STATE OF LOUISIANA

DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

OFFICE OF PUBLIC WORKS AND INTERMODAL

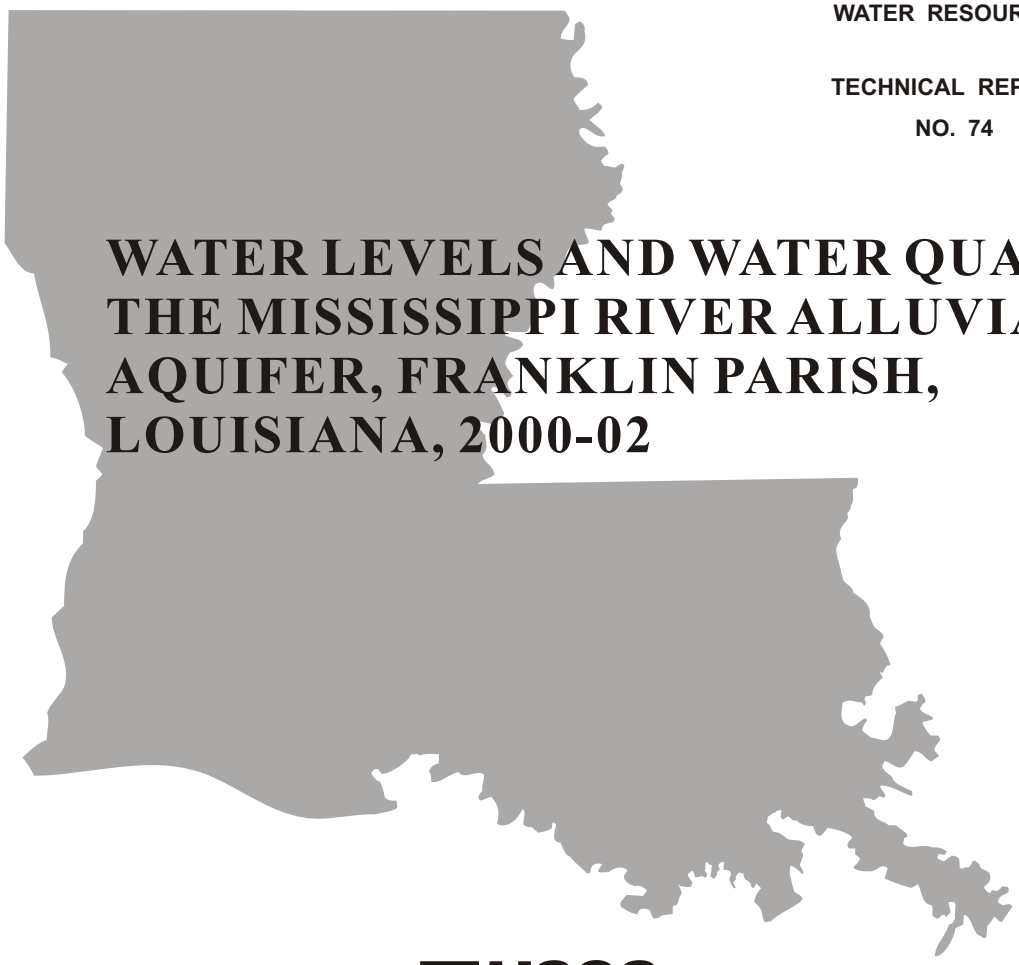
PUBLIC WORKS AND WATER RESOURCES DIVISION

WATER RESOURCES

TECHNICAL REPORT

NO. 74

WATER LEVELS AND WATER QUALITY IN THE MISSISSIPPI RIVER ALLUVIAL AQUIFER, FRANKLIN PARISH, LOUISIANA, 2000-02



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2004

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CONVERSION FACTORS, DATUMS, AND ABBREVIATED WATER-QUALITY UNITS

Multiply	By	To obtain
foot (ft)	0.3048	meter (m)
foot per day (ft/d)	0.3048	meter per day (m/d)
foot per year (ft/yr)	0.3048	meter per year (m/yr)
foot squared per day (ft^2/d)	0.0929	meter squared per day (m^2/d)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
gallon per minute (gal/min)	0.06309	liter per second (L/s)
million gallons per day (Mgal/d)	3,785	cubic meter per day (m^3/d)

Transmissivity: In this report, the mathematically reduced form for transmissivity, foot squared per day (ft^2/d), is used for convenience. The standard unit for transmissivity is cubic foot per day per square foot times foot of aquifer thickness [(ft^3/d)/ft^2]ft.

Temperature in degrees Celsius (^oC) can be converted to degrees Fahrenheit (^oF) as follows: $^oF = 1.8(^oC) + 32$.

Horizontal coordinate information in this report is referenced to the North American Datum of 1983.

Vertical coordinate information in this report is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada.

Abbreviated water-quality units:

milligrams per liter (mg/L)
milliequivalents per liter (meq/L)
microsiemens per centimeter at 25 degrees Celsius (μS/cm)

WATER LEVELS AND WATER QUALITY IN THE MISSISSIPPI RIVER ALLUVIAL AQUIFER, FRANKLIN PARISH, LOUISIANA, 2000-02

By Ronald C. Seanor and Wade H. Kress

ABSTRACT

Water levels were measured in 82 wells in October 2001, and water-quality samples were collected at 25 wells in April-May 2002 as part of an investigation of the Mississippi River alluvial aquifer in Franklin Parish, Louisiana. Ground-water withdrawals from the aquifer have been increasing since 1960; the largest use of water in the parish is for aquaculture and irrigation.

Water levels ranged from 29.37 feet above the National Geodetic Vertical Datum of 1929 (NGVD 29) in southwest Franklin Parish to 64.99 feet above NGVD 29 in north-central Franklin Parish. The general direction of ground-water flow in the Mississippi River alluvial aquifer in Franklin Parish is to the south. Seasonal water-level fluctuations in the aquifer are generally less than 4 feet per year. Water-level data indicated no long-term trends, but the decline in water levels from 1998-2001 indicated the effects of drought. Cones of depression are not evident in the potentiometric surface of the aquifer, based on data collected for this report.

Chloride concentrations ranged from 7.7 to 3,150 mg/L (milligrams per liter) with a median value of 89 mg/L. Chloride concentrations indicated a slight increase from 1990-2002 in well Fr-720, but decreased in well Fr-721 during the same period. Areas of high chloride concentrations (greater than 250 mg/L) were present in central and north-central Franklin Parish, which generally coincides with historically documented areas of high chloride. Dissolved solids concentrations ranged from 200 to 6,160 mg/L, with a median value of 419 mg/L. Iron concentrations ranged from 0.006 to 11.4 mg/L, with a median value of 2.04 mg/L. Manganese concentrations ranged from <0.001 to 2.73 mg/L, with a median value of 0.307 mg/L.

INTRODUCTION

The Mississippi River alluvial aquifer is the primary source of water for aquaculture, agriculture, and public supply in Franklin Parish, Louisiana. In 2000, ground-water withdrawals from the aquifer in the parish were approximately 46.61 Mgal/d. Of that amount, aquaculture (22.94 Mgal/d) and irrigation (20.15 Mgal/d) accounted for 92.4 percent, and public supply (1.83 Mgal/d) accounted for 3.9 percent. Of the 28 parishes that withdrew water from the Mississippi River alluvial aquifer, Franklin Parish withdrew the most (13.2 percent, Sargent, 2002).

The water quality of the Mississippi River alluvial aquifer varies, both spatially and temporally. High concentrations of chloride (greater than 250 mg/L), iron (greater than 0.3 mg/L), and hardness (greater than 60 mg/L) represent the major water-quality concerns in the aquifer (Whitfield, 1975). Saltwater (chloride concentrations greater than 250 mg/L) is present in parts of Franklin Parish due to leakage of saltwater from

the underlying Cockfield aquifer. An increase in chloride concentrations in wells located in Winnsboro has been attributed to pumping that induces flow from saltwater areas of the Mississippi River alluvial aquifer (Whitfield, 1973).

Based on well registration records from the Louisiana Department of Transportation and Development (DOTD), Public Works and Water Resources Division, 920 wells were installed and screened in the Mississippi River alluvial aquifer in Franklin Parish from 1990-2002 (700 wells for irrigation, 175 for domestic supply, 10 for public supply, and 35 for other uses). The effects of withdrawals from these wells on the water quantity and quality of the aquifer in the parish are unknown. Farmers in Franklin Parish are concerned that increased withdrawals resulting from new well installations may decrease the amount of available water and affect the water quality in the aquifer. The U.S. Geological Survey (USGS), in cooperation with the DOTD, Public Works and Water Resources Division, studied water levels and water quality in the Mississippi River alluvial aquifer in Franklin Parish during 2000-02.

