STATE OF LOUISIANA

DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

OFFICE OF PUBLIC WORKS, HURRICANE FLOOD PROTECTION

AND INTERMODAL TRANSPORTATION

WATER RESOURCES PROGRAMS

WATER RESOURCES
TECHNICAL REPORT
NO. 79

WATER WITHDRAWALS AND TRENDS IN GROUND-WATER LEVELS AND STREAM DISCHARGE IN LOUISIANA, 1996-2005

Prepared by the

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

In cooperation with the

LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

2009

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By

Lawrence B. Prakken and Lucille S. Wright

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Contents

Figures

Tables

Conversion Factors and Datums

Multiply	By	To obtain
inch (in.)	25.4	millimeter (mm)
inch per year (in/yr)	25.4	millimeter per year (mm/yr)
foot (ft)	0.3048	meter (m)
foot per year (ft/yr)	0.3048	meter per year (m/yr)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
cubic foot per second per year [(ft^3/s)/yr]	0.02832	cubic meter per second per year [(m^3/s)/yr]
million gallons per day (Mgal/d)	3,785	cubic meters per day (m^3/d)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)

Temperature in degrees Fahrenheit (°F) can be converted to degrees Celsius (°C) as follows:
°C = (°F - 32)/1.8.

Vertical coordinate information in this report is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).

Horizontal coordinate information in this report is referenced to the North American Datum of 1927.

Water Withdrawals and Trends in Ground-Water Levels and Stream Discharge in Louisiana, 1996-2005

By Lawrence B. Prakken *and* Lucille S. Wright

Abstract

In 2005, approximately 10,299 Mgal/d (million gallons per day) of water was withdrawn from ground-water and surface-water sources in Louisiana; about 15 percent was ground water, and 85 percent was surface water. Total water withdrawals in the State increased about 6 percent from 1995 to 2005. Approximately 92 percent of the ground water withdrawn was from six aquifers or aquifer systems: the Chicot aquifer system (42 percent), Mississippi River alluvial aquifer (26 percent), Jasper equivalent aquifer system (8 percent), Chicot equivalent aquifer system (7 percent), Evangeline equivalent aquifer system (6 percent), and Sparta aquifer (4 percent). Approximately 83 percent of ground-water withdrawals in 2005 were for irrigation, public supply, and industry.

Water-level trends in the six selected aquifers and aquifer systems were determined for the approximate period 1996-2005 using water-level data collected from 151 wells. The Chicot, Evangeline equivalent, and Jasper equivalent aquifer systems, and the Sparta aquifer contain areas where declines in ground-water levels were greater than or equal to 1 ft/yr (foot per year) during the approximate period 1996-2005.

Rates of water-level change in the Chicot aquifer system indicate water levels generally declined between 0 and 1.1 ft/yr in the rice-growing areas. In Calcasieu Parish, water levels in the Chicot aquifer system generally rose in response to decreased withdrawals from the "500-foot" sand of the Lake Charles area.

Water-level data from wells screened in the Evangeline equivalent aquifer system indicate water-level changes ranged from about -5.5 to +0.5 ft/yr. In the deep aquifers of the system, rates of water-level decline were greatest in East and West Baton Rouge parishes and can be attributed to ground-water withdrawals.

Water-level data from wells screened in the Jasper equivalent aquifer system indicate water-level changes ranged from about -3.9 to -0.3 ft/yr during the period 1996-2005. The greatest rate of water-level decline, greater than 3 ft/yr, was in East Baton Rouge Parish and can be attributed to ground-water withdrawals.

Water-level data from wells screened in the Sparta aquifer indicate water-level changes ranged from about -2.2 to +0.2 ft/yr. Water levels declined throughout most of the Sparta aquifer with the exception of the northwestern area. The greatest rate of water-level decline, greater than 2 ft/yr, was in southeastern Winn Parish. Declines generally were less than 1.5 ft/yr in most of the aquifer. Conservation efforts in Arkansas have affected water levels in the Sparta aquifer in Louisiana; water levels in northern Claiborne Parish have been rising since about 2000.

In 2005, about 8,727 Mgal/d of surface water was withdrawn in Louisiana and used for various categories of use as follows: power generation, 59 percent; industry, 33 percent; public supply, 4 percent;

and the remainder for irrigation, aquaculture, and livestock. About 76 percent of all surface-water withdrawals in 2005 in Louisiana was from the Mississippi River. Total surface-water withdrawals increased nearly 3 percent from 1995 to 2005. Trend analysis was performed on daily discharge records from 34 continuous-record streamflow-gaging stations. Only one of the stations analyzed had a significant trend in discharge; Red Chute Bayou at Sligo, in northwestern Lousiana, had a decline in discharge of about 76 cubic feet per second per year during the period 1996-2005.

Introduction

In 2005, approximately 10,299 Mgal/d of water was withdrawn from ground-water and surface-water sources in Louisiana (fig. 1); about 15 percent (1,572 Mgal/d) was ground water, and about 85 percent (8,727 Mgal/d) was surface water (Sargent, 2007, p. 87). Total water withdrawals in the State increased about 6 percent from 1995 to 2005 (J.K. Lovelace, U.S. Geological Survey, written commun., 2006; Sargent, 2007).

Although Louisiana has abundant supplies of fresh ground and surface water in most areas of the State, the effects of withdrawals on water resources is a continuing concern. To address this concern, a cooperative study between the U.S. Geological Survey (USGS) and the Louisiana Department of Transportation and Development (DOTD) was initiated to summarize water withdrawals and trends in ground-water levels and stream discharge for the approximate period 1996-2005 (hereinafter called the the period 1996-2005). Trends in ground-water levels and stream discharge in Louisiana were last documented in 2002 using data collected from about 1990-2000 (Tomaszewski and others, 2002).

Background

Withdrawals of water are largely unregulated in Louisiana. As water use increases, some water sources may be adversely affected. Adverse effects of water withdrawals from an aquifer include lowered

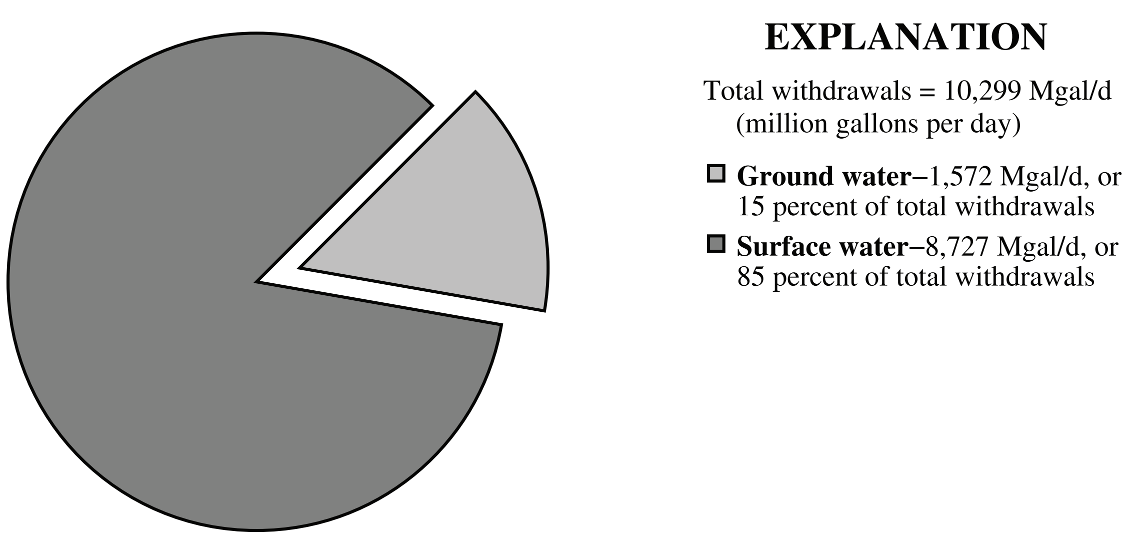


Figure 1. Ground- and surface-water withdrawals in Louisiana, 2005 (Sargent, 2007, p. 87).

water levels, which may lower well yields, leave some wells dry, or cause flowing artesian wells to stop flowing. Long-term declines in water levels indicate overdraft of the aquifer (implying discharge rates exceed recharge rates). Dewatering of an aquifer may lead to compaction of sediments and land subsidence. Local or regional cones of depression, usually caused by large withdrawals, can alter ground-water flow paths and possibly induce saltwater encroachment in vulnerable areas.

Several factors cause ground-water levels to fluctuate. Water levels naturally rise and fall during a given year in response to seasonal weather patterns. Seasonal withdrawals for agriculture, industry, or public supply may temporarily lower water levels before recovery during the off-season. Long-term changes in ground-water levels result from changes in water budgets (such as discharge being greater than recharge) which may be affected by changes in climate but is often due to withdrawals (Tomaszewski and others, 2002, p. 6).

Ground-water levels are affected by withdrawals from wells. As water is withdrawn from a well, water levels in the aquifer are drawn down, and a cone-shaped depression is formed on the water-level surface of the aquifer. This cone-shaped depression is maintained as long as the well is pumped. This depression on the water-level surface can be very localized, or can extend many miles when several high-capacity wells are pumped in the same area (Tomaszewski and others, 2002, p. 6).

As aquifers are developed and cones of depression become extensive, water levels in much of the aquifer begin to decline. When water levels continuously decline, a level may be reached that affects well use; shallower wells in the area may become dry or, more likely, the water level declines below the pump inlet. When this happens, even though the situation may be temporary, concern about withdrawals, allocation, and availability of ground-water resources increases (Tomaszewski and others, 2002, p. 6).

An adverse effect of water withdrawals from a stream could be decreased streamflow. This could allow saltwater intrusion in coastal streams, decrease ground-water recharge to unconfined aquifers, decrease wildlife habitat areas, or decrease water availability to downstream water users.

Purpose and Scope

This report summarizes:

1. Ground- and surface-water withdrawals for 1995, 2000, and 2005.
2. Trends in ground-water levels for selected aquifers or aquifer systems based on data from a statewide network of observation wells for the period 1996-2005.
3. Trends in streamflow based on data from a statewide network of discharge stations for the period 1996-2005.

Data for the period 1996-2005 were statistically analyzed to identify trends in ground-water and surface-water resources in the State. Water-level trends are discussed for the six most extensively pumped aquifers or aquifer systems in Louisiana, which include the Chicot aquifer system in southwestern Louisiana, Chicot equivalent, Evangeline equivalent, and Jasper equivalent aquifer systems in southeastern Louisiana; the Mississippi River alluvial aquifer; and the Sparta aquifer (fig. 2). Water-withdrawal data, statistical analyses of water-level data, and hydrographs for selected wells are presented to describe water-level trends. Statistical analyses of water-level change are presented in tables. Maps showing areas of general water-level change for selected aquifers or aquifer systems are included.

System	Series	Stratigraphic unit		Hydrogeologic unit Northern Louisiana Aquifer or confining unit
Quaternary	Holocene	Red River alluvial deposits Mississippi River alluvial deposits		Red River alluvial aquifer or surficial confining unit Mississippi River alluvial aquifer or surficial confining unit
	?			
	Pleistocene	Northern Louisiana terrace deposits Unnamed Pleistocene deposits		Upland terrace aquifer or surficial confining unit
Tertiary	Pliocene	Fleming Formation	Blounts Creek Member	Aquifers in Pliocene-Miocene sediments are absent in this area
	?			
	Miocene		Castor Creek Member	
			Williamson Creek Member Dough Hills Member Carnahan Bayou Member	
			Lena Member	
	?			
	Oligocene	Catahoula Formation		
		Vicksburg Group, undifferentiated		Vicksburg-Jackson confining unit
	Eocene	Jackson Group, undifferentiated		
		Claiborne Group	Cockfield Formation	Cockfield aquifer or surficial confining unit
			Cook Mountain Formation	Cook Mountain aquifer or surficial confining unit
			Sparta Sand	Sparta aquifer or surficial confining unit
			Cane River Formation	Cane River aquifer or surficial confining unit
			Carrizo Sand	Carrizo-Wilcox aquifer or surficial confining unit
		?		
	Paleocene	Wilcox Group, undifferentiated		
		Midway Group, Undifferentiated		Midway confining unit

Figure 2. Hydrogeologic units in Louisiana (modified from Lovelace and Lovelace, 1995, fig. 1).

Hydrogeologic unit—Continued						
Central and southwestern Louisiana			Southeastern Louisiana			
Aquifer system or confining unit	Aquifer or confining unit		Aquifer system[1] or confining unit	Aquifer[2] or confining unit		
	Lake Charles area	Rice growing area		Baton Rouge area[3]	St. Tammany, Tangipahoa, and Washington Parishes	New Orleans area and lower Mississippi River Parishes
Units absent			Near surface aquifers or surficial confining unit	Mississippi River alluvial aquifer or surficial confining unit		
Chicot aquifer system or surficial confining unit	"200-foot" sand "500-foot" sand "700-foot" sand	Undifferentiated (massive) sand Upper sand unit Lower sand unit	Chicot equivalent aquifer system or surficial confining unit	Shallow sands Upland terrace aquifer "400-foot" sand "600-foot" sand	Upland terrace aquifer Upper Ponchatoula aquifer	Gramercy aquifer[4] Norco aquifer[4] Gonzales-New Orleans aquifer[4] "1,200-foot" sand[4]
Evangeline aquifer or surficial confining unit			Evangeline equivalent aquifer system or surficial confining unit	"800-foot" sand "1,000-foot" sand "1,200-foot" sand "1,500-foot" sand "1,700-foot" sand	Lower Ponchatoula aquifer Kentwood aquifer Big Branch aquifer Abita aquifer Covington aquifer Slidell aquifer	
Castor Creek confining unit			Unnamed confining unit			
Jasper aquifer system or surficial confining unit	Williamson Creek aquifer Dough Hills confining unit Carnahan Bayou aquifer		Jasper equivalent aquifer system or surficial confining unit	"2,000-foot" sand "2,400-foot" sand "2,800-foot" sand	Tchefuncte aquifer Hammond aquifer Amite aquifer Ramsay aquifer	
Lena confining unit			Unnamed confining unit			
Catahoula aquifer			Catahoula equivalent aquifer system or surficial confining unit	Catahoula aquifer	Franklinton aquifer	
No freshwater occurs in deeper units						

[1]North of the Baton Rouge fault the interval containing the four aquifer systems is called the Southern Hills regional aquifer system.
[2]Clay units separating aquifers in southeastern Louisiana are discontinuous, unnamed, and not listed herein.
[3]Includes East and West Baton Rouge, East and West Feliciana, Livingston, Pointe Coupee, and St. Helena Parishes.
[4]The interval containing the four aquifers is called the New Orleans aquifer system.

Statistical analyses of monthly-mean discharge data for 34 continuous-record streamflow gaging stations are presented in a table. Ground water-level measurements and stream discharge data presented in this report are stored in the USGS National Water Information System data base. These data are available on the internet at http://waterdata.usgs.gov/la/nwis/nwis.

Description of the Study Area

Louisiana (fig. 3) encompasses about 52,000 mi^2 including about 8,300 mi^2 classified as water (U.S. Census Bureau, 2001). Population estimates for Louisiana indicate a change from 4,327,978 people in 1995 to 4,523,628 people in 2005, an increase of about 4.5 percent (U.S. Census Bureau, 1999, 2007). The State's average precipitation for the period 1996-2005 was 58.72 in., which was 1.37 in. below the long-term average of 60.09 in. calculated for the 30-year period 1971-2000 (National Oceanic and Atmospheric Administration, 2006). Precipitation for the period 1996-2005 (fig. 4) varied, with relatively dry years (precipation 8 in. or more below the long-term average) during 1999, 2000, and 2005, and wet years (precipitation 8 in. or more above the long-term average) during 2001 and 2004.

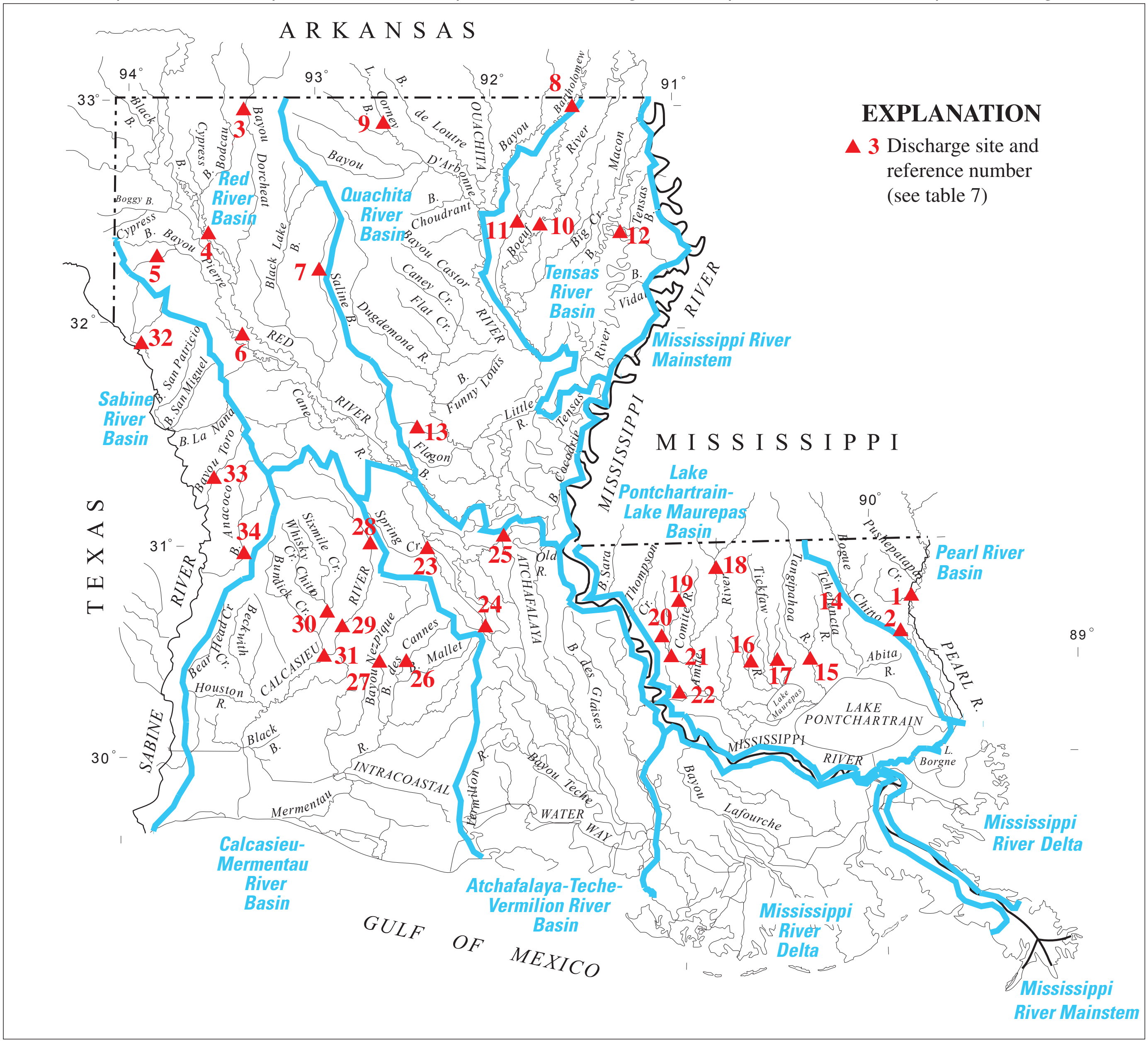
Methods

Water-use data collected during 1995, 2000, and 2005 were reviewed to determine whether withdrawals have changed over time and could be affecting ground-water levels or surface-water discharges. Water-use terms (Sargent, 2007, p. 6) are listed in the section, "Glossary." Data for wells included in this report were selected based on the following criteria: (1) The wells were part of an established monitoring network in Louisiana; (2) a minimum of at least 10 water-level measurements were documented during the period 1996-2005; (3) the screened interval was known; and (4) the wells were screened in the selected aquifers or aquifer systems.

