THE GROUND-WATER-LEVEL MONITORING NETWORK IN IOWA

By Rebecca B. Lambert

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CONTENTS

Page

ILLUSTRATIONS

Page

ILLUSTRATIONS--Continued

TABLES

CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED WATER-QUALITY UNITS

Multiply	*By*	*To obtain*
acre	4,047	square meter
foot (ft)	0.3048	meter
foot per day (ft/d)	0.3048	meter per day
gallon (gal)	0.003785	cubic meter
gallon per minute (gal/min)	0.06308	liter per second
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer

Vertical Datum

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviated Water-Quality Units

mg/L = milligrams per liter

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by Rebecca B. Lambert

ABSTRACT

The ground-water-level monitoring network in Iowa consists of 202 wells completed in the principal bedrock and surficial aquifers that supply ground water to numerous users throughout the State. The bedrock aquifers include the Cambrian-Ordovician aquifer system, the Silurian-Devonian aquifer, the Mississippian aquifer, localized Pennsylvanian aquifers, and the Dakota aquifer. The surficial aquifers can be divided into three types: (1) buried channel, (2) alluvial, and (3) glacial drift. Information about the location, date of construction, and depth of each well, and the year water-level measurements began are provided for wells completed in each aquifer.

The objectives of the ground-water-level monitoring network in Iowa are to provide the data needed to: (1) determine the change in aquifer storage, (2) document the effects of climatic stress and human activities on discharge and recharge to the principal aquifers, (3) quantify the physical characteristics of ground-water flow including the transmissivity, hydraulic conductivity, and specific capacity of aquifers; and (4) provide historical baseline data for future research. The design of the ground-water-level monitoring network in Iowa that satisfies these objectives includes three types of data: (1) hydrologic data, (2) water-management data for use by State and local officials, and (3) baseline data.

INTRODUCTION

Ground water is an important natural resource in Iowa. During 1985, a total of 1,010,000 million gal of water was estimated to have been withdrawn from surface- and ground-water sources, with 24 percent of the total withdrawn from ground-water sources (Clark and Thamke, 1988). Information about the hydrologic characteristics of the aquifer systems is needed in order for State and local officials to make informed decisions regarding the use and development of this resource. A ground-water-level monitoring network accomplishes this requirement primarily through the measurement of ground-water levels in each principal aquifer. Ground-water scientists use this information to describe the hydrologic characteristics of the ground-water flow systems.

Through long-term, water-level-monitoring networks, such as the one in Iowa, the U.S. Geological Survey, in cooperation with State and local agencies, provides information about the quantity of ground water. These data are used by Congress and Federal, State, and local agencies to inform the general public about the changes and trends in the availability of the Nation's water resources.

In Iowa, the ground-water-level monitoring network is operated by the U.S. Geological Survey in cooperation with the Iowa Department of Natural Resources. The current (1991) monitoring network of 202 wells is used to document the changes in ground-water levels in each of the principal bedrock and surficial aquifers at selected locations in Iowa.

Purpose and Scope

This report describes the 1991 ground-water-level monitoring network for each principal aquifer in Iowa. The primary objectives of the ground-water-level monitoring network are to: (1) determine changes in aquifer storage, (2) document the effects of climate and human activities on the principal aquifers that supply ground water to the State, and (3) quantify the physical characteristics of ground-water flow including transmissivity, hydraulic conductivity, and specific capacity of the aquifers. As a secondary objective, the Iowa monitoring network provides historical baseline data for future research.

Well-Numbering Systems

Each well in the ground-water-level monitoring network has been assigned a unique, 15-digit identification number. The number, which is derived from the grid system of latitude and longitude, is assigned when a well site is first visited. The first six digits of the number denote the degrees, minutes and seconds of latitude; the next seven digits denote the degrees, minutes, and seconds of longitude; and the last two digits are reserved for a well sequence number to identify sites within a 1-second grid.

Each well in the ground-water-level monitoring network also is identified by a local well number based on a modification of the U.S. Bureau of Land Management's system of land subdivision. A local well number consists of four segments. The first segment indicates the township, the second the range, and the third the section in which the well is located (fig. 1). The letters after the section number, which are assigned in a counterclockwise direction (beginning with "A" in the northeast quarter), represent subdivisions of the section. The first letter denotes the quarter section or 160-acre tract; the second, a quarter-quarter section or 40-acre tract; the third, a quarter-quarter-quarter section or 10-acre tract; and the fourth, a quarter-quarter-quarter-quarter section or 2.5-acre tract. Numbers are added as suffixes to distinguish wells in the same 2.5-acre tract. For example, the local well number for the Mt. Pleasant No. 3 well is 071N06W09CBCA1, which locates the well in the NE 1/4 of the SW 1/4 of the NW 1/4 of the SW 1/4 of section 9, township 71 north, range 6 west (fig. 1).

Acknowledgments

Special thanks are extended to the Geological Survey Bureau of the Iowa Department of Natural Resources, which has contributed time, effort, and funds to further the study of ground-water systems in Iowa.

DESIGN GOALS OF THE MONITORING NETWORK

Objectives

An effective ground-water-level monitoring network provides information useful for quantifying and qualifying the physical characteristics of an aquifer, and provides a historical perspective on long-term changes in ground-water storage. A ground-water-level monitoring network also attempts to collect data to quantify the physical characteristics that affect ground-water storage and flow within an aquifer. These characteristics include transmissivity, hydraulic conductivity, and specific capacity.

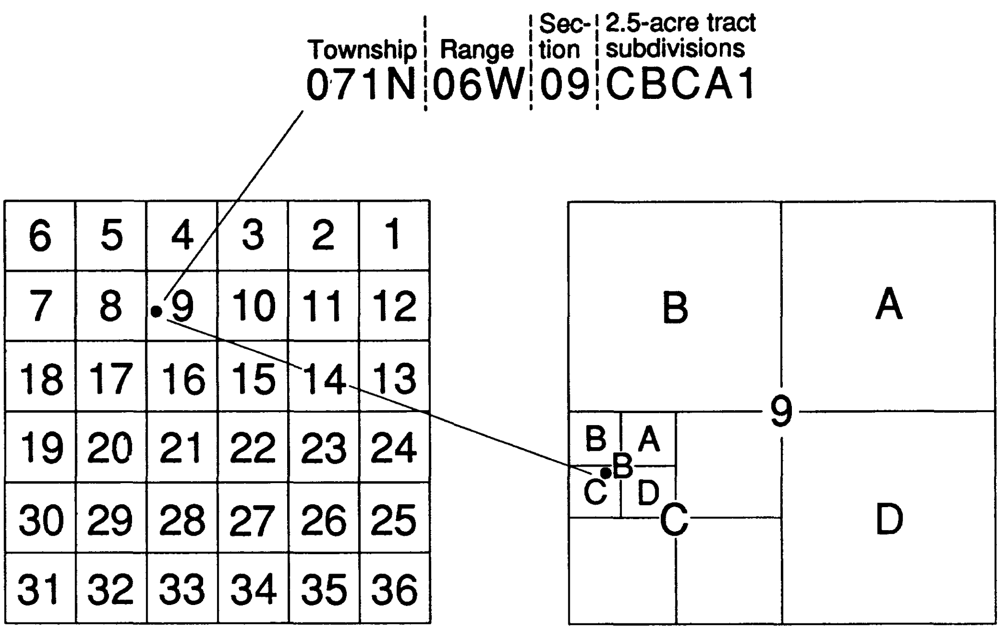


Figure 1. Local well-numbering system.

Data Components

Data collected from wells in a ground-water-level monitoring network can be divided into three components that are described in the following sections and summarized in figure 2.

Hydrologic Data

Hydrologic data serve two purposes. First, the determination of change in aquifer storage is addressed by water-level measurements from a randomly spaced network of wells across the extent of the aquifer of interest (fig. 2). All wells from which hydrologic data are collected for a specific aquifer are open to the same aquifer or water-yielding zone (Heath, 1976). Water-level measurements in these wells are made within a similar time frame so that the measurements represent the aquifer storage at a single moment in time. Water-level measurements from wells completed in a specific aquifer are used to construct potentiometric maps of the altitude of the water surface in the aquifer. These maps document the change in storage by the rise or decline of the altitude of the water surface. If these maps are constructed for differing time periods, the change in aquifer storage can be documented by the increase or decrease in altitude of the water surface.

Second, the hydrologic data are used to define the areal extent of a specific aquifer by the physical expression of the altitude of the water surface. Those wells that are completed in a hydraulically connected aquifer generally have similar water-level measurements. Potentiometric maps of the water surface are constructed using data from wells completed in a single aquifer.

Water-Management Data

The collection of water-management data from a ground-water-level monitoring network provides information needed by State and local officials to make informed decisions regarding water-resources management. The water-management data collected from a monitoring network are used to quantify the effects of climate and human-induced stresses on aquifer recharge and discharge, in addition to being used to determine the hydraulic characteristics

NETWORK COMPONENTS	PURPOSES	APPLICATIONS TO PRINCIPAL AQUIFERS IN IOWA
HYDROLOGIC DATA	Determine aquifer storage. Define areal extent of aquifer.	All bedrock aquifers and buried-channel and alluvial surficial aquifers.
WATER-MANAGEMENT DATA FOR USE BY STATE AND LOCAL OFFICIALS	Measure effects of stress on recharge and discharge. Determine the hydraulic characteristics of a specific aquifer.	All bedrock aquifers and buried-channel and alluvial surficial aquifers.
BASELINE DATA	Define the effects of climate on ground-water storage. Define the effects of topography and geology on climatic response of water levels.	Alluvial or glacial-drift surficial aquifers. Buried-channel or alluvial surficial aquifers, or the first underlying bedrock aquifer.

Figure 2. Summary of components of a ground-water-level monitoring network, associated purposes, and applications to principal aquifers in Iowa (modified from Heath, 1976).

of an aquifer (fig. 2). This is accomplished by monitoring wells that are located near major pumping centers, close enough to measure the water-level drawdown from pumping throughout an area of at least several square miles (Heath, 1976). Information obtained from monitoring pumped wells can be used to estimate long-term yields from the principal aquifers and can provide the historical background regarding the extent of aquifer development. Monitoring wells that provide water-management data include those that are open to the underlying and overlying permeable zones, as well as those wells open to the main producing zones (Heath, 1976). Wells completed in the permeable units overlying and underlying the main producing zone of the aquifer can be used to measure the three-dimensional response of the ground-water system to the withdrawals (Heath, 1976).

Baseline Data

Baseline data collected from two sets of monitoring wells can be used for different purposes. Data from wells located away from pumping centers and areas of development are used to construct maps of the water-level surface, and a series of these maps for a long period of time can be used as indicators of climatic change in a region (fig. 2). These measurements also are used as baseline information in evaluating hydrologic and water-management data from the monitoring network. Wells for this purpose are located in similar topographic positions and in areas having similar depths to the water table. These wells are open to a permeable, unconfined surficial aquifer, and their construction details and screened intervals are the same. Thus, these wells can be used for regional correlation as they respond directly to climatic effects (Heath, 1976). In Iowa, this type of baseline data is collected primarily from wells completed in alluvial or glacial-drift surficial aquifers because these aquifers are most affected by direct infiltration of precipitation.

Data from a second set of monitoring wells provide information on how the effects of climate are modified by different geology and topography (fig. 2). These wells are completed in buried-channel or alluvial surficial aquifers, or in the first bedrock aquifer, and are in close proximity to the first set of monitoring wells (fig. 2).

DESCRIPTION OF THE MONITORING NETWORK

The ground-water-level monitoring network in Iowa began in 1935 as part of a water-resources study in Montgomery and Page Counties in southwest Iowa (fig. 3) (Logel, 1980). Since 1935, the water-level monitoring network has been expanded through joint-funding agreements between the U.S. Geological Survey and the State of Iowa. The current (1991) network consists of 202 monitoring wells completed in all of the principal bedrock and surficial aquifers in the State. Since its inception, the monitoring network has provided a long-term record of water-level fluctuations needed to help determine storage capacity of the principal aquifers and to monitor the effects of climatic stress and human activities on the aquifers through time.