Purpose and Scope

This report presents water-level data collected in October 2000 to December 2002 and water-quality data collected in April-May 2002 from wells screened in the Mississippi River alluvial aquifer in Franklin Parish. The USGS collected water-level measurements and analyzed water from wells screened in the aquifer for selected physiochemical properties and chemical constituents. Water levels were measured once at 82 wells in Franklin Parish, and the data were used to construct a potentiometric-surface map of the aquifer in the parish. Water levels were measured monthly at 4 wells to evaluate seasonal changes. Water-quality data were collected from 25 wells in the parish. In this report, water use, potentiometric surface, and water-level trends are used to determine some of the effects, if any, caused by ground-water withdrawals from the Mississippi River alluvial aquifer in Franklin Parish. Specific conductance, pH, and temperature were measured in the field, and water-quality samples were collected for analysis of dissolved chloride, solids, iron, and manganese. Water-quality data are presented in tables, graphs, and a map to characterize the water quality in the aquifer. When possible, water-level and water-quality data were compared to historical data. The information about water levels and water quality in the Mississippi River alluvial aquifer in the parish may be useful to water-resources managers and aid decision-making to protect the resource.

Description of Study Area

Franklin Parish (fig. 1), located in northeastern Louisiana, covers approximately 624 mi^2 (U.S. Census Bureau, 2003). The altitude of land surface ranges from approximately 35 to 137 ft above NGVD 29. Franklin Parish is largely agricultural in land use and is sparsely populated, except in Winnsboro, the parish seat. According to the U.S. Census Bureau (2003), the population of Franklin Parish was 21,263 in 2000, and the population for the city of Winnsboro was 5,344.

Major physiographic regions in Franklin Parish are the terrace uplands, which extend through the center of the parish, and the undulating alluvial plains in the eastern and western edges of the parish (Martin and others, 1981, p. 1). The major streams in the parish are Big Creek, Boeuf River, Turkey Creek, Bayou Macon, and the Tensas River.

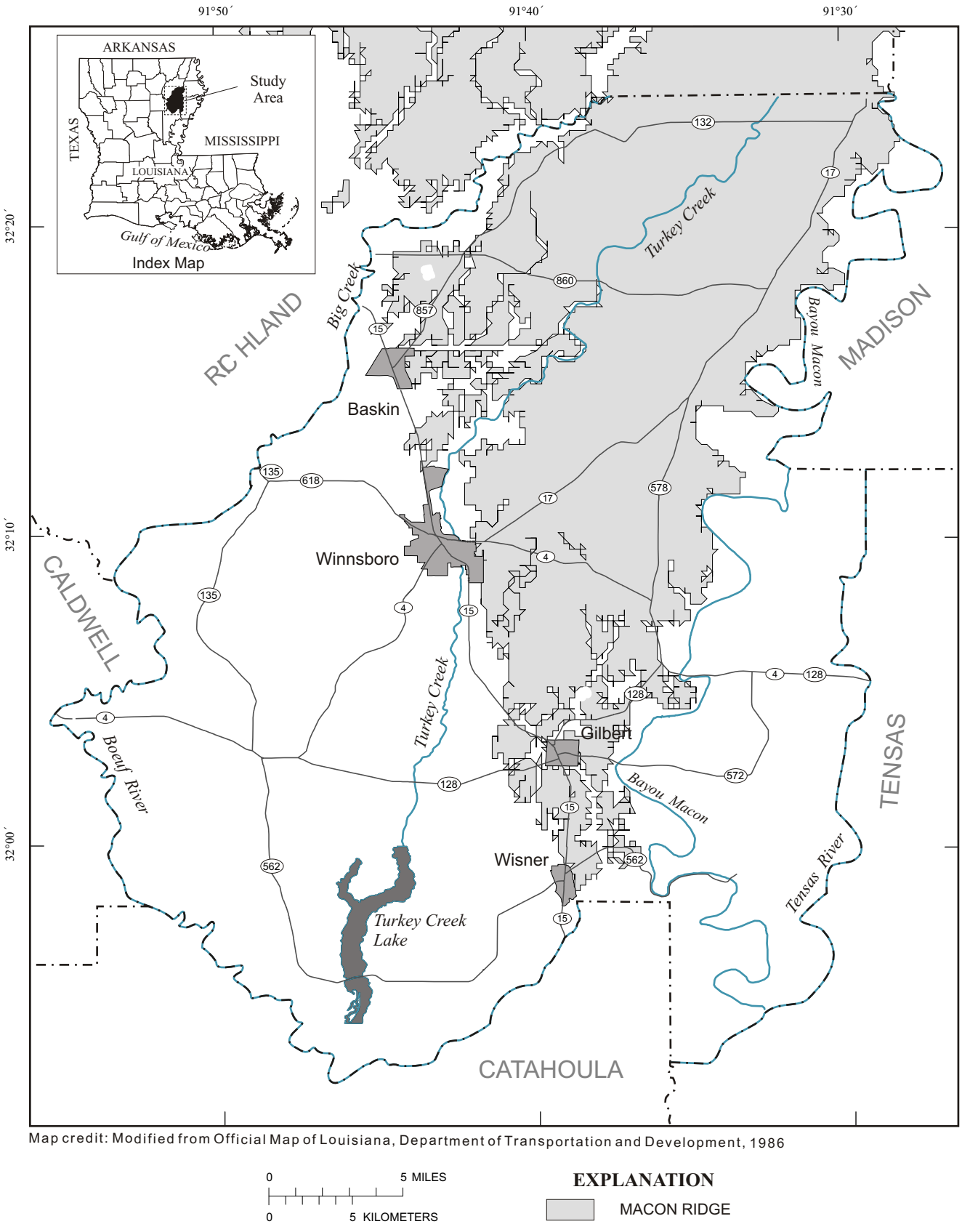


Figure 1. Location of study area, Franklin Parish, Louisiana.

Methods of Study

Water levels were measured at existing wells in accordance with methods described by the USGS (2001). Well locations were selected to give a uniform distribution throughout the parish, with additional locations concentrated around current and potential pumping centers.

Water-quality samples were collected from 25 wells in the parish, although not necessarily at wells where water-level measurements were made. Wells were selected using an equally spaced parish grid to ensure an even distribution of sampling sites. Wells with historical water-quality data were sampled when possible. Specific conductance, pH, and temperature were measured using portable meters, which were calibrated at the beginning of each data-collection day in accordance with the manufacturer's procedures. Samples were collected and processed in accordance with methods described by the USGS (variously dated) and shipped to the USGS Quality of Water Service Unit, Ocala, Florida, for analysis. Samples were analyzed for major ions, alkalinity, total dissolved solids, iron, and manganese. Methods used to analyze water samples are described by Fishman (1993), Fishman and Friedman (1989), and the U.S. Environmental Protection Agency (1994).

Sequential field replicates were completed for approximately 10 percent of the samples for quality-control purposes. A sequential field replicate sample is a quality-control sample collected after an environmental sample; both are analyzed for the same properties and constituents to assess the effects of field and laboratory procedures on measurement variability. All water-level and water-quality data were entered into the USGS National Water Information System (NWIS) data base, which is accessible on the Internet at Uniform Resource Locator *http://waterdata.usgs.gov.*

Previous Investigations

Many studies on the Mississippi River alluvial aquifer in northeastern Louisiana have been performed, but only one study focused specifically on Franklin Parish (Whitfield, 1973). Turcan and Meyer (1962) discussed the hydraulic properties of the aquifer and reported on the high yields available in properly constructed wells. Whitfield (1973) discussed the suitability of water in the aquifer for public supply in Winnsboro and the surrounding area. Whitfield (1975) discussed the hydrogeology of the aquifer and the water quality. A potentiometric-surface map of the aquifer was constructed in 1991 (Seanor and Smoot, 1995). Huff and Bonck (1993) discussed the origin of saltwater in the aquifer. McGee (1997) studied the occurrence of nitrate in the aquifer.

Acknowledgments

The authors gratefully acknowledge the assistance and cooperation of numerous farmers, industries, public-supply water systems, and private well owners who allowed access to wells used in this study. Carroll Pinnell-Alison, County Agent, Louisiana Cooperative Extension Service, provided assistance in contacting well owners throughout Franklin Parish. We also thank Zahir "Bo" Bolourchi, Chief, Public Works and Water Resources Division, Louisiana Department of Transportation and Development, for providing well information and assistance in the publication of this report.

HYDROGEOLOGY

The Mississippi River alluvial aquifer is present throughout northeastern Louisiana. The aquifer consists of alluvium adjacent to the Mississippi River. The alluvium grades downward from a silt and clay composition at the surface to coarse sand and gravel at the base of the alluvium. The lower coarse-grained part of the alluvium is considered the Mississippi River alluvial aquifer. The aquifer lies horizontally throughout Franklin Parish and is overlain by silt and clay and underlain by deposits of Tertiary age (Whitfield, 1975, p. 5). In Franklin Parish, these underlying units are the Cockfield Formation and the Jackson and Vicksburg Groups, undifferentiated (fig. 2). The aquifer thickens to the south and southeast toward the Mississippi River and ranges from 80 to 140 ft in thickness in Franklin Parish (Whitfield, 1975, pl. 1).

