                         | 130                   |
| Dark shale          | 185                       | 315                   |
| Gray limestone      | 105                       | 420                   |
| Gray shale          | 140                       | 560                   |
| Gray limestone      | 225                       | 785                   |
| Brown limestone     | 65                        | 850                   |
| St. Peter sandstone | 159                       | 1009                  |

The following mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. B105917) is for a water sample from the well collected January 3, 1973, after 45 min of pumping at 80 gpm.

### WELL NO. 1, LABORATORY NO. B105917

|           |                 | <i>mg/l</i> | <i>me/l</i> |                                   |                  | <i>mg/l</i> | <i>me/l</i> |
|-----------|-----------------|-------------|-------------|-----------------------------------|------------------|-------------|-------------|
| Iron      | Fe              | 1.2         | 0.04        | Silica                            | SiO <sub>2</sub> | 17          |             |
| Manganese | Mn              | 0.09        | 0.00        | Fluoride                          | F                | 3.6         | 0.19        |
| Ammonium  | NH <sub>4</sub> | 1.7         | 0.09        | Boron                             | B                | 1.5         |             |
| Sodium    | Na              | 525         | 22.84       | Nitrate                           | NO <sub>3</sub>  | 0           |             |
| Potassium | K               | 18          | 0.46        | Chloride                          | Cl               | 310         | 8.74        |
| Calcium   | Ca              | 180         | 8.98        | Sulfate                           | SO <sub>4</sub>  | 1200        | 24.96       |
| Magnesium | Mg              | 82          | 6.74        | Alkalinity(as CaCO <sub>3</sub> ) |                  | 262         | 5.24        |
| Arsenic   | As              | 0.00        |             |                                   |                  |             |             |
| Berium    | Ba              | 0.1         |             | Hardness (as CaCO <sub>3</sub> )  |                  | 786         |             |
| Copper    | Cu              | 0.00        |             |                                   |                  |             |             |
| Cadmium   | Cd              | 0.00        |             | Total dissolved                   |                  |             |             |
| Chromium  | Cr              | 0.00        |             | minerals                          |                  | 2490        |             |
| Lead      | Pb              | 0.00        |             |                                   |                  |             |             |
| Mercury   | Hg              | 0.0000      |             |                                   |                  |             |             |
| Nickel    | Ni              | 0.0         |             |                                   |                  |             |             |
| Selenium  | Se              | 0.00        |             |                                   |                  |             |             |
| Silver    | Ag              | 0.00        |             |                                   |                  |             |             |
| Zinc      | Zn              | 0.1         |             | pH (as rec'd)                     |                  | 7.9         |             |

The well is apparently cased with 10-in. pipe from 0.1 ft above the pumphouse floor to a depth of 800 ft and 8-in. pipe from 800 ft to a depth of 872 ft. Below the casing, the hole was finished 6 in. in diameter to the bottom.

In 1934, the well reportedly produced 100 gpm for 1 hr with a drawdown of 8 ft from a nonpumping water level of 63 ft below land surface.

The pumping equipment presently installed is a Red Jacket submersible pump rated at 112 gpm at about 101 ft TDH, and powered by a 15-hp electric motor.

WELL NO. 2, open to the Burlington-Keokuk Limestone, was completed in May 1938 to a depth of 69.5 ft by D. E. Edwards, West Branch, Iowa, and reconstructed to a reported depth of 67.5 ft in the latter part of 1938 by Ellis Jones, Burlington, Iowa. This well was abandoned and sealed prior to 1971. The well was located about 0.2 mile south of the village limits on the east side of Route 94, approximately 1100 ft N and 25 ft E of the SW corner of Section 30, T9N, R4W. The land surface elevation at the well is approximately 680 ft.

A correlated drillers log of Well No. 2 furnished by the State Geological Survey follows:

| <i>Strata</i>               | <i>Thickness<br/>(ft)</i> | <i>Depth<br/>(ft)</i> |
|-----------------------------|---------------------------|-----------------------|
| <b>PLEISTOCENE SERIES</b>   |                           |                       |
| Drift, clay                 | 37                        | 37                    |
| <b>MISSISSIPPIAN SYSTEM</b> |                           |                       |
| Burlington-Keokuk Limestone |                           |                       |
| Yellow limestone            | 9                         | 46                    |
| Chert, limestone, mud       | 23.5                      | 69.5                  |

Originally, a 12-in. diameter hole was drilled to a depth of 45.5 ft, reduced to 10 in. between 45.5 and 63 ft, and finished 8 in. in diameter from 63 to 69.5 ft. The well was then cased with 12-in. pipe from land surface to a depth of 45.5 ft and a 10-in. slotted pipe from 33 ft to a depth of 54 ft. During reconstruction by Ellis Jones, the well was cleaned out to the original depth of 69.5 ft and the bottom 2 ft was filled with cement grout. The original 10-in. casing was removed and replaced with a continuous string of 10-in. pipe from land surface to a depth of 67.5 ft (slotted between 40 and 65.5 ft). The 12-in. casing was not removed and cement grout was placed between the casings from land surface to a depth of 45.5 ft. Two 10-in. holes were drilled close beside the well to depths of 37 and 42 ft. A total of 14 cubic yards of gravel was placed in the holes and tamped with the drill bit.

A production test was conducted by the State Water Survey on June 17-18, 1938. After 20.9 hr of pumping at a rate of 61 gpm, the drawdown was 6.8 ft from a nonpumping water level of 26.0 ft below the top of the casing.