Bedrock Aquifers

Bedrock aquifers are present in Paleozoic rocks from Cambrian through Permian age, as well as in Mesozoic rocks of Cretaceous age (figs. 4 and 5). These bedrock aquifers are the Dresbach, Jordan-St. Peter, and Galena aquifers, which are part of the Cambrian-Ordovician aquifer system; the Silurian-Devonian aquifer; the Mississippian aquifer; localized Pennsylvanian aquifers; and the Dakota aquifer. Water withdrawn from these bedrock aquifers accounted for about 40 percent of all ground water used in Iowa during 1985 (Clark and Thamke, 1988).

Cambrian-Ordovician Aquifer System

The Cambrian-Ordovician aquifer system is defined here as the three aquifers and the three confining units that are present in Cambrian and Ordovician rocks, as used by Burkart and Buchmiller (1990) in the northern Midwest regional aquifer-system analysis.

Cambrian and Ordovician rocks are present throughout most of Iowa, except in northwestern Iowa. In extreme northeastern Iowa, Cambrian rocks are exposed at the land

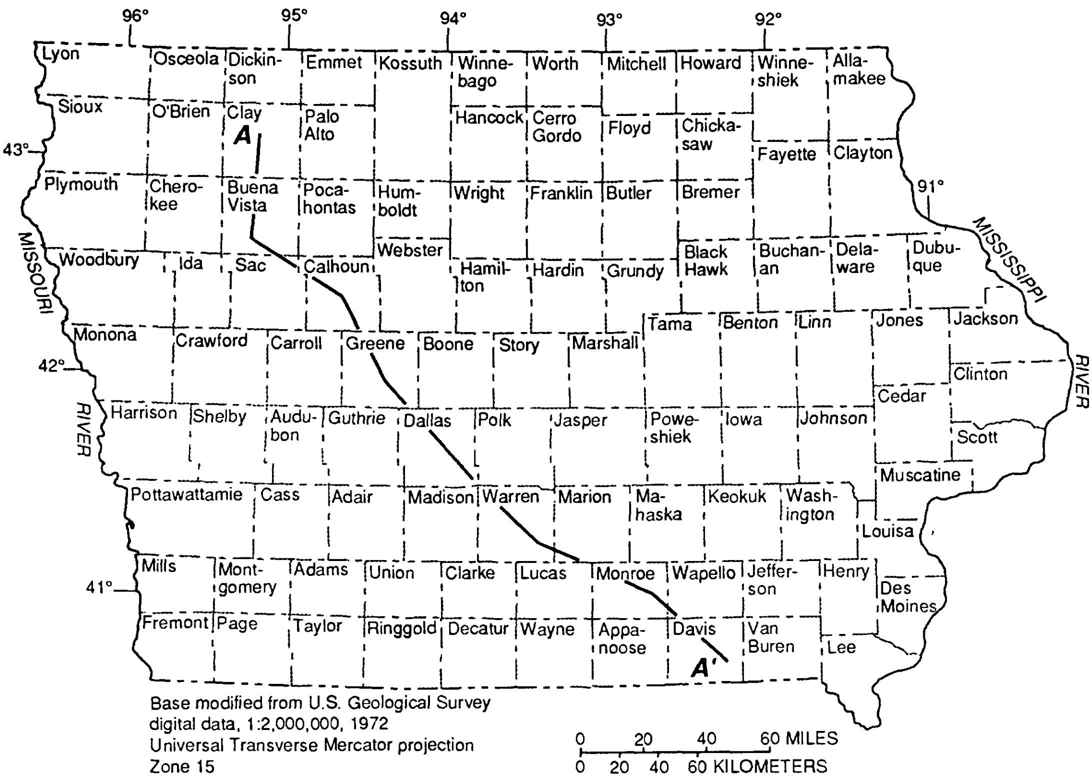


Figure 3. Location of counties and trace of generalized hydrogeologic section shown in figure 4.

surface (fig. 6). In Iowa, the Cambrian-Ordovician aquifer system consists of a series of aquifers and confining units that are characterized by interbedded sequences of sandstone, carbonate rocks, and shale.

The basal aquifer in the Cambrian-Ordovician aquifer system, the Dresbach, is present locally in northeastern and east-central Iowa, and consists of Upper Cambrian sandstone and siltstone of the Mount Simon, Eau Claire, and Wonewoc Formations (fig. 5).

Overlying the Dresbach aquifer is the more areally extensive Jordan-St. Peter aquifer. The Jordan-St. Peter aquifer consists of the Upper Cambrian Jordan Sandstone at the base, Lower Ordovician Prairie du Chien Group, and the Middle Ordovician St. Peter Sandstone (fig. 5) (Horick and Steinhilber, 1978). The Jordan-St. Peter aquifer has the greatest areal extent and provides the largest quantity of water of the three aquifers in the Cambrian-Ordovician aquifer system.

Separated by a confining unit of mostly shale, the Galena aquifer overlies the Jordan-St. Peter aquifer. The Galena aquifer, which is of local importance in northeastern Iowa, consists of Ordovician carbonate rocks and shale of the Decorah, Dunleith, Wise Lake, and Dubuque Formations (Horick, 1989).

The Cambrian-Ordovician aquifer system yields abundant quantities of water that are used principally for public and industrial supplies. Thirteen percent of all ground-water withdrawals in Iowa during 1985 were from the Cambrian-Ordovician aquifer system (Clark and Thamke, 1988). The aquifer system supplied about 21 percent of all estimated public-supply and 33 percent of all estimated industrial withdrawals from ground water in Iowa during 1985 (Clark and Thamke, 1988). The largest quantities of water were withdrawn

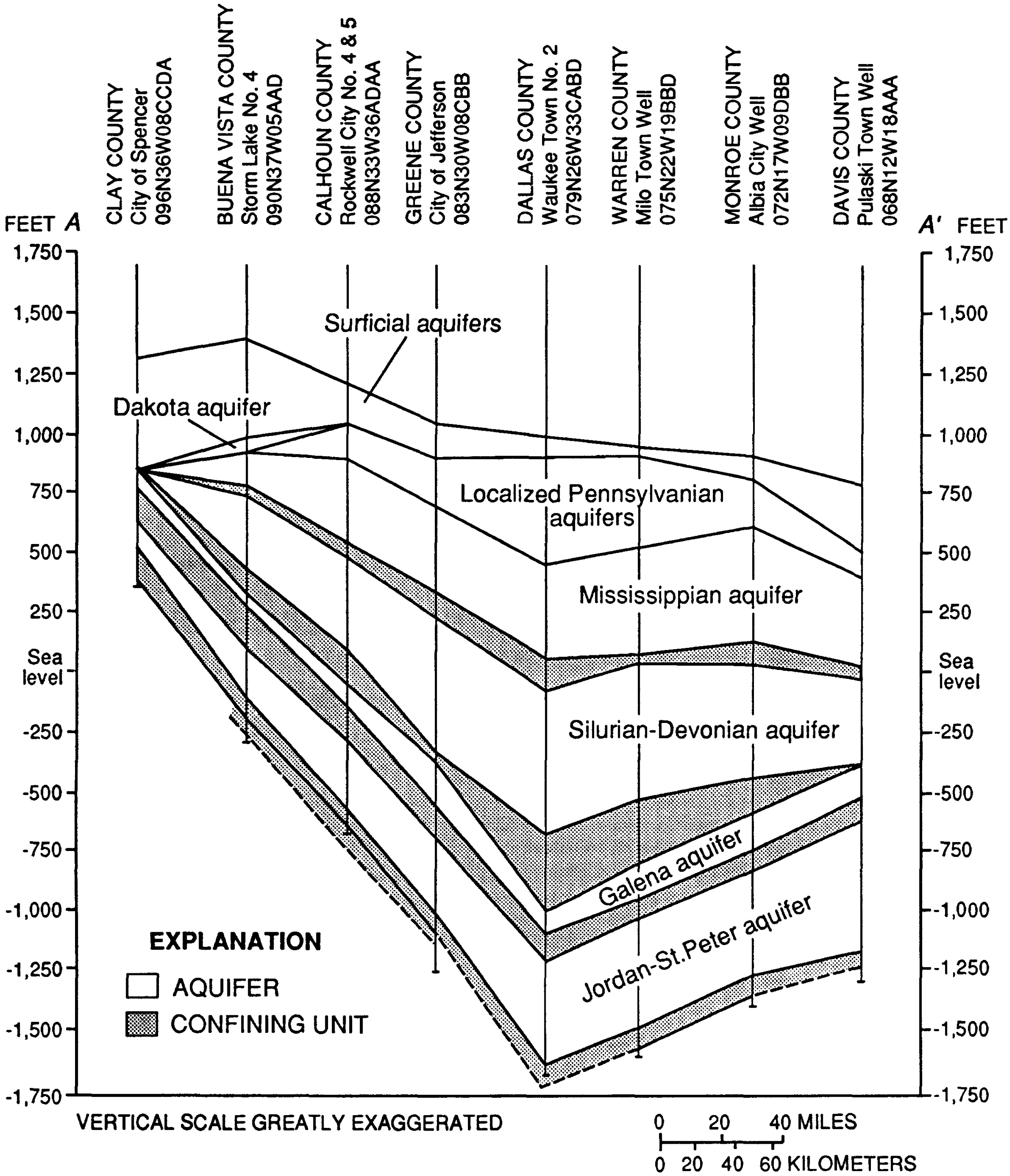


Figure 4. Generalized section of hydrologeologic units from northwestern to southeastern Iowa. Trace of hydrogeologic section shown in figure 3.

from the Jordan-St. Peter aquifer in northeastern Iowa, where the water is predominantly a calcium magnesium bicarbonate type, and dissolved-solids concentrations are less than 500 mg/L (Horick and Steinhilber, 1978). The water becomes increasingly mineralized to the west and southwest, where the aquifer is more deeply buried under younger sedimentary rocks.

On the basis of ground-water modeling results, the primary source of recharge to the Jordan-St. Peter aquifer at equilibrium before development was vertical leakage from overlying rocks (Burkart and Buchmiller, 1990). The largest transmissivity values determined for the aquifer are in areas where the sandstone is thinnest compared to the total aquifer thickness, thereby indicating that the greatest transmissivity results from fracture or solution-opening permeability in the Jordan Sandstone and Prairie du Chien Group (Burkart and Buchmiller, 1990).