<table>
<tr><th>System</th><th>Series</th><th>Stratigraphic unit</th><th>Hydrogeologic unit</th></tr>
<tr><td rowspan="2">Quaternary</td><td>Holocene</td><td rowspan="2">Alluvial and terrace deposits</td><td>Mississippi River alluvial surficial confining unit</td></tr>
<tr><td>Pleistocene</td><td>Mississippi River alluvial aquifer</td></tr>
<tr><td rowspan="5">Tertiary</td><td>Pliocene</td><td>Absent in this area</td><td rowspan="2">Pliocene-Miocene aquifers are absent in this area</td></tr>
<tr><td>?
Miocene</td><td>Absent in this area</td></tr>
<tr><td>?
Oligocene</td><td>Vicksburg Group, undifferentiated</td><td rowspan="2">Vicksburg-Jackson confining unit</td></tr>
<tr><td rowspan="2">Eocene</td><td>Jackson Group, undifferentiated</td></tr>
<tr><td>Cockfield Formation</td><td>Cockfield aquifer or surficial confining unit</td></tr>
</table>

Figure 2. Partial hydrogeologic column of aquifers in Franklin Parish, Louisiana (modified from Lovelace and Lovelace, 1995, p. 10).

The silt and clay on Macon Ridge that overlie the aquifer are considered to be Pleistocene age, although the Mississippi River alluvial aquifer is Holocene to Pleistocene age. Silt and clay layers are thickest in backswamp areas due to the depositional conditions. These thick deposits have a low permeability and form a cap, which impedes infiltration of rainfall. Conversely, infiltration into the Mississippi River alluvial aquifer is relatively rapid through the permeable point-bar and natural-levee deposits adjacent to the streams that are hydraulically connected to the aquifer.

In some areas of Franklin Parish, the aquifer is confined by overlying clay referred to as the Mississippi River alluvial surficial confining unit. In areas where water levels are above the top of the aquifer, confined conditions occur. In other areas, water levels occur below the top of the aquifer, and unconfined conditions occur. Because the water levels fluctuate seasonally and as a result of pumping, the aquifer can be confined or unconfined (Turcan and Meyer, 1962, p. V8-V9; Whitfield, 1975, p. 5). During the study, water levels were under both confined and unconfined conditions.

The major source of recharge to the aquifer is rainfall, although recharge does occur from leakage of ground water from underlying aquifers and discharge from streams during high stages (Whitfield, 1975). Recharge from rainfall is dependent on the thickness and permeability of the overlying confining unit (Covay, 1985).

In northeastern Louisiana, the hydraulic characteristics of the Mississippi River alluvial aquifer are highly varied due to variations in the thickness of the aquifer and the size and sorting of the sand and gravel. Aquifer tests indicate transmissivity ranges from 13,000 to 45,000 ft^2/d; hydraulic conductivity ranges from 130 to 530 ft/d; and storage coefficients range from 0.001 to 0.05. The aquifer yields large quantities of water. Yields from wells can range from a few gallons per minute for small domestic wells to several thousand gallons per minute for large diameter wells (Whitfield, 1975, p. 9).

WATER LEVELS

Potentiometric Surface

The potentiometric-surface map (pl. 1) shows the altitude to which water would rise in tightly cased wells screened in the Mississippi River alluvial aquifer. Water levels used to construct the potentiometric surface were measured during the month of October 2001 (appendix 1). This time period represents the dry time of the year, after most pumping for general irrigation has ceased. The potentiometric surface was mapped using the altitude of the water levels measured in the wells and is represented on the map by contours that connect points of equal altitude. Water levels ranged from 29.37 ft above NGVD 29 at well Fr-882 in southwest Franklin Parish to 64.99 ft above NGVD 29 at well Fr-1323 in north-central Franklin Parish.

The general direction of ground-water flow is perpendicular to the potentiometric-surface contours. The contours indicate the direction of ground-water flow in Franklin Parish is generally toward the south (pl. 1). However, ground water associated with the Macon Ridge tends to move from the topographic high toward the east and west. In general, the contours are parallel and evenly spaced throughout the parish. The hydraulic gradient ranged from less than 1 to 4 ft/mi.

Water-Level Changes

Water levels at four existing wells were measured monthly during the study (October 2000 through November 2002) to determine seasonal fluctuations (fig. 3). The water levels are primarily influenced by rainfall, proximity to streams, and aquifer characteristics. Water-level fluctuations in the four wells were less than 4 ft/yr during 2000-02. Wells closer to larger streams exhibit greater fluctuations than wells farther away from the streams. The larger streams are incised through the overlying confining silts and clays, allowing the aquifer and the streams to interact hydraulically. The smaller width and depth of smaller streams has a reduced effect on water levels in the aquifer (Ackerman, 1989, p. 21-23). Wells Fr-358, Fr-1012, and Fr-1092 are near large streams and fluctuated about 4 ft/yr. Water-level fluctuations in well Fr-721 (not near a large stream) were less than 2 ft/yr. The magnitude of the fluctuations can vary from year to year, as shown in the hydrograph for well Fr-721 (fig. 4), where fluctuations of about 4 ft/yr or more occurred in 1991 and 1999.

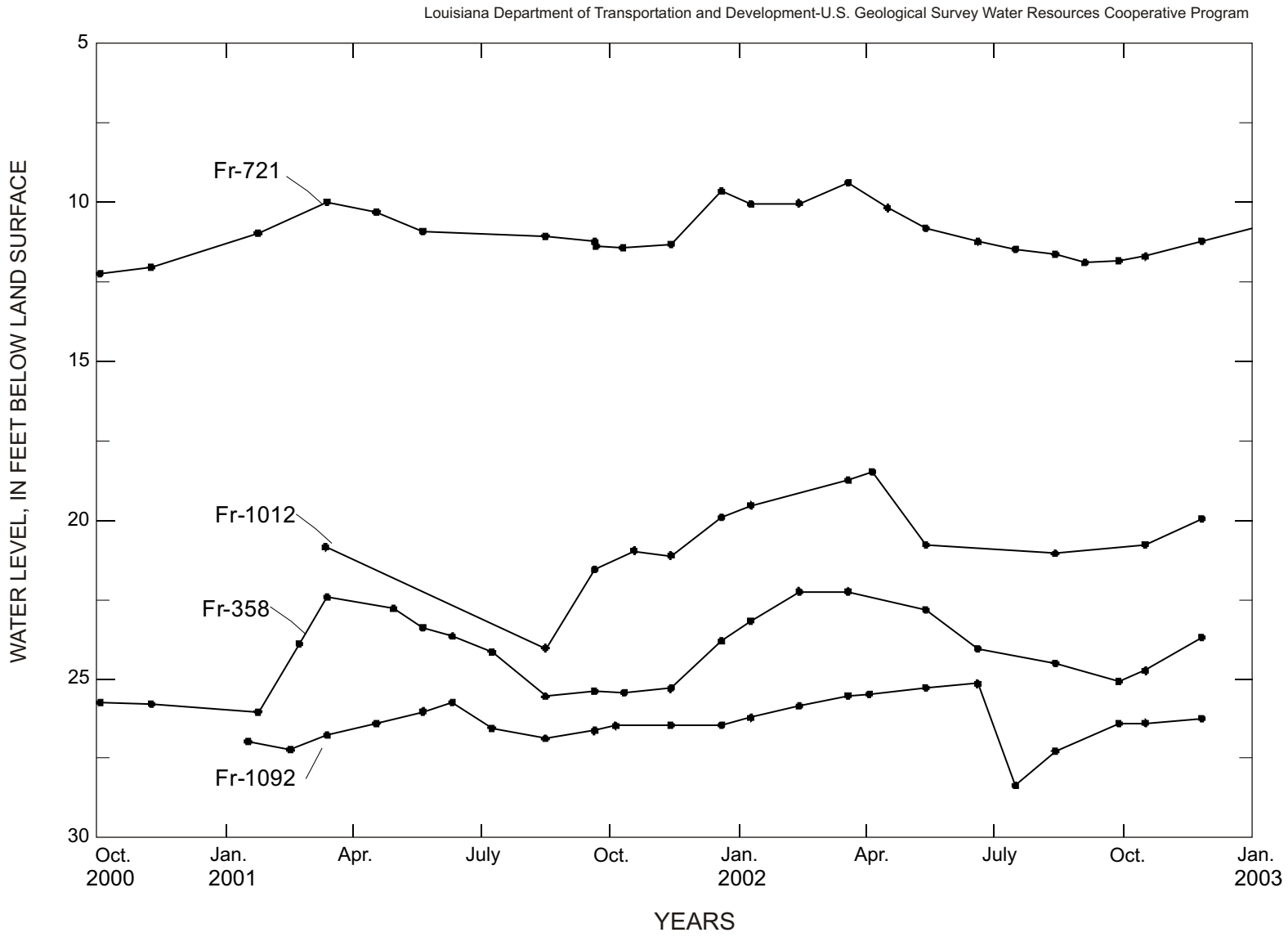


Figure 3. Seasonal water-level fluctuations in wells Fr-358, Fr-721, Fr-1012, and Fr-1092 screened in the Mississippi River alluvial aquifer, Franklin Parish, Louisiana.