The USGS, in cooperation with the DOTD, maintains long-term observation networks for major aquifers, aquifer systems, and streams in Louisiana to monitor changes in ground-water levels and stream discharge. Currently (2007), the USGS, in cooperation with the DOTD, monitors water levels quarterly at 200 wells throughout Louisiana and semi-annually at 46 wells as part of a chloride monitoring network. In addition, the USGS, in cooperation with the Capital Area Ground Water Conservation Commission, monitors water-level data quarterly at 77 wells in five Parishes (East and West Baton Rouge, East and West Feliciana, and Pointe Coupee).

Water-level trends in selected aquifers and aquifer systems were determined using quarterly or semiannual water-level data collected by the USGS from 151 wells for the period 1996-2005. For each well, a rate of water-level change, represented by the slope of the trend line, was computed by ordinary least squares linear regression (SAS Institute, Inc., 2002/2003). The rates were plotted and contoured (if possible) on maps to illustrate regional rates of water-level change. Hydrographs are plots showing water levels in a well over a period of time. These graphs can be used to determine seasonal fluctuations in water levels (the effects of droughts and seasonal withdrawals), and long-term trends in water levels (effects of ground-water withdrawals for various uses over time).

Streamflow data from continuous-record gaging stations in Louisiana (fig. 3) have been statistically analyzed to identify waterways in which mean annual discharge is changing with time. The data generally represent discharge from major waterways in the State, with the exception of large, controlled waterways, such as the Mississippi, Red, and Sabine Rivers, and smaller controlled waterways, such as Bayou Teche



Base map modified from Louisiana Oil Spill Coordinator, Office of the Governor, Louisiana GIS CD: A Digital Map of the State, Version 2.0

0 50 MILES
0 50 KILOMETERS

Figure 3. Locations of selected surface-water discharge sites in major basins in Louisiana.

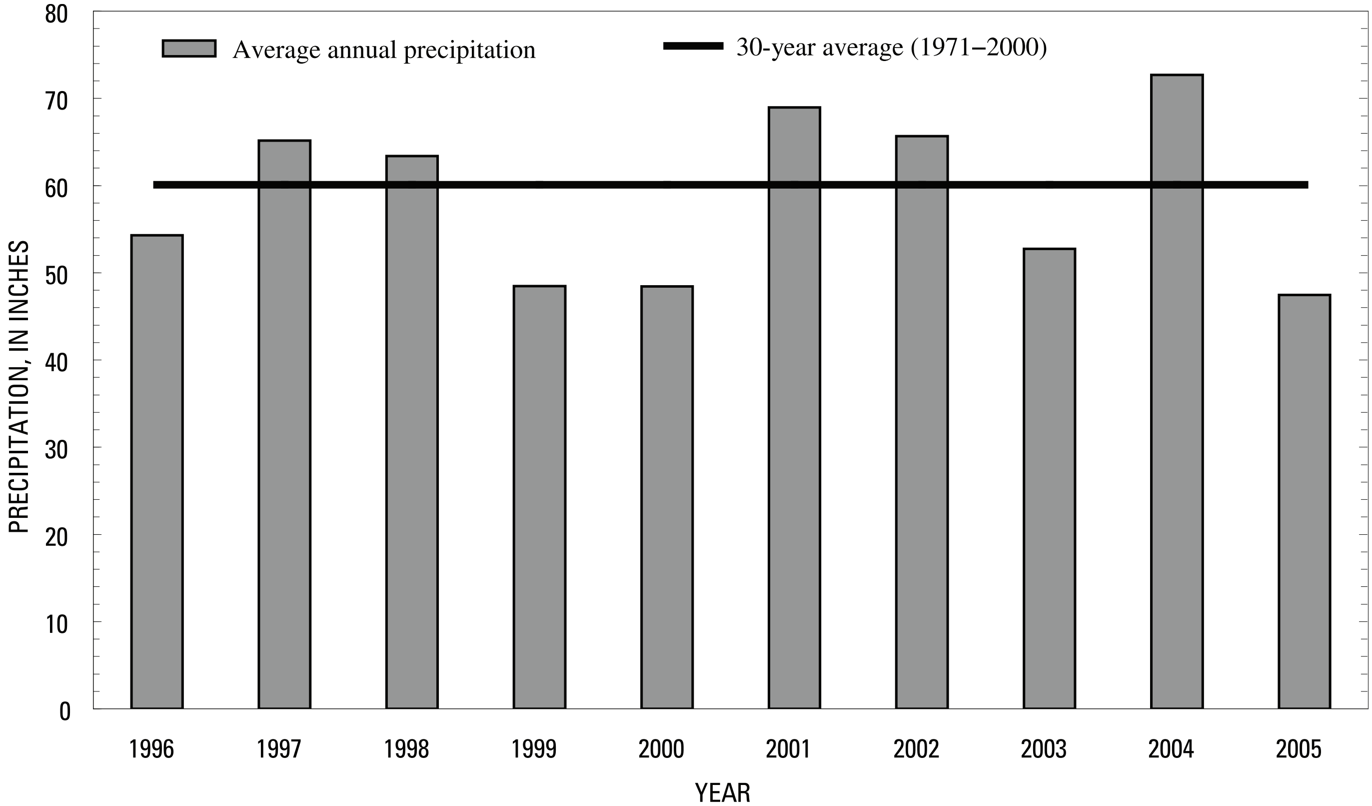


Figure 4. Average annual precipitation in Louisiana, 1996-2005 (National Oceanic and Atmospheric Administrtion, 2006).

in southern Louisiana, where the analyses are not applicable. Surface-water discharge trends were determined utilizing hourly discharge data collected by the USGS at 34 stream-gaging stations for the period 1996-2005. Monthly mean discharge values (typically 120) were calculated and used for trend analyses. Ordinary least squares linear regression methods were used for trend analysis (Microsoft Corporation, 2003). The trend was considered significant if the p-value (level of significance) was less than 0.05.

Previous Investigations

The USGS, in cooperation with the DOTD, has collected and published water-withdrawal and water-use information in reports on a 5-year cycle since 1960. The 5-year water-use reports that have been published are as follows: Snider and Forbes (1961), Bieber and Forbes (1966), Dial (1970a, 1970b), Cardwell and Walter (1979), Walter (1982), Lurry (1987a, 1987b), Lovelace (1991), Lovelace and Johnson (1996), and Sargent (2002, 2007). In addition, Lurry (1985) and Stuart and Lurry (1988) discuss specific information about public-water supplies in Louisiana. Reports describing water levels in various aquifers are listed in the section, "Selected References."

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The authors thank Zahir "Bo" Bolourchi, Director, Water Resources Programs, Louisiana Department of Transportation and Development, who contributed substantially to the design and format of this report. The authors also thank Don C. Dial, Director, Capital Area Ground Water Conservation Commission, who provided information on the five-parish area under the commission's jurisdiction.

Ground-Water Withdrawals and Water-level Trends

In 2005, about 15 percent (1,572 Mgal/d) of the water withdrawn in Louisiana was ground water (Sargent, 2007) (fig. 1). Approximately 92 percent of the ground water withdrawn was from six aquifers or aquifer systems: the Chicot aquifer system (42 percent), Mississippi River alluvial aquifer (26 percent), Jasper equivalent aquifer system (8 percent), Chicot equivalent aquifer system (7 percent), Evangeline equivalent aquifer system (6 percent), and Sparta aquifer (4 percent) (fig. 5). Four of these, the Chicot, Evangeline equivalent, and Jasper equivalent aquifer systems, and the Sparta aquifer contain areas where declines in ground-water levels were greater than or equal to 1 ft/yr during the period 1996-2005. Approximately 83 percent of ground-water withdrawals in 2005 were for irrigation, public supply, and industry (Sargent, 2007) (fig. 6). Because large amounts of ground water have been used the past few decades, and withdrawals may increase in future decades, there is concern about declining ground-water levels and whether water is being withdrawn at a rate higher than it is being recharged (Tomaszewski and others, 2002, p. 6).

Mississippi River Alluvial Aquifer

The Mississippi River alluvial aquifer was the second most extensively pumped aquifer in the State in 2005 (Sargent, 2007) (fig. 7). About 402 Mgal/d of water was withdrawn for various categories of use as follows: irrigation, 72 percent; aquaculture, 16 percent; industry, 8.4 percent; public supply, 2.4 percent; and 1.2 percent for other uses (rural-domestic, livestock, and power generation). In 2005, the largest withdrawals from the aquifer were in Morehouse Parish (83 Mgal/d), Franklin Parish (46 Mgal/d), East Carroll Parish (34 Mgal/d), Richland Parish (25 Mgal/d), West Carroll Parish (23 Mgal/d), Iberville Parish (23 Mgal/d), and Concordia Parish (21 Mgal/d) (Sargent, 2007, p. 102). These seven parishes accounted for 63 percent of the water withdrawn from the aquifer system. Withdrawal rates have risen since 1995 mainly because of increased irrigation and aquaculture withdrawals. The greatest increases in withdrawal rates from 1995 to 2005 were in Morehouse (from 21 to 83 Mgal/d) and Franklin (from 21 to 46 Mgal/d) Parishes (J.K. Lovelace, U.S. Geological Survey, written commun., 2006; Sargent, 2007, p. 102).

Rainfall is the major source of recharge to the Mississippi River alluvial aquifer. Water levels in the aquifer are influenced by rainfall, withdrawals, and proximity to major streams. Streams recharge the aquifer during periods of high stream stage (wet seasons). Conversely, streams may receive discharge from the aquifer during periods of low stream stage (dry seasons) (Whitfield, 1975, p. 6, 8). The Mississippi River provides local recharge during high stages, or when ground-water withdrawals have induced recharge from the river (Whitfield, 1975, p. 6, 8).

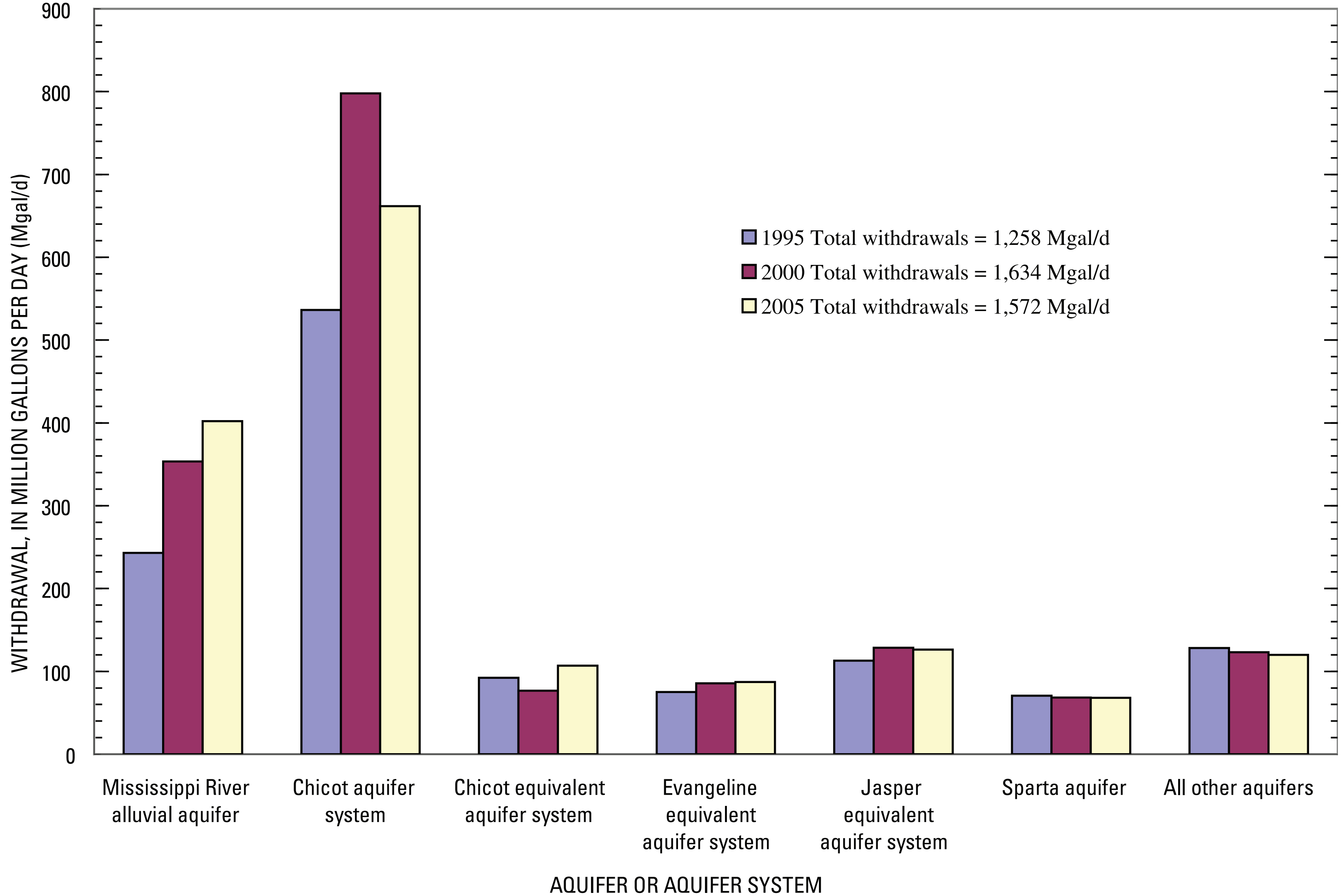


Figure 5. Ground-water withdrawals in Louisana by aquifer or aquifer system in 1995, 2000, and 2005 (J.K. Lovelace, written commun., U.S. Geological Survey, 2006; Sargent, 2002; Sargent, 2007).

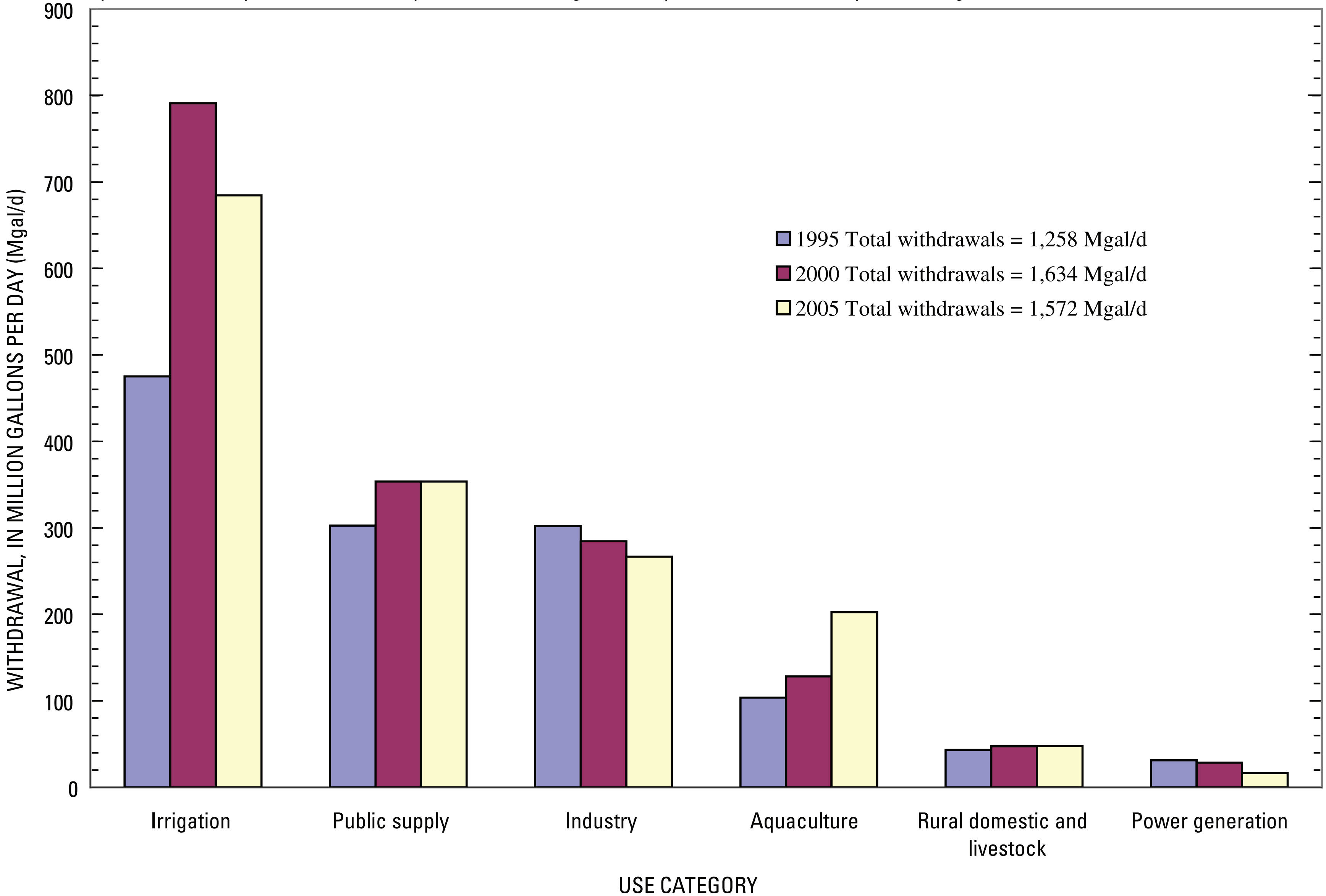


Figure 6. Ground-water withdrawals in Louisana by use in 1995, 2000, and 2005 (J.K. Lovelace, written commun., U.S. Geological Survey, 2006; Sargent, 2002; Sargent, 2007).