There are currently 18 active monitoring wells completed in the Cambrian-Ordovician

ERA	SYSTEM	SERIES	GROUP	FORMATION	HYDROGEOLOGIC UNIT	
Cenozoic	Quaternary	Holocene	--	--	Surficial aquifers	
		Pleistocene	--	--		
Mesozoic	Cretaceous	--	Colorado	Carlile Shale Greenhorn Limestone Graneros Shale	Confining unit	
				Dakota Formation	Dakota aquifer	
	Jurassic	--	--	Fort Dodge Gypsum	Confining unit	
Paleozoic	Pennsylvanian	Virgilian	Wabaunsee	--	Confining unit	
			Shawnee	--		
			Douglas	--		
		Missourian	Lansing	--		
			Kansas City	--	Localized aquifer	
			Pleasanton	--	Confining unit	
		Des Moinesian	Marmaton	--		
			Cherokee	--	Localized aquifer	
		Morrowan	--	Caseyville Formation	Confining unit	
	Mississippian	Meramecian	--	Ste. Genevieve Limestone St. Louis Limestone Spergen Formation	Mississippian aquifer	
		Osagean	--	Warsaw Limestone Keokuk Limestone Burlington Formation		
		Kinderhookian	--	Gilmore City Limestone		
			--	Hampton Formation		
			North Hill	Starrs Cave Limestone Prospect Hill Siltstone McCraney Limestone		
	Devonian	Upper	Yellow Spring	English River Formation Maple Mill Shale Aplington Formation Sheffield Formation	Confining unit	
			--	Lime Creek Formation Shell Rock Formation	Silurian-Devonian aquifer	
		Middle	--	Cedar Valley Limestone Wapsipinicon Limestone Bertram Dolomite		
	Silurian	--	--	Gower Dolomite Scotch Grove Formation Hopkinton Dolomite		
			--	Blanding Formation Tete des Morts Formation Mosalem Formation		
	Ordovician	Upper	--	Maquoketa Formation	Confining unit	Cambrian-Ordovician aquifer system
		Middle	Galena	Dubuque Formation Wise Lake Formation Dunleith Formation Decorah Formation	Galena aquifer	
			--	Platteville Formation	Confining unit	
			Ancell	Glenwood Formation St. Peter Sandstone		
		Lower	Prairie du Chien	Shakopee Dolomite Oneota Dolomite	Jordan-St. Peter aquifer	
	Cambrian	Upper	Trempealeau	Jordan Sandstone St. Lawrence Formation		
			--	Franconia Sandstone	Confining unit	
			Elk Mound	Wonewoc Formation Eau Claire Sandstone Mount Simon Sandstone	Dresbach aquifer	

Figure 5. Generalized stratigraphic column of geologic and hydrogeologic units in Iowa (modified from Horick and Steinhilber, 1973 and 1978; Cagle and Heinitz, 1978; Swanson and others 1981; Burkart, 1984; Horick, 1984; and Buchmiller and others, 1985). The classification and nomenclature are those of the Geological Survey Bureau, Iowa Department of Natural Resources.

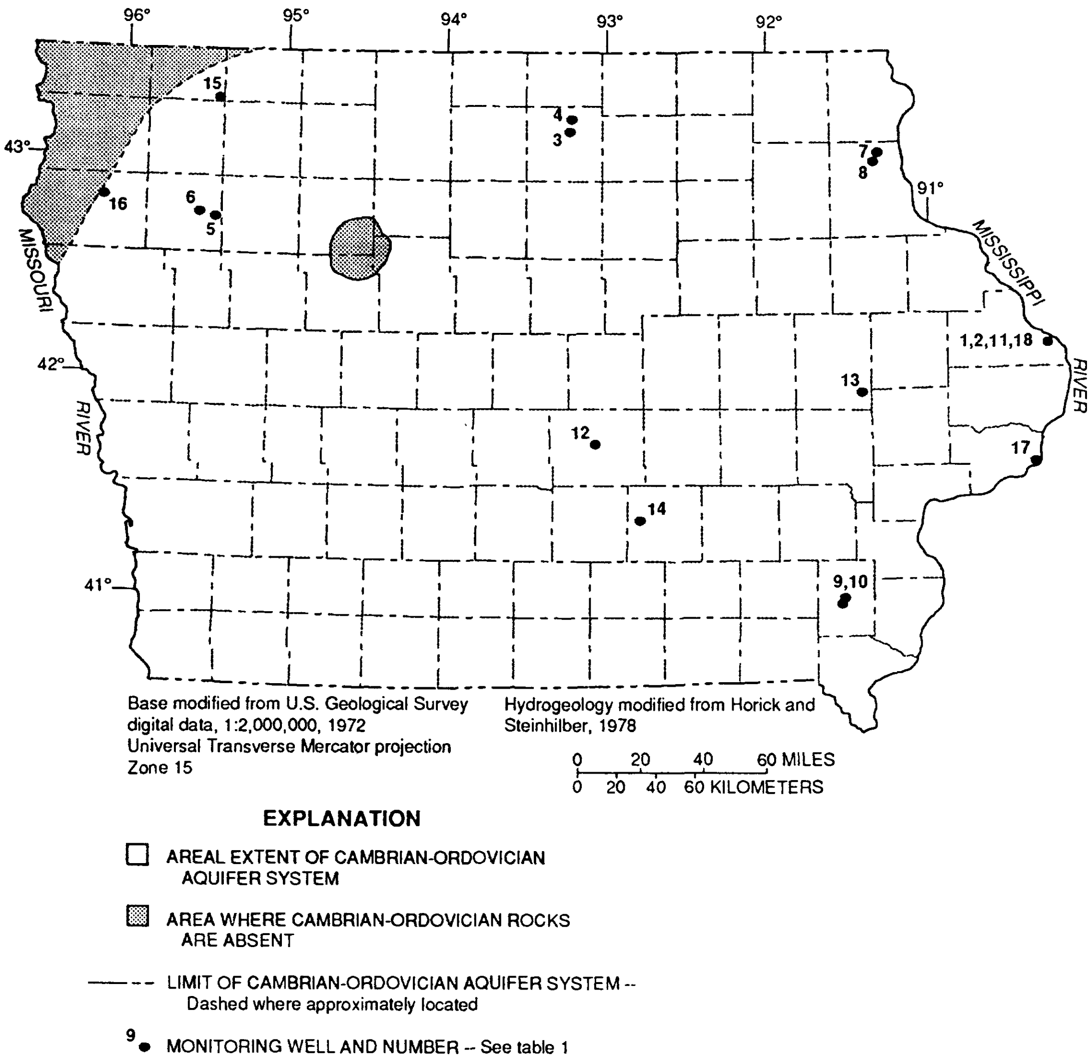


Figure 6. Areal extent of Cambrian-Ordovician rocks and location of monitoring wells completed in the Cambrian-Ordovician aquifer system.

aquifer system, with four wells nested at one location in Jackson County (fig. 6, table 1). Two wells are completed in the Dresbach aquifer, 15 wells in the Jordan-St. Peter aquifer, and 1 well in the Galena aquifer. There are currently no active monitoring wells in the west-central and southwestern part of the State. All the wells provide hydrologic data, and the four wells in Henry and Cerro Gordo Counties, located near major pumping centers, provide additional water-management data. None of the active monitoring wells completed in the Cambrian-Ordovician aquifer system provide baseline data.

Silurian-Devonian Aquifer

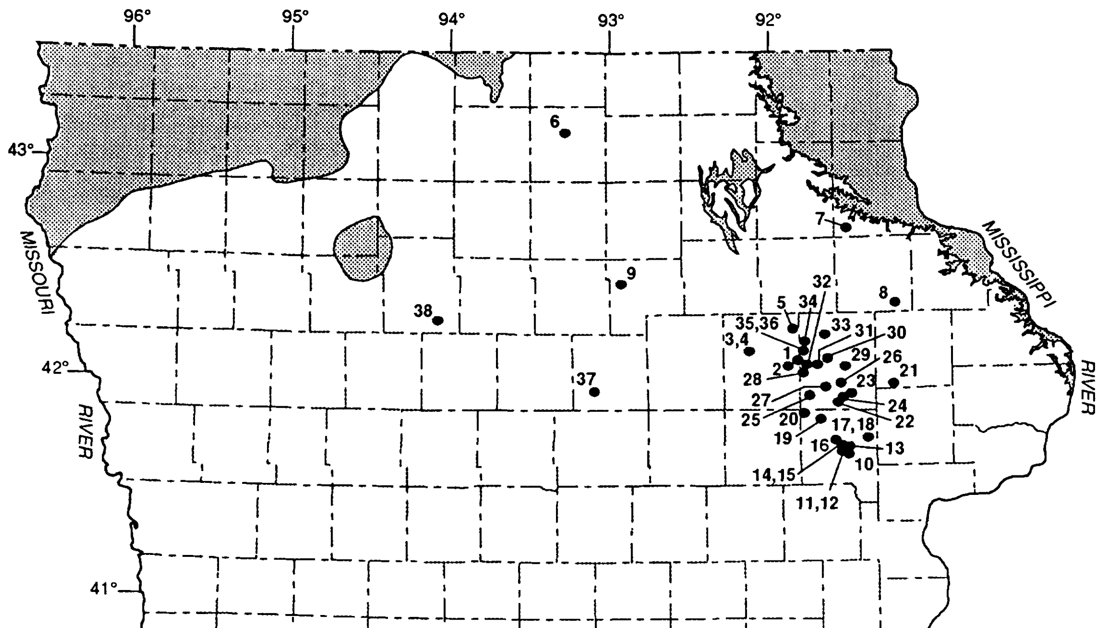
The Silurian-Devonian aquifer underlies about 90 percent of Iowa and is the uppermost bedrock aquifer in about 20 percent of the State (Horick, 1984). Silurian-Devonian rocks are absent in northwestern and northeastern Iowa (fig. 7). The Silurian-Devonian aquifer generally is 200 to 400 ft thick in eastern and northeastern Iowa; the thickness increases to 500 to 600 ft in southwestern Iowa (Karsten and Burkart, 1984). An erosional contact exists between the Silurian and Devonian rocks because the Silurian rocks were deposited and eroded before the deposition of flat-lying

Table 1. *Active monitoring wells completed in the Cambrian-Ordovician aquifer system*

Map number (fig. 6)	Site identification number	County	Local well number	Year well cons-tructed	Local well name	Depth of well (feet)	Year measure-ments began
			Dresbach aquifer				
1	420842090165701	Jackson	085N06E29ACAD1	1980	Green Island No. 1	1,800	1983
2	420842090165702	Jackson	085N06E29ACAD2	1980	Green Island No. 2	1,270	1983
			Jordan-St. Peter aquifer				
3	430757093131801	Cerro Gordo	096N20W17DAAD	1933	State Brand Creameries 1	1,340	1968
4	431123093124301	Cerro Gordo	097N20W28CAAC	1923	American Crystal Sugar	1,260	1937
5	424348095231601	Cherokee	091N39W01ADAD	1980	Larson Lake D-28	1,540	1979
6	424459095322411	Cherokee	092N40W26CCDD	1968	Cherokee City Test	700	1987
7	430156091182901	Clayton	095N04W22BCBD	1947	Gerald Mielke	49	1957
8	425940091194701	Clayton	095N04W32DDDD	1950	Milton & Willis Meier	380	1957
9	405810091330502	Henry	071N06W09ABAC2	1915	Mt. Pleasant City No. 4	1,650	1946
10	405741091334501	Henry	071N06W09CBCA1	1935	Mt. Pleasant City No. 3	1,790	1935
11	420842090165703	Jackson	085N06E29ACAD3	1980	Green Island No. 3	910	1983
12	414147093035401	Jasper	080N19W33ACCA	1930	John Coppess	2,567	1963
13	415534091251502	Linn	082N05W10CBAA	1972	Mt. Vernon 2	1,557	1987
14	412020092471002	Mahaska	076N17W35CADB	1968	Leighton No. 4	2,200	1989
15	431620095250501	Osceola	098N39W26CDAD	1980	IGS Cret Proj D-38 deep	662	1980
16	424850096074801	Plymouth	092N45W02CBCB	1978	IGS Cret Proj D-21	1,090	1979
17	413544090212901	Scott	078N05E03AADA	1966	Le Claire No. 3	1,610	1975
			Galena aquifer				
18	420842090165704	Jackson	085N06E29ACAD4	1980	Green Island No. 4	400	1983

Devonian rocks (fig. 5). The Silurian-Devonian aquifer consists predominantly of limestone and dolostone interbedded with shale. In the eastern part of Iowa, the underlying Maquoketa Formation is a shale that functions as a confining unit for the aquifer. Farther to the west, the lithology of the Maquoketa Formation changes from more dominantly shale to predominantly limestone and dolomite, and the formation becomes hydraulically connected with the Silurian-Devonian aquifer (fig. 4) (Horick, 1984).