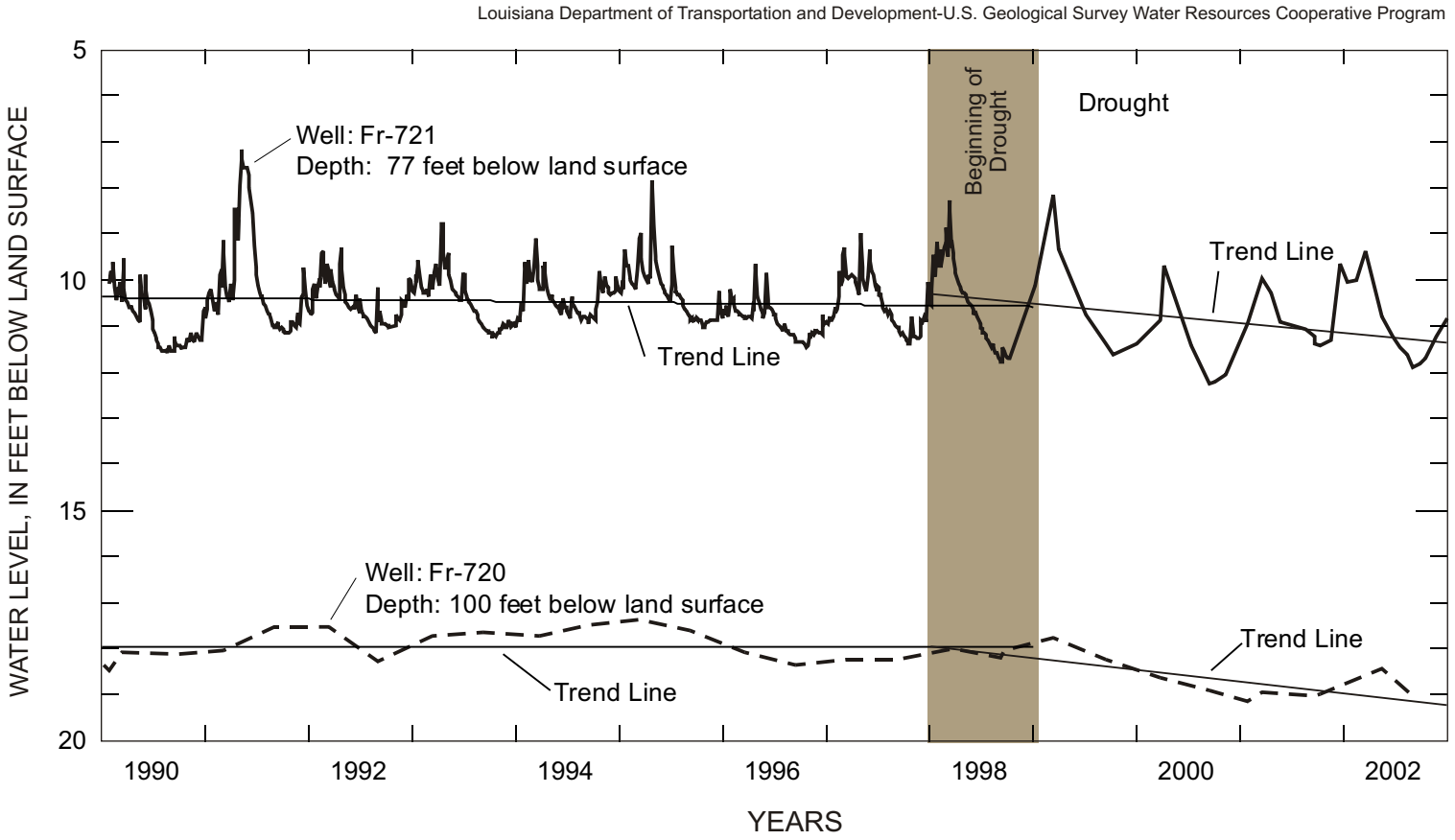


Figure 4. Water levels in wells Fr-720 and Fr-721 screened in the Mississippi River alluvial aquifer, Franklin Parish, Louisiana.

Water-level measurements for two wells (Fr-720 and Fr-721) show long-term fluctuations (fig. 4). Trend analysis of these water levels using the method of least squares linear regression results in a line which has a slope equivalent to the water-level change (+ or -) in feet per year during the period analyzed (Tomaszewski and others, 2002, p. 10). For the period 1990-2002, water levels in well Fr-721 declined -0.04 ft/yr, and water levels in well Fr-720 declined -0.08 ft/yr. These declines are not substantial. However, since 1998, water levels have declined -0.26 ft/yr and -0.32 ft/yr, respectively, in these wells. This decline is a result of drought conditions that were prevalent throughout the southeastern United States from 1998-2000 (National Oceanic and Atmospheric Administration National Climatic Data Center, 2001).

Withdrawal of water from an aquifer can cause changes in water levels, water quality, and well yields. Ground-water withdrawals in Franklin Parish during 2000 (46.61 Mgal/d) were almost 15 times greater than withdrawals in 1960 (3.12 Mgal/d) as shown in figure 5 (Sargent, 2002). In order of decreasing withdrawals, the major use of water from the Mississippi River alluvial aquifer in the parish was aquaculture, irrigation, public supply, and domestic supply. According to the DOTD water well registration data base, 2,200 registered wells were located in the parish in December 2002. Of these wells, 1,177 (53.5 percent) were for irrigation, 89 (4.0 percent) for aquaculture, 570 (25.9 percent) for domestic supply, 8 (0.4 percent) for public supply, and 356 (16.2 percent) for other uses such as industrial and monitor wells. Figure 6 shows the distribution of registered wells based on water use in Franklin Parish as of December 2002.

In 2000, withdrawals for aquaculture (22.94 Mgal/d) accounted for 49.2 percent of ground-water withdrawals in Franklin Parish (Sargent, 2002). The distribution of wells used for aquaculture is uneven; wells are concentrated in the southwestern part of the parish (fig. 6). Withdrawals for irrigation (20.15 Mgal/d) accounted for 43.2 percent of ground-water withdrawals in the parish (Sargent, 2002). Wells used for irrigation are evenly distributed throughout the parish (fig.6). Withdrawals for public supply, rural domestic use, and other uses (3.52 Mgal/d) accounted for only 7.6 percent of ground-water withdrawals in Franklin Parish in 2000 (Sargent, 2002).

The potentiometric-surface map of October 2001 (pl. 1) is similar to the 1990 potentiometric-surface map (Seanor and Smoot, 1995). Cones of depression, substantially declining water levels, and changes in the direction of ground-water flow are not evident in Franklin Parish, based on data collected for this report.

WATER QUALITY

Water-quality samples were collected from 25 wells in Franklin Parish (pl. 2) during April-May 2002. Water-quality data for these wells are presented in appendix 2. The physiochemical properties and chemical constituents analyzed were specific conductance, pH, water temperature, alkalinity, chloride, dissolved solids, iron, and manganese. At two of the wells, water-quality samples also were analyzed for hardness, calcium, magnesium, sodium, potassium, sulfate, fluoride, and silica. As part of the water-quality-collection process, quality-control samples were collected to test sample-collection procedures, sample processing, and laboratory analysis.