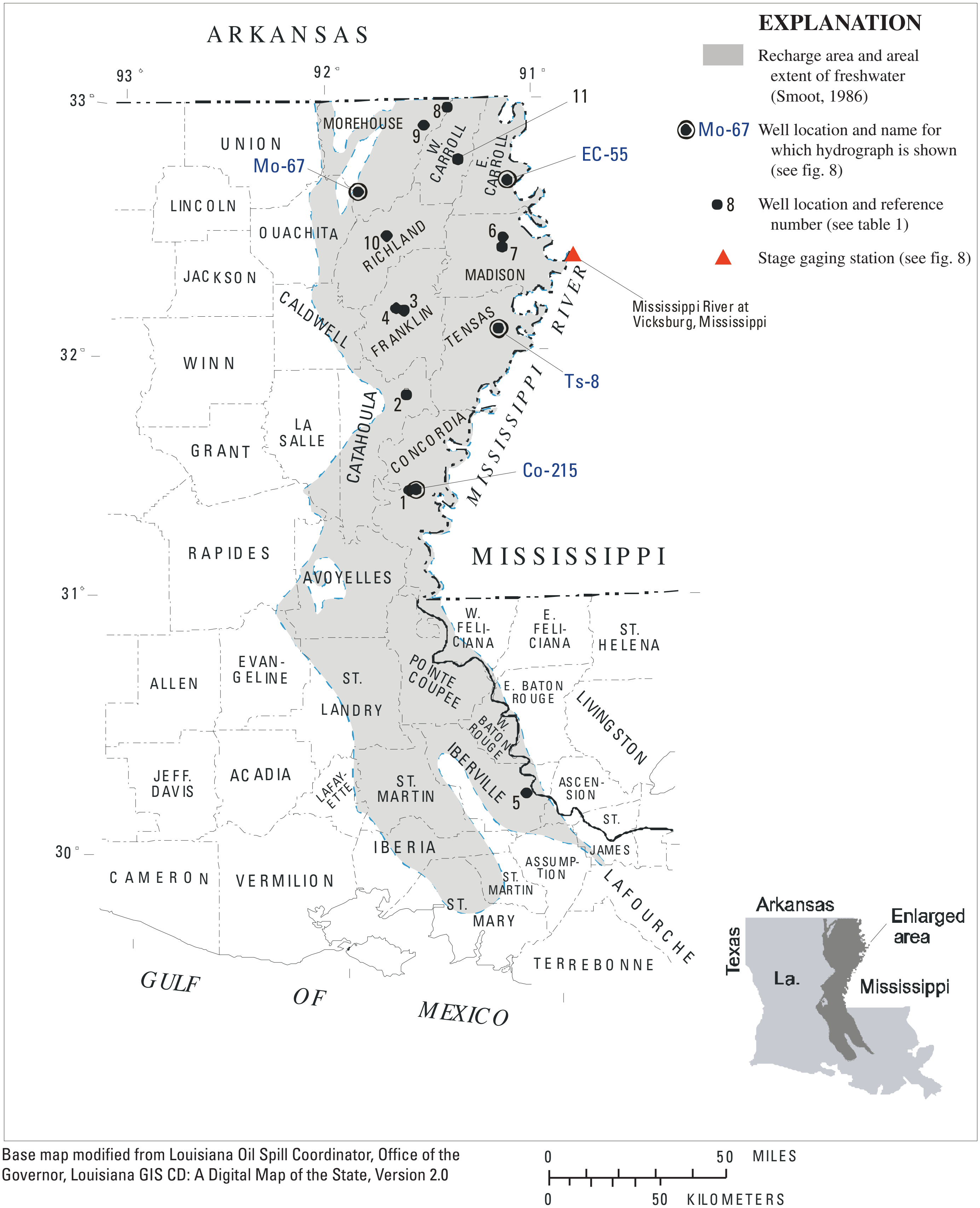


Figure 7. Locations of water-level monitor wells screened in the Mississippi River alluvial aquifer in Louisiana and the stage gaging station on the Mississippi River at Vicksburg, Mississippi.

Water-level data from 15 wells screened in the Mississippi River alluvial aquifer were statistically analyzed. Rates of water-level change ranged from about -0.4 to +0.2 ft/yr (table 1). During the period 1996-2005, no regionally extensive areas of decline (less than or equal to -0.5 ft/yr) or rise (greater than or equal to 0.5 ft/yr) were determined. With the exception of well Ib-106 (number 5, fig. 7, table 1) in Iberville Parish, wells used in the analysis are located in the northern half of Louisiana (fig. 7).

Water levels in wells Co-215, EC-55, Mo-67, and Ts-8 and stage data for the Mississippi River at Vicksburg, Mississippi (fig. 7) (U.S. Army Corps of Engineers, 2007) for the period 1996-2005 are presented in figure 8. Water levels in all four wells fluctuated seasonally, and water levels trended lower during the relatively dry years of 1999 and 2000 (fig. 4). Water levels generally were highest in spring and lowest in fall. Water levels in well EC-55, located about 1 mi west of the Mississippi River, probably were affected by high river stages. Water levels in well Ts-8, located away from major streams, fluctuated least.

Table 1. Summary of water-level trends for selected wells screened in the Mississippi River alluvial aquifer in Louisiana.

[Source: Louisiana Department of Transportation and Development—U.S. Geological Survey Cooperative Program monitor-well network. Well with hydrograph (fig. 8) is in bold. <, less than]

Reference number on map (fig. 7)	Well name	Parish	Water-level change, 1996-2005, in feet per year [1]	Level of significance, 1996-2005 [2]	Number of observations, 1996-2005 [3]	Period of record analyzed [4]	
						Begin date, 1996	End date, 2005
1	Co-205	Concordia	-0.34	0.3500	19	3-20	9-8
Co-215	**Co-215**	Concordia	-.21	.1535	60	1-2	10-4
2	Ct-347	Catahoula	-.32	<.0001	40	1-2	10-5
EC-55	**EC-55**	East Carroll	-.07	.7828	41	1-9	10-5
3	Fr-720	Franklin	-.05	.0808	23	3-20	9-8
4	Fr-721	Franklin	-.01	.6768	281	1-2	10-5
5	Ib-106	Iberville	-.37	.3294	41	3-8	10-12
6	Ma-64	Madison	-.04	.7212	60	1-9	10-4
7	Ma-65	Madison	.03	.8942	20	3-20	9-12
Mo-67	**Mo-67**	Morehouse	.06	.8051	42	1-9	10-5
8	Mo-710	Morehouse	-.22	.0004	21	3-19	11-3
9	Mo-842	Morehouse	-.03	.5711	61	1-9	10-5
10	Ri-92	Richland	.18	<.0001	41	1-2	10-5
Ts-8	**Ts-8**	Tensas	.15	.2430	40	1-2	10-4
11	WC-230	West Carroll	-.25	<.0001	41	1-9	10-5

[1] Computed slope in the trend line using method of ordinary least squares linear regression. The slope is equivalent to the change in water level, in feet per year, during the period analyzed.

[2] Probability that water-level change is due to chance rather than trend; values less than 0.05 generally are considered statistically significant.

[3] Total number of water-level measurements used to determine the slope in the trend line during the period analyzed.

[4] Dates (month-day) of first and last measurement of period analyzed.

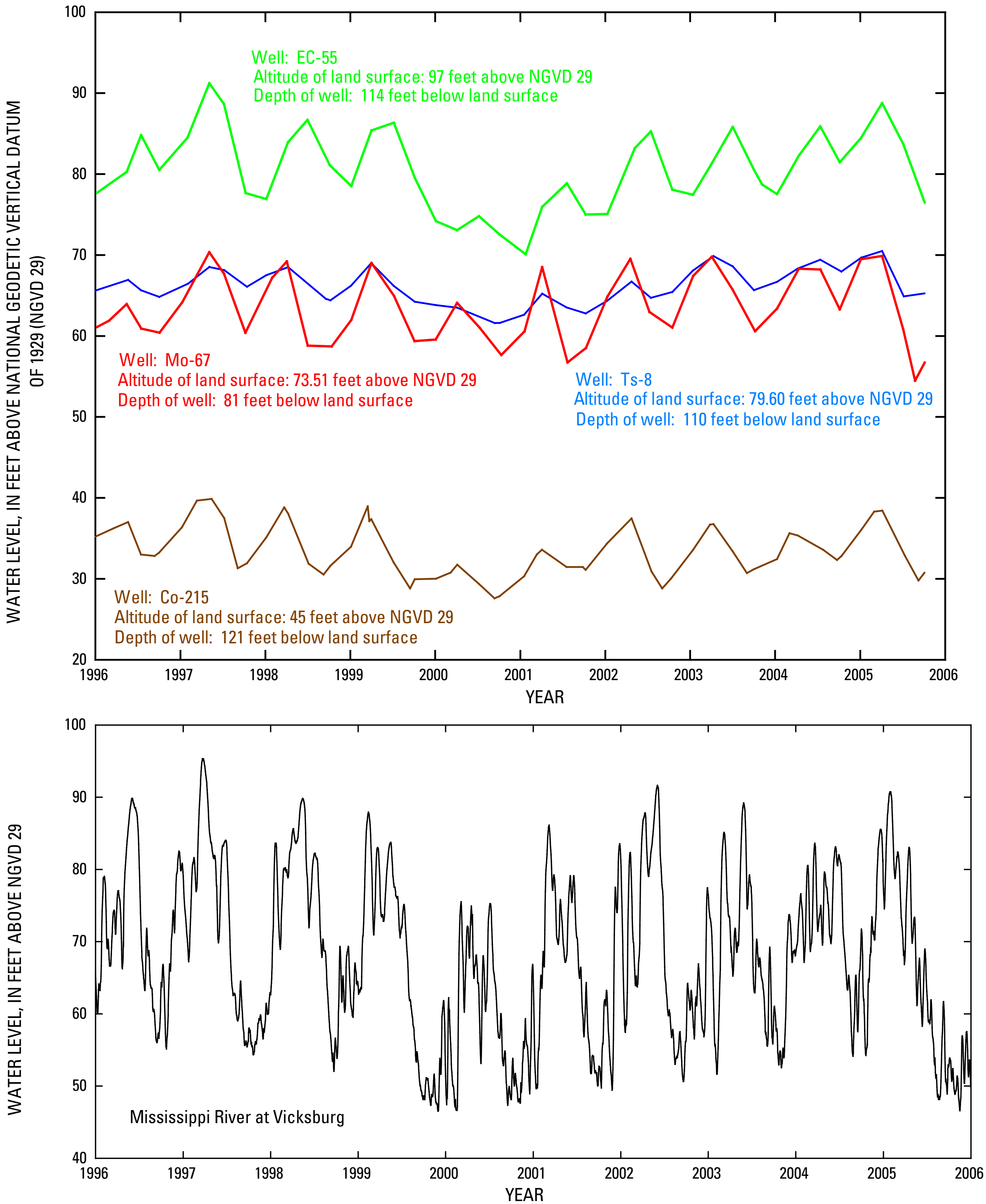


Figure 8. Water levels at selected wells screened in the Mississippi River alluvial aquifer in Louisiana; and altitude of the Mississippi River at Vicksburg, Mississippi, 1996-2005. See figure 7 for locations of wells and the stage gaging station on the Mississippi River.

Chicot Aquifer System in Southwestern Louisiana

The Chicot aquifer system in southwestern Louisiana (fig. 9) consists of several aquifers including the undifferentiated (massive) sand, upper and lower sands, and sands of the Lake Charles area (fig. 2). The Chicot aquifer system was the most extensively pumped aquifer or aquifer system in the State in 2005 (Sargent, 2007). About 662 Mgal/d of water was withdrawn for various categories of use as follows: rice irrigation, 57 percent; aquaculture, 17 percent; public supply, 14 percent; industry, 9 percent; and other uses, 3 percent. The largest withdrawals were in Acadia Parish (168 Mgal/d), Jefferson Davis Parish (152 Mgal/d), Calcasieu Parish (89 Mgal/d), Evangeline Parish (69 Mgal/d), Lafayette Parish (43 Mgal/d), and Vermilion Parish (40 Mgal/d) (Sargent, 2007, p. 102). These six parishes accounted for nearly 85 percent of the water withdrawn from the aquifer system.

The water-level surface throughout most of the Chicot aquifer system is greatly influenced by seasonal withdrawals for rice irrigation. In the Lake Charles area, ground-water withdrawals for industry and public supply also affect water levels. By the early 1950's, an extensive cone of depression had developed in the aquifer system, extending from eastern Calcasieu Parish to western St. Landry Parish (Fader, 1954, pls. 2, 3, 4). During the period 1990-2000, water levels declined as much as 1.7 ft/yr (Tomaszewski and others, 2002, p. 8). In 2003, the cone of depression was still present (Lovelace and others, 2004).

Rates of water-level change for 26 wells (table 2) were used to construct a map showing generalized water-level trends in the Chicot aquifer system for the period 1996-2005 (fig. 9). The map shows rates of water-level changes in the aquifers with the greatest withdrawal rates (the upper sand unit and the "500-foot" sand of the Lake Charles area) but does not show rates of water-level change in the "200-foot" sand of the Lake Charles area in Calcasieu Parish. During the period 1996-2005, water levels generally declined between 0 and 1.1 ft/yr in the rice-growing areas. Seasonal water-level fluctuations were more than 20 ft at well Ev-229 (fig. 10). Well Ev-229 is located in the rice-growing area, where water-level declines are mostly in response to withdrawals for irrigation use.

In Calcasieu Parish, water levels generally rose in response to decreased withdrawals (from 90 Mgal/d in 1995 to 70 Mgal/d in 2005 [B.P. Sargent, U.S. Geological Survey, written commun., 2007]) from the "500-foot" sand of the Lake Charles area. In Calcasieu Parish, water levels fluctuated about 5 to 10 ft at wells Cu-851 and Cu-767 (fig. 10), mostly in response to seasonal withdrawals by industry. Water levels in well Cu-851, screened in the "500-foot" sand, rose about 1.5 ft/yr during the period 1996-2005, while water levels in well Cu-767, screened in the "700-foot" sand, rose about 0.8 ft/yr. In Calcasieu Parish, withdrawals from the "200-foot" and "700-foot" sands were about 9 and 5 Mgal/d in 2005 (B.P. Sargent, U.S. Geological Survey, written commun., 2007). Water levels at well Be-443 (fig. 10), located in the outcrop area of the Chicot aquifer system (fig. 9), fluctuated about 2 ft seasonally and declined about 0.1 ft/yr during the period 1996-2005 (table 2).

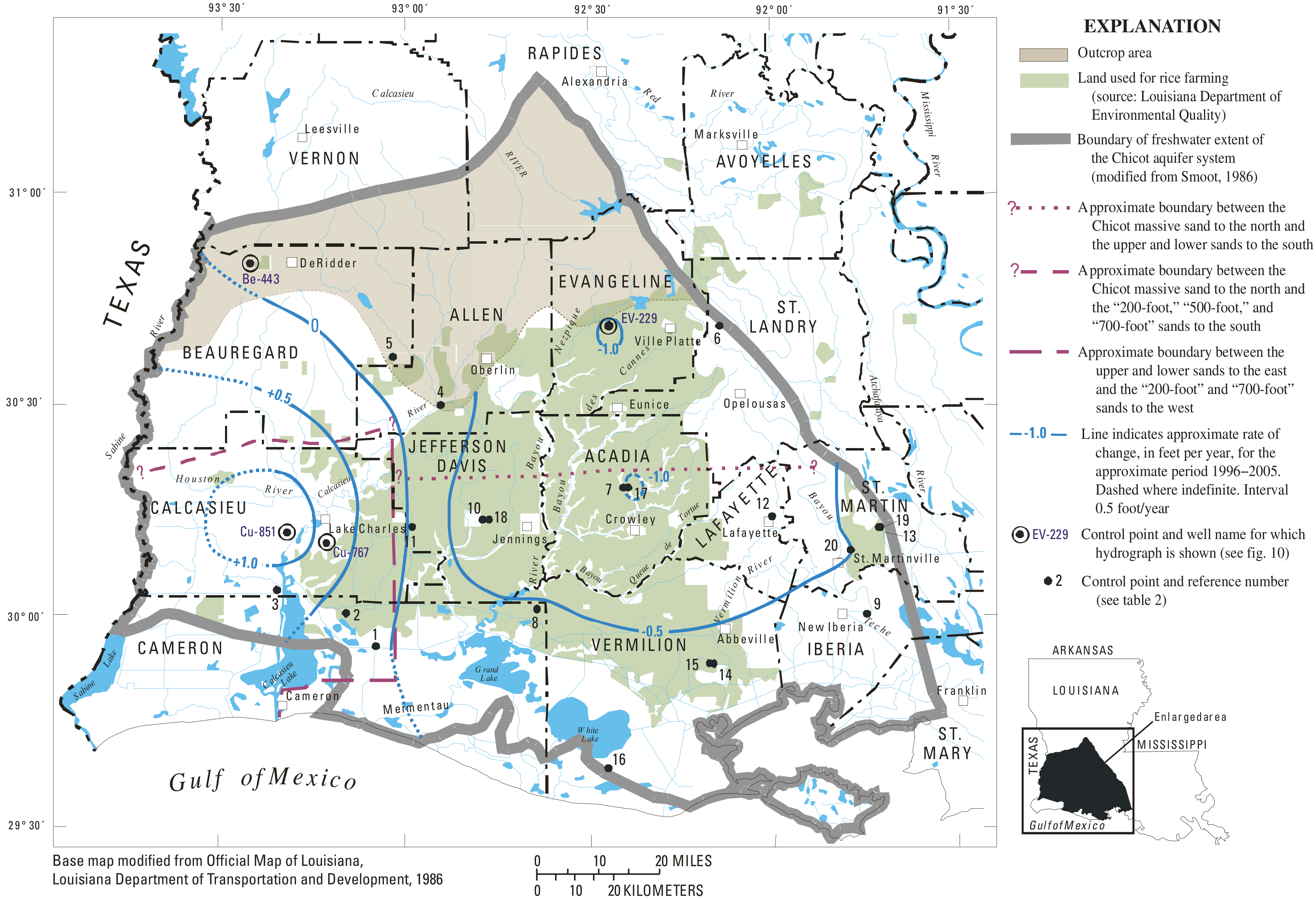


Figure 9. Rate of water-level change in the Chicot aquifer system in southwestern Louisiana, 1996–2005.