The main area of development of the Silurian-Devonian aquifer is in the northeastern and east-central parts of the State, where concentrations of dissolved solids are less than 500 mg/L, and well yields are greatest (Horick, 1984). Well yields of 100 to 500 gal/min are possible in this eroded karst terrain where the limestone and dolomite have been fractured or dissolved (Horick, 1984). West and northwest of this main area of development, the mineralization of the water in the Silurian-Devonian aquifer increases, and dissolved-solids, sulfate, and fluoride concentrations exceed Federal Secondary Drinking-Water Regulations of 500, 250, and 2.0 mg/L, respectively (Steinhilber and Horick, 1970). Well yields decrease to the southwest as the Silurian-Devonian rocks are more deeply buried and are not as fractured or dissolved



Base modified from U.S. Geological Survey digital data, 1:2,000,000, 1972
Universal Transverse Mercator projection
Zone 15

Hydrogeology modified from Horick, 1984

0 20 40 60 MILES
0 20 40 60 KILOMETERS

EXPLANATION

☐ AREAL EXTENT OF THE SILURIAN-DEVONIAN AQUIFER

▨ AREA WHERE SILURIAN-DEVONIAN ROCKS ARE ABSENT

——— LIMIT OF SILURIAN-DEVONIAN AQUIFER

9● MONITORING WELL AND NUMBER -- See table 2

Figure 7. Areal extent of Silurian-Devonian rocks and location of monitoring wells completed in the Silurian-Devonian aquifer.

(Steinhilber and Horick, 1970).

Withdrawals from the Silurian-Devonian aquifer accounted for 14 percent of the total ground water withdrawn in Iowa during 1985 (Clark and Thamke, 1988). The ground water withdrawn from the Silurian-Devonian aquifer is used primarily as a source for public or commercial supplies. About 20 percent of the total estimated ground-water withdrawals for public supplies in Iowa during 1985 was derived from the Silurian-Devonian aquifer. About 40 percent of the estimated ground water used for commercial enterprises in Iowa during 1985 was withdrawn from the Silurian-Devonian aquifer (Clark and Thamke, 1988).

Of the 38 active monitoring wells completed in the Silurian-Devonian aquifer, 31 of these wells are located in Benton, Johnson, and Linn Counties in east-central Iowa (fig. 7, table 2). This cluster of wells provides information about withdrawals from nearby pumping centers for water-management purposes. The aquifer in these counties is used extensively for drinking-water supplies. Well information is lacking along the boundaries of the Silurian-Devonian aquifer, especially in northwestern Iowa. Also, there are no active monitoring wells completed in the downdip part of the aquifer in the southern part of Iowa. Even though a great percentage of the active monitoring wells are closely spaced, all of the wells provide hydrologic data. A better areal distribution of monitoring wells would improve the quality of the hydrologic data collected from the monitoring network. At the present time, none of the wells provide baseline data.

Mississippian Aquifer

The Mississippian System in Iowa is divided into the basal Kinderkookian Series, the middle Osagean Series, and the upper Meramecian Series, which consists of the uppermost Mississippian rocks in Iowa (fig. 5). The Mississippian aquifer consists of a thick sequence of limestone and dolomite that is bounded by the overlying Pennsylvanian Caseyville Formation (shale) and the underlying Devonian Sheffield, Aplington, Maple Mill, and English River Formations (primarily shale) (Steinhilber and Horick, 1970). Mississippian rocks crop out in Iowa along a wide band that trends from Humboldt and Kossuth Counties in the northwest to Des Moines County in the southeast. The aquifer ranges in thickness from a featheredge to 600 ft, with an average thickness of about 350 ft (Steinhilber and Horick, 1970).

The Mississippian aquifer underlies about 60 percent of the State, but only in 15 percent of this area is the aquifer considered to be a major source of potable water (Horick and Steinhilber, 1973). During 1985, only 5 percent of the total estimated ground-water withdrawals in Iowa were from Mississippian-Pennsylvanian rocks (Clark and Thamke, 1988). Of this total, 12 percent of the estimated withdrawals were from domestic wells.

Average well yields from the Mississippian aquifer of 10 to 30 gal/min are common because of the lack of fracturing or dissolution in the limestone and dolomite. In areas of north-central Iowa, however, where fracturing and dissolution of the Mississippian strata have occurred, well yields of 400 to 900 gal/min have been reported (Horick and Steinhilber, 1973). Water withdrawn from the Mississippian aquifer generally has dissolved-solids concentrations exceeding 1,500 mg/L (Horick and Steinhilber, 1973). Except for areas of the aquifer in north-central and southeastern Iowa, the water generally is unsuitable for most uses. The least mineralized water is obtained from the aquifer where it crops out (fig. 8) (Horick and Steinhilber, 1973).

There are only 16 active monitoring wells completed in the Mississippian aquifer, primarily in the southeastern and central parts of the State, especially near the aquifer boundaries (fig. 8, table 3). Additional monitoring wells are needed in southwestern and south-central Iowa. All 16 of the active monitoring wells completed in the Mississippian aquifer provide hydrologic data, with only 4 wells located near pumping centers providing information for water management. None of the wells currently provides baseline data.

Pennsylvanian Aquifers

Pennsylvanian rocks, primarily interbedded sequences of sandstone, siltstone, shale and limestone, are present only in the southwestern

Table 2. *Active monitoring wells completed in the Silurian-Devonian aquifer*

[--, data not available]

Map number (fig. 7)	Site identification number	County	Local well number	Year well const-ructed	Local well name	Depth of well (feet)	Year measure-ments began
1	420459091500201	Benton	084N09W13DDAD	1974	Shellsburg Quary	421	1975
2	420319091540102	Benton	084N09W28DBCC	1974	Parker's Grove Cemetary	590	1975
3	420731092083801	Benton	085N11W33CCBC	1975	Garrison 170	237	1977
4	420731092083803	Benton	085N11W33CCBC	1975	Garrison 109	97	1977
5	421326091522701	Benton	086N09W34AAA	1919	Town of Urbana No. 1	1,030	1984
6	430806093164501	Cerro Gordo	096N21W13BCCB	--	MC & CL Railroad	198	1940
7	424057091320001	Clayton	091N06W22ACAC	1936	Strawberry Point No. 2	492	1963
8	422029091144302	Delaware	087N03W18CBCD	1905	Hopkinton No. 1	86	1984
9	422605092560001	Grundy	088N18W15DBBB	1953	Wellsburg No. 1	280	1960
10	414107091322901	Johnson	079N06W04AAAA	--	Forest View Trailer Court	280	1960
11	413940091344701	Johnson	079N06W07DAA	1959	Hawkeye Apts No. 1	400	1987
12	413925091324001	Johnson	079N06W09DDBC	1956	UI Quandrangle No. 1	431	1975
13	414315091252002	Johnson	080N0522CBCB2	--	Elmira, deep (22M2)	82.5	1941
14	414132091345501	Johnson	080N06W31ADAC	1988	Coralville OBS., East	500	1988
15	414132091345502	Johnson	080N06W31ABBC	1988	Coralville OBS., North	500	1988
16	414132091345503	Johnson	080N06W31ABBD	1986	Coralville production well	500	1988
17	414221091361101	Johnson	080N07W25DBDA	1990	Oakdale No. 1/Silurian	532	1991
18	414221091361102	Johnson	080N07W25DBDA	1990	Oakdale No. 2/Devonian	301	1991
19	414853091425101	Johnson	081N07W19BCBB	1976	Plum Creek	535	1976
20	415052091483801	Johnson	081N08W05CCCD	1972	First Hole/Swisher	533	1972
21	415808091160501	Jones	083N04W25CBBB	1976	White Oak Creek	517	1976
22	415556091313001	Linn	082N06W10AABB	1976	Bertram	471	1976
23	415442091343101	Linn	082N06W17CBAB	1976	Ely North	480	1976
24	415343091360101	Linn	082N07W25AAAB	1976	Ely Railroad	320	1976
25	415509091461801	Linn	082N08W20ACBB	1972	Rockpile	569	1973

Table 2. *Active monitoring wells completed in the Silurian-Devonian aquifer*--Continued

Map number (fig. 7)	Site identification number	County	Local well number	Year well const-ructed	Local well name	Depth of well (feet)	Year measure-ments began
26	415834091351601	Linn	083N06W30ABBA	1935	Katz/B.L. Anderson	76.5	1940
27	415725091410101	Linn	083N07W32ACDC	1937	Floyd Fetter	282	1940
28	420126091484701	Linn	083N08W06DDAD	1972	Lincoln Church well	561	1972
29	420300091325801	Linn	084N06W33ABBB	1976	Marion	481	1976
30	420508091395811	Linn	084N07W16DBBB	1975	Robins #15 USGS	520	1975
31	420340091431601	Linn	084N08W25ACAD	1973	Hiawatha	468	1973
32	420320091472201	Linn	084N08W28CBDD	1975	Palo	442	1976
33	421149091403301	Linn	085N07W04CCCC	1973	Alice/Power Station	435	1973
34	420954091480801	Linn	085N08W20ABCD	1973	Center Point Bridge	433	1974
35	420730091490401	Linn	085N08W31DDCD1	1975	Pleasant Creek/Silurian	481	1975
36	420730091490402	Linn	085N08W31DDCD2	1946	Pleasant Creek/Devonian	205	1975
37	415640093062101	Marshall	082N19W06ACCB	1939	Melbourne No. 1	1,340	1988
38	421550094041001	Webster	086N28W14ADAB	1931	Dayton No. 2	1,240	1942

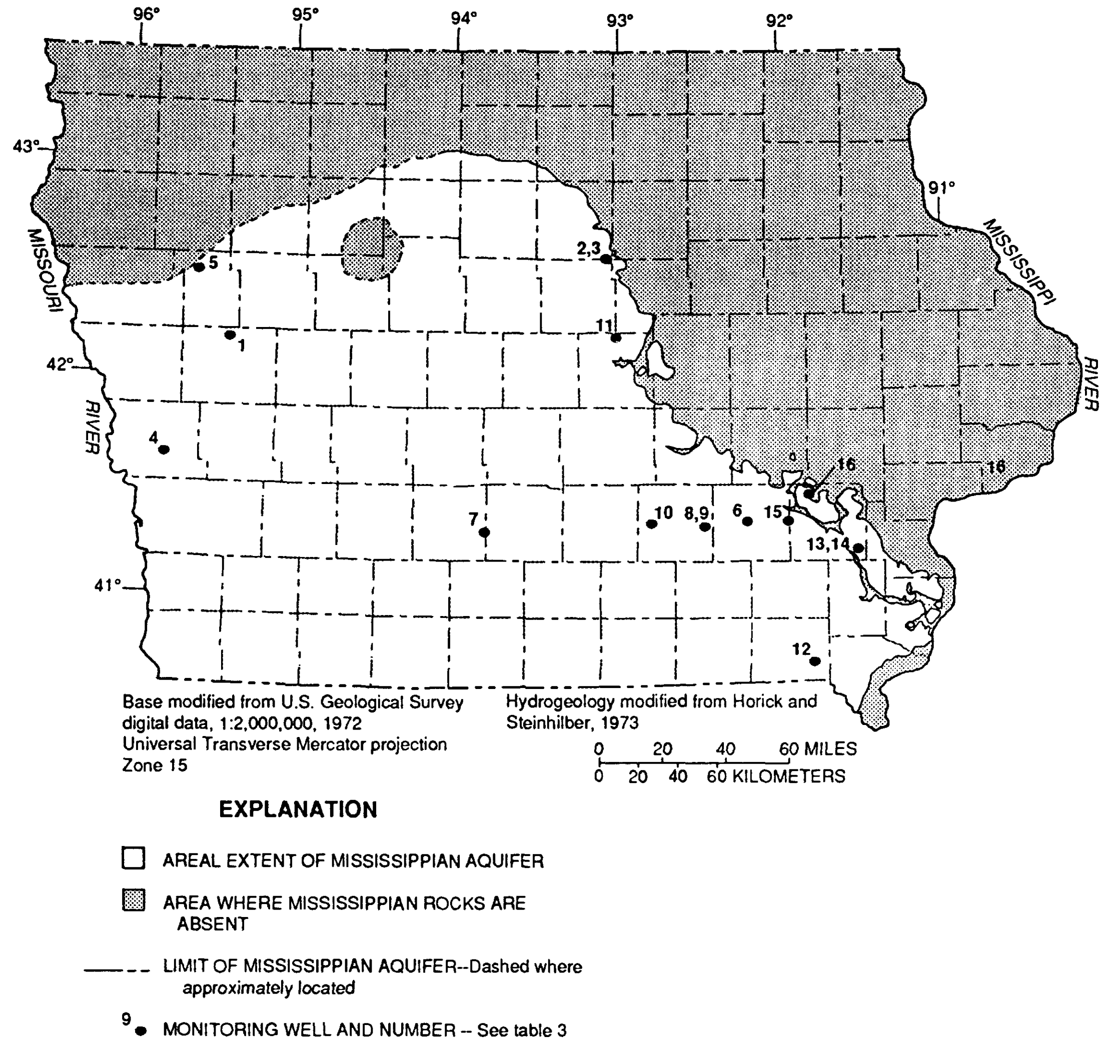


Figure 8. Areal extent of Mississippian rocks and location of monitoring wells completed in the Mississippian aquifer.

one-half of Iowa (fig. 9). These rocks thicken and dip to the southwest. Interbedded with the more extensive impermeable shale units are permeable limestone and sandstone lenses that form localized aquifers in the Cherokee and Kansas City Groups in south-central Iowa (fig. 5) (Cagle and Heinitz, 1978). The Kansas City Group ranges in thickness from a featheredge to 225 ft, whereas the Cherokee Group ranges in thickness from a featheredge to 510 ft (Cagle and Heinitz, 1978). Available drilling information for the Pennsylvanian aquifers is sparse, and the localized aquifers in rocks of the Cherokee and Kansas City Groups are not well mapped.

