In cooperation with the Edwards Aquifer Research and Data Center and the Texas Water Development Board

Monitoring of Selected Water-Quality Constituents Near the Freshwater/Saline-Water Interface of the Edwards Aquifer, July 1996–December 1997

The Edwards aquifer is the sole source of water for about 1.3 million people in and near San Antonio, Texas, as well as for ranchers and farmers throughout south-central Texas. Because of the demand for this resource, various studies have been conducted to better understand the Edwards aquifer and how the aquifer reacts to environmental changes and human influences. In July 1996, the U.S. Geological Survey (USGS), in cooperation with the Edwards Aquifer Research and Data Center (EARDC) at Southwest Texas State University (SWTSU) and the Texas Water Development Board (TWDB), began a study to investigate possible changes in water quality of the Edwards aquifer near the freshwater/saline-water interface that might result if drought occurs. The continuing study is part of the USGS National Water-Quality Assessment (NAWQA) Program in south-central Texas.

The freshwater/saline-water interface, known locally as the "bad-water line," marks the beginning of the transition in the aquifer from freshwater (updip) to saline water (downdip). The interface is defined as the 1,000-milligram-per-liter (mg/L) line of equal dissolved solids concentration as delineated by Maclay and others (1980, fig. 7). Water in the freshwater zone of the Edwards aquifer tends to have dissolved solids concentrations of 250 to 300 mg/L (Pavlicek and others, 1987, p. 3). In contrast, water in the saline-water zone of the Edwards aquifer commonly has dissolved solids concentrations greater than 10,000 mg/L, and sample concentrations as large as 232,000 mg/L have been measured (Groschen and Buszka, 1997, p. 21).

The freshwater/saline-water interface is the convergence of two flow systems within the Edwards aquifer. Large transmissivity