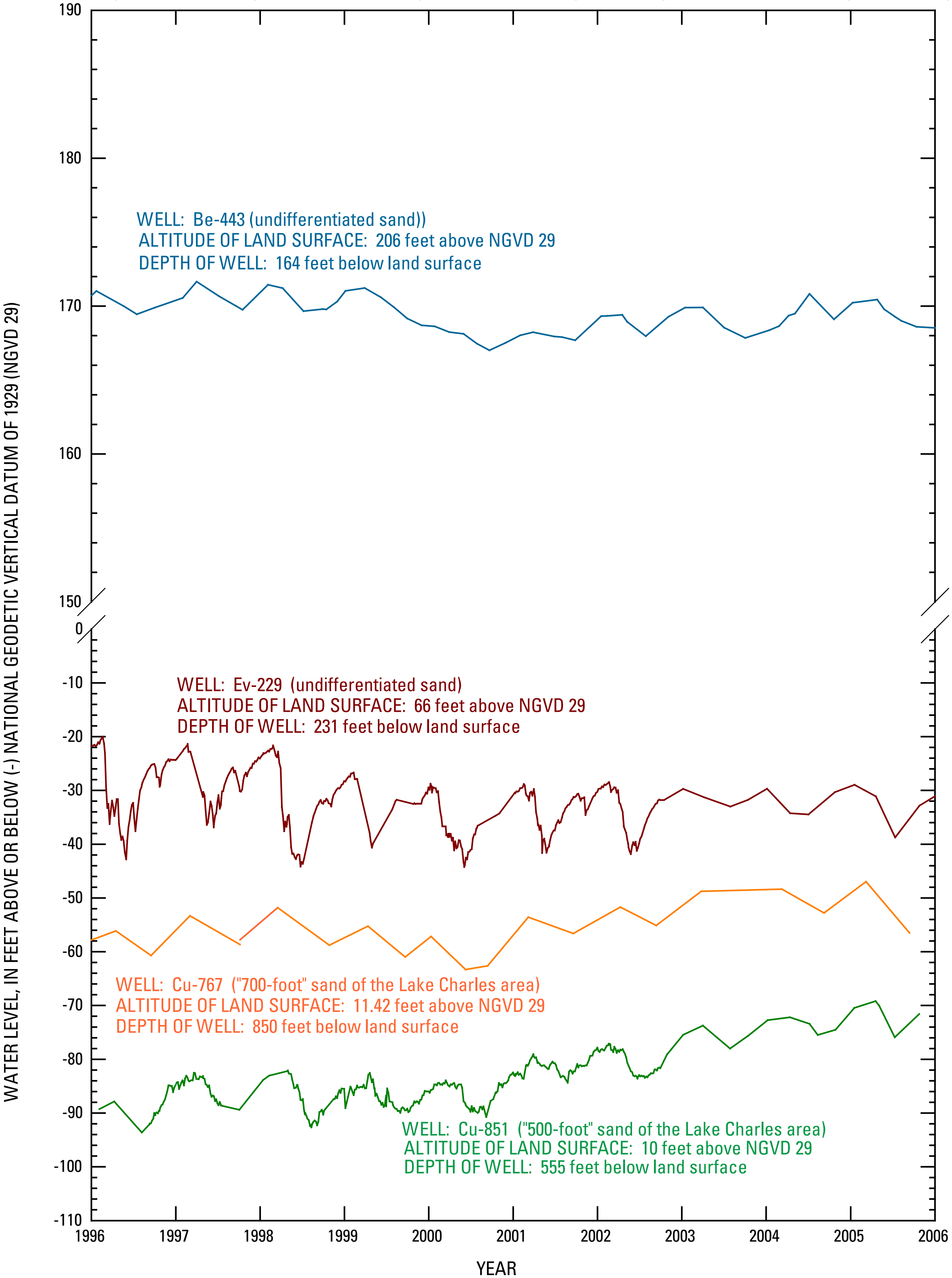


Figure 10. Water levels at selected wells screened in the Chicot aquifer system in southwestern Louisiana, 1996–2005. See figure 9 for locations of wells.

Table 2. Summary of water-level trends for selected wells screened in the Chicot aquifer system in southwestern Louisiana.

[Source: Louisiana Department of Transportation and Development-U.S. Geological Survey cooperative monitor-well network. Well with hydrograph (fig. 10) is in bold. –, no data; <, less than]

Reference number on map (fig. 9)	Well name	Parish	Historical water-level change, 1990-2000, in feet per year[1]	Water-level change, 1996-2005, in feet per year[2]	Level of significance, 1996-2005[3]	Number of observations, 1996-2005[4]	Period of record analyzed[5] Begin date, 1996	End date, 2005
			Wells screened in the "200-foot" sand of the Lake Charles area					
1	Cn-90	Cameron	--	0.06	0.7354	40	4-17	10-25
	Cu-771	Calcasieu	--	.39	.0119	26	4-16	10-25
	Cu-843	Calcasieu	--	.34	.0002	42	2-5	10-25
			Wells screened in the "500-foot" sand of the Lake Charles area					
2	Cn-88L	Cameron	--	0.30	0.1238	20	4-17	9-13
3	Cu-787	Calcasieu	--	.67	<.0001	35	4-16	10-24
Cu-851	**Cu-851**	Calcasieu	-0.1	1.45	<.0001	414	2-5	10-25
			Wells screened in the "700-foot" sand of the Lake Charles area					
Cu-767	**Cu-767**	Calcasieu	--	0.78	0.0304	20	4-16	9-13
			Wells screened in the Chicot aquifer (undifferentiated sand)					
4	Al-241	Allen	-0.2	-0.19	0.0452	41	2-5	10-24
5	Be-430	Beauregard	.1	-.25	<.0001	41	2-5	10-24
Be-443	**Be-443**	Beauregard	-.1	-.14	.0091	53	1-23	10-13
Ev-229	**Ev-229**	Evangeline	-1.1	-1.01	<.0001	439	1-5	10-26
6	SL-179	St. Landry	.0	-.68	<.0001	41	2-6	10-26
			Wells screened in the Chicot aquifer (upper sand unit)					
7	Ac-326	Acadia	-1.7	-0.96	<0.0001	219	2-6	10-24
8	Cn-81L	Cameron	-.7	-.42	.0184	39	2-6	10-26
9	I-93	Iberia	-.2	-.15	.0580	55	2-6	10-28
10	JD-9	Jefferson Davis	-1.1	-.99	.0005	39	2-5	10-24
11	JD-485A	Jefferson Davis	-1.6	.00	.9809	503	1-5	10-24
12	Lf-662	Lafayette	-.3	-.74	<.0001	37	2-7	10-26
13	SMN-109	St. Martin	-.4	-.20	.1191	56	2-7	10-28
14	Ve-637L	Vermilion	--	-.38	.0002	24	4-18	10-27
15	Ve-637U	Vermilion	-.2	-.40	<.0001	43	2-6	10-27
16	Ve-639	Vermilion	--	-.17	.0066	24	4-17	3-10
			Wells screened in the Chicot aquifer (lower sand unit)					
17	Ac-335U	Acadia	-1.7	-1.03	<0.0001	38	2-6	10-24
18	JD-773	Jefferson Davis	-1.1	-.59	.0084	39	2-5	10-24
19	SMN-108	St. Martin	--	-.21	.3116	25	3-29	10-28

Table 2. Summary of water-level trends for selected wells screened in the Chicot aquifer system in southwestern Louisiana.—Continued

[Source: Louisiana Department of Transportation and Development-U.S. Geological Survey cooperative monitor-well network. Well with hydrograph (fig. 10) is in bold. –, no data; <, less than]

Reference number on map (fig. 9)	Well name	Parish	Historical water-level change, 1990-2000, in feet per year[1]	Water-level change, 1996-2005, in feet per year [2]	Level of significance, 1996-2005 [3]	Number of observations, 1996-2005 [4]	Period of record analyzed [5]	
							Begin date, 1996	End date, 2005
20	SMN-134B	St. Martin	-.3	-.51	<.0001	40	2-7	10-26

[1] Tomaszewski and others (2002, p. 10).

[2] Computed slope in the trend line using method of ordinary least squares linear regression. The slope is equivalent to the change in water level, in feet per year, during the period analyzed.

[3] Probability that water-level change is due to chance rather than trend; values less than 0.05 generally are considered statistically significant.

[4] Total number of water-level measurements used to determine the slope in the trend line during the period analyzed.

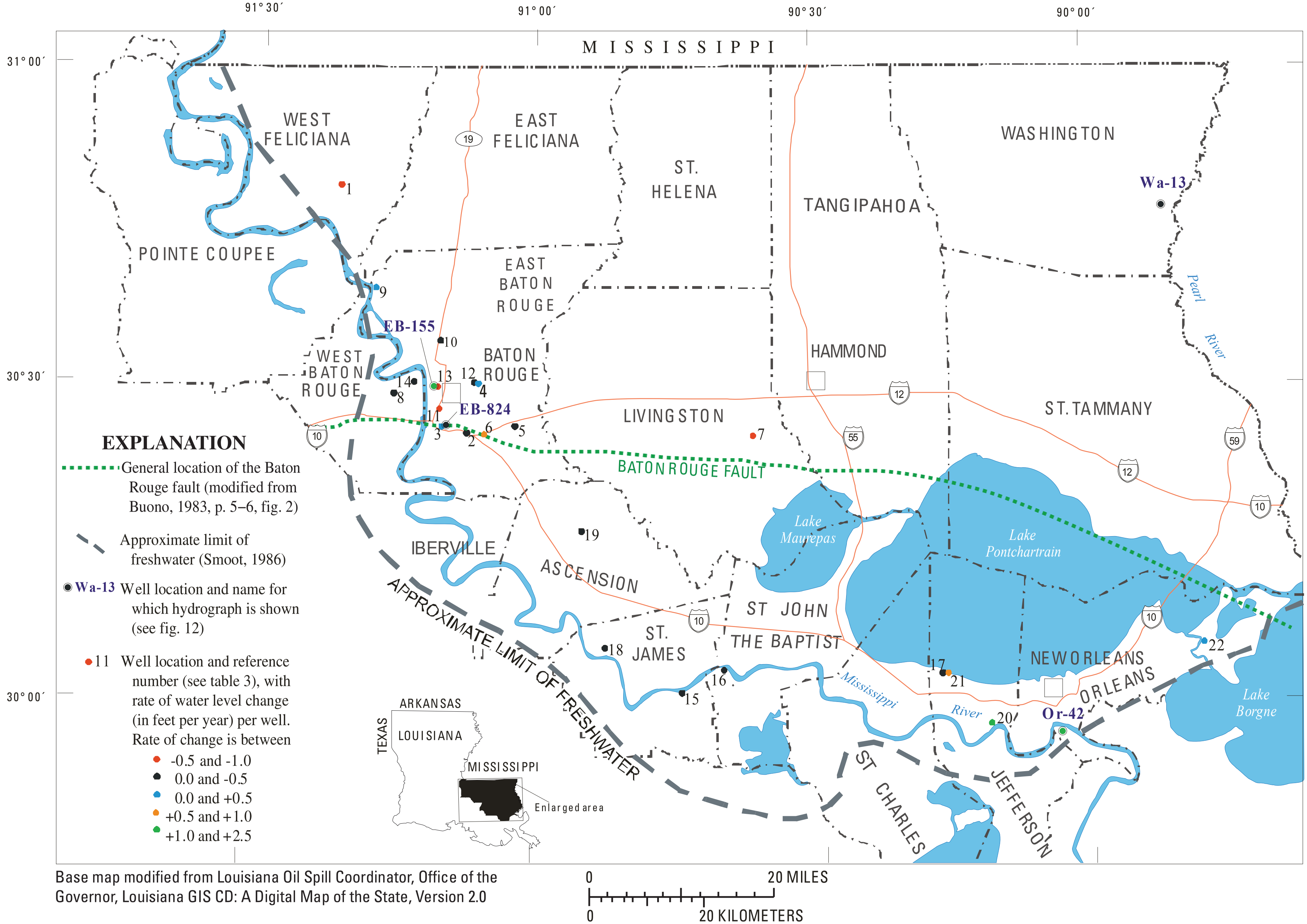
[5] Dates (month-day) of first and last measurement of period analyzed.

Chicot Equivalent Aquifer System in Southeastern Louisiana

The Chicot equivalent aquifer system in southeastern Louisiana (fig. 11) consists of several aquifers (fig. 2) and was the fourth most extensively pumped aquifer or aquifer system in the State in 2005 (Sargent, 2007). The Chicot equivalent aquifer system generally contains freshwater north of the Baton Rouge fault (fig. 11). South of the fault and downdip, freshwater often is underlain or replaced with saltwater. There are areas of freshwater in the upper part of the aquifer system that extend as far south as New Orleans.

About 107 Mgal/d was withdrawn for various categories of use as follows: industry, 51 percent; aquaculture, 17 percent; rural domestic and livestock, 15 percent; public supply, 12 percent; power generation, 3 percent; and irrigation, 1 percent. In 2005, the largest withdrawals from the aquifer system were in East Baton Rouge Parish (25.3 Mgal/d), St. James Parish (19.3 Mgal/d), Ascension Parish (10.6 Mgal/d), St. John the Baptist Parish (9.6 Mgal/d), Washington Parish (7.2 Mgal/d), St. Tammany Parish (6.0 Mgal/d), and Orleans Parish (5.0 Mgal/d) (Sargent, 2007, p. 102). These seven parishes accounted for 78 percent of the water withdrawn from the aquifer system in 2005.

Water-level data from 26 wells screened in the Chicot equivalent aquifer system indicate water-level changes ranged from about -0.8 to +2.1 ft/yr during the period 1996-2005 (table 3). A comparison of water-level changes for the periods 1990-2000 (Tomaszewski and others, 2002) and 1996-2005 (table 3) indicates water levels in the “400-foot” and “600-foot” sands are declining at lower rates or rising. Because rates of change varied in individual aquifers that constitute the system, a map of water-level changes was not constructed. A map showing rates of change for individual wells is presented in figure 11.



Base map modified from Louisiana Oil Spill Coordinator, Office of the Governor, Louisiana GIS CD: A Digital Map of the State, Version 2.0

Figure 11. Rate of water-level change at selected monitor wells screened in the Chicot equivalent aquifer system in southeastern Louisiana, 1996–2005.

Table 3. Summary of water-level trends for selected wells screened in the Chicot equivalent aquifer system in southeastern Louisiana.

[Source: Louisiana Department of Transportation and Development—U.S. Geological Survey Cooperative Program monitor-well network. Well with hydrograph (fig. 12) is in bold. –, no data; <, less than]

Reference number on map (fig. 11)	Well name	Parish	Historical water-level change, 1990-2000, in feet per year[1]	Water-level change, 1996-2005, in feet per year[2]	Level of significance, 1996-2005[3]	Number of observations, 1996-2005[4]	Period of record analyzed[5]	
							Begin date, 1996	End date, 2005
Wells screened in the Upland terrace aquifer								
Wa-13	**Wa-13**	Washington	0.1	-0.01	0.9252	40	2-28	10-18
1	WF-158	West Feliciana	.2	-.63	<.0001	40	2-23	10-7
Wells screened in the “400-foot” sand of the Baton Rouge area								
EB-155	**EB-155**	East Baton Rouge	-2.4	1.89	<0.0001	257	1-5	10-6
2	EB-789A	East Baton Rouge	-.6	-.37	.2505	40	1-9	10-4
3	EB-825	East Baton Rouge	-.7	.25	.1471	50	1-10	11-14
4	EB-934	East Baton Rouge	-1.1	.07	.6370	40	2-14	10-5
5	EB-1264	East Baton Rouge	--	-.25	.1832	45	3-11	10-4
6	EB-1278	East Baton Rouge	--	.51	.0249	43	[6] 7-22	11-10
7	Li-122	Livingston	--	-.56	<.0001	41	3-11	10-14
8	WBR-146	West Baton Rouge	-.2	-.45	.2811	41	2-15	10-11
Wells screened in the “400-foot” and “600-foot” sands of the Baton Rouge area								
9	EB-1234	East Baton Rouge	--	0.49	0.2217	42	3-13	10-6
Wells screened in the “600-foot” sand of the Baton Rouge area								
EB-824	**EB-824**	East Baton Rouge	-1.8	-0.41	0.0714	40	1-10	10-4
10	EB-827	East Baton Rouge	-.7	-.43	.1101	40	1-11	10-5
11	EB-870	East Baton Rouge	-2.5	-.71	.0012	49	1-10	11-15
12	EB-933	East Baton Rouge	-1.5	-.36	.0463	40	2-14	10-5
13	EB-945	East Baton Rouge	-2.8	-.76	<.0001	79	1-12	10-6
14	WBR-161	West Baton Rouge	-1.6	-.38	.1122	40	2-15	10-11
Wells screened in the Gramercy aquifer								
15	SJ-86	St. James	--	-0.10	0.6219	38	2-27	10-20
16	SJB-145	St. John the Baptist	--	-.01	.9709	39	2-27	10-20
Wells screened in the Norco aquifer								
17	Jf-186	Jefferson	--	-0.43	<0.0001	37	8-6	10-20
18	SJ-203	St. James	--	-.15	.4897	38	2-27	10-20
Wells screened in the Gonzales-New Orleans aquifer								
19	An-267	Ascension	--	-0.14	0.3061	42	3-8	10-20
20	Jf-156	Jefferson	--	1.23	<.0001	40	2-26	11-1
21	Jf-178	Jefferson	--	.60	<.0001	40	5-13	10-20

Table 3. Summary of water-level trends for selected wells screened in the Chicot equivalent aquifer system in southeastern Louisiana.—Continued

[Source: Louisiana Department of Transportation and Development—U.S. Geological Survey Cooperative Program monitor-well network. Well with hydrograph (fig. 12) is in bold. –, no data; <, less than]

Reference number on map (fig. 11)	Well name	Parish	Historical water-level change, 1990-2000, in feet per year[1]	Water-level change, 1996-2005, in feet per year [2]	Level of significance, 1996-2005 [3]	Number of observations, 1996-2005 [4]	Period of record analyzed [5]	
							Begin date, 1996	End date, 2005
Or-42	**Or-42**	Orleans	--	2.13	<.0001	495	1-5	11-2
22	Or-175	Orleans	--	.20	.0003	40	3-4	11-8

[1] Tomaszewski and others (2002, p. 20-21).

[2] Computed slope in the trend line using method of ordinary least squares linear regression. The slope is equivalent to the change in water level, in feet per year, during the period analyzed.

[3] Probability that water-level change is due to chance rather than trend; values less than 0.05 generally are considered statistically significant.

[4] Total number of water-level measurements used to determine the slope in the trend line during the period analyzed.

[5] Dates (month-day) of first and last measurement of period analyzed.

[6] Measurement made July 22, 1997.

The hydrograph for well Or-42 shows rising water levels in Orleans Parish for the period 1996-2005 (fig. 12). A cone of depression in the New Orleans area, caused by water withdrawals, was documented in 1980 (Martin and Whiteman, 1985a). In 1993, the cone was still present although water levels had risen about 22 ft in the center (Walters, 1995). Since the early 1970's, water levels have risen in the New Orleans area in response to decreased ground-water withdrawals.

Hydrographs for wells EB-155 and EB-824 (fig. 12) show water-level trends in the "400-foot" and "600-foot" sands north of the Baton Rouge fault in East Baton Rouge Parish. The water level in well EB-155, which is located in the Baton Rouge industrial district and screened in the "400-ft" sand, has been rising since 2002 in response to decreased withdrawals. The water level in well EB-824, which is located in Baton Rouge just north of the Baton Rouge fault and screened in the "600-foot" sand, declined 0.4 ft/yr during the period 1996-2005. A cone of depression in the Baton Rouge area, caused by water withdrawals from the "400-foot" and "600-foot" sands of the Baton Rouge area, was documented in 1980 (Martin and Whiteman, 1985a). In 1990, the cone was still present (Tomaszewski, 1996, p. 31, 32) although water levels had risen about 100 ft. The water level in well Wa-13 (fig. 12), which is located in Washington Parish and screened in the upland terrace aquifer, is representative of water levels in outcrop and subcrop areas and shows seasonal fluctuations but no substantial long-term change in water level.