Estimates of well yields from Pennsylvanian rocks in south-central Iowa are small, less than 25 gal/min, and are usually between 3 and 10 gal/min. In some areas, sandstone in the Cherokee Group will yield 25 to 100 gal/min; limestone in the Kansas City Group also will yield 25 to 100 gal/min where there are fractures or solution cavities in the rocks (Cagle and Heinitz, 1978). The water withdrawn from these aquifers is too mineralized for most uses. The dissolved-solids concentrations usually exceed the Federal Secondary Drinking-Water Regulation of 500 mg/L and can be as much as 6,000 mg/L (Cagle and Heinitz, 1978). Other constituents, such as sulfate, fluoride, and iron, also exceed Federal

Table 3. *Active monitoring wells completed in the Mississippian aquifer*

Map number (fig. 8)	Site identification number	County	Local well number	Year well const-ructed	Local well name	Depth of well (feet)	Year measure-ments began
1	421031095225602	Crawford	085N39W16ADDD	1981	IGS & USGS WC-7B	351	1981
2	423332093034302	Franklin	090N19W35CDCC	1946	Ackley No. 1	172	1988
3	423310093032802	Hardin	089N19S02BDAC	1953	Ackley No. 5	134	1988
4	413838095462001	Harrison	07N942W19AADB	1981	IGS & USGS WC #22	628	1981
5	423107095383201	Ida	08N941W13CCCC	1977	IGS Cret Proj D-9	469	1978
6	412030092121601	Keokuk	076N12W35DBDC	1942	Sigourney S. Rock Island	300	1988
7	411727093483001	Madison	075N26W23AAAC	1956	St. Charles No. 1	867	1962
8	411912092273601	Mahaska	075N14W10BAAC	1967	Rose Hill No. 2	370	1989
9	411914092273001	Mahaska	075N14W10BABC	1978	Rose Hill No. 4	275	1989
10	412023092471201	Mahaska	076N17W35CADB	1955	Leighton No. 1	210	1989
11	421120093003001	Marshall	085N19W12ADCA	1949	Liscomb No. 1	278	1988
12	404150091483001	Van Buren	068N08W08CDD	1949	Bonaparte No. 1	205	1988
13	411300091320701	Washington	074N06W15BDAC	1956	Crawfordsville North	215	1987
14	411244091323501	Washington	074N06W15CBDD	1941	Crawfordsville South	250	1987
15	412037091564701	Washington	076N09W31CBBC	1979	Pepper Quarry	136	1979
16	412750091495201	Washington	077N09W24AAD	1934	Wellman No. 1	110	1963

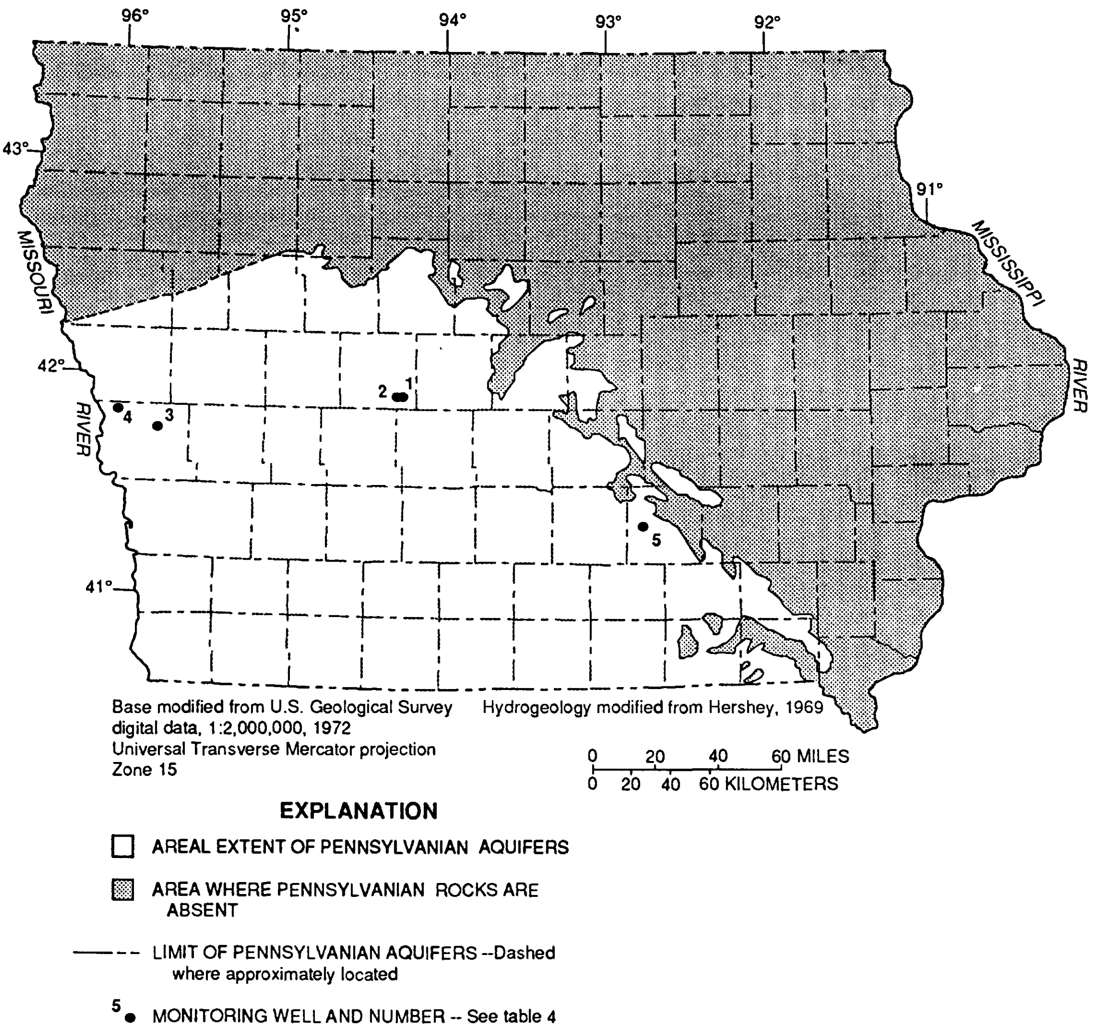


Figure 9. Areal extent of Pennsylvanian rocks and location of monitoring wells completed in Pennsylvanian aquifers.

drinking-water regulations. Dissolved-solids, sulfate, fluoride, and iron concentrations increase to the west as the Pennsylvanian rocks become more deeply buried (Cagle and Heinitz, 1978). Because of the small yields and extremely mineralized character of the water from Pennsylvanian rocks, these localized aquifers commonly are no longer used as a source of potable water.

There are currently only five active monitoring wells completed in the Pennsylvanian aquifers (fig. 9, table 4). All five wells provide hydrologic data; four of these monitoring wells were originally drilled for an aquifer study in west-central Iowa. None of the monitoring wells completed in the Pennsylvanian aquifers provide water-management data, and only 1 well in Mahaska County provides baseline data.

Dakota Aquifer

Sandstone in the Cretaceous Dakota Formation is the source of water for the Dakota aquifer. This poorly cemented, fine-grained sandstone is present primarily in northwestern and west-central Iowa (fig. 10), and was unconformably deposited on older Paleozoic and Precambrian rocks (fig. 4). Isolated remnants of

Table 4. *Active monitoring wells completed in Pennsylvanian aquifers*

Map number (fig. 9)	Site identification number	County	Local well number	Year well const-ructed	Well name	Depth of well (feet)	Year measure-ments began
1	415449094161501	Greene	082N29W18CAAA	1982	IGS & USGS WC #116	100	1982
2	415449094173201	Greene	082N30W13CABA	1982	IGS & USGS WC #118	230	1982
3	414517095453401	Harrison	080N42W08ACCC	1981	IGS & USGS WC #3	336	1982
4	414955096000601	Harrison	081N44W18AADA	1981	IGS & USGS WC #23	126	1982
5	412002092470301	Mahaska	075N17W02BAAB	1966	Leighton No. 2	50	1988

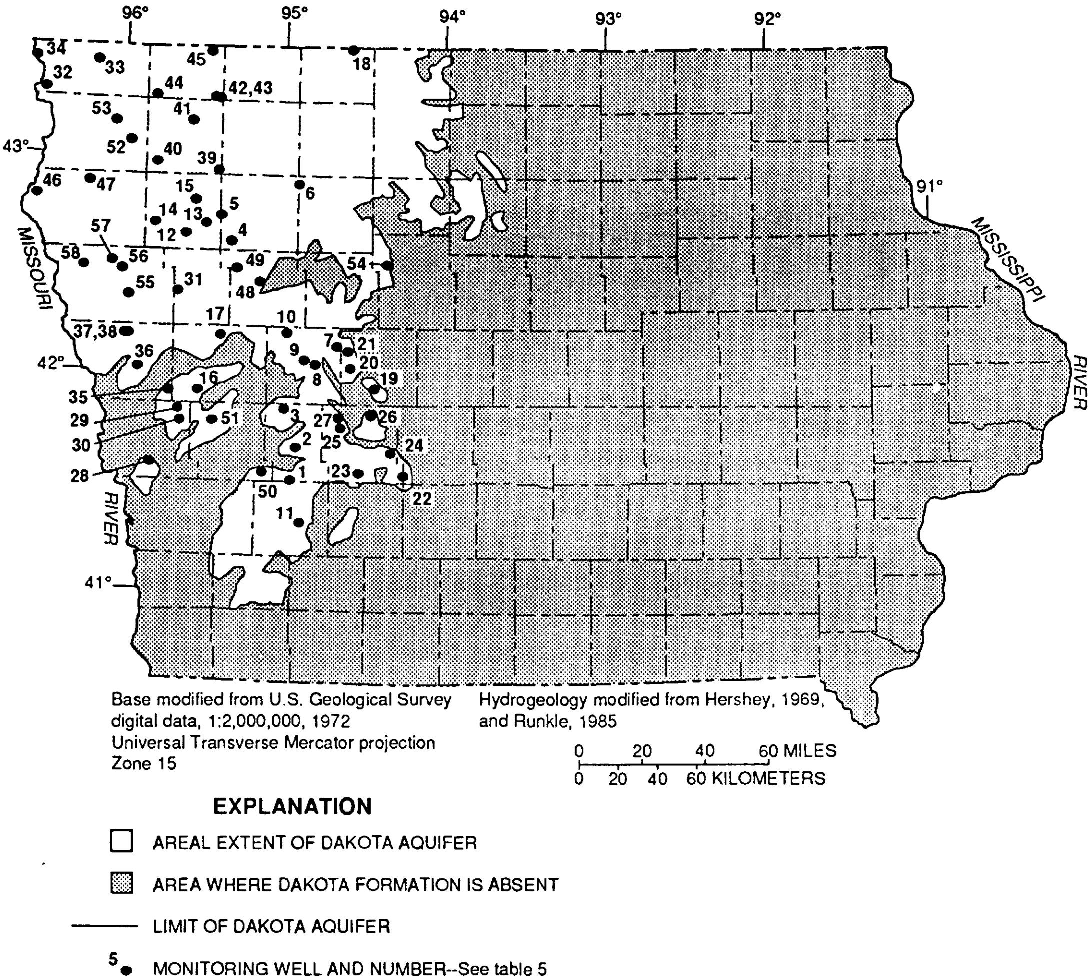


Figure 10. Areal extent of Dakota Formation and location of monitoring wells completed in the Dakota aquifer.