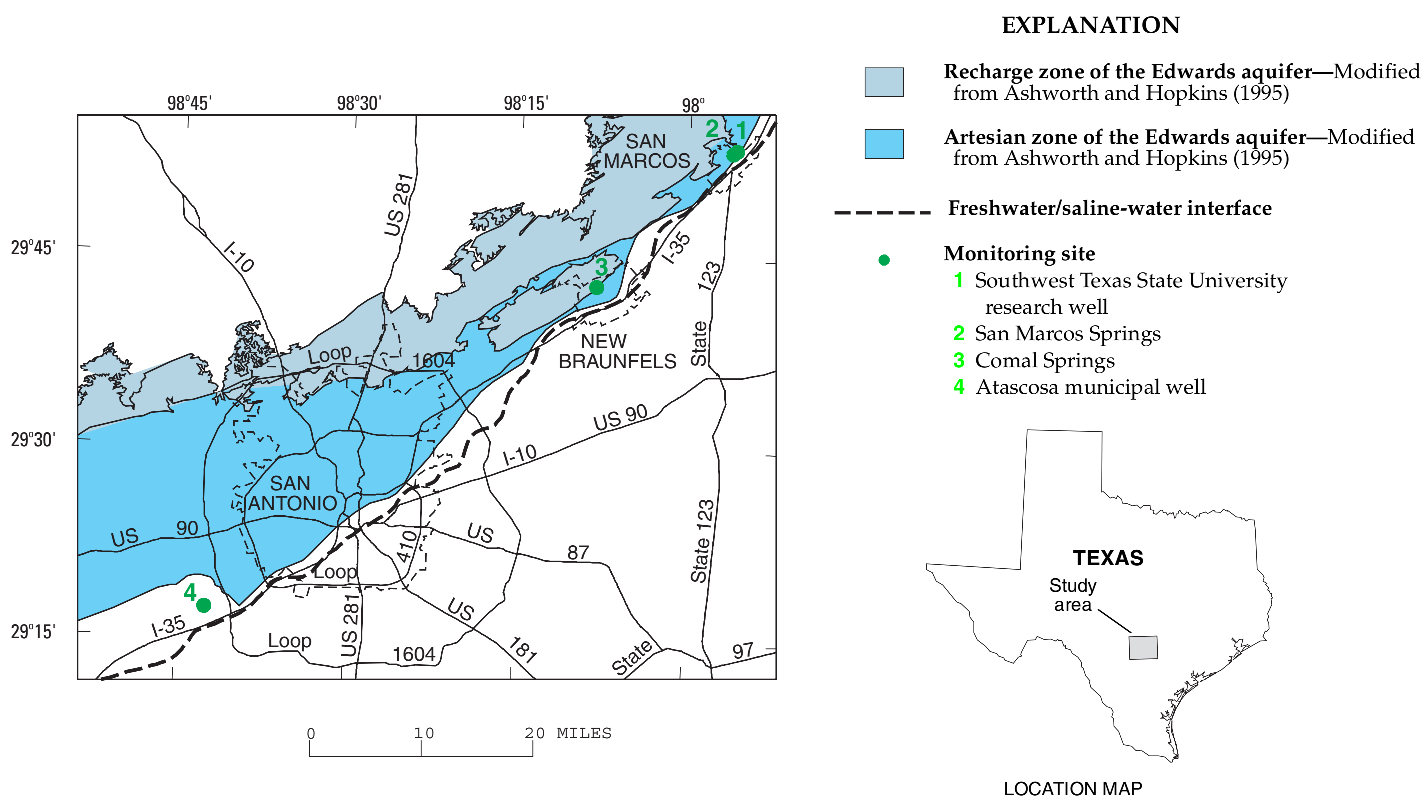

Figure 1. Location of monitoring sites near the freshwater/saline-water interface of the Edwards aquifer, south-central Texas, July 1996–December 1997.

[200,000 to 2,000,000 feet squared per day (ft^2/d) (Maclay and Small, 1986, p. 61)] characterizes the freshwater zone. By comparison, the saline-water zone has small transmissivity [about 10,000 ft^2/d or less (Groschen and Buszka, 1997, p. 11)] and longer residence times. Although the freshwater and saline-water zones are in contact with each other, mixing of water between the two is believed to be limited because of the difference in transmissivity and other geologic constraints (Sharp and Banner, 1997).

Increased withdrawals from the Edwards aquifer because of population growth have raised the issue of saline water encroaching into the freshwater zone and contaminating public water-supply wells and a series of natural springs, including San Marcos and Comal Springs. These springs are home to several endangered species, which because of their protected status, further complicates issues related to public water-supply withdrawals and the subsequent effects of possible saline-water encroachment.

In addition to increased withdrawals, seasonal droughts that affect the freshwater/saline-water interface are possible. During droughts, withdrawals from public water-supply wells increase, and recharge to the aquifer decreases, resulting in a decrease in storage in the freshwater zone of the aquifer. This decrease in storage, if large enough, might make saline-water intrusion hydraulically possible (Pavlicek and others, 1987).

The purpose of the USGS study is to (1) monitor selected water-quality constituents at sites near the interface for early detection of saline-water encroachment into the freshwater zone of the Edwards aquifer, and (2) provide information on the seasonal variation of general water-quality conditions at the sites. This fact sheet describes water-quality monitoring at four sites near the freshwater/saline-water interface and presents data collected at the monitoring sites during July 1996–December 1997.

The City of New Braunfels and Atascosa Rural Water Supply provided access to Comal Springs and the Atascosa public water-supply well, respectively.

Water-Quality Monitoring

Water-quality monitors were installed at one research water well (at SWTSU), two natural springs (San Marcos and Comal), and one public water-supply well (at Atascosa) (fig. 1).

Water-quality instrumentation was installed at a SWTSU research well and at San Marcos and Comal Springs in July 1996. The monitors have self-contained data loggers that collect continuous measurements of pH, temperature, and specific conductance.

Monthly data evaluation was judged inadequate for early detection of saline-water encroachment. Therefore, in May 1997, the self-contained data loggers at the SWTSU research well and San Marcos and Comal Springs were converted to stand-alone telephone telemetry systems to accomplish near real-time data collection. This system uses a data logger, modem, cellular telephone, and three sensors (pH, temperature, and specific conductance). Power is supplied by a 12-volt battery, which is recharged by a solar panel. Data at these three sites are recorded every 15 minutes and automatically downloaded daily by computer. Monitoring equipment at the SWTSU research well is shown in figure 2.

Figure 2. Monitoring equipment at Southwest Texas State University research well, San Marcos, Texas.