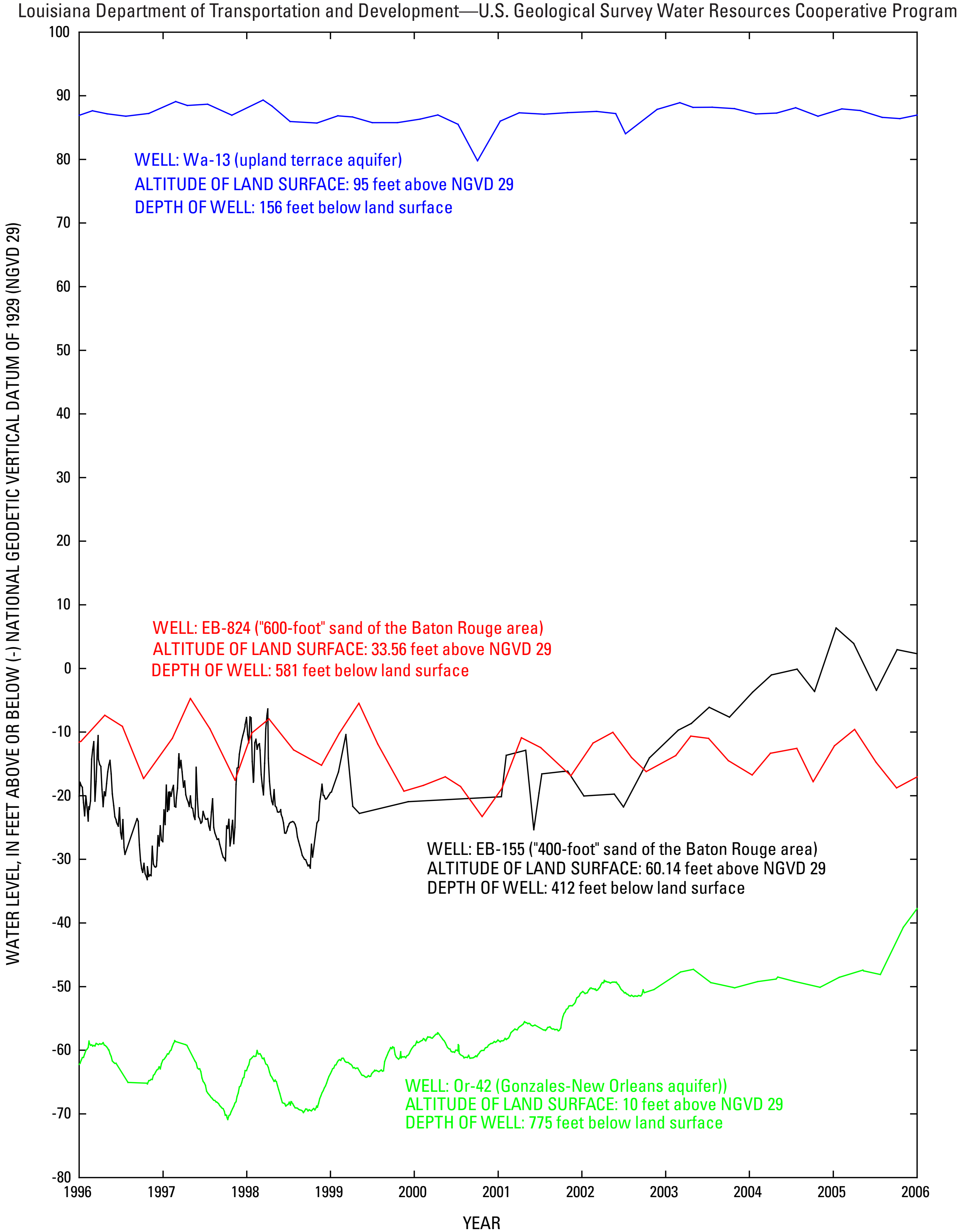


Figure 12. Water levels at selected wells screened in the Chicot equivalent aquifer system in southeastern Louisiana, 1996–2005. See figure 11 for locations of wells.

Evangeline Equivalent Aquifer System in Southeastern Louisiana

The Evangeline equivalent aquifer system in southeastern Louisiana (fig. 13) consists of several aquifers (fig. 2) and was the fifth most extensively pumped aquifer or aquifer system in the State in 2005. About 87 Mgal/d was withdrawn for various categories of use as follows: public supply, 68 percent; industry, 24 percent; power generation, 5 percent; and other, 3 percent. In 2005, the largest withdrawals from the aquifer system were in East Baton Rouge Parish (52.3 Mgal/d), St. Tammany Parish (12.3 Mgal/d), West Baton Rouge Parish (6.8 Mgal/d), and Livingston Parish (4.8 Mgal/d) (Sargent, 2007, p. 102). These four parishes accounted for 88 percent of the water withdrawn from the aquifer system.

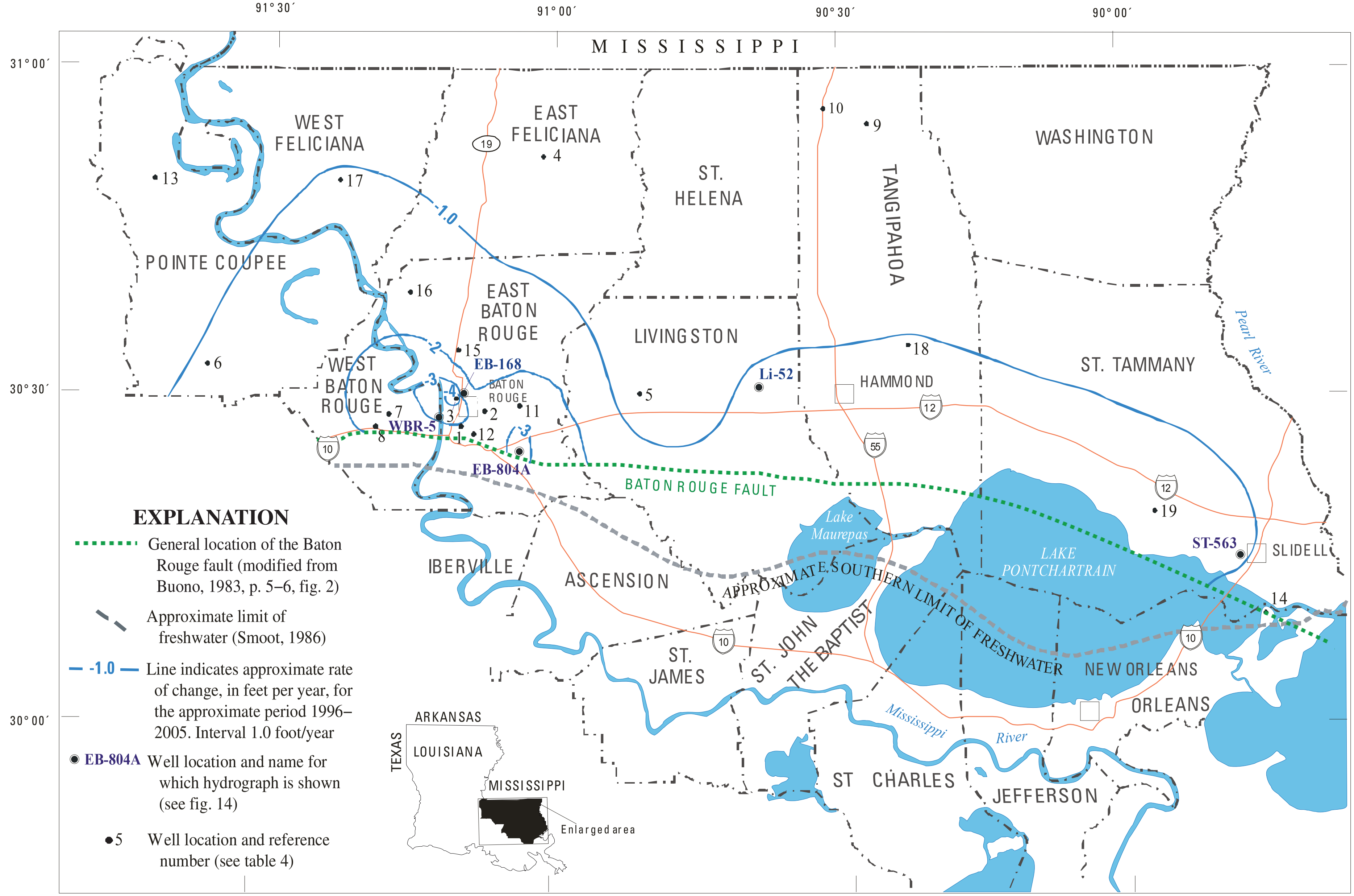
The Evangeline equivalent aquifer system is recharged mostly by rainfall on the upland alluvial terraces of southwestern Mississippi and southeastern Louisiana (Martin and Whiteman, 1985b). The aquifer system generally contains saline water south of the Baton Rouge fault. In 1980, a cone of depression caused by ground-water withdrawals in the Baton Rouge area was documented in the Evangeline equivalent aquifer system (Martin and Whiteman, 1985b). This cone is still present and affects water levels in the Baton Rouge area, Livingston Parish, and northward into St. Helena Parish (Prakken, 2004).

Water-level data from 31 wells screened in the Evangeline equivalent aquifer system indicate water-level changes ranged from about -5.5 to +0.5 ft/yr during the period 1996-2005 (table 4). These data were used to construct a map showing generalized water-level changes north of the Baton Rouge fault for the period 1996-2005 (fig. 13). The map shows rates of water-level changes in the aquifers with the greatest withdrawal rates (“1,200-foot,” “1,500-foot,” and “1,700-foot” sands of the Baton Rouge area and the Kentwood, Abita, Covington, and Slidell aquifers) and does not show rates of water-level change in wells screened in the “800-foot” and “1,000-foot” sands, lower Ponchatoula aquifer, or Big Branch aquifer. Additionally, well WBR-100A , screened in the “1,700-foot” sand in West Baton Rouge Parish was not used for map construction because the aquifer is not as intensively pumped in the parish as the “1,200-foot” or “1,500-foot” sands. In the deep aquifers of the system, rates of water-level decline were greatest in East and West Baton Rouge Parishes and can be attributed to ground-water withdrawals.

A comparison of water-level changes for the periods 1990-2000 (Tomaszewski and others, 2002) and 1996-2005 (table 4) indicates water levels in the “800-foot” sand generally are declining at a lower rate, while levels in the “1,200-foot” and “1,700-foot”sands generally are declining at a higher rate. Water levels generally declined in the “1,500-foot” sand, lower Ponchatoula, Big Branch, Kentwood, Abita, and Slidell aquifers during the period 1996-2005.

Hydrographs showing water-level trends in the Evangeline equivalent aquifer system for the period 1996-2005 are presented in figure 14. Water levels in well WBR-5, located in West Baton Rouge Parish and screened in the “1,200-foot” sand, have declined at an average rate of 3.4 ft/yr. Water levels in well EB-168, located in East Baton Rouge Parish and screened in the “1,500-foot” sand, declined at a rate of 2.1 ft/yr. Hydrographs of wells EB-804A in East Baton Rouge Parish and Li-52 in Livingston Parish show declining water levels in the “1,700-foot” sand. Water levels in well ST-563, located in St. Tammany Parish and screened in the Slidell aquifer, declined at a rate of 1.1 ft/yr.

Well EB-1274, located in the city of Baton Rouge and screened in the “800-foot” sand, monitors water levels near a connector well. The connector well takes advantage of head differences, allowing water to flow from the shallower “800-foot” sand into the deeper “1,500-foot” sand. The purpose of the connector well is to raise water levels in the “1,500-foot” sand and slow northward encroachment of saline water, which would affect public-supply wells in the area. The rate of change in well EB-1274 during the period 1996-2005 is -4.3 ft/yr, but the principal decline in water level occurred in 1999 when the connector well went into operation.



Base map modified from Louisiana Oil Spill Coordinator, Office of the Governor, Louisiana GIS CD: A Digital Map of the State, Version 2.0

0 20 MILES
0 20 KILOMETERS

Figure 13. Rate of water-level change north of the Baton Rouge fault in the deep aquifers of the Evangeline equivalent aquifer system in southeastern Louisiana, 1996–2005.

Table 4. Summary of water-level trends for selected wells screened in the Evangeline equivalent aquifer system in southeastern Louisiana.

[Source: Louisiana Department of Transportation and Development—U.S. Geological Survey Cooperative Program monitor-well network. Well with hydrograph (fig. 14) is in bold. –, no data; <, less than]

Reference number on map (fig. 13)	Well name	Parish	Historical water-level change, 1990-2000, in feet per year[1]	Water-level change, 1996-2005, in feet per year[2]	Level of significance 1996-2005[3]	Number of observations 1996-2005[4]	Period of record analyzed[5]: Begin date, 1996	Period of record analyzed[5]: End date, 2005
Wells screened in the "800-foot" sand of the Baton Rouge area[6]								
	EB-1019	East Baton Rouge	-1.2	-0.37	0.0436	37	10-8	10-4
	EB-1274	East Baton Rouge	--	-4.28	<.0001	370	12-17	10-13
	WBR-160	West Baton Rouge	-5.0	.52	.3791	40	2-15	10-11
Wells screened in the Lower Ponchatoula aquifer[6]								
	ST-776	St. Tammany	-0.5	-0.16	0.0681	21	10-31	10-19
Wells screened in the "1,000-foot" sand of the Baton Rouge area[6]								
	EB-805	East Baton Rouge	-1.8	-0.71	0.0007	49	1-12	12-7
Wells screened in the "1,200-foot" sand of the Baton Rouge area								
1	EB-146	East Baton Rouge	-2.0	-2.61	<0.0001	41	2-13	10-4
2	EB-327	East Baton Rouge	-1.8	-2.43	<.0001	36	3-11	10-4
3	EB-946	East Baton Rouge	-.9	-5.47	<.0001	78	1-12	10-6
4	EF-61	East Feliciana	-.2	-.62	<.0001	40	2-22	10-7
5	Li-113	Livingston	-.5	-.42	<.0001	40	3-1	10-12
6	PC-155	Pointe Coupee	-.4	-1.05	<.0001	40	2-16	10-10
WBR-5	**WBR-5**	West Baton Rouge	-.9	-3.40	<.0001	40	2-15	10-11
7	WBR-102A	West Baton Rouge	-.7	-2.25	<.0001	40	2-15	10-11
8	WBR-148	West Baton Rouge	-.7	-2.15	<.0001	49	1-11	10-11
Wells screened in the Big Branch aquifer[6]								
	ST-532	St. Tammany	-0.1	-0.26	<0.0001	39	3-12	10-19
Wells screened in the Kentwood aquifer								
9	Ta-440	Tangipahoa	-0.6	-0.30	0.0054	41	2-28	10-17
10	Ta-454	Tangipahoa	-.1	-.18	.1297	40	2-29	10-13

Table 4. Summary of water-level trends for selected wells screened in the Evangeline equivalent aquifer system in southeastern Louisiana.—Continued

[Source: Louisiana Department of Transportation and Development—U.S. Geological Survey Cooperative Program monitor-well network. Well with hydrograph (fig. 14) is in bold. –, no data; <, less than]

Reference number on map (fig. 13)	Well name	Parish	Historical water-level change, 1990-2000, in feet per year[1]	Water-level change, 1996-2005, in feet per year [2]	Level of significance 1996-2005 [3]	Number of observations 1996-2005 [4]	Period of record analyzed [5]	
							Begin date, 1996	End date, 2005
Wells screened in the "1,500-foot" sand of the Baton Rouge area								
EB-168	**EB-168**	East Baton Rouge	--	-2.11	<0.0001	41	2-13	10-5
11	EB-392	East Baton Rouge	-2.8	-2.96	<.0001	39	2-14	10-4
12	EB-917	East Baton Rouge	--	-2.61	<.0001	511	1-17	12-28
13	PC-39	Pointe Coupee	-.2	-.39	.1866	41	2-16	10-10
Wells screened in the Abita aquifer								
14	Or-179	Orleans	-1.0	-0.72	<0.0001	41	3-4	11-8
Wells screened in the "1,700-foot" sand of the Baton Rouge area								
15	EB-685	East Baton Rouge	-1.0	-1.46	0.0038	41	1-11	10-5
EB-804A	**EB-804A**	East Baton Rouge	-1.0	-3.23	<.0001	49	1-18	12-7
16	EB-849	East Baton Rouge	--	-1.50	.0003	40	2-14	10-7
Li-52	**Li-52**	Livingston	-1.1	-1.16	<.0001	40	3-1	10-17
	WBR-100A	West Baton Rouge	-2.0	-.42	.2847	40	2-15	10-11
17	WF-254	West Feliciana	-.4	-1.07	<.0001	40	2-23	10-7
Wells screened in the Covington aquifer								
18	Ta-278	Tangipahoa	-0.9	-1.04	<0.0001	39	2-29	7-29
Wells screened in the Slidell aquifer								
ST-563	**ST-563**	St. Tammany	-2.4	-1.07	<0.0001	40	2-28	10-19
19	ST-576	St. Tammany	-1.2	-1.10	<.0001	38	2-28	10-19

[1] Tomaszewski and others (2002, p. 20-22).

[2] Computed slope in the trend line using method of ordinary least squares linear regression. The slope is equivalent to the change in water level, in feet per year, during the period analyzed.

[3] Probability that water-level change is due to chance rather than trend; values less than 0.05 generally are considered statistically significant.

[4] Total number of water-level measurements used to determine the slope in the trend line during the period analyzed.

[5] Dates (month-day) of first and last measurement of period analyzed.

[6] Wells not used for contouring, and locations do not appear in fig. 13.

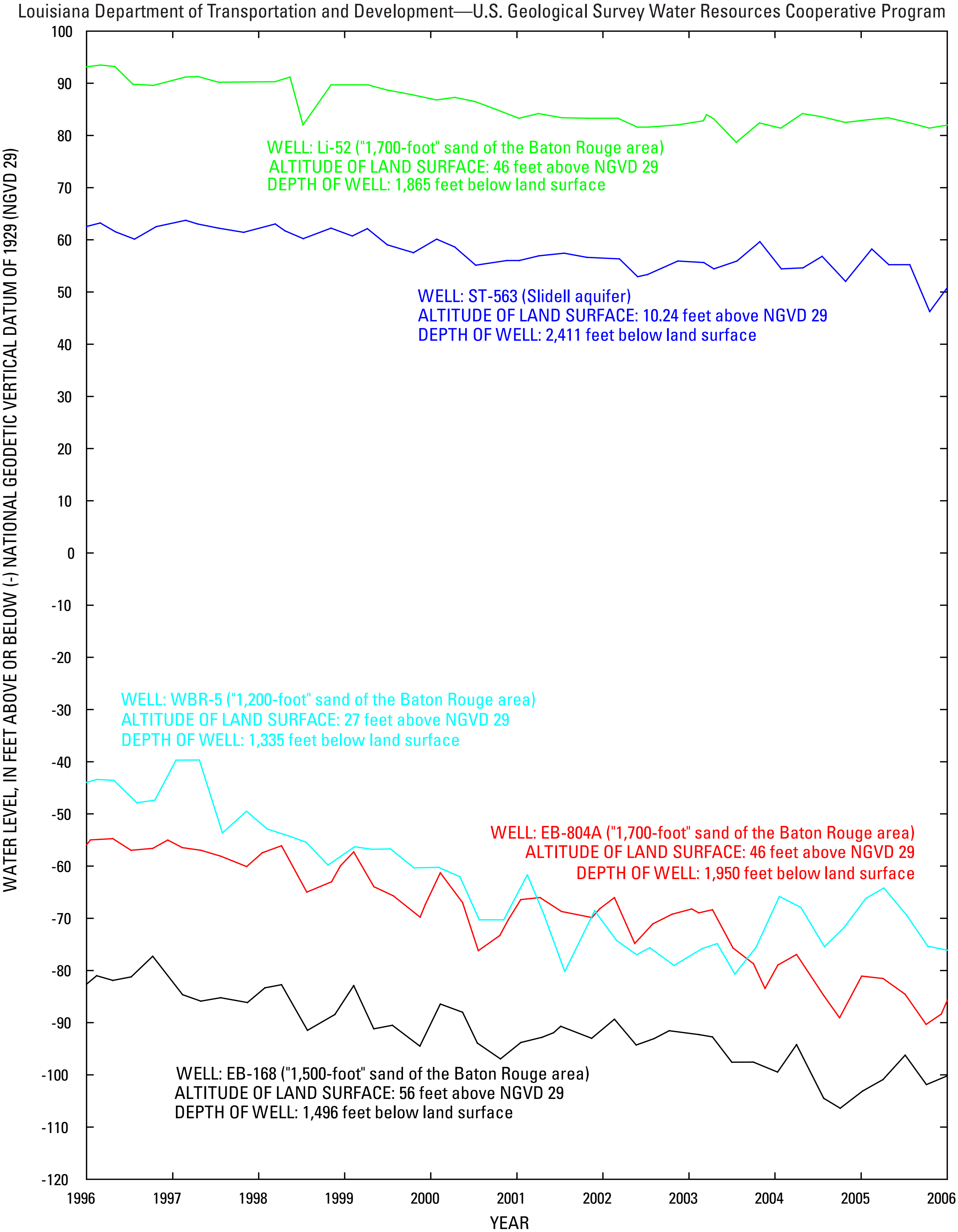


Figure 14. Water levels at selected wells screened in the Evangeline equivalent aquifer system in southeastern Louisiana, 1996–2005. See figure 13 for locations of wells.