Cretaceous rocks are present in southwestern Iowa (fig. 10). The cumulative thickness of the sandstone units comprising the Dakota aquifer is about 200 ft throughout much of northwestern Iowa (Burkart, 1984). The Dakota aquifer is the primary source of water in northwestern Iowa and of local importance in west-central Iowa. Eight percent of the estimated total ground-water withdrawals in Iowa during 1985 was from the Dakota aquifer (Clark and Thamke, 1988). Of this total, 14 percent of the water was used for agricultural purposes, and 14 percent was used for domestic supplies.

Water derived from the Dakota aquifer is a calcium magnesium sulfate type; dissolved-solids concentrations range from 279 to 2,820 mg/L (Burkart, 1984). Dissolved-sulfate concentrations commonly exceed 1,000 mg/L in the recharge areas. Farther to the south and west, in a downgradient direction, sulfate concentrations are less than 250 mg/L (Burkart, 1984).

The main source of recharge to the Dakota aquifer is by indirect infiltration from the water table through confining material, or from aquifers overlying the Dakota aquifer (Burkart, 1984). Direct recharge to the Dakota aquifer occurs by infiltration of precipitation in a limited area in Plymouth and northern

Woodbury Counties where the sandstone is exposed at land surface (Burkart, 1984). Yields from the Dakota aquifer generally are 50 to 100 gal/min, although some yields in excess of 1,000 gal/min have been reported (Steinhilber and Horick, 1970). Aquifer tests indicate that the hydraulic conductivity of the Dakota aquifer in northwestern Iowa ranges from 37 to 50 ft/d (Burkart, 1984).

The 58 active monitoring wells completed in the Dakota aquifer provide the best coverage of any aquifer in Iowa (fig. 10, table 5). This coverage is due in part to the incorporation of wells from two previous cooperative studies of the Dakota aquifer in northwestern and west-central Iowa. All of the active monitoring wells provide hydrologic data. Because the primary aquifer in northwestern Iowa is the Dakota aquifer, most of the data collected from the monitoring wells also is used for water-management purposes. None of the wells currently provides baseline data.

Surficial Aquifers

There are three types of surficial aquifers in Iowa--buried channel, alluvial, and glacial drift (Steinhilber and Horick, 1970). Lenses of sand and gravel deposited in pre-glacial stream channels and overlain by a thick sequence of glacial till form the buried-channel aquifers. Sand and gravel deposited by the rivers and streams form the alluvial aquifers. Isolated water-yielding lenses of sand and silt in the glacial drift form glacial-drift aquifers.

Withdrawals from surficial aquifers comprise the largest percentage of ground water used in Iowa. During 1985, 60 percent of the total estimated ground-water withdrawals were from surficial aquifers (Clark and Thamke, 1988). Of this total, nearly 49 percent of the withdrawals for public supplies, 56 percent for domestic supplies, and 53 percent for industrial water supplies were derived from surficial aquifers (Clark and Thamke, 1988). Nearly all of the ground water used for irrigation, mining, and thermoelectric-power generation was withdrawn from surficial aquifers.

Buried-Channel Aquifers

In Iowa, buried-channel aquifers were formed when sand and gravel were deposited in pre-glacial river and stream channels and then were covered by thick sequences of glacial till. These aquifers commonly yield between 10 and 100 gal/min, but might yield 500 gal/min or more. The most productive buried-channel aquifers are in eastern and central Iowa (Steinhilber and Horick, 1970).

The distribution of the 18 active monitoring wells completed in buried-channel aquifers is fairly scattered (fig. 11, table 6). The best coverage of buried-channel aquifers is in west-central Iowa, with a few wells in central and eastern Iowa. Additional monitoring wells are needed in the eastern part of Iowa because buried-channel aquifers are a principal source of water in this area. All 18 active monitoring wells provide hydrologic data because many of the wells are located some distance from pumping centers. None of the active monitoring wells provide water-management or baseline data.

Alluvial Aquifers

Quaternary sand and gravel associated with present-day fluvial systems form the alluvial aquifers in Iowa, which are recharged primarily by infiltration of precipitation. Along the east and west borders of Iowa, the Quaternary deposits associated with the Mississippi and Missouri Rivers are 100 to 160 ft thick. The thickness of alluvium associated with the interior streams in Iowa generally ranges from 30 to 70 ft thick (Steinhilber and Horick, 1970). Well yields from alluvial aquifers along the Mississippi River range from 1,000 to 2,000 gal/min; the water is used for irrigation, industry, and public supplies (Steinhilber and Horick, 1970). Well yields from the alluvial aquifers along the Missouri River range from 1,000 to 1,500 gal/min; the water is used primarily for irrigation.

The 32 active monitoring wells completed in alluvial aquifers are located mainly in east-central and west-central Iowa (fig. 12, table 7). Only one active monitoring well in Muscatine County in southeastern Iowa is completed in the Mississippi River alluvium, and no active monitoring wells are completed in the Missouri River alluvium. Also, there are no active monitoring wells completed in alluvium

Table 5. *Active monitoring wells completed in the Dakota aquifer*

Map number (fig. 10)	Site identification number	County	Local well number	Year well const-ructed	Local well name	Depth of well (feet)	Year measure-ments began
1	413044094565601	Audubon	078N36W35ADCC	1982	IGS & USGS WC #69	115	1982
2	413958094544501	Audubon	079N35W10CABB	1981	IGS & USGS WC #17	210	1981
3	415023094593801	Audubon	081N36W12CBCA	1981	IGS & USGS WC #18	315	1982
4	423618095194511	Buena Vista	090N38W16DDDD	1979	IGS Cret Proj D-25	497	1980
5	424023095571401	Buena Vista	091N35W26BCCC	1978	IGS Cret Proj D-24	357	1979
6	425233094545001	Buena Vista	093N35W13ADAA	1979	IGS Cret Proj D-36	381	1980
7	420705094394501	Carroll	084N33W02BDBA	1982	IGS & USGS WC #132	76	1982
8	420233094475901	Carroll	084N34W35BCDC	1982	IGS & USGS WC #148	99	1982
9	420335094521501	Carroll	084N35W25BDAD	1939	Carroll Test #1	120	1939
10	421058094582701	Carroll	085N35W07CCCC	1942	Breda No. 2	340	1942
11	411900094530101	Cass	075N35W07BBAB	1986	Southwest IA SW-17	218	1986
12	423833095365701	Cherokee	090N40W06BDCD	1977	IGS Cret Proj D-6	253	1978
13	424348095231602	Cherokee	091N39W01ADAD	1979	IGS Cret Proj D-29	340	1979
14	424132095480211	Cherokee	091N42W16DDDD	1978	IGS Cret Proj D-11	390	1980
15	424802095331201	Cherokee	092N40W10BDDD	1977	IGS Cret Proj D-5	300	1980
16	415514095312001	Crawford	082N40W17AABB	1981	IGS & USGS WC #9	141	1981
17	421031095225601	Crawford	085N39W16ADDD	1981	IGS & USGS WC #7A	561	1981
18	432927094345501	Emmet	100N32W11DDDD	1933	Okamanpedan State Park	277	1939
19	415608094260701	Greene	082N31W10AAAA	1983	IGS & USGS WC #235	125	1983
20	420149094344701	Greene	083N32W04ACCC	1983	IGS & USGS WC #228	240	1983
21	420603094355101	Greene	084N32W08ACDB	1982	IGS & USGS WC #124	129	1982
22	413223094150801	Guthrie	078N30W24CAAB	1983	IGS & USGS WC #238	72	1983
23	413248094314301	Guthrie	078N32W21AAAA	1983	IGS & USGS WC #239	135	1983
24	413837094194601	Guthrie	079N30W22BAAC	1982	IGS & USGS WC #109	150	1982
25	414514094381601	Guthrie	080N33W12ACCC	1982	IGS & USGS WC #90	81	1982

Table 5. *Active monitoring wells completed in the Dakota aquifer*--Continued

Map number (fig. 10)	Site identification number	County	Local well number	Year well constructed	Local well name	Depth of well (feet)	Year measurements began
26	414821094271301	Guthrie	081N31W22CCCC	1982	IGS & USGS WC #105	133	1982
27	414728094385301	Guthrie	081N33W26DDDD	1982	IGS & USGS WC #93	75	1982
28	413523095483101	Harrison	078N43W05ACDD	1982	IGS & USGS WC #33	179	1982
29	415003095382301	Harrison	081N41W17ABAA	1981	IGS & USGS WC #11	166	1981
30	414700095373001	Harrison	081N41W33CAAA	1982	IGS & USGS WC #52	155	1982
31	422215095390811	Ida	087N41W05CCCC	1977	IGS Cret Proj D-10	490	1980
32	431812096302701	Lyon	098N48W16DDAD	1978	IGS Cret Proj D-20	358	1978
33	432553096105701	Lyon	099N45W05ABAC	1955	Rock Rapids Test No. 3	375	1960
34	432601096335511	Lyon	100N48W31CCCC	1978	IGS Cret Proj D-19	657	1978
35	415456095414101	Monona	082N42W14ADCA	1981	IGS & USGS WC #4	336	1981
36	420139095155701	Monona	083N43W04CBCB	1981	IGS & USGS WC #5	315	1981
37	421018095582001	Monona	085N44W16CDAA	1982	IGS & USGS WC#155	77	1982
38	421018095591301	Monona	085N44W17DCAA	1982	IGS & USGS WC #158	135	1982
39	425610095250611	O'Brien	094N39W26BADB	1977	IGS Cret Proj D-3	329	1980
40	425808095480311	O'Brien	094N42W09DDDD	1980	IGS Cret Proj D-42	638	1980
41	430930095350401	O'Brien	096N40W05DDDA	1980	IGS Cret Proj D-41	701	1980
42	431620095250511	Osceola	098N39W26CDAD	1980	IGS Cret Proj D-38 shallow	345	1980
43	431613095251801	Osceola	098N39W26CDCC	1980	IGS Cret Proj D-39	500	1980
44	431620095482402	Osceola	098N42W33AABB	1980	IGS Cret Proj D-40	400	1980
45	432828095283611	Osceola	100N39W17DCCB	1978	IGS Cret Proj D-13	760	1979
46	424833096324701	Plymouth	092N48W06DDDA	1979	IGS Cret Proj D-35	581	1979
47	425249096125001	Plymouth	093N46W12DDDD	1977	IGS Cret Proj D-2	570	1980
48	422500095084801	Sac	088N37W22CCCC	1978	IGS Cret Proj D-16	435	1978
49	422850095171501	Sac	089N38W36CBCC	1978	IGS Cret Proj D-17	521	1978
50	413255095070401	Shelby	078N37W17DDDD	1981	IGS & USGS WC #16	181	1981