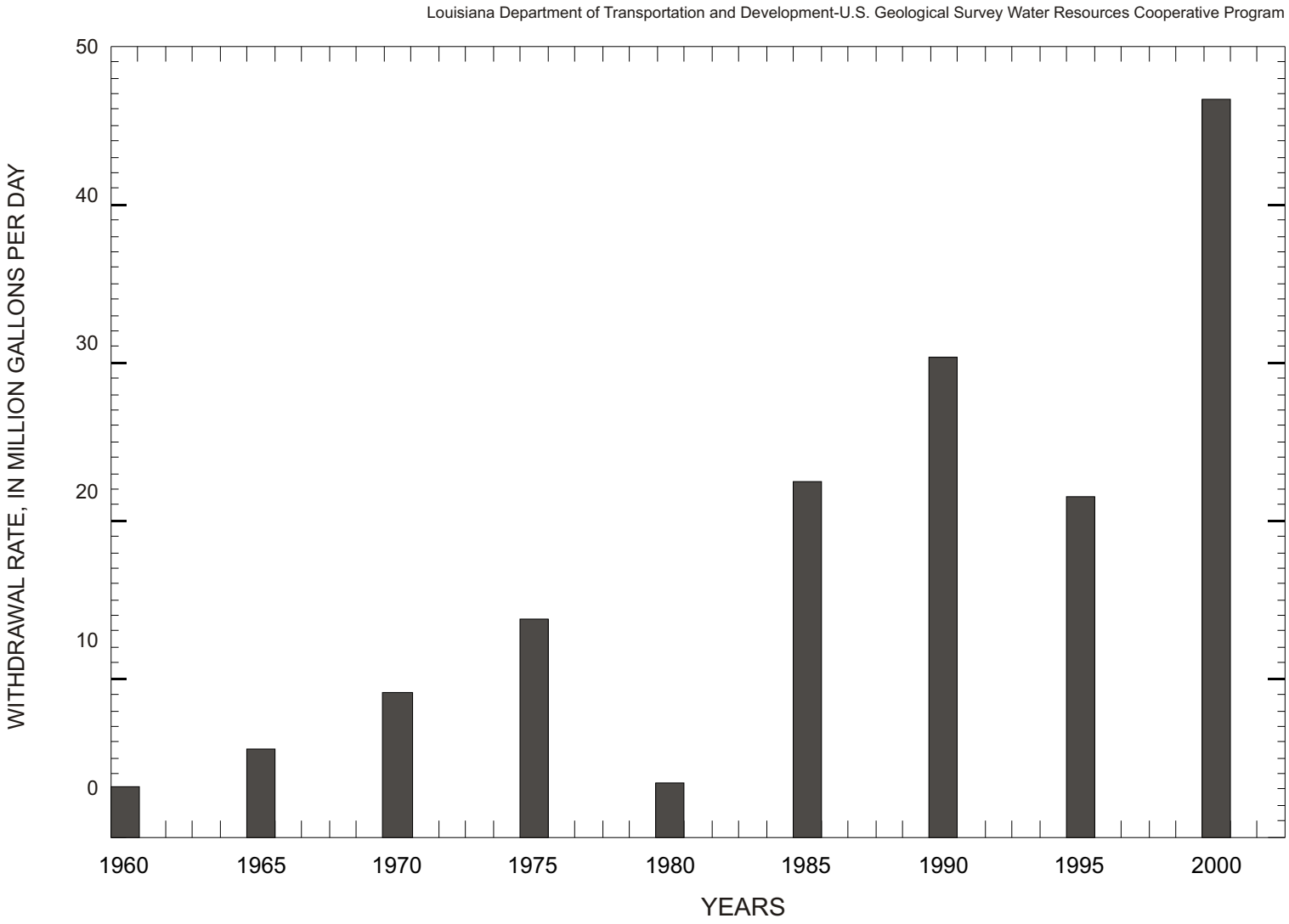
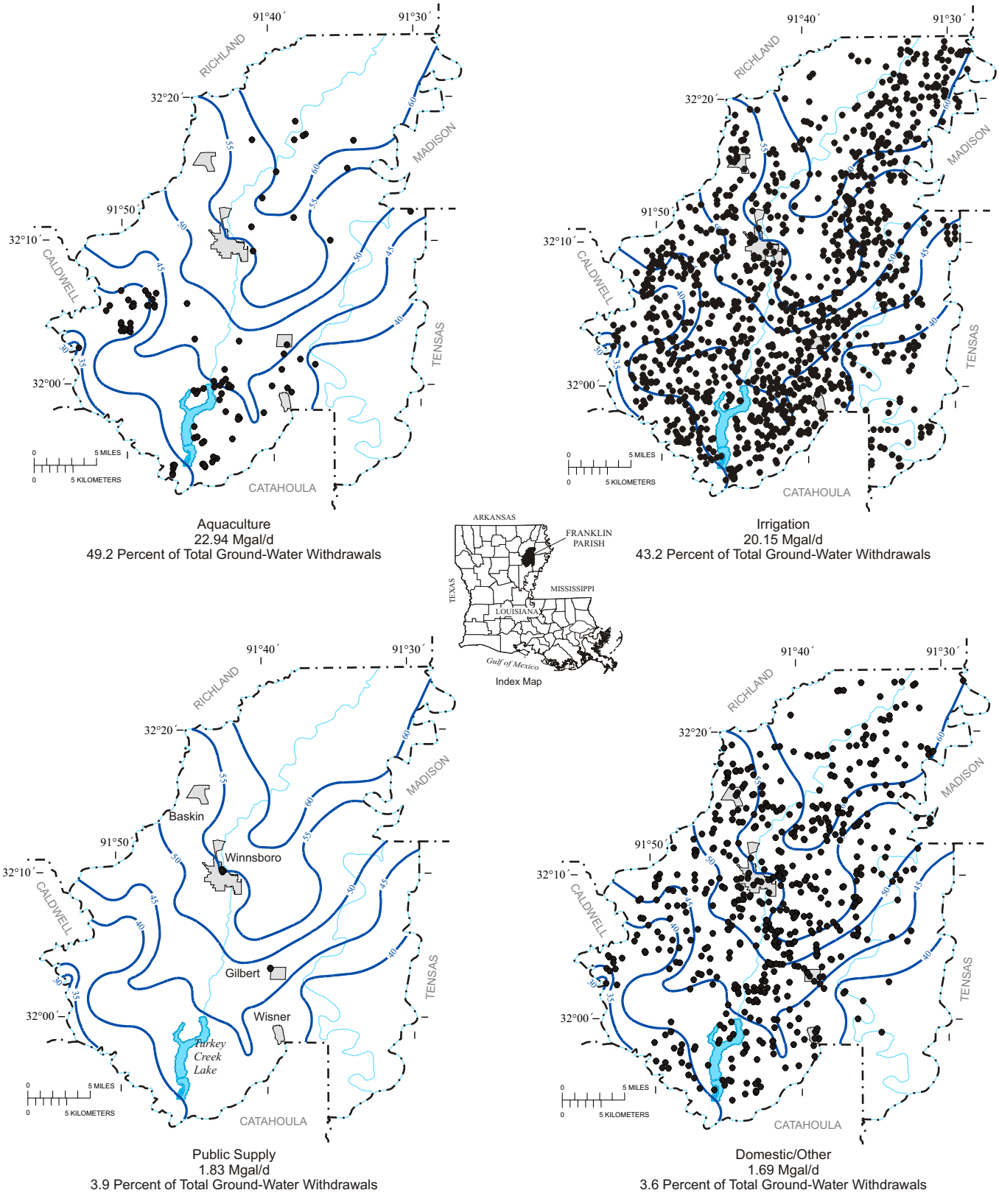


Figure 5. Ground-water withdrawal rates for the Mississippi River alluvial aquifer, Franklin Parish, Louisiana, 1960-2000 (modified from Sargent, 2002).



Map credit: Modified from Official Map of Louisiana, Department of Transportation and Development, 1986

Figure 6. Potentiometric surface of the Mississippi River alluvial aquifer in October 2001 and the distribution of registered wells, based on water use in Franklin Parish, Louisiana.

Data Analysis

Water-quality data from the 25 wells sampled in Franklin Parish are presented in appendix 2. A statistical summary of values for selected physiochemical properties and chemical constituents is presented in table 1.

Table 1. Statistical summary of selected physiochemical properties and chemical constituents in water from selected wells screened in the Mississippi River alluvial aquifer, Franklin Parish, Louisiana, April-May 2002.

[Except as noted, values are in milligrams per liter.]

Property or constituent	Number of samples	Value at indicated percentile[1]					Secondary Maximum Contaminant Level[2]
		0 (minimum)	25	50 (median)	75	100 (maximum)	
Specific conductance, in microsiemens per centimeter at 25 degrees Celsius	25	327	656	717	1,470	9,560	
pH, in standard units	25	6.6	7.1	7.2	7.3	7.8	6.5-8.5
Water temperature, in degrees Celsius	25	18.4	19.1	19.4	19.6	20.6	
Alkalinity, total (as calcium carbonate)	25	122	258	329	443	502	
Chloride, dissolved	25	7.7	39	89	230	3,150	250
Solids, residue at 180 degrees Celsius, dissolved	25	200	372	419	844	6,160	500
Iron, dissolved	25	.006	.376	2.04	5.03	11.4	.30
Manganese, dissolved	25	<.001	.181	.307	.579	2.73	.05

[1]Value below which lies indicated percentage of observations.
[2]U.S. Environmental Protection Agency (2002).

Specific conductance ranged from 327 to 9,560 µS/cm, with a median value of 717 µS/cm. The range in pH is from 6.6 to 7.8 with a median value of 7.2. A pH of 7.0 is considered neutral. The Secondary Maximum Contaminant Level (SMCL) established in the U.S. Environmental Protection Agency

Secondary Drinking Water Regulations[1] (U.S. Environmental Protection Agency, 2002) for pH is 6.5-8.5. Water temperature (in degrees Celsius) ranged from 18.4 to 20.6, with a median of 19.4. Field alkalinity as calcium carbonate ranged from 122 to 502 mg/L, with a median of 329 mg/L.

Dissolved chloride concentrations ranged from 7.7 to 3,150 mg/L, with a median of 89 mg/L. The SMCL for chloride is 250 mg/L (U.S. Environmental Protection Agency, 2002). Chloride concentrations are higher near the base of the aquifer (Whitfield, 1975, p. 13). The wells sampled were screened in the lower part of the aquifer.

Dissolved solids concentrations, determined by residue on evaporation at 180° C, ranged from 200 to 6,160 mg/L, with a median value of 419 mg/L. In 50 percent of the samples, the dissolved solids concentrations were less than the SMCL of 500 mg/L (U.S. Environmental Protection Agency, 2002). Dissolved solids can be used as a measure of salinity. Robinove (1958) classifies water with concentrations of less than 1,000 mg/L dissolved solids as being fresh. Water with dissolved solids concentrations in the 1,000-3,000 mg/L range is classified as slightly saline. The maximum dissolved solids concentration (6,160 mg/L) was from well Fr-720, and according to Robinove (1958), would be the only well with water classified as moderately saline (3,000-10,000 mg/L).

Concentrations of dissolved iron ranged from 0.006 to 11.4 mg/L, with a median value of 2.04 mg/L. The presence of iron in the Mississippi River alluvial aquifer is a result of the dissolution of iron-bearing minerals as water moves through the aquifer (Poole, 1961). The SMCL for iron in drinking water is 0.3 mg/L (U.S. Environmental Protection Agency, 2002). Over 75 percent of the samples collected exceeded this limit. The highest concentrations of dissolved iron occurred in water from wells in the central and southeastern parts of Franklin Parish.