Jasper Equivalent Aquifer System in Southeastern Louisiana

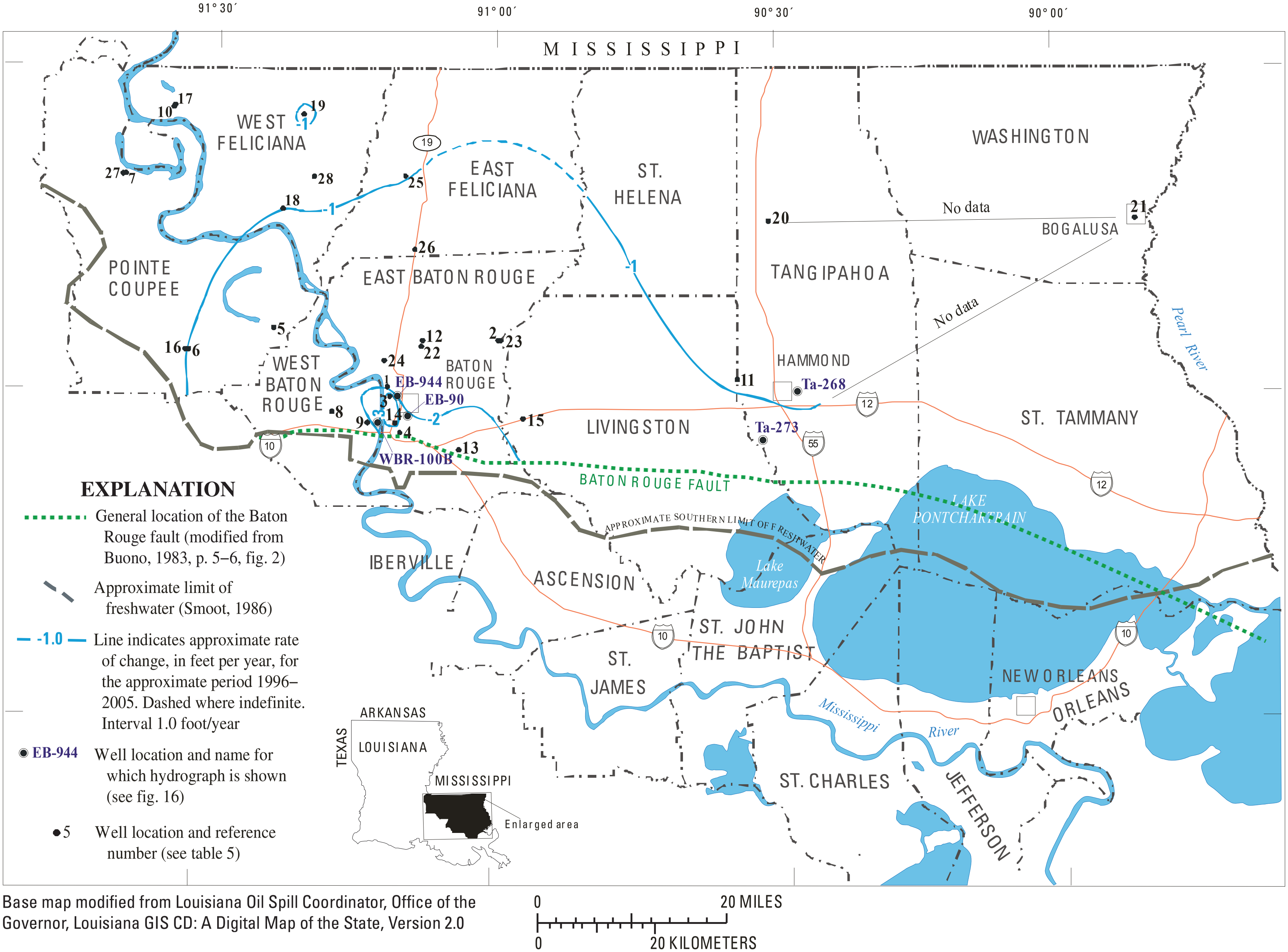
The Jasper equivalent aquifer system in southeastern Louisiana (fig. 15) consists of several aquifers (fig. 2) and was the third most extensively pumped aquifer or aquifer system in the State in 2005. About 126 Mgal/d was withdrawn for various categories of use as follows: public-supply, 57 percent; industry, 38 percent; power generation, 4 percent; and other, 1 percent. In 2005, the largest withdrawals from the aquifer system were in East Baton Rouge Parish (68.2 Mgal/d), Washington Parish (21.5 Mgal/d), and Tangipahoa Parish (12.2 Mgal/d) (Sargent, 2007, p. 102). These three parishes accounted for almost 81 percent of the water withdrawn from the aquifer system.

In 1984, a cone of depression, mainly caused by ground-water withdrawals in East Baton Rouge Parish (Martin and others, 1988), was documented in the upper Jasper equivalent aquifer system (“2,000-foot” and “2,400-foot” sands of the Baton Rouge area). Separate water-level surfaces for the “2,000-foot” and “2,400-foot” sands of the Baton Rouge area were mapped in 2002 (Tomaszewski and Accardo, 2004a, 2004b). The “2,000-foot” sand had a deep cone of depression (lowest water level about -248 ft NGVD 29) in 2002, while the “2,400-foot” sand had a shallower cone of depression (lowest water level about -178 ft NGVD 29).

Also in 1984, a cone of depression mostly caused by ground-water withdrawals from East Baton Rouge Parish (Martin and others, 1988) was documented in the lower Jasper equivalent aquifer (“2,800-foot” sand of the Baton Rouge area). Martin and others (1988) noted that, “Although a large volume of water is pumped from aquifers equivalent to the lower Jasper aquifer in the area north of Baton Rouge, the pumpage is widely distributed at numerous sites and the resulting cone of depression is widespread but relatively shallow.” The central part of the broad cone extended from Baton Rouge into West Feliciana Parish. Martin and others (1988) also documented a cone of depression in eastern Washington Parish, which can be attributed to withdrawals from the Amite aquifer in the Bogalusa area. In 2006, a water-level map for the Amite aquifer and “2,800-foot” sand (Fendick, in press), had cones of depression shaped similarly to the cones shown in Martin and others (1988).

Water-level data from 33 wells screened in the Jasper equivalent aquifer system indicate water-level changes ranged from about -3.9 to -0.3 ft/yr during the period 1996-2005 (table 5). These data were used to construct a map showing generalized water-level changes north of the Baton Rouge fault (fig. 15). The greatest rate of water-level decline (greater than 3 ft/yr) was in East Baton Rouge Parish and can be attributed to ground-water withdrawals. More data are needed to accurately illustrate the water-level changes between western Tangipahoa Parish and Bogalusa in eastern Washington Parish. A comparison of water-level changes for the periods 1990-2000 (Tomaszewski and others, 2002) and 1996-2005 (table 5) indicates inconsistent water-level changes in the “2,000-foot” sand, while water levels in the “2,400-foot” and “2,800-foot” sands generally are declining at lower rates. At Bogalusa in Washington Parish, the Amite aquifer was pumped at a rate of about 14 Mgal/d in 2005 (B.P. Sargent, U.S. Geological Survey, written commun., 2007), which is reflected in the water-level change of -2.7 ft/yr at well Wa-158 (number 21, table 5).

Hydrographs showing water-level trends in the Jasper equivalent aquifer system for the period 1996-2005 are presented in figure 16. Water levels in well EB-90, located in East Baton Rouge Parish and screened in the “2,000-foot” sand, declined at an average rate of 2.1 ft/yr. Water levels in well WBR-100B, located in West Baton Rouge Parish and screened in the “2,400-foot” sand, declined at an average rate of 2.9 ft/yr. Water levels in well EB-944, located in East Baton Rouge Parish and screened in the “2,800-foot” sand, declined at an average rate of 1.2 ft/yr. Water levels in well Ta-268, located in Tangipahoa Parish and screened in the Hammond aquifer, declined at an average rate of 0.8 ft/yr, and water levels in nearby well Ta-273, screened in the Tchefuncte aquifer, declined at an average rate of 1.6 ft/yr.



Base map modified from Louisiana Oil Spill Coordinator, Office of the Governor, Louisiana GIS CD: A Digital Map of the State, Version 2.0

Figure 15. Rate of water-level change north of the Baton Rouge fault in the Jasper equivalent aquifer system in southeastern Louisiana, 1996–2005.

Table 5. Summary of water-level trends for selected wells screened in the Jasper equivalent aquifer system in southeastern Louisiana.

[Source: Louisiana Department of Transportation and Development—U.S. Geological Survey Cooperative Program monitor-well network. Well with hydrograph (fig. 16) is in bold. –, no data; <, less than]

Reference number on map (fig. 15)	Well name	Parish	Historical water-level change, 1990-2000, in feet per year[1]	Water-level change, 1996-2005, in feet per year[2]	Level of significance 1996-2005[3]	Number of observations 1996-2005[4]	Period of record analyzed [5]	
							Begin date, 1996	End date, 2005
Wells screened in the Tchefuncte aquifer								
Ta-273	**Ta-273**	Tangipahoa	-1.2	-1.60	<0.0001	40	3-18	10-14
Wells screened in the "2,000-foot" sand of the Baton Rouge area								
EB-90	**EB-90**	East Baton Rouge	-2.0	-2.14	0.0258	40	2-13	10-4
1	EB-297	East Baton Rouge	-3.4	-1.37	.1510	40	2-14	10-5
2	EB-304	East Baton Rouge	-2.2	-1.87	<.0001	40	2-15	10-5
3	EB-367	East Baton Rouge	1.0	-3.93	<.0001	179	1-5	10-6
4	EB-1028	East Baton Rouge	-3.0	-2.58	.0037	44	1-17	10-4
5	PC-66	Pointe Coupee	--	-1.58	<.0001	40	2-16	10-10
6	PC-138	Pointe Coupee	--	-1.37	<.0001	40	2-16	10-10
7	PC-144	Pointe Coupee	-.4	-.54	<.0001	40	2-16	10-10
8	WBR-102B	West Baton Rouge	-1.7	-1.44	.0132	40	2-15	10-11
9	WBR-106	West Baton Rouge	-1.5	-1.67	.0693	40	3-11	10-11
10	WF-40	West Feliciana	-.2	-.37	.0002	40	2-22	10-7
Wells screened in the Hammond aquifer								
Ta-268	**Ta-268**	Tangipahoa	-1.4	-0.75	0.0069	40	3-14	10-17
11	Ta-343	Tangipahoa	-1.2	-.85	<.0001	40	3-1	10-17
Wells screened in the "2,400-foot" sand of the Baton Rouge area								
12	EB-322	East Baton Rouge	-2.0	-1.53	<0.0001	40	3-11	10-5
13	EB-804B	East Baton Rouge	--	-2.65	<.0001	49	1-12	12-7
14	EB-806B	East Baton Rouge	-3.5	-3.37	<.0001	39	2-13	10-4
15	Li-185	Livingston	-1.9	-1.68	<0.0001	41	3-11	10-11

Table 5. Summary of water-level trends for selected wells screened in the Jasper equivalent aquifer system in southeastern Louisiana.—Continued

[Source: Louisiana Department of Transportation and Development—U.S. Geological Survey Cooperative Program monitor-well network. Well with hydrograph (fig. 16) is in bold. –, no data; <, less than]

Reference number on map (fig. 15)	Well name	Parish	Historical water-level change, 1990-2000, in feet per year[1]	Water-level change, 1996-2005, in feet per year[2]	Level of significance 1996-2005[3]	Number of observations 1996-2005[4]	Period of record analyzed[5]: Begin date, 1996	Period of record analyzed[5]: End date, 2005
16	PC-70	Pointe Coupee	-1.1	-.82	<.0001	40	2-16	10-10
WBR-100B	**WBR-100B**	West Baton Rouge	-3.5	-2.95	<.0001	49	1-22	11-16
17	WF-22D	West Feliciana	-.6	-.28	.0199	40	2-22	10-7
18	WF-222	West Feliciana	-1.4	-1.00	<.0001	39	3-13	10-7
19	WF-286	West Feliciana	--	-1.04	<.0001	38	3-14	10-7
Wells screened in the Amite aquifer								
20	Ta-260	Tangipahoa	-1.0	-0.49	<0.0001	39	2-29	10-17
21	Wa-158	Washington	--	-2.66	.0002	39	3-12	10-18
Wells screened in the "2,800-foot" sand of the Baton Rouge area								
22	EB-468	East Baton Rouge	-1.9	-1.21	<0.0001	40	2-14	10-5
23	EB-581	East Baton Rouge	-1.6	-1.19	<.0001	40	2-15	10-5
EB-944	**EB-944**	East Baton Rouge	-1.7	-1.23	<.0001	77	1-12	10-6
24	EB-1000	East Baton Rouge	-1.6	-1.27	<.0001	43	1-11	10-5
25	EF-185	East Feliciana	--	-.98	<.0001	41	2-22	10-7
26	EF-223	East Feliciana	--	-1.22	<.0001	41	2-22	10-7
27	PC-143	Pointe Coupee	-.7	-.45	<.0001	40	2-16	10-10
28	WF-274	West Feliciana	-1.5	-.84	<.0001	40	3-14	10-7

[1] Tomaszewski and others (2002, p. 20-22).

[2] Computed slope in the trend line using method of ordinary least squares linear regression. The slope is equivalent to the change in water level, in feet per year, during the period analyzed.

[3] Probability that water-level change is due to chance rather than trend; values less than 0.05 generally are considered statistically significant.

[4] Total number of water-level measurements used to determine the slope in the trend line during the period analyzed.

[5] Dates (month-day) of first and last measurement of period analyzed.

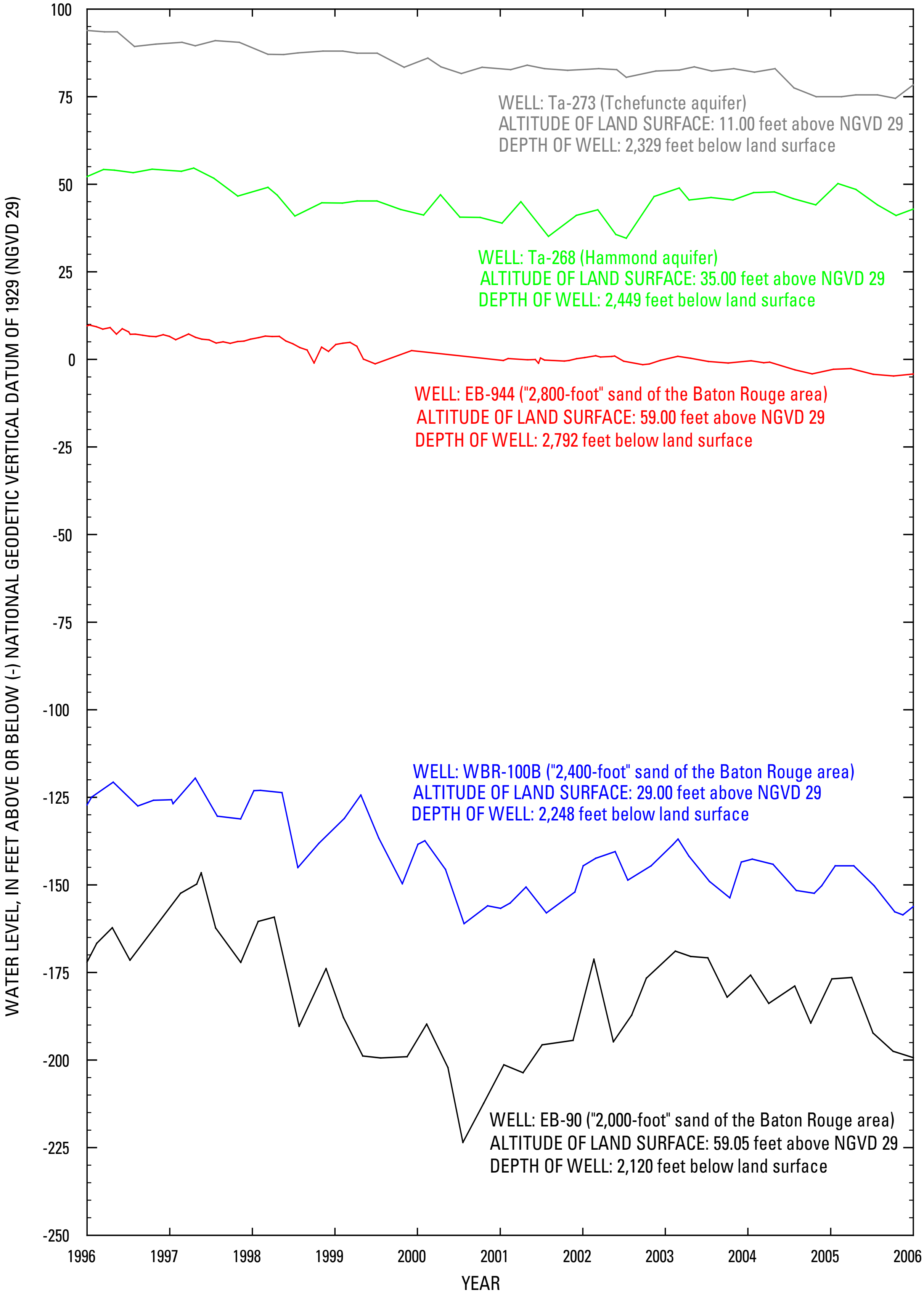


Figure 16. Water levels at selected wells screened in the Jasper equivalent aquifer system in sotheastern Louisiana, 1996–2005. See figure 15 for locations of wells.