An attempt to make a 24-hr test was made by the State Water Survey on September 14, 1938. After 5 hr of pumping at 75 gpm, the discharge became very muddy, the pumping rate decreased sharply, and the drawdown which had been fairly constant began to increase appreciably. The well was sounded and found to be 62 ft deep. The 12-in. casing was virtually suspended from a wood clamp left by the driller.

The cloudiness in the water was presumed to be caused by a loose seating of the 12-in. casing in the rock, allowing drift material to wash into the well. Recommendations were made by the State Water Survey that pumping be continued until the water cleared up before any additional production tests were made.

A production test was made by the State Water Survey on September 26-27, 1938. The well reportedly produced from 68 to 61 gpm for 24 hr with a drawdown of 12.3 ft from a nonpumping water level of 24.6 ft below the top of the casing. The water was clear throughout the test. The numerical results in this test indicated that a desired yield of 50 gpm might be expected but the State Water Survey recommended that the well be reconstructed. The State Department of Health felt considerable doubt about continued acceptable quality of the water because of the defective construction.

After the well was reconstructed in the latter part of 1938, a production test was conducted by the State Water Survey on January 16-17, 1939. After 26.2 hr of pumping at an average rate of 51 gpm, the final drawdown was 12.5 ft from a nonpumping water level of 25.0 ft below the top of the casing. Thirty min after pumping was stopped, the water level had recovered to 28.5 ft. The water was clear at all times except for a few minutes in the latter part of the test.

A production test was conducted by the State Water Survey on April 3-4, 1939. The well reportedly produced at rates of 45 to 42 gpm for 24 hr with a drawdown of 16.0 ft from a nonpumping water level of 25.0 ft below the top of the casing. After pumping had been stopped for 4.5 hr, the water level was 26.5 ft.

A mineral analysis of a sample (Lab. No. 107985) collected October 15, 1946, after pumping for 9 hr at 43 gpm, showed the water to have a hardness of 310 mg/l, total dissolved minerals of 333 mg/l, and an iron content of 2.1 mg/l.

WELL NO. 3, open to the Burlington-Keokuk Limestone, was completed in 1939 to a depth of 69 ft by Ellis Jones, Burlington, Iowa, and acquired for village use in 1953. The well is located about 300 ft northwest of Well No. 2, approximately 1310 ft N and 190 ft W of the SE corner of Section 25, T9N, R5W. The land surface elevation at the well is approximately 665 ft.

A 6-in. diameter hole was drilled to a depth of 69 ft. The well is cased with 6-in. ID pipe to a depth of 68.5 ft (partially slotted).

In 1953, the well reportedly produced 55 gpm for 2 hr with a drawdown of 1 ft from a nonpumping water level of 32 ft.

The pumping equipment presently installed is a Red Jacket submersible pump rated at 120 gpm, and powered by a Red Jacket electric motor.

A mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. B37680) of a sample collected March 16, 1977, after pumping for 2 hr at 130 gpm, showed the water to have a hardness of 351 mg/l, total dissolved minerals of 367 mg/l, and an iron content of 4.0 mg/l.

WELL NO. 4, open to the Burlington-Keokuk Limestone, was completed about 1959 to a depth of 70 ft. The well is located about 15 ft north of Well No. 3, approximately 1325 ft N and 190 ft W of the SE corner of Section 25, T9N, R5W. The land surface elevation at the well is approximately 665 ft.

The well is cased from 1 ft above the pumphouse floor to an unknown depth.

The pumping equipment presently installed is a Burks turbine pump rated at 90 gpm, and powered by a 5-hp Burks motor (Serial No. JF5137).

The following mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. B37684) is for a water sample from the well collected March 16, 1977, after 1 hr of pumping.

| WELL NO. 4, LABORATORY NO. B37684 |                 |        |      |                                    |                          |
|-----------------------------------|-----------------|--------|------|------------------------------------|--------------------------|
|                                   |                 | mg/l   | me/l |                                    | mg/l me/l                |
| Iron                              | Fe              | 4.0    |      | Silica                             | SiO <sub>2</sub> 13      |
| Manganese                         | Mn              | 0.09   |      | Fluoride                           | F 0.2 0.01               |
| Ammonium                          | NH <sub>4</sub> | 0.76   | 0.04 | Boron                              | B 0.1                    |
| Sodium                            | Na              | 9      | 0.39 | Nitrate                            | NO <sub>3</sub> 0.0 0.00 |
| Potassium                         | K               | 0.7    | 0.02 | Chloride                           | Cl 21 0.59               |
| Calcium                           | Ca              | 80     | 3.99 | Sulfate                            | SO <sub>4</sub> 38 0.79  |
| Magnesium                         | Mg              | 33     | 2.72 | Alkalinity (as CaCO <sub>3</sub> ) | 283 5.66                 |
| Arsenic                           | As              | 0.01   |      | Hardness (as CaCO <sub>3</sub> )   | 358 7.16                 |
| Barium                            | Ba              | 0.1    |      |                                    |                          |
| Copper                            | Cu              | 0.01   |      |                                    |                          |
| Cadmium                           | Cd              | 0.00   |      | Total dissolved minerals           | 378                      |
| Chromium                          | Cr              | 0.00   |      |                                    |                          |
| Lead                              | Pb              | 0.00   |      |                                    |                          |
| Mercury                           | Hg              | 0.0002 |      |                                    |                          |
| Nickel                            | Ni              | 0.0    |      |                                    |                          |
| Selenium                          | Se              | 0.00   |      |                                    |                          |
| Silver                            | Ag              | 0.00   |      |                                    |                          |
| Cyanide                           | CN              | 0.00   |      |                                    |                          |
| Zinc                              | Zn              | 0.0    |      | pH (as rec'd)                      | 7.5                      |