Similar telephone telemetry instrumentation was installed at the public water-supply well at Atascosa in June 1997. Data are recorded every 30 minutes while the pump is operating and automatically downloaded daily by computer. The pump operates when the public water-supply storage tank needs refilling.

All four sites are visited every 2 to 3 weeks for probe recalibration and an on-site systems check. In addition to these visits, the data logger performs a systems check every 24 hours that allows for remote identification of equipment problems.

In January 1998, the EARDC assumed responsibility for maintenance and data collection at all four sites for a period of at least 1 year. The EARDC provides public access to the data through the Internet on their homepage at <http://www.eardc.swt.edu>.

Data Collection July 1996–December 1997

Data collected during July 1996–December 1997 from the four monitoring sites are listed in table 1. Median pH at all four sites appears to be stable, ranging from 6.8 to 7.6 standard units. Mean temperature also appears to be stable at all four sites, ranging from 20.4 to 23.5 degrees Celsius (°C) at the SWTSU research well and San Marcos and Comal Springs and ranging from 27.0 to 27.6 °C at the public water-supply well. Mean specific conductance at the four sites ranged from 511 to 633 microsiemens per centimeter at 25 °C (µS/cm), which indicates a range of dissolved solids concentration of about 300 to 400 mg/L (Hem, 1989, p. 67).

The monthly mean temperature and monthly total precipitation data for July 1996–December 1997 and the mean monthly data for 1961–90 for San Antonio are listed in table 2 (National Oceanic and Atmospheric Administration, National Climatic Data Center, 1998). Because precipitation during the monitoring period was above normal for the region, substantial changes in water quality as a result of drought conditions were neither expected nor observed at any of the monitoring sites. Therefore, the water-quality data collected during July 1996–December 1997 at the four sites are considered a baseline that can be used for comparison with new data that might be collected during a future drought.

References

Ashworth, J.B., and Hopkins, Janie, 1995, Aquifers of Texas: Texas Water Development Board Report 345, 69 p.

Groschen, G.E., and Buszka, P.M., 1997, Hydrogeologic framework and geochemistry of the Edwards aquifer saline-water zone, south-central, Texas: U.S. Geological Survey Water-Resources Investigations Report 97–4133, 47 p.

Hem, J.D., 1989, Study and interpretation of the chemical characteristics of natural water: U.S. Geological Survey Water-Supply Paper 2254, 263 p.

Maclay, R.W., Rettman, P.L., and Small, T.A., 1980, Hydrochemical data for the Edwards aquifer in the San Antonio area, Texas: Texas Department of Water Resources LP–131, 38 p.

Table 1. Monthly water-quality data collected at monitoring sites near the freshwater/saline-water interface of the Edwards aquifer, July 1996–December 1997

[Number in parentheses refers to figure 1. SWTSU, Southwest Texas State University; median pH in standard units; T, mean temperature in degrees Celsius; SC, mean specific conductance in microsiemens per centimeter at 25 degrees Celsius; --, no data because of malfunctioning equipment]

Month	(1) SWTSU research well			(2) San Marcos Springs			(3) Comal Springs			(4) Atascosa municipal well		
	pH	T	SC	pH	T	SC	pH	T	SC	pH	T	SC
July 1996	6.8	22.4	624	7.1	22.4	592	--	--	--	Water-quality monitor not installed until June 1997		
Aug. 1996	7.1	22.4	625	7.1	22.4	609	--	--	--			
Sept. 1996	7.0	22.4	621	7.0	22.4	602	7.1	23.4	525			
Oct. 1996	7.0	22.4	624	7.1	22.4	610	7.1	23.4	524			
Nov. 1996	7.0	22.4	631	7.1	22.4	611	7.1	23.4	523			
Dec. 1996	7.2	22.4	633	7.0	22.4	621	7.0	23.4	526			
Jan. 1997	--	--	--	--	--	--	7.2	23.4	533			
Feb. 1997	7.1	22.4	591	7.1	22.4	607	7.2	23.5	533			
Mar. 1997	7.1	22.4	592	7.0	22.4	606	7.2	23.4	539			
Apr. 1997	7.1	22.4	614	7.2	22.4	602	7.1	23.4	538			
May 1997	7.2	22.3	618	7.2	21.5	608	7.5	23.5	534			
June 1997	7.1	22.4	611	7.2	20.8	609	7.6	23.5	532	--	27.0	575
July 1997	7.0	22.2	601	7.1	20.5	606	7.1	23.5	530	7.0	27.6	624
Aug. 1997	7.0	22.0	604	7.1	20.6	607	7.5	23.5	533	7.1	27.6	630
Sept. 1997	6.9	21.9	610	7.0	20.6	608	--	23.5	531	7.0	27.6	620
Oct. 1997	7.0	21.8	615	7.0	20.4	610	7.2	--	--	7.2	27.4	630
Nov. 1997	6.9	21.8	619	7.1	20.4	612	6.8	--	--	7.2	27.3	630
Dec. 1997	7.0	21.9	621	7.0	20.4	614	7.2	23.5	511	6.9	27.3	627