Sparta Aquifer in North-Central Louisiana

The Sparta aquifer in north-central Louisiana (fig. 17) was the sixth most extensively pumped aquifer or aquifer system in the State in 2005. About 68 Mgal/d was withdrawn for various categories of use as follows: public supply, 53 percent; industry, 44 percent; and other, 3 percent. In 2005, the largest withdrawals from the aquifer were in Ouachita Parish (22.3 Mgal/d), Bienville Parish (12.1 Mgal/d), Lincoln Parish (7.8 Mgal/d), and Webster Parish (7.4 Mgal/d) (Sargent, 2007, p. 102). These four parishes accounted for about 73 percent of the water withdrawn from the aquifer. Withdrawals in other parishes were less than 6 Mgal/d each.

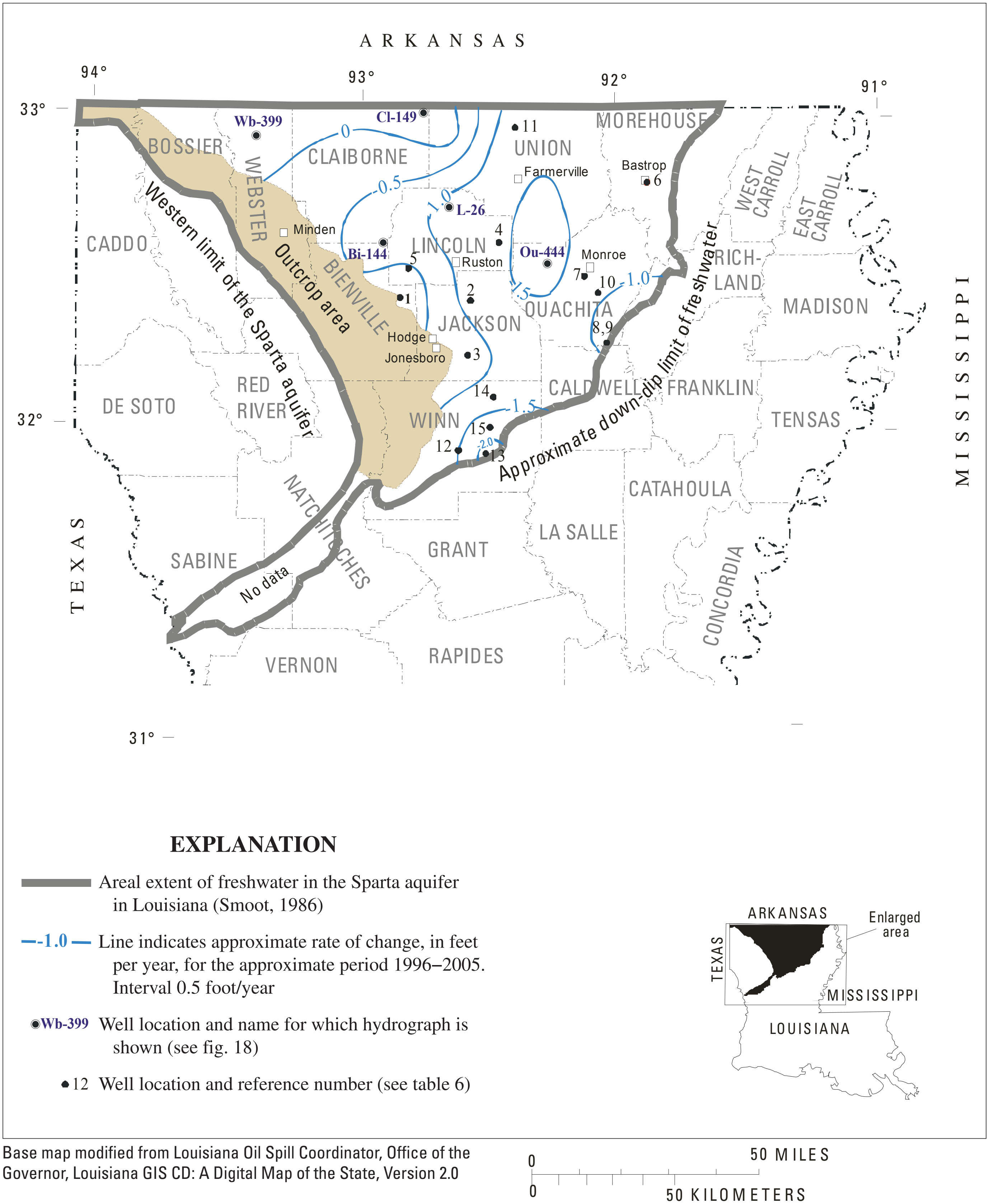
Ground-water withdrawals have substantially lowered water levels in the Sparta aquifer. In 1980, a regional cone of depression extended from the Monroe-Bastrop area northwest into Arkansas (Ryals, 1980). By spring 2001 (Schrader, 2004), the regional cone of depression extended from Ouachita Parish northwest into Arkansas with smaller, individual cones in central Winn Parish, western Jackson Parish, and south-central Lincoln Parish.

Water-level data from 20 wells screened in the Sparta aquifer indicate water-level changes ranged from about -2.2 to +0.2 ft/yr during the period 1996-2005 (table 6). These data were used to construct a map showing generalized water-level trends in the aquifer for the same period (fig. 17). Water levels declined throughout most of the Sparta aquifer with the exception of the northwestern area. The greatest rate of decline, greater than 2 ft/yr, was in southeastern Winn Parish. Declines generally were less than 1.5 ft/yr in most of the aquifer. A comparison of water-level changes for the periods 1990-2000 (Tomaszewski and others, 2002) and 1996-2005 (table 6) indicates water levels generally are declining at a lower rate; 9 of 11 wells have improved rates of change. Contributing factors to lower rates of change between 1996 and 2005 include decreased withdrawals in Bienville Parish (from 16.4 Mgal/d in 1995 to 12.1 Mgal/d in 2005) and Jackson Parish (from 5.7 Mgal/d in 1995 to 2.0 Mgal/d in 2005).

Hydrographs showing water-level trends in the Sparta aquifer for the period 1996-2005 are presented in figure 18. During this period, water levels in well Ou-444, located in Ouachita Parish, declined at an average rate of 1.9 ft/yr. This rate is lower than the 10-year period 1990-2000 when the rate of decline was determined to be 2.6 ft/yr (table 6). Ouachita Parish withdrew the most water from the Sparta aquifer in 1995 (19.8 Mgal/d), 2000 (23.2 Mgal/d), and 2005 (22.3 Mgal/d).

Water levels in well Bi-144 (fig. 18), located in Bienville Parish, declined at an average rate of 1.0 ft/yr during the period 1996-2005 . This rate of change is slightly more than the historical decline of 0.8 ft/yr determined for the period 1990-2000 (table 6). Water levels in well L-26 (fig. 18), located in Lincoln Parish, declined at an average rate of 1.3 ft/yr during the period 1996-2005. This rate of change is lower than the historical decline of 1.7 ft/yr determined during the period 1990-2000.

In Union County, Arkansas, located north and northwest of Union Parish, Louisiana, conservation efforts are underway to decrease withdrawals from 21 Mgal/d (1997) to 6 Mgal/d. The goal of this effort is to allow water levels to recover to a level that can be maintained through managed ground-water withdrawals (Yeatts, 2004). The conservation efforts in Arkansas have affected water levels in the Sparta aquifer in Louisiana; water levels in northern Claiborne Parish have been rising since about 2000 (fig. 18, well Cl-149). Water levels in well Cl-149 declined about 2.0 ft/yr during the historical period 1990-2000 (table 6) in response to withdrawals in Arkansas and Louisiana but rose about 0.2 ft/yr during the period 1996-2005. Withdrawal rates in Claiborne Parish were 2.8 Mgal/d in 1995, 3.0 Mgal/d in 2000, and 2.5



Base map modified from Louisiana Oil Spill Coordinator, Office of the Governor, Louisiana GIS CD: A Digital Map of the State, Version 2.0

Figure 17. Rate of water-level change in the Sparta aquifer in north-central Louisiana, 1996–2005.

Table 6. Summary of water-level trends for selected wells screened in the Sparta aquifer in north-central Louisiana.

[Source: Louisiana Department of Transportation and Development—U.S. Geological Survey Cooperative Program monitor-well network. Well with hydrograph (fig. 18) is in bold. --, no data; <, less than]

Reference number on map (fig. 17)	Well name	Parish	Historical water-level change, 1990-2000, in feet per year[1]	Water-level change, 1996-2005, in feet per year[2]	Level of significance 1996-2005[3]	Number of observations 1996-2005[4]	Period of record analyzed[5]	
							Begin date, 1996	End date, 2005
Bi-144	**Bi-144**	Bienville	-0.8	-0.96	<0.0001	44	3-1	10-4
1	Bi-166	Bienville	-1.0	-.09	.0003	41	3-1	10-4
Cl-149	**Cl-149**	Claiborne	-2.0	.23	.0184	43	3-1	10-6
2	Ja-147	Jackson	-1.7	-1.19	<.0001	61	1-2	10-5
3	Ja-148	Jackson	--	-.70	<.0001	20	10-2	10-6
L-26	**L-26**	Lincoln	-1.7	-1.28	<.0001	44	2-29	10-6
4	L-68	Lincoln	--	-1.39	<.0001	23	10-10	10-6
5	L-113	Lincoln	--	-.45	.0475	16	10-8	10-7
6	Mo-5	Morehouse	-1.3	-1.05	<.0001	40	1-9	10-5
7	Ou-80	Ouachita	-5.2	-1.10	<.0001	247	1-2	10-7
8	Ou-402	Ouachita	--	-.89	<.0001	22	3-21	9-19
9	Ou-403	Ouachita	--	-.93	<.0001	21	3-21	9-19
10	Ou-405	Ouachita	--	-1.05	<.0001	19	3-26	11-8
Ou-444	**Ou-444**	Ouachita	-2.6	-1.85	<.0001	45	1-4	12-19
11	Un-84	Union	--	-1.45	<.0001	32	10-24	12-20
12	W-28	Winn	-2.6	-1.45	<.0001	41	1-4	10-6
13	W-144B	Winn	--	-2.19	<.0001	21	3-14	9-8
14	W-172	Winn	-1.1	-1.19	<.0001	43	1-4	10-6
15	W-179	Winn	--	-1.83	<.0001	23	3-14	9-8
Wb-399	**Wb-399**	Webster	-.1	.18	.0014	45	1-18	10-3

[1] Tomaszewski and others (2002, p. 15).

[2] Computed slope in the trend line using method of ordinary least squares linear regression. The slope is equivalent to the change in water level, in feet per year, during the period analyzed.

[3] Probability that water-level change is due to chance rather than trend; values less than 0.05 generally are considered statistically significant.

[4] Total number of water-level measurements used to determine the slope in the trend line during the period analyzed.

[5] Dates (month-day) of first and last measurement of period analyzed.

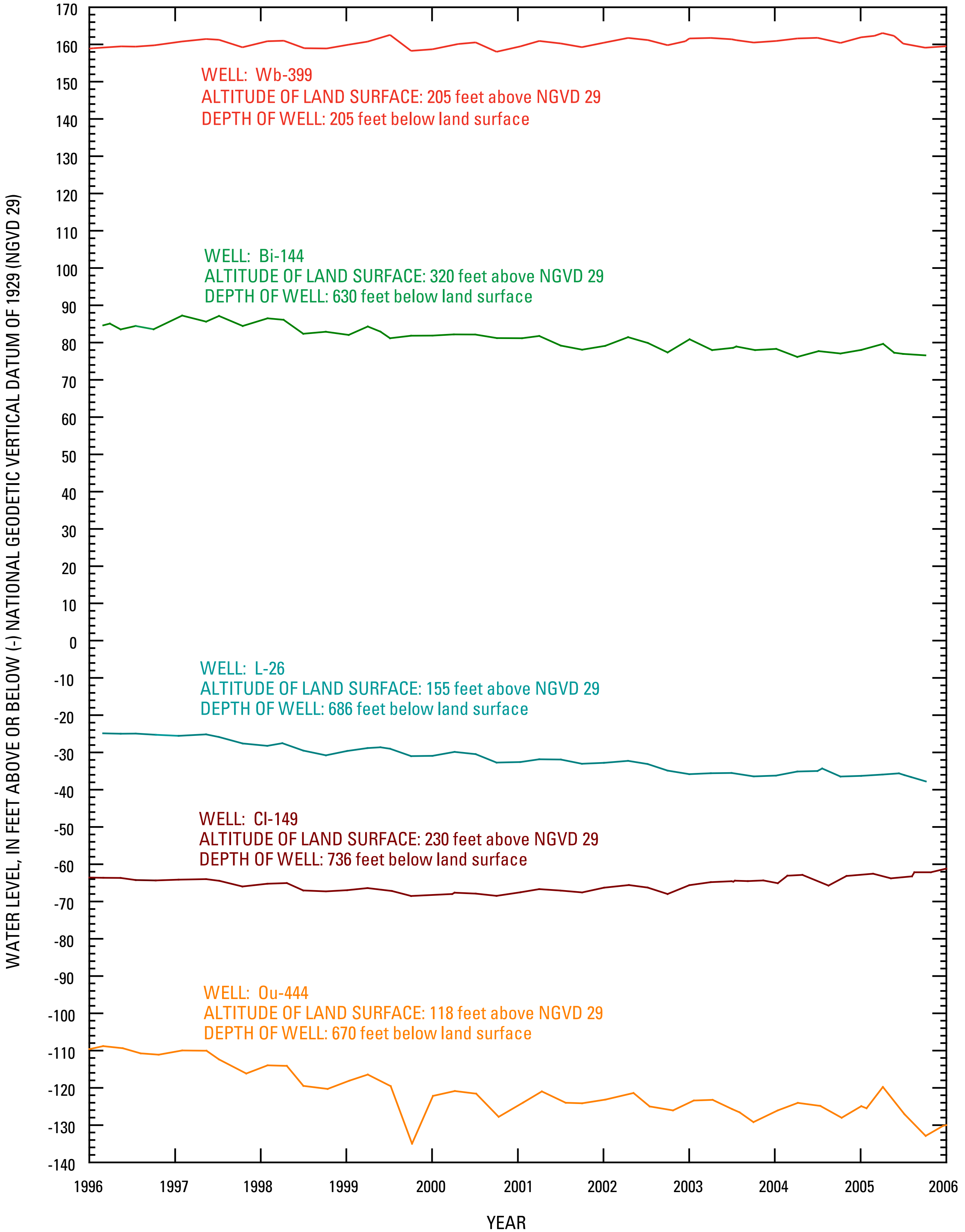


Figure 18. Water levels at selected wells screened in the Sparta aquifer in north-central Louisiana, 1996–2005. See figure 17 for locations of wells.

Mgal/d in 2005. Water levels in well Wb-399 (fig. 18), located in northern Webster Parish near the outcrop area of the Sparta aquifer, are representative of water levels in many wells in or near the outcrop area. Water levels in well Wb-399 fluctuated seasonally with a rise of 0.2 ft/yr during the period 1996-2005.

Stream Withdrawals and Discharge Trends

In 2005, about 8,727 Mgal/d of surface water (Sargent, 2007) was withdrawn in Louisiana and used for various categories as follows: power generation, 59 percent; industry, 33 percent; public supply, 4 percent; and the remainder for irrigation, aquaculture, and livestock (fig. 19). Most surface-water withdrawals occurred near the larger cities and in parishes along the Mississippi River south of Baton Rouge. About 76 percent of all surface-water withdrawals in Louisiana in 2005 was from the Mississippi River. Total surface-water withdrawals increased nearly 3 percent from 1995 to 2005 (fig. 20).

Discharge trends are based on the analysis of daily discharge records from 34 continuous-record streamflow-gaging stations (table 7). The locations of the continuous-record streamflow-gaging stations are shown in figure 3. Only those continuous-record streamflow-gaging stations containing daily mean data for the period 1996-2005 were used in the analysis. Only one of the stations analyzed had a significant trend in discharge; Red Chute Bayou at Sligo, in northwestern Lousiana, had a decline in discharge of about 76 $ft^3/s/yr$ during the period 1996-2005 (table 7). The decline in discharge cannot be explained simply as a result of decreased rainfall and could be due to control structures on Bayou Bodcau, a major tributary to Red Chute Bayou. There are no reported surface-water withdrawals from Red Chute Bayou or Bayou Bodcau.

Summary

In 2005, approximately 10,299 Mgal/d (million gallons per day) of water was withdrawn from ground-water and surface-water sources in Louisiana; about 15 percent (1,572 Mgal/d) was ground water, and about 85 percent (8,727 Mgal/d) was surface water. Total water withdrawals in the State increased about 6 percent from 1995 to 2005. Approximately 92 percent of the ground water withdrawn was from six aquifers or aquifer systems: the Chicot aquifer system (42 percent), Mississippi River alluvial aquifer (26 percent), Jasper equivalent aquifer system (8 percent), Chicot equivalent aquifer system (7 percent), Evangeline equivalent aquifer system (6 percent), and Sparta aquifer (4 percent). Approximately 83 percent of ground-water withdrawals in 2005 were for irrigation, public supply, and industry.

Water-level trends in the six selected aquifers and aquifer systems were determined for the approximate period 1996-2005 using water-level data collected from 151 wells. The Chicot, Evangeline equivalent, and Jasper equivalent aquifer systems, and the Sparta aquifer, contain areas where declines in ground-water levels were greater than or equal to 1 ft/yr (foot per year) during the approximate period 1996-2005.