Concentrations of dissolved manganese ranged from <0.001 to 2.73 mg/L, with a median value of 0.307 mg/L. The SMCL for manganese in drinking water is 0.05 mg/L (U.S. Environmental Protection Agency, 2002) and was exceeded in water from 24 (96 percent) wells. The two highest concentrations occurred in wells Fr-1012 and Fr-1174 in the southeastern part of Franklin Parish.

A linear regression analysis indicated specific conductance was strongly correlated to chloride (Pearson r=100) and dissolved solids (Pearson r=100). Figure 7 shows the relation between specific conductance and dissolved chloride concentrations in water from wells screened in the Mississippi River alluvial aquifer in Franklin Parish. The graph includes historical data in addition to the 25 wells sampled for this study. Specific conductance can be determined in the field; thus, the relation can be used to estimate dissolved chloride concentrations in wells screened in the Mississippi River alluvial aquifer in Franklin Parish.

Historical data were available for nine of the wells sampled (appendix 2). Only three of those wells (Fr-368, Fr-720, and Fr-721) had more than 10 previous analyses, with dissolved chloride being the constituent analyzed. Wells Fr-720 and Fr-721 are included in a program with the DOTD and the USGS to monitor chloride concentrations in selected areas throughout the State. Dissolved chloride concentrations for these three wells are shown in figure 8. Dissolved chloride concentrations in well Fr-720 indicated a slight increasing trend from 1990-2002, while dissolved chloride concentrations in well Fr-721 declined from 340 mg/L in 1990 to 270 mg/L in 2002.

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[1]Secondary Drinking Water Regulations Secondary Maximum Contaminant Level (SMCL): Contaminants that affect the aesthetic quality of drinking water. At high concentrations or values, health implications as well as aesthetic degradation also may exist. SMCL's are not Federally enforceable, but are intended as guidelines for the states.

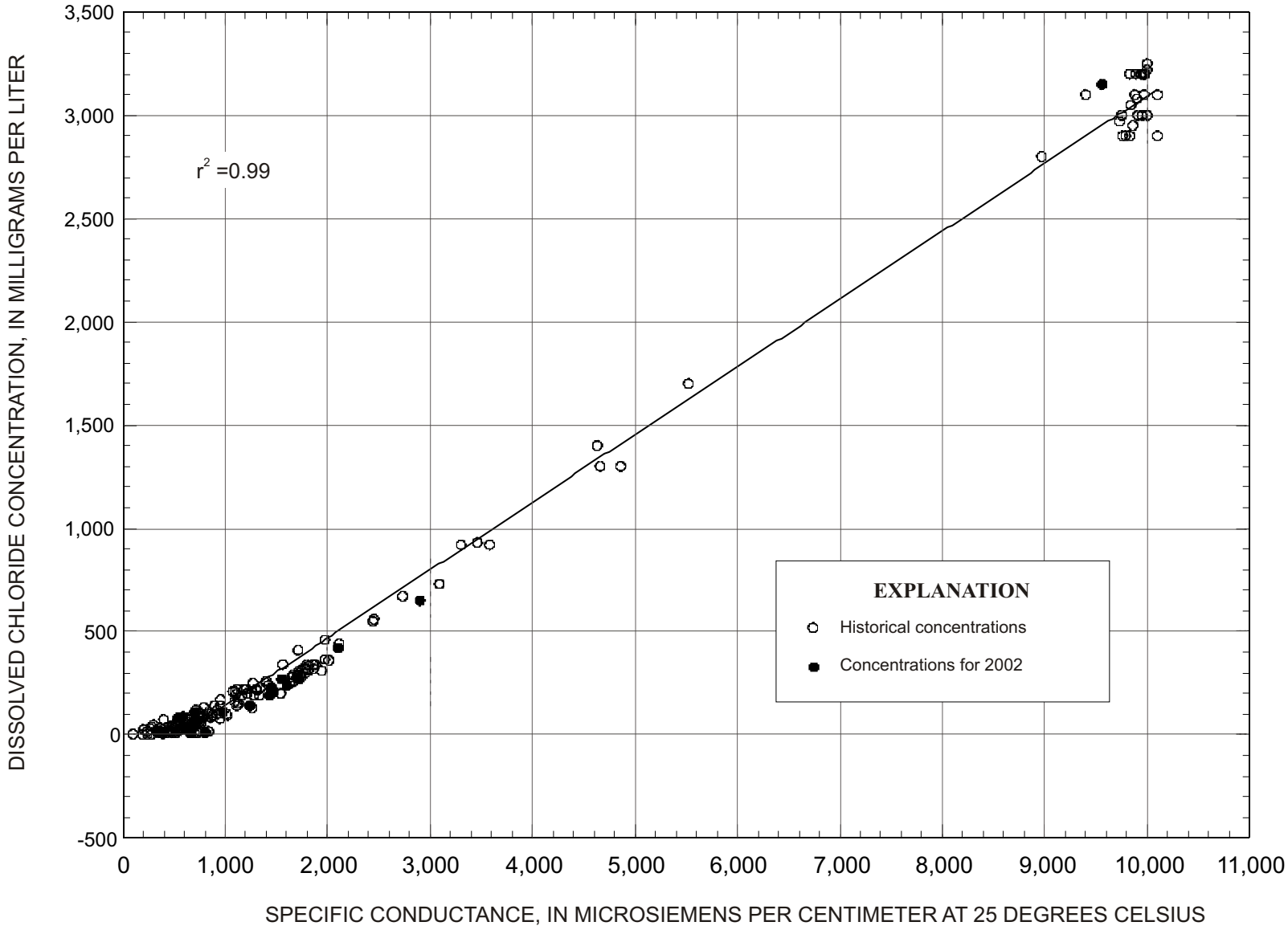

Figure 7. Relation between specific conductance and dissolved chloride concentration for selected wells screened in the Mississippi River alluvial aquifer, Franklin Parish, Louisiana, 1939-2002.

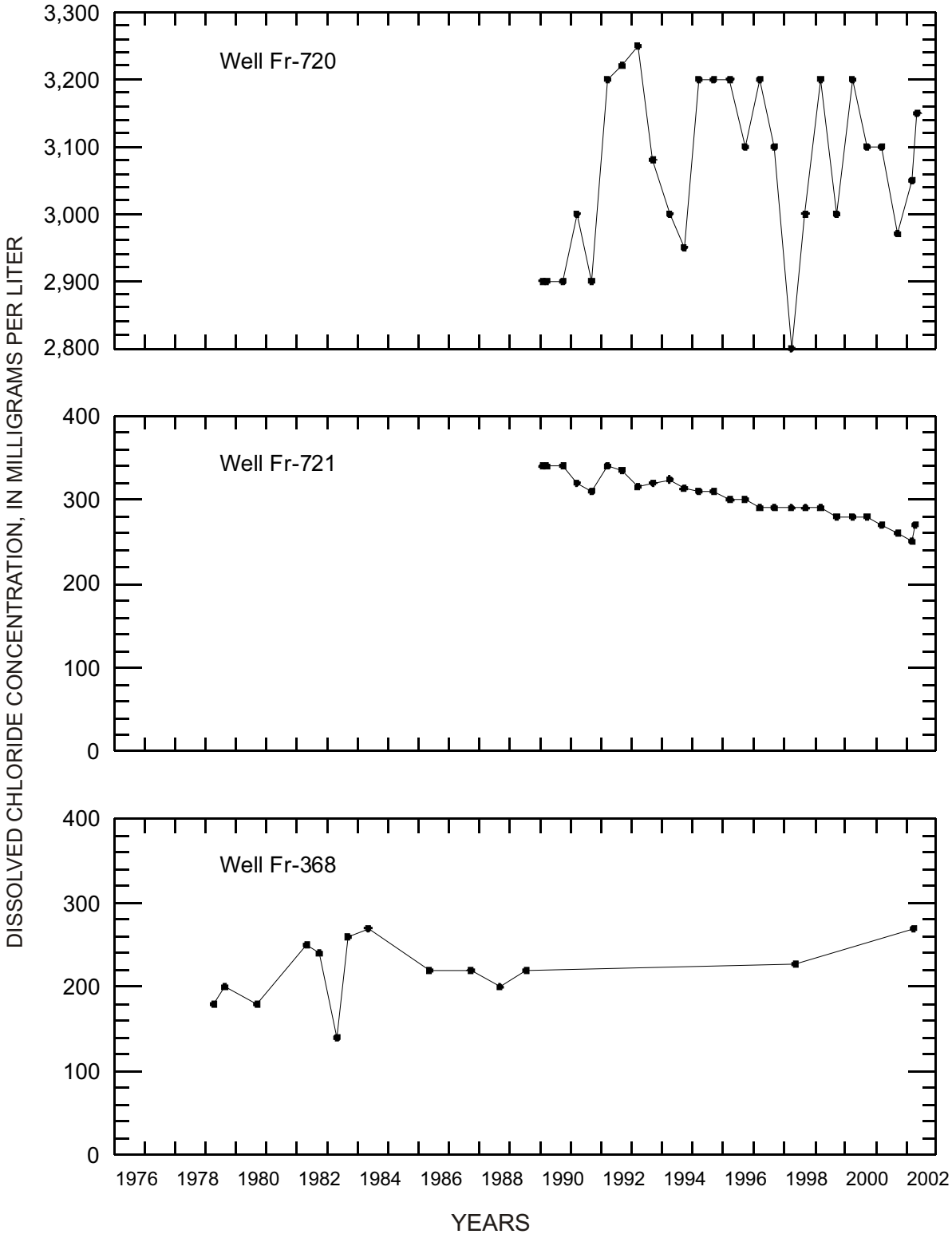

Figure 8. Dissolved chloride concentrations for wells Fr-368, Fr-720, and Fr-721 screened in the Mississippi River alluvial aquifer, Franklin Parish, Louisiana.