Table 5. *Active monitoring wells completed in the Dakota aquifer*--Continued

Map number (fig. 10)	Site identification number	County	Local well number	Year well const-ructed	Local well name	Depth of well (feet)	Year measure-ments began
51	414624095252301	Shelby	080N39W06AADC	1981	IGS & USGS WC #10	370	1981
52	430140095573101	Sioux	095N43W07AAAA	1980	IGS Cret Proj D-43	681	1980
53	430913096033201	Sioux	096N44W08ADAA	1980	IGS Cret Proj D-44	682	1980
54	423018094214701	Webster	089N30W23CCBB	1924	Barnum School	208	1942
55	422058095573701	Woodbury	087N44W15CBBB	1979	IGS Cret Proj D-34	197	1980
56	422830096000511	Woodbury	088N44W06BAAB	1979	IGS Cret Proj D-33	337	1979
57	423015096034601	Woodbury	089N44W20DCDC	1979	IGS Cret Proj D-32	221	1979
58	422910096135811	Woodbury	089N46W36BBDC	1979	IGS Cret Proj D-30	500	1980

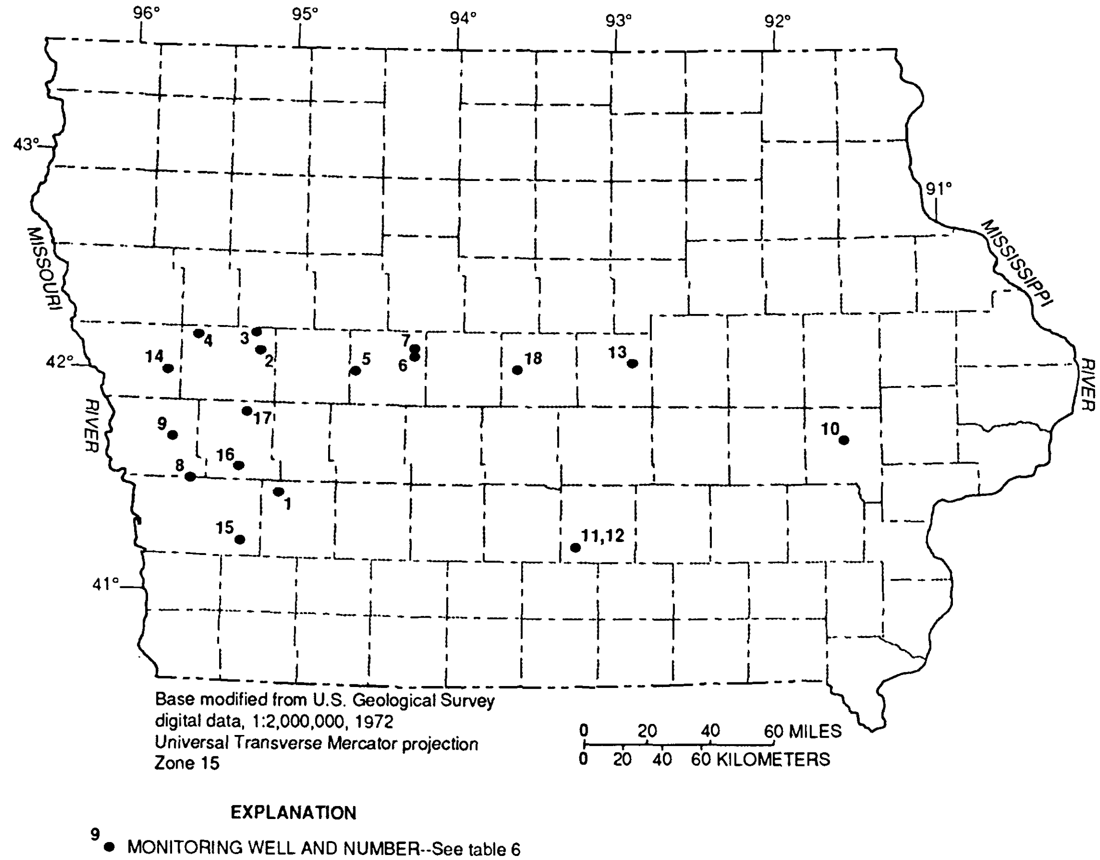


Figure 11. Location of monitoring wells completed in buried-channel aquifers.

along the major interior streams. All of the monitoring wells provide hydrologic and baseline data. None of the wells provide information for water management.

Glacial-Drift Aquifers

Thin, discontinuous sand-and-gravel lenses in glacial drift form glacial-drift aquifers. Water from these isolated lenses is used primarily for domestic supplies. The thickness of the glacial drift in Iowa ranges from a featheredge to 600 ft and averages about 200 ft (Steinhilber and Horick, 1970). Glacial drift is present throughout much of Iowa, but is absent in the northeastern part of the State (fig. 13). Wells completed in the glacial drift are usually shallow. Well yields from the water-yielding intervals of the glacial drift are small, averaging only a few gallons per minute (Steinhilber and Horick, 1970).

The 17 active monitoring wells completed in glacial-drift aquifers in Iowa are fairly well distributed (fig. 13, table 8). Many of these wells have long periods of record; some wells have been measured since the middle to late 1930's and early 1940's. Although the data collected from these wells provide information on seasonal and long-term trends in climate, the wells do not always have similar construction or screened intervals, making regional comparisons of climatic variation difficult. None of the wells provides hydrologic or water-management data. All the wells provide hydrologic baseline data.

NEED FOR FUTURE ADDITIONS TO THE NETWORK

Although the current monitoring network provides a good framework for the collection of ground-water-level data in Iowa, there are regions that would benefit from improved network coverage in each specific aquifer.

Table 6. *Active monitoring wells completed in buried-channel aquifers*

Map number (fig. 11)	Site identification number	County	Local well number	Year well constructed	Local well name	Depth of well (feet)	Year measurements began
1	412832095033501	Cass	077N37W13BBBB	1986	IGS & USGS SW #18	201	1986
2	420608095111701	Crawford	084N37W08BCCB	1983	IGS & USGS WC #226	541	1983
3	421106095125501	Crawford	085N38W12DCBA	1981	IGS & USGS WC #14	315	1981
4	421005095342801	Crawford	085N41W13CCCC	1981	IGS & USGS WC #6	322	1981
5	420116094363001	Greene	083N32W08BBBC	1983	IGS & USGS WC #229	181	1983
6	420507094141901	Greene	084N29W16CBAB	1983	IGS & USGS WC #233	181	1983
7	420723094143201	Greene	085N29W32DDDD	1983	IGS & USGS WC #232	171	1983
8	413024095353901	Harrison	078N41W31DDDD	1981	IGS & USGS WC #27	129	1982
9	414149095422401	Harrison	080N42W35BDCC	1983	IGS & USGS WC #193	118	1983
10	414221091361103	Johnson	080N07W25DBDA	1990	Oakdale No. 3	171	1991
11	411329093142902	Marion	074N21W11DBB	1945	Melcher Test No. 3	119	1945
12	411328093143503	Marion	074N21W11CAAD3	1953	Melcher No. 5	96.5	1956
13	420355092534701	Marshall	084N18W24CDCA	1943	City of Marshalltown	200	1949
14	420004095451501	Monona	083N42W17ACDD	1983	IGS & USGS WC #176	161	1983
15	411359095171901	Pottawattamie	074N39W01CCCC	1986	Southwest IA SW-21	216	1986
16	413359095182701	Shelby	078N38W11CCBC	1983	IGS & USGS WC #227	541	1983
17	414856095160101	Shelby	081N38W21ADAD	1983	IGS & USGS WC #222	535	1983
18	420137093361501	Story	083N24W02DABC	1935	Ames City No. 4	124	1987

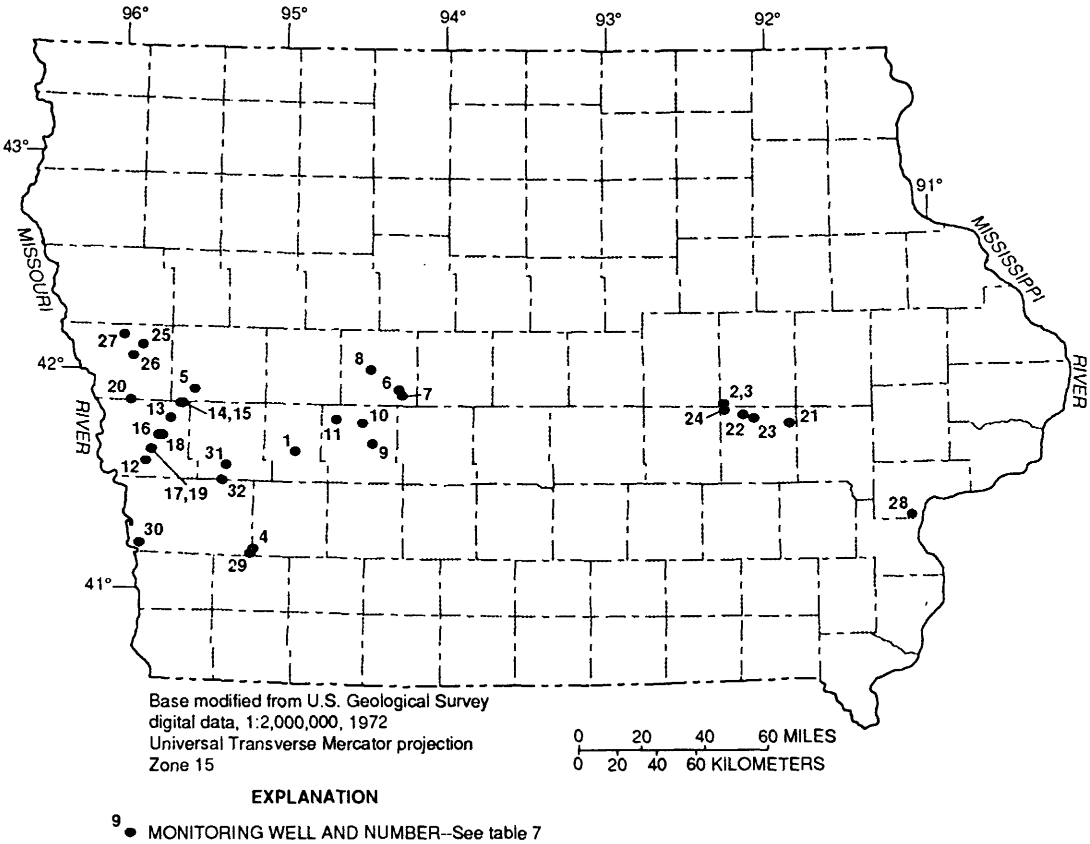


Figure 12. Location of monitoring wells completed in alluvial aquifers.

The number of wells completed in the Cambrian-Ordovician aquifer system is small, with the majority of wells completed in the Jordan-St.Peter aquifer. For the Jordan-St. Peter aquifer, an improved distribution of wells is needed in north-central and central Iowa. At the present time, there are no wells in west-central and southwestern Iowa completed in this aquifer. Additional wells also are needed to expand the areal coverage of the Galena and Dresbach aquifers. These wells need to be located in the northeastern and east-central parts of Iowa.

The distribution of wells completed in the Silurian-Devonian aquifer is concentrated in east-central Iowa. Although this distribution provides adequate data for water-management purposes, it is not useful for providing hydrologic data. The Silurian-Devonian monitoring network needs to be expanded to the south and west to improve the distribution of wells providing hydrologic data. Additional wells along the aquifer boundaries in northwestern and northeastern Iowa will provide data that can be used to better define the aquifer characteristics.

Existing network wells completed in the Mississippian aquifer have a fairly good areal distribution. A more equitable distribution of wells providing hydrologic data will be achieved, however, if additional wells in north-central, central, and southwestern Iowa are included in the monitoring network.