The Mississippi River alluvial aquifer was the second most extensively pumped aquifer in the State in 2005. About 402 Mgal/d of water was withdrawn for various categories of use as follows: irrigation, 72 percent; aquaculture, 16 percent; industry, 8.4 percent; public supply, 2.4 percent; and 1.2 percent for other uses. Withdrawal rates have risen since 1995 mainly because of increased irrigation and aquaculture withdrawals. The greatest increases in withdrawal rates from 1995 to 2005 were in Morehouse (from 21

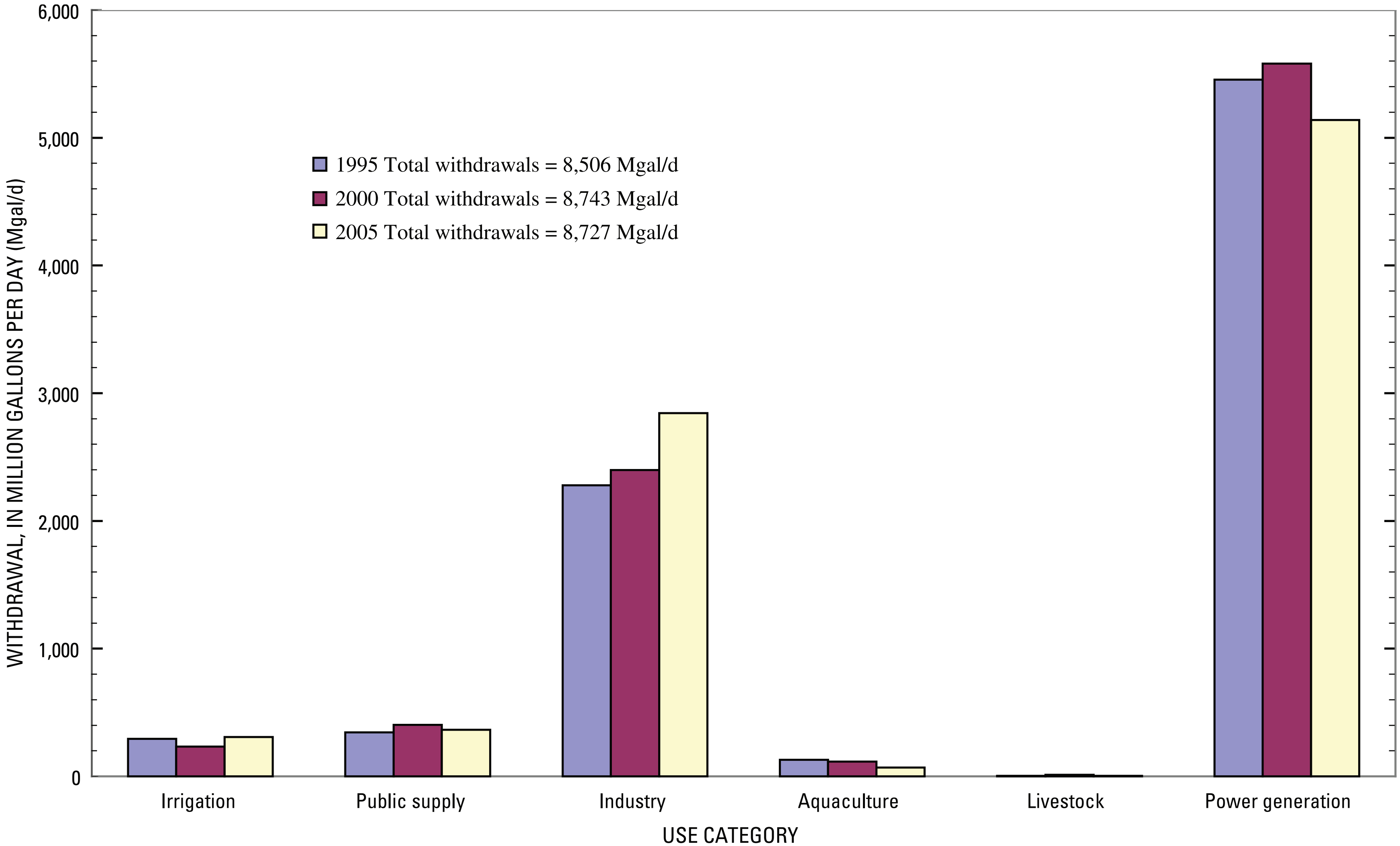


Figure 19. Surface-water withdrawals in Louisana by use in 1995, 2000, and 2005 (J.K. Lovelace, written commun.; U.S. Geological Survey, 2006; Sargent, 2002; Sargent, 2007).

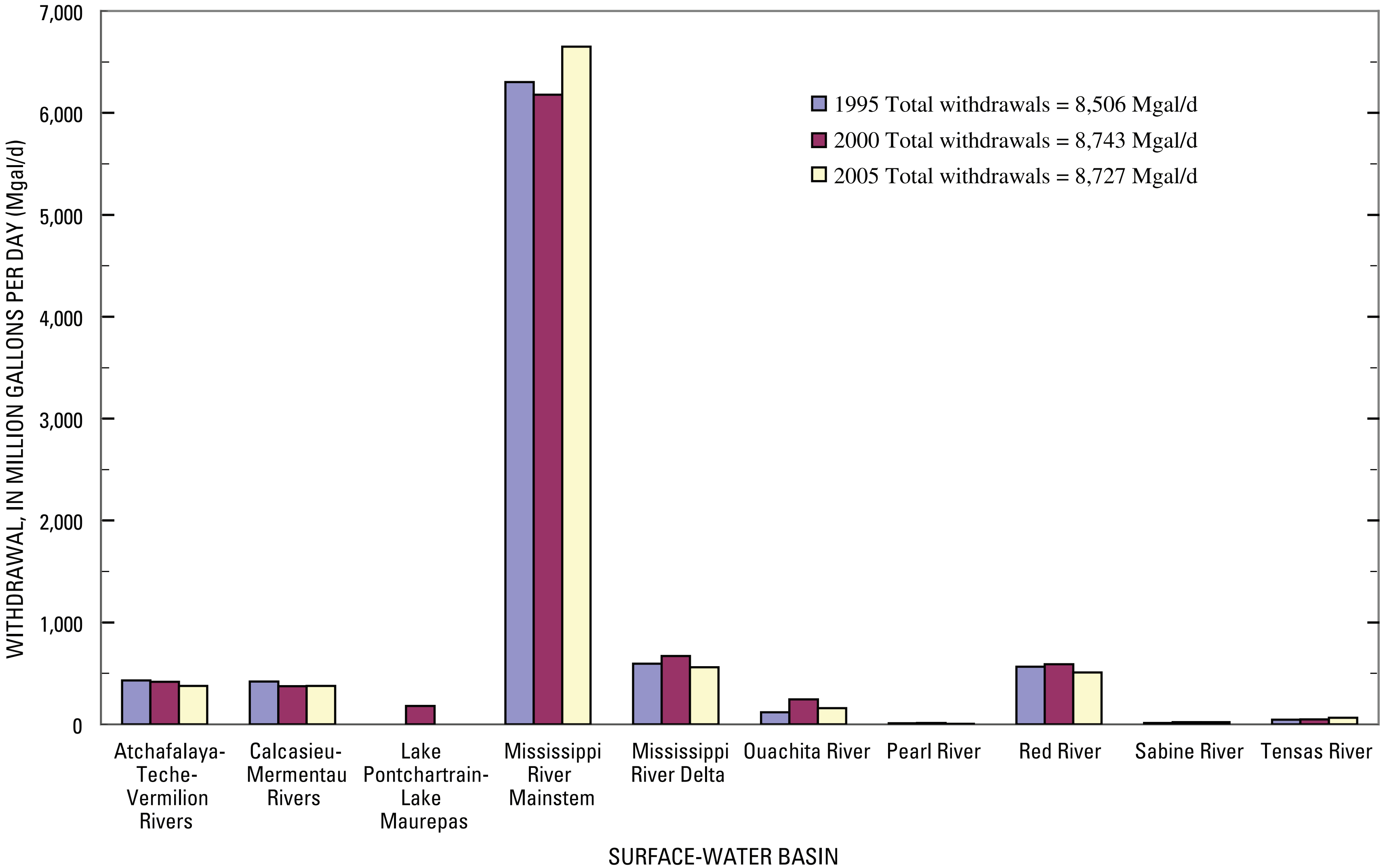


Figure 20. Surface-water withdrawals from major basins in Louisana in 1995, 2000, and 2005 (J.K. Lovelace, written commun.; U.S. Geological Survey, 2006; Sargent, 2002; Sargent, 2007).

Table 7. Summary of discharge trends for selected sites in major surface-water basins in Louisiana, 1996–2005.

[Data are for the period of record Jan. 1, 1996, through Dec. 31, 2005 (120 months); (ft^3/s)/yr, cubic feet per second per year]

Reference number on map (fig. 3)	Site number	Site name	Drainage area (square miles)	Change in discharge, in (ft^3/s)/yr[1]	Level of significance[2]
		Pearl River Basin			
1	02489500	Pearl River near Bogalusa	6,573	-0.85	0.9978
2	02492000	Bogue Chitto River near Bush	1,213	-5.22	.9249
		Red River Basin			
3	07348700	Bayou Dorcheat near Springhill	605	-26.60	0.4149
4	07349860	Red Chute Bayou at Sligo	980	-75.78	.0475
5	07351500	Cypress Bayou near Keithville	66	-4.14	.3743
6	07351750	Bayou Pierre near Lake End	860	-17.71	.6695
7	07352000	Saline Bayou near Lucky	154	-.96	.9065
		Ouachita River Basin			
8	07364200	Bayou Bartholomew near Jones	1,187	12.17	0.8066
9	07366200	Little Corney Bayou near Lillie	208	-3.22	.7342
13	07373000	Big Creek at Pollock	51	.61	.7285
		Tensas River Basin			
10	07368000	Boeuf River near Girard	1,226	4.24	0.4302
11	07369000	Bayou Lafourche near Crew Lake	361	-28.44	.7210
12	07369500	Tensas River at Tendal	309	-5.26	.7409
		Lake Pontchartrain-Lake Maurapas Basin			
14	07375000	Tchefuncte River near Folsom	103	-2.07	0.6636
15	07375500	Tangipahoa River at Robert	646	1.27	.9649
16	07376000	Tickfaw River at Holden	247	-3.40	.7602
17	07376500	Natalbany River at Baptist	79.5	-3.40	.4107
18	07377000	Amite River near Darlington	580	-23.84	.3245
19	07377500	Comite River near Olive Branch	145	-3.15	.7270
20	07377782	White Bayou southeast of Zachary	45	.09	.9770
21	07378000	Comite River near Comite	284	2.27	.9128
22	07378500	Amite River near Denham Springs	1,280	-15.97	.8295
		Atchafalaya-Teche-Vermilion River Basin			
23	07382000	Bayou Cocodrie near Clearwater	240	10.73	0.3961
24	07382500	Bayou Courtableau at Washington	715	31.35	.3430
25	07383500	Bayou Des Glaises Diversion Channel at Moreauville	270	12.04	.3529
		Calcasieu-Mermentau River Basin			
26	08010000	Bayou Des Cannes near Eunice	131	7.92	0.4803
27	08012000	Bayou Nezpique near Basile	527	23.77	.4751
28	08013000	Calcasieu River near Glenmora	499	-5.36	.8649
29	08013500	Calcasieu River near Oberlin	753	40.68	.3688

Table 7. Summary of discharge trends for selected sites in major surface-water basins in Louisiana, 1996–2005.

[Data are for the period of record Jan. 1, 1996, through Dec. 31, 2005 (120 months); (ft^3/s)/yr, cubic feet per second per year]

Reference number on map (fig. 3)	Site number	Site name	Drainage area (square miles)	Change in discharge, in (ft^3/s)/yr[1]	Level of significance[2]
30	08014500	Whiskey Chitto Creek Near Oberlin	510	12.78	.5887
31	08015500	Calcasieu River near Kinder	1,700	35.49	.6884
		Sabine River Basin			
32	08023080	Bayou Grand Cane near Stanley	72.5	0.14	0.9738
33	08025500	Bayou Toro near Toro	148	5.43	.4732
34	08028000	Bayou Anacoco near Rosepine	365	18.12	.3733

[1] Computed change in discharge using method of ordinary least squares linear regression. The change in discharge is equal to the slope in the trend line for the period analyzed.

[2] Probability that the change in discharge is due to chance rather than trend; values less than 0.05 generally are considered statistically significant.

to 83 Mgal/d) and Franklin (from 21 to 46 Mgal/d) Parishes. Water-level data from 15 wells screened in the Mississippi River alluvial aquifer were statistically analyzed. Rates of water-level change ranged from about -0.4 to +0.2 ft/yr. During the period 1996-2005, no regionally extensive areas of decline (less than or equal to -0.5 ft/yr) or rise (greater than or equal to 0.5 ft/yr) were determined. With the exception of well Ib-106 in Iberville Parish, wells used in the analysis are located in the northern half of Louisiana.

The Chicot aquifer system was the most extensively pumped aquifer or aquifer system in the State in 2005. About 662 Mgal/d of water was withdrawn for various categories of use as follows: rice irrigation, 57 percent; aquaculture, 17 percent; public supply, 14 percent; industry, 9 percent; and other uses, 3 percent. The water-level surface throughout most of the Chicot aquifer system is greatly influenced by seasonal withdrawals for rice irrigation. In the Lake Charles area, ground-water withdrawals for industry and public supply also affect water levels. Rates of water-level change for 26 wells were used to construct a map showing generalized water-level trends in the Chicot aquifer system for the period 1996-2005. Water levels generally declined between 0 and 1.1 ft/yr in the rice-growing areas. In Calcasieu Parish, water levels generally rose in response to decreased withdrawals from the “500-foot” sand of the Lake Charles area.

The Chicot equivalent aquifer system in southeastern Louisiana was the fourth most extensively pumped aquifer or aquifer system in the State in 2005. The Chicot equivalent aquifer system generally contains freshwater north of the Baton Rouge fault. South of the fault and downdip, freshwater often is underlain or replaced with saltwater. There are areas of freshwater in the upper part of the aquifer system that extend as far south as New Orleans. About 107 Mgal/d was withdrawn for various categories of use as follows: industry, 51 percent; aquaculture, 17 percent; rural domestic and livestock, 15 percent; public supply, 12 percent; power generation, 3 percent; and irrigation, 1 percent.

Water-level data from 26 wells screened in the Chicot equivalent aquifer system indicate water-level changes ranged from about -0.8 to +2.1 ft/yr during the period 1996-2005. A comparison of water-level changes for the periods 1990-2000 and 1996-2005 indicates water levels in the “400-foot” and “600-foot” sands are declining at lower rates or rising. Since the early 1970’s, water levels have risen in the New Orleans area in response to decreased ground-water withdrawals.

The Evangeline Equivalent aquifer system in southeastern Louisiana was the fifth most extensively pumped aquifer or aquifer system in the State in 2005. About 87 Mgal/d was withdrawn for various categories of use as follows: public supply, 68 percent; industry, 24 percent; power generation, 5 percent; and other, 3 percent. The aquifer system generally contains saline water south of the Baton Rouge fault. Water-level data from 31 wells screened in the Evangeline equivalent aquifer system indicate water-level changes ranged from about -5.5 to +0.5 ft/yr during the period 1996-2005. In the deep aquifers of the system, rates of water-level decline were greatest in East and West Baton Rouge Parishes and can be attributed to ground-water withdrawals. A comparison of water-level changes for the periods 1990-2000 and 1996-2005 indicates water levels in the “800-foot” sand generally are declining at a lower rate, while levels in the “1,200-foot” and “1,700-foot”sands generally are declining at a higher rate. Water levels generally declined in the “1,500-foot” sand, lower Ponchatoula, Big Branch, Kentwood, Abita, and Slidell aquifers during the period 1996-2005.

The Jasper equivalent aquifer system in southeastern Louisiana was the third most extensively pumped aquifer or aquifer system in the State in 2005. About 126 Mgal/d was withdrawn for various categories of use as follows: public-supply, 57 percent; industry, 38 percent; power generation, 4 percent; and other, 1 percent Water-level data from 33 wells screened in the Jasper equivalent aquifer system indicate water-level changes ranged from about -3.9 to -0.3 ft/yr during the period 1996-2005. The greatest rate of water-level decline, greater than 3 ft/yr, was in East Baton Rouge Parish and can be attributed to ground-water withdrawals. A comparison of water-level changes for the periods 1990-2000 and 1996-2005 indicates inconsistent water-level changes in the “2,000-foot” sand, while water levels in the “2,400-foot” and “2,800-foot” sands generally are declining at lower rates.

The Sparta aquifer in north-central Louisiana was the sixth most extensively pumped aquifer or aquifer system in the State in 2005. About 68 Mgal/d was withdrawn for various categories of use as follows: public supply, 53 percent; industry, 44 percent; and other, 3 percent. Ground-water withdrawals have substantially lowered water levels in the Sparta aquifer.

Water-level data from 20 wells screened in the Sparta aquifer indicate water-level changes ranged from about -2.2 to +0.2 ft/yr during the period 1996-2005. Water levels declined throughout most of the Sparta aquifer with the exception of the northwestern area. The greatest rate of water-level decline, greater than 2 ft/yr, was in southeastern Winn Parish. Declines generally were less than 1.5 ft/yr in most of the aquifer. A comparison of water-level changes for the periods 1990-2000 and 1996-2005 indicate water levels generally are declining at a lower rate; 9 of 11 wells have improved rates of change. Contributing factors to lower rates of change between 1996 and 2005 include decreased withdrawals in Bienville Parish (from 16.4 Mgal/d in 1995 to 12.1 Mgal/d in 2005) and Jackson Parish (from 5.7 Mgal/d in 1995 to 2.0 Mgal/d in 2005). Ouachita Parish withdrew the most water from the Sparta aquifer in 1995 (19.8 Mgal/d), 2000 (23.2 Mgal/d), and 2005 (22.3 Mgal/d). Conservation efforts in Arkansas have affected water levels in the Sparta aquifer in Louisiana; water levels in northern Claiborne Parish have been rising since about 2000.

In 2005, about 8,727 Mgal/d of surface water was withdrawn in Louisiana and used for various categories as follows: power generation, 59 percent; industry, 33 percent; public supply, 4 percent; and the remainder for irrigation, aquaculture, and livestock. Most surface-water withdrawals occurred near the larger cities and in parishes along the Mississippi River south of Baton Rouge. About 76 percent of all surface-water withdrawals in Louisiana in 2005 was from the Mississippi River. Total surface-water withdrawals increased nearly 3 percent from 1995 to 2005. Discharge trends are based on the analysis of daily discharge records from 34 continuous-record streamflow-gaging stations. Only those continuous-record streamflow gaging-stations containing daily mean data for the period 1996-2005 were used in the analysis. Only one of the stations analyzed had a significant trend in discharge; Red Chute Bayou at Sligo, in northwestern Lousiana, had a decline in discharge of about 76 cubic feet per second per year during the period 1996-2005. The decline in discharge cannot be explained simply as a result of decreased rainfall and could be due to control structures on Bayou Bodcau, a major tributary to Red Chute Bayou. There are no reported surface-water withdrawals from Red Chute Bayou or Bayou Bodcau.

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Glossary

[Source: Sargent (2007, p. 6)]

Aquaculture withdrawal refers to the withdrawal of water for purposes such as fish, crawfish, and alligator farming. Instream fish farming is not included in this category.

Industrial withdrawal refers to water withdrawn for industrial purposes such as process and production, boiler feed, air conditioning, cooling, sanitation, washing, and steam generation.

Irrigation withdrawal refers to any withdrawal of water for application to vegetation. This includes application to field crops such as rice, corn, cotton, fruit crops, nurseries, and special applications such as the watering of golf courses and sporting fields.

Livestock withdrawal refers to water withdrawn for use in the production of cattle, horses, sheep, swine, poultry, and other animals. The water can be used for livestock consumption, sanitation, and other on-farm needs.

Power-generation withdrawal refers to water withdrawn for thermoelectric power-generation purposes such as cooling, sanitation, washing, and steam generation. Use of water for hydroelectric power generation is considered an instream use and not a withdrawal. Therefore, hydroelectric power-generation use is not included in surface-water withdrawals.

Public-supply withdrawal refers to water withdrawn and delivered to a group of users by public and private water suppliers. Typically a public water supply is one that serves at least 25 people or has at least 15 connections on a year-round basis. The water is used for a variety of purposes such as domestic, commercial, industrial, and public water use. In some instances, a portion of public-supply withdrawals are conveyed to a large industrial facility that does not have its own water supply, and, thus, the water would be assigned to the public-supply category, when in actuality, it is used for industrial purposes.

Rural-domestic withdrawal refers to water withdrawn by a person or family for personal home use. These users are often in rural areas where public supplies are unavailable.