A map showing chloride concentrations for wells sampled in this study is shown on plate 2. Areas of high chloride concentrations (greater than 250 mg/L) were present in central and north-central Franklin Parish, which generally coincides with historically documented areas of high chloride. Whitfield (1975) defined a zone of saltwater based on chloride concentrations exceeding 250 mg/L. It is beyond the scope of this report to redefine this zone; however, for comparative purposes this zone of saltwater is included on plate 2. Chloride concentrations in water from two wells, Fr-368 and Fr-721, located in Winnsboro, were 270 mg/L. The presence of high chloride concentrations in these wells may be due to increased pumping near the zone of saltwater.

Quality Control

Sequential field replicate samples were collected from 2 (Fr-301 and Fr-1322) of the 25 wells sampled during this study. The quality-control samples were analyzed by comparing the relative percent differences (RPD) of the results (table 2). The RPD's for acid-neutralizing capacity, dissolved solids, iron, and manganese ranged from 0 to less than 1. The RPD for chloride for both wells was 0. None of the constituents had a RPD greater than 1. These results indicate a low variability in the field and laboratory techniques used in the collection and analysis of the water samples.

In addition to alkalinity and chloride, other inorganic ions (calcium, magnesium, sodium, potassium, sulfate, fluoride, and silica) were analyzed in water collected at 2 of the 25 wells sampled, Fr-59 and Fr-983. Ion balances were calculated and examined as a quality-assurance check of the chemical analyses. The ion balance was calculated in milliequivalents per liter as the total dissolved-cation concentration minus the total dissolved-anion concentration divided by the total concentration of ions dissolved in solution. The ion balances were -0.4 percent for well Fr-59 and -1.8 percent for well Fr-983, indicating the laboratory procedures were sound.

Table 2. Calculated relative-percent differences between environmental and sequential field replicate samples from two wells screened in the Mississippi River alluvial aquifer, Franklin Parish, Louisiana, April-May 2002.

[The relative percent differences (RPD) of the results is calculated for a property or constituent by using the absolute value of the difference between the environmental sample result and the replicate sample result divided by the average of the two results. RPD's greater than 0 but less than (<) 1 percent are reported as <1. Except as noted, values are in milligrams per liter.]

Property or constituent	Well Fr-301			Well Fr-1322		
	Environmental sample	Replicate sample	RPD (percent)	Environmental sample	Replicate sample	RPD (percent)
Acid-neutralizing capacity, laboratory (as calcium carbonate)	339	339	0	441	440	<1
Chloride, dissolved	110	110	0	140	140	0
Solids, residue at 180 degrees Celsius, dissolved	532	532	0	700	701	<1
Iron, dissolved	4.33	4.27	<1	2.37	2.38	<1
Manganese, dissolved	.219	.218	<1	.307	.307	0

SUMMARY

The Mississippi River alluvial aquifer is an important resource in Franklin Parish. The largest use of water in the parish is for aquaculture and irrigation. Chloride, iron, and hardness represent the major water-quality concerns in the aquifer.

Water levels were measured in 82 wells screened in the Mississippi River alluvial aquifer in October 2001 and ranged from 29.37 feet above National Geodetic Vertical Datum of 1929 (NGVD 29) in southwest Franklin Parish to 64.99 feet above NGVD 29 in north-central Franklin Parish. The general direction of ground-water flow in the Mississippi River alluvial aquifer in Franklin Parish is to the south. Seasonal water-level fluctuations in the aquifer are generally less than 4 feet per year. Water-level data indicated no substantial long-term declines; however, the declines in water levels at wells Fr-720 and Fr-721 from 1998-2001 are a result of drought conditions.

Ground-water withdrawals from the Mississippi River alluvial aquifer in Franklin Parish increased from 3.12 million gallons per day in 1960 to 46.61 million gallons per day in 2000. The effects of withdrawals on the aquifer are minimal. Cones of depression are not evident in the potentiometric surface of the aquifer, based on data collected for this report.

Water-quality samples were collected at 25 wells in Franklin Parish in April-May 2002. Chloride concentrations ranged from 7.7 to 3,150 mg/L (milligrams per liter) with a median value of 89 mg/L. Chloride concentrations increased slightly from 1990-2002 in well Fr-720, but decreased slightly in well Fr-721 during the same period. Areas of high chloride concentrations (greater than 250 mg/L) were present in central and north-central Franklin Parish, which generally coincides with historically documented areas of high chloride. Dissolved solids concentrations ranged from 200 to 6,160 mg/L, with a median value of 419 mg/L. Iron concentrations ranged from 0.006 to 11.4 mg/L, with a median value of 2.04 mg/L. Manganese concentrations ranged from <0.001 to 2.73 mg/L, with a median value of 0.307 mg/L. Iron and manganese generally exceeded U.S. Environmental Protection Agency Secondary Maximum Contaminant Levels for wells sampled in the aquifer.

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APPENDIXES

1. Water-level data for selected wells screened in the Mississippi River alluvial aquifer, Franklin Parish, Louisiana, October 2001.

2. Selected physiochemical properties and constituents in water from selected wells screened in the Mississippi River alluvial aquifer, Franklin Parish, Louisiana, April-May 2002.

Appendix 1. Water-level data for selected wells screened in the Mississippi River alluvial aquifer, Franklin Parish, Louisiana, October 2001.

Well number	Latitude (degrees)	Longitude (degrees)	Altitude of land surface (feet relative to NGVD 29)	Depth of well (feet)	Date Measured	Depth to water level (feet below land surface)	Altitude of water level (feet relative to NGVD 29)
Fr-59	320852	914901	70	105	10/30/01	26.66	43.34
Fr-88	320349	915326	65	75	10/05/01	28.15	36.85
Fr-225	320441	914441	65	105	10/18/01	19.39	45.61
Fr-358	322210	912909	85	127	10/11/01	25.43	59.57
Fr-375	320404	913224	60	107	10/19/01	19.31	40.69
Fr-380	315621	913213	55	109	10/30/01	18.42	36.58
Fr-391	315426	913541	57	113	10/30/01	21.24	35.76
Fr-397	315421	914656	65	87	10/05/01	28.90	36.10
Fr-427	321007	913823	80	100	10/19/01	20.06	59.94
Fr-434	320742	913438	70	105	10/19/01	21.18	48.82
Fr-437	320713	914412	70	88	10/26/01	17.03	52.97
Fr-477	315958	914353	65	85	10/18/01	19.91	45.09
Fr-513	320159	915136	65	90	10/05/01	22.00	43.00
Fr-601	315950	915210	65	100	10/05/01	25.46	39.54
Fr-612	321202	913722	85	80	10/19/01	30.80	54.20
Fr-635	321753	913612	92	70	10/15/01	27.33	64.67
Fr-648	315502	914612	60	80	10/05/01	17.03	42.97
Fr-682	315538	914420	65	90	10/29/01	23.22	41.78
Fr-697	315939	914122	75	80	10/18/01	31.59	43.41
Fr-710	320733	913848	79	85	10/26/01	21.05	57.95
Fr-720	320941	914113	75	100	10/10/01	19.00	56.00
Fr-721	320958	914255	65	77	10/10/01	11.42	53.58
Fr-748	322306	913704	85	80	10/10/01	21.43	63.57
Fr-770	320728	914852	68	102	10/26/01	24.93	43.07
Fr-771	320347	914408	66	90	10/29/01	18.11	47.89
Fr-772	321149	914604	72	80	10/15/01	20.15	51.85
Fr-776	315855	914537	65	90	10/29/01	22.02	42.98
Fr-783	320010	913750	75	100	10/18/01	34.26	40.74
Fr-784	320830	915034	75	92	10/15/01	28.13	46.87
Fr-808	321541	913403	90	80	10/30/01	33.30	56.70
Fr-809	321509	914435	74	80	10/15/01	23.00	51.00
Fr-816	320142	913443	63	100	10/19/01	23.49	39.51
Fr-858	321014	914351	70	70	10/18/01	18.15	51.85
Fr-876	320728	914616	70	82	10/26/01	18.58	51.42
Fr-882	320245	915345	56	79	10/03/01	26.63	29.37
Fr-884	322327	913005	89	109	10/11/01	27.12	61.88
Fr-932	321040	912950	65	98	10/19/01	23.08	41.92
Fr-944	320615	914601	71	107	10/29/01	23.78	47.22
Fr-952	321828	913042	90	104	10/11/01	30.18	59.82
Fr-995	321830	914024	80	80	10/15/01	16.98	63.02
Fr-1004	321057	914252	75	82	10/26/01	16.98	58.02
Fr-1006	322221	913439	87	80	10/10/01	22.51	64.49
Fr-1054	320700	914218	75	69	10/26/01	19.95	55.05
Fr-1067	321542	913315	81	80	10/11/01	24.19	56.81
Fr-1078	315737	914128	75	100	10/30/01	29.22	45.78