Maclay, R.W., and Small, T.A., 1986, Carbonate geology and hydrology of the Edwards aquifer in the San Antonio area, Texas: Texas Water Development Board Report 296, 90 p.

National Oceanic and Atmospheric Administration, National Climatic Data Center, 1998, Regional climatic data: Asheville, N.C., U.S. Department of Commerce. URL: <http://www.ncdc.noaa.gov/ol/climate/climatedata.html>

Pavlicek, Dianne, Small, T.A., and Rettman, P.L., 1987, Hydrogeologic data from a study of the freshwater zone/saline-water zone interface in the Edwards aquifer, San Antonio region, Texas: U.S. Geological Survey Open-File Report 87–389, 108 p.

Table 2. Monthly mean temperature and monthly total precipitation, July 1996–December 1997, and mean monthly temperature and mean monthly total precipitation, 1961–90, for San Antonio, Texas

[Data from National Oceanic and Atmospheric Administration, National Climatic Data Center, 1998. Temperature in degrees Celsius and precipitation in inches]

Month	Monthly mean temper-ature	Monthly total pre-cipitation	Month	1961–90 mean monthly temper-ature	1961–90 mean monthly total pre-cipitation
July 1996	30.1	1.34	July	29.4	2.20
Aug. 1996	28.1	2.89	Aug.	29.4	2.50
Sept. 1996	25.4	4.72	Sept.	26.3	3.40
Oct. 1996	21.4	.39	Oct.	21.2	3.20
Nov. 1996	15.9	3.09	Nov.	15.8	1.50
Dec. 1996	12.3	1.41	Dec.	11.2	1.40
Jan. 1997	9.4	.49	Jan.	9.6	1.70
Feb. 1997	11.6	2.52	Feb.	11.9	1.80
Mar. 1997	17.4	1.90	Mar.	16.5	1.50
Apr. 1997	17.7	5.25	Apr.	20.7	2.50
May 1997	22.8	3.94	May	24.2	4.20
June 1997	26.0	6.48	June	27.9	3.80
July 1997	28.9	.00			
Aug. 1997	29.3	.59			
Sept. 1997	27.2	1.85			
Oct. 1997	20.9	4.12			
Nov. 1997	14.1	1.74			
Dec. 1997	10.1	4.37			

Sharp, J.M., Jr., and Banner, J.L., 1997, The Edwards aquifer—A resource in conflict: Geological Society of America Today, v. 7, no. 8, p. 1–9.

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Information on technical reports and hydrologic data related to this study can be obtained from:

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The National Water-Quality Assessment Program

In 1991, the U.S. Geological Survey, U.S. Department of the Interior, began a National Water-Quality Assessment (NAWQA) Program. The long-term goals of the NAWQA Program are to describe the status of and trends in the quality of a large representative part of the Nation’s surface- and ground-water resources and to identify the major factors that affect the quality of these resources. In addressing these goals, the NAWQA Program will produce water-quality information that is useful to policymakers and managers at Federal, State, and local levels.

Studies of 59 hydrologic systems that include parts of most major river basins and aquifer systems are the building blocks of the national assessment. The study units range in size from less than 1,000 to more than 60,000 square miles and represent 60 to 70 percent of the Nation’s water use and population served by public water supplies. Twenty investigations began in fiscal year 1991, 16 in fiscal year 1994, 13 in fiscal year 1997, and 2 are scheduled to begin in fiscal year 1999.