There are currently only five wells completed in the Pennsylvanian aquifers, with four of those wells located near each other. Additional wells are needed near the aquifer boundaries and in south-central and southwestern Iowa to improve the coverage of the aquifers.

The existing distribution of wells completed

Table 7. *Active monitoring wells completed in alluvial aquifers*

Map number (fig. 12)	Site identification number	County	Local well number	Year well const-ructed	Local well name	Depth of well (feet)	Year measure-ments began
1	413843094541701	Audubon	079N35W15DCDD	1982	IGS & USGS WC #75	30	1982
2	415211092164101	Benton	082N12W31DAAD1	1984	USGS Obs. well IRA-16A	26	1984
3	415211092164102	Benton	082N12W31DAAD2	1984	USGS Obs. well IRA-16B	15	1984
4	411117095091902	Cass	074N37W30BBBB	1986	Southwest IA SW-16B	70	1986
5	415512095313801	Crawford	082N40W17ABBC	1983	IGS & USGS WC #188	46	1983
6	415448094163401	Greene	082N29W18CBAA	1982	IGS & USGS WC #115	30	1982
7	415449094155601	Greene	082N29W18DBAA	1982	IGS & USGS WC #117	75	1982
8	420146094272301	Greene	083N31W04ADDB	1982	IGS & USGS WC #120	51	1982
9	414110094260501	Guthrie	079N31W23BBBB	1982	IGS & USGS WC #85	27	1982
10	414652094293301	Guthrie	081N31W32CBCC	1982	IGS & USGS WC #106	51	1982
11	414728094392401	Guthrie	081N33W35ABBC	1982	IGS & USGS WC #94	35	1982
12	413524095490601	Harrison	078N43W05BCDD	1982	IGS & USGS WC #32	51	1982
13	413836095465502	Harrison	079N42W19BADC	1983	IGS & USGS WC #196	49	1982
14	414226095435002	Harrison	080N42W27CCBA	1983	IGS & USGS WC #192	40	1982
15	414228095442301	Harrison	080N42W28DBCD	1982	IGS & USGS WC #37	52	1982
16	414213095431602	Harrison	080N42W34ABBB	1983	IGS & USGS WC #191	37	1983
17	415124095361501	Harrison	081N41W31ACCC	1983	IGS & USGS WC #189	46	1983
18	415109095363201	Harrison	081N41W03CDBB	1983	IGS & USGS WC #190	40	1983
19	414702095395101	Harrison	081N41W31BDDD	1982	IGS & USGS WC #53	30	1982
20	415148095545001	Harrison	081N44W01ABAB	1983	IGS & USGS WC #177	58	1983
21	414709091515801	Iowa	081N09W35BCAA	1984	USGS Obs. well IRA-24	27	1984
22	414930092093801	Iowa	081N11W17CBBC	1984	USGS Obs. well IRA-6	30	1984
23	414816092053401	Iowa	081N11W23DCCC1	1984	USGS Obs. well IRA-4A	31	1984
24	415125092164201	Iowa	081N12W06ADDA	1984	USGS Obs. well IRA-14	36	1984
25	420730095510701	Monona	084N43W04ABAA	1983	IGS & USGS WC #163	58	1983

Table 7. *Active monitoring wells completed in alluvial aquifers*--Continued

Map number (fig. 12)	Site identification number	County	Local well number	Year well const-ructed	Local well name	Depth of well (feet)	Year measure-ments began
26	420406095543301	Monona	084N44W24DCAD	1983	IGS & USGS WC #166	71	1983
27	421006095580301	Monona	085N44W16DCDD	1982	IGS & USGS WC #156	40	1982
28	412120091080401	Muscatine	076N02W30CBAA	1966	Fruitland/USGS 30M4	27	1966
29	411024095095502	Pottawattamie	074N38W36BAAA	1986	Southwest IA SW-34B	40	1986
30	411246095502001	Pottawattamie	074N43W18BCCC1	1950	Manawa State Park/18E1	16	1950
31	413442095193101	Shelby	078N39W10BBBA	1983	IGS & USGS WC #200	44	1983
32	413031095204901	Shelby	078N39W32DDAA	1983	IGS & USGS WC #197	24	1983

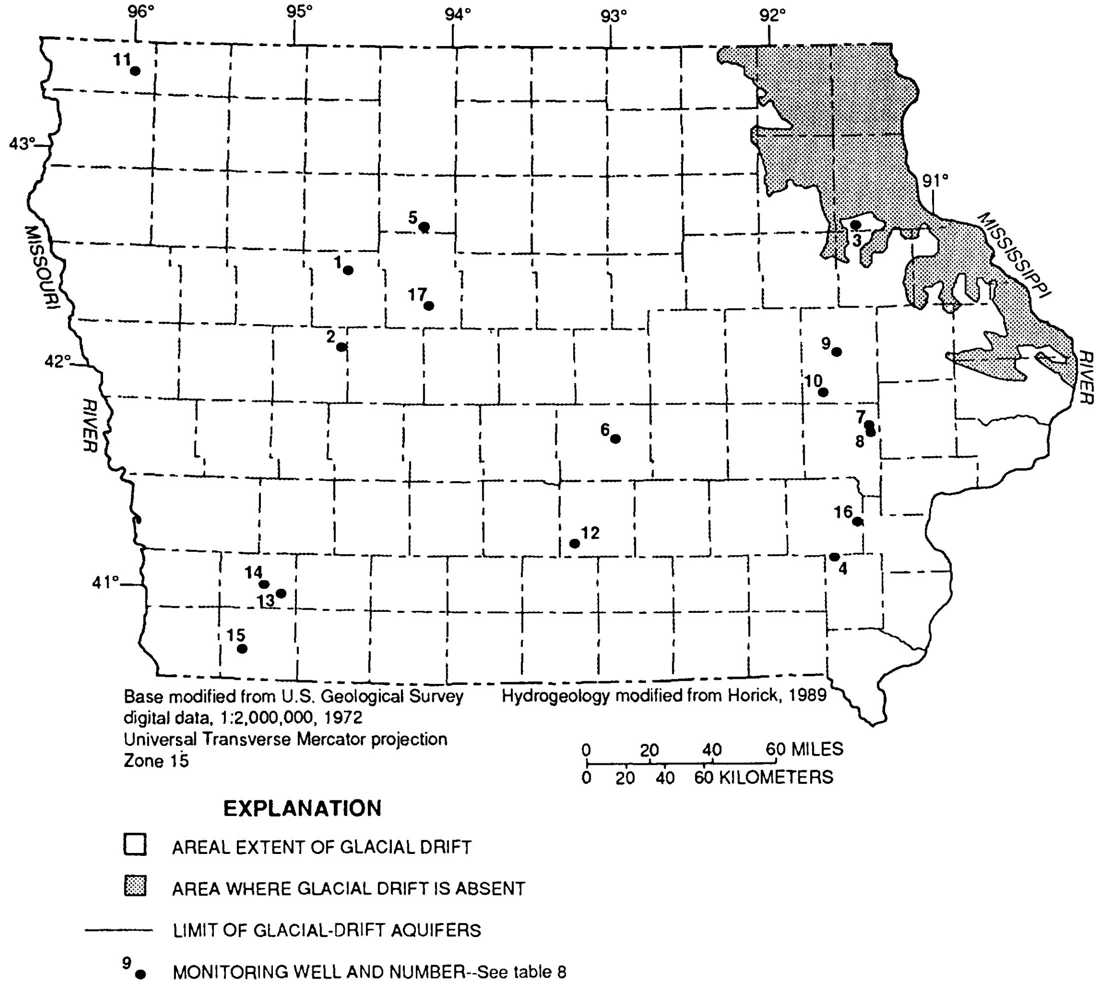


Figure 13. Areal extent of glacial drift and location of monitoring wells completed in glacial-drift aquifers.

in the Dakota aquifer is the best of any aquifer in Iowa. A few additional wells in the northeastern part of the aquifer, and in the extreme southern part of the aquifer in Cass, Pottawattamie, and Montgomery Counties, would provide data at the aquifer boundaries.

The monitoring-well coverage of surficial buried-channel aquifers is adequate in the western part of Iowa, but needs to be improved in the east-central and central parts of the State. Additional wells in these areas will improve the areal distribution of buried-channel wells.

The distribution of monitoring wells completed in alluvial aquifers in Iowa is mainly concentrated in the east-central and west-central parts of Iowa. At the present time, there are no active monitoring wells in the northern one-half of Iowa, and in the central and southern parts of the State. Additional wells are needed along the major interior streams as well as along the Mississippi and Missouri Rivers.

The present areal distribution of glacial-drift wells is scattered. Although the distribution of these wells is fairly widespread and some of these wells have been measured for many years, the depth, type of construction, and screened interval of the wells are not the same. This difference in the physical character

Table 8. *Active monitoring wells completed in glacial-drift aquifers*

[--, data not available]

Map number (fig. 13)	Site identification number	County	Local well number	Year well const-ructed	Local well name	Depth of well (feet)	Year measure-ments began
1	422812094383501	Calhoun	088N33W01BACD	--	Twin Lakes	35	1989
2	420643094403701	Carroll	084N33W03CADA	1982	IGS & USGS WC #131	15	1982
3	424023091291201	Clayton	091N05W30BBBB	1895	Harold Knight	36	1957
4	410852091394301	Henry	073N07W09AABD	1900	Town of Wayland	52	1960
5	424039094103601	Humboldt	091N28W20CAAA	--	Elmer Gravlund	25	1988
6	414210092592001	Jasper	080N18W31ABBB	1939	P.W. Beukema	37	1940
7	414458091260201	Johnson	080N05W09DBBC	1950	Mrs Miller/Morse	15	1950
8	414315091252001	Johnson	080N05W22CBCB1	1941	Elmira Depot/Tall	20	1941
9	415422091422601	Linn	082N07W18CDCD1	--	Lester Petrak	14	1959
10	420526091370701	Linn	084N07W13BCBB	1948	USGS 13E2	17	1948
11	432140095595301	Lyon	099N44W26DDDD	1938	George/26R1	38	1940
12	411323093142601	Marion	074N21W11BBCD1	--	Melcher No. 2	12	1950
13	405841095012702	Montgomery	071N36W06DADA	1989	Viking Lake State Park 6J2	36	1989
14	410057095075101	Montgomery	072N37W29BABA	1937	John Ogden/29C1/No. 82	40	1937
15	404257095150801	Page	068N38W07CCAA	1934	William Brayman	44	1934
16	421829091304701	Washington	075N06W14ABBB	1940	Mrs. David Armstrong	45	1983
17	421837094083601	Webster	087N28W29CCCD	--	Grace Helms/USGS No. 3	42	1942

of the wells makes comparisons of the water levels for long-term regional climatic change difficult at best. Wells with similar construction and screened interval need to be added to the monitoring network across the State to improve the integrity of the data collected so that long-term comparisons can be made.

SUMMARY

The ground-water-level monitoring network in Iowa consists of 202 wells completed in the principal bedrock and surficial aquifers. The bedrock aquifers are the Dresbach, Jordan-St. Peter, and Galena aquifers, which are part of the Cambrian-Ordovician aquifer system; the Silurian-Devonian aquifer; the Mississippian aquifer; localized Pennsylvanian aquifers; and the Dakota aquifer. The three types of surficial aquifers are the buried-channel, alluvial, and glacial-drift aquifers.

The objectives of the ground-water-level monitoring network in Iowa are to: (1) determine the change in storage in these aquifers, (2) document the changes in water levels in the aquifer due to climatic stress and human activities, (3) quantify the physical characteristics of the ground-water flow system, and (4) provide baseline data for future research. Data from specific wells in each of the aquifers can be used to meet more than one purpose. Network components include hydrologic, water-management, and baseline data. Although the existing ground-water-level monitoring network includes wells completed in all of the principal aquifers in the State, the areal distribution of wells within individual aquifers generally is uneven, with large areas having no monitoring wells.

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