Appendix 1. Water-level data for selected wells screened in the Mississippi River alluvial aquifer, Franklin Parish, Louisiana, October 2001.—Continued

Well number	Latitude (degrees)	Longitude (degrees)	Altitude of land surface (feet relative to NGVD 29)	Depth of well (feet)	Date Measured	Depth to water level (feet below land surface)	Altitude of water level (feet relative to NGVD 29)
Fr-1084	321025	914524	72	89	10/26/01	21.09	50.91
Fr-1091	315459	914720	67	80	10/05/01	27.99	39.01
Fr-1092	315716	914930	65	80	10/05/01	26.48	38.52
Fr-1109	315838	913736	59	120	10/30/01	18.29	40.71
Fr-1133	320323	913959	75	110	10/30/01	25.31	49.69
Fr-1142	320108	914825	65	93	10/05/01	23.85	41.15
Fr-1143	320404	913737	76	90	10/18/01	28.60	47.40
Fr-1144	320155	913654	60	105	10/18/01	23.89	36.11
Fr-1145	321640	913343	94	80	10/11/01	29.43	64.57
Fr-1174	315904	913342	60	100	10/18/01	21.26	38.74
Fr-1187	321235	914102	80	80	10/10/01	18.79	61.21
Fr-1206	321431	913816	82	65	10/10/01	17.15	64.85
Fr-1249	321215	914400	75	80	10/26/01	18.12	56.88
Fr-1254	320424	914835	66	85	10/03/01	25.38	40.62
Fr-1255	320420	915045	67	84	10/03/01	31.21	35.79
Fr-1261	321959	913401	89	80	10/10/01	24.05	64.95
Fr-1268	320143	914047	75	100	10/18/01	27.14	47.86
Fr-1288	321803	914511	74	95	10/15/01	22.28	51.72
Fr-1289	321357	914056	72	80	10/10/01	13.86	58.14
Fr-1309	321125	914904	70	80	10/15/01	22.76	47.24
Fr-1319	322156	913001	86	120	10/11/01	24.90	61.10
Fr-1323	322312	913338	86	95	10/10/01	21.01	64.99
Fr-1345	321305	913711	82	95	10/19/01	25.61	56.39
Fr-1351	321110	913312	73	95	10/19/01	22.57	50.43
Fr-1353	321543	913623	85	80	10/19/01	25.47	59.53
Fr-1358	320831	914201	75	60	10/18/01	21.29	53.71
Fr-1368	320043	913947	75	102	10/18/01	31.89	43.11
Fr-1371	315630	914322	66	90	10/26/01	22.30	43.70
Fr-1382	320621	914719	68	80	10/03/01	22.12	45.88
Fr-1404	321123	913517	84	80	10/19/01	30.62	53.38
Fr-1416	320319	913333	68	95	10/18/01	26.40	41.60
Fr-1422	320627	913242	68	110	10/19/01	22.67	45.33
Fr-1448	320251	914818	69	108	10/03/01	20.60	48.40
Fr-1450	322053	913104	89	100	10/11/01	26.78	62.22
Fr-1457	321011	914320	72	82	10/30/01	16.41	55.59
Fr-1466	320845	913800	82	95	10/19/01	22.79	59.21
Fr-5374Z	320538	914114	80	77	10/18/01	24.00	56.00

Appendix 2. Selected physiochemical properties and constituents in water from selected wells screened in the Mississippi River alluvial aquifer, Franklin Parish, Louisiana, April-May 2002.

[Analyses by U.S. Geological Survey; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; <, actual value determined to be less than value shown; --, no data]

Well number	Latitude (degrees)	Longitude (degrees)	Depth of well (feet below land surface)	Date	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	pH, field (standard units)	Tempera-ture (degrees Celsius)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)
[1]Fr-59	320852	914901	105	4/09/02	700	7.8	19.0	230	56	21	57
[1]Fr-68	315357	914515	120	4/08/02	684	7.0	19.6	--	--	--	--
[1]Fr-301	321321	914514	96	4/09/02	975	7.6	19.6	--	--	--	--
[1]Fr-324	320829	913626	90	4/05/02	539	6.6	19.8	--	--	--	--
[1]Fr-358	322210	912909	127	5/13/02	638	7.2	19.9	--	--	--	--
[1]Fr-368	321014	914316	79	4/02/02	1,550	7.1	19.0	--	--	--	--
Fr-520	320615	914601	94	4/02/02	700	7.3	19.9	--	--	--	--
Fr-612	321202	913722	80	4/10/02	717	7.2	19.5	--	--	--	--
[1]Fr-720	320941	914113	100	5/13/02	9,560	7.1	20.6	--	--	--	--
[1]Fr-721	320958	914255	77	4/16/02	1,710	7.3	20.1	--	--	--	--
Fr-768	321810	913549	100	4/09/02	1,450	7.3	19.3	--	--	--	--
Fr-840	321136	913039	110	4/11/02	656	7.2	19.4	--	--	--	--
Fr-952	321828	913042	104	4/11/02	587	6.6	19.1	--	--	--	--
Fr-983	322014	913441	92	4/10/02	2,900	7.3	19.4	550	127	57	380
Fr-995	321830	914024	80	4/09/02	687	7.2	19.2	--	--	--	--
Fr-1006	322221	913439	80	4/11/02	1,470	7.1	19.3	--	--	--	--
Fr-1012	320229	913307	60	4/05/02	805	7.1	18.9	--	--	--	--
Fr-1092	315716	914930	80	4/03/02	327	7.0	18.8	--	--	--	--
Fr-1137	322020	913542	90	4/10/02	1,600	7.3	19.5	--	--	--	--
Fr-1174	315904	913342	100	4/08/02	664	7.1	19.1	--	--	--	--
Fr-1261	321959	913401	80	4/11/02	2,100	7.0	19.4	--	--	--	--
Fr-1268	320143	914047	100	4/03/02	1,430	7.1	18.5	--	--	--	--
Fr-1322	322330	913308	95	4/11/02	1,240	7.2	19.3	--	--	--	--
Fr-1448	320251	914818	108	4/03/02	386	7.7	19.6	--	--	--	--
[1]Fr-5366Z	315631	914118	100	4/03/02	600	7.7	18.4	--	--	--	--

Appendix 2. Selected physiochemical properties and constituents in water from selected wells screened in the Mississippi River alluvial aquifer, Franklin Parish, Louisiana, April-May 2002. —Continued

[Analyses by U.S. Geological Survey; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; <, actual value determined to be less than value shown; --, no data]

Well number	Potassium, dissolved (mg/L)	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Silica, dissolved (mg/L as SiO_2)	Solids, residue at 180 degrees Celsius, dissolved (mg/L)	Iron, dissolved (mg/L)	Manganese, dissolved (mg/L)
[1]Fr-59	1.3	245	2	73	0.2	23	387	2.04	0.189
[1]Fr-68	--	271	--	45	--	--	398	2.04	1.54
[1]Fr-301	--	328	--	110	--	--	532	4.33	.219
[1]Fr-324	--	122	--	81	--	--	346	0.006	<.001
[1]Fr-358	--	293	--	39	--	--	346	2.07	.181
[1]Fr-368	--	365	--	270	--	--	844	5.03	.579
Fr-520	--	182	--	110	--	--	391	.190	.077
Fr-612	--	277	--	69	--	--	419	.180	.490
[1]Fr-720	--	466	--	3,150	--	--	6,160	11.4	.168
[1]Fr-721	--	502	--	270	--	--	927	3.19	.287
Fr-768	--	416	--	230	--	--	803	.830	.966
Fr-840	--	320	--	13	--	--	372	6.10	.836
Fr-952	--	148	--	89	--	--	365	.370	.942
Fr-983	3.4	479	4	650	.2	29	1,600	5.36	.259
Fr-995	--	261	--	59	--	--	407	.270	.058
Fr-1006	--	456	--	210	--	--	846	1.53	.532
Fr-1012	--	404	--	11	--	--	471	6.99	2.73
Fr-1092	--	139	--	15	--	--	200	.940	.094
Fr-1137	--	436	--	240	--	--	881	2.03	.451
Fr-1174	--	339	--	7.7	--	--	383	5.59	1.72
Fr-1261	--	468	--	420	--	--	1,190	.940	.409
Fr-1268	--	462	--	190	--	--	806	5.03	.502
Fr-1322	--	443	--	140	--	--	700	2.37	.307
Fr-1448	--	164	--	15	--	--	231	.380	.079
[1]Fr-5366Z	--	258	--	34	--	--	356	.160	.227

[1]Historical water-quality data available.