USGS
science for a changing world

DOTD
LOUISIANA DEPARTMENT OF TRANSPORTATION & DEVELOPMENT

Prepared in cooperation with the Louisiana Department of Transportation and Development

Water Resources of Madison Parish, Louisiana

Introduction

Information concerning the availability, use, and quality of water in Madison Parish, Louisiana (fig. 1), is critical for proper water-supply management. The purpose of this fact sheet is to present information that can be used by water managers, parish residents, and others for stewardship of this vital resource. In 2014, 50.66 million gallons per day (Mgal/d) of water were withdrawn in Madison Parish: 44.37 Mgal/d from groundwater sources and 6.30 Mgal/d from surface-water sources[1] (table 1).

Withdrawals for agricultural use—composed of general irrigation, rice irrigation, livestock, and aquaculture—accounted for about 96 percent (48.86 Mgal/d) of the total water withdrawn (table 2). Other categories of use included public supply and rural domestic. Water-use data collected at 5-year intervals from 1960 to 2010 and again in 2014 indicated that water withdrawals peaked in 2014 (fig. 2). The relatively large increase in water use from 2005 to 2010 is largely attributable to a change in the methods used for estimation of general irrigation land usage. General irrigation withdrawals from groundwater increased from 11.13 Mgal/d in 2005 to 28.28 Mgal/d in 2010 (U.S. Geological Survey [USGS], 2016a).

[1]Water-withdrawal data are based on estimated or reported site-specific data and aggregated data, which are distributed to sources. For a full description of water-use estimate methodology, see "Data Collection" in Sargent (2011). Tabulation of numbers in text and tables may result in different totals because of rounding; nonrounded numbers are used for calculation of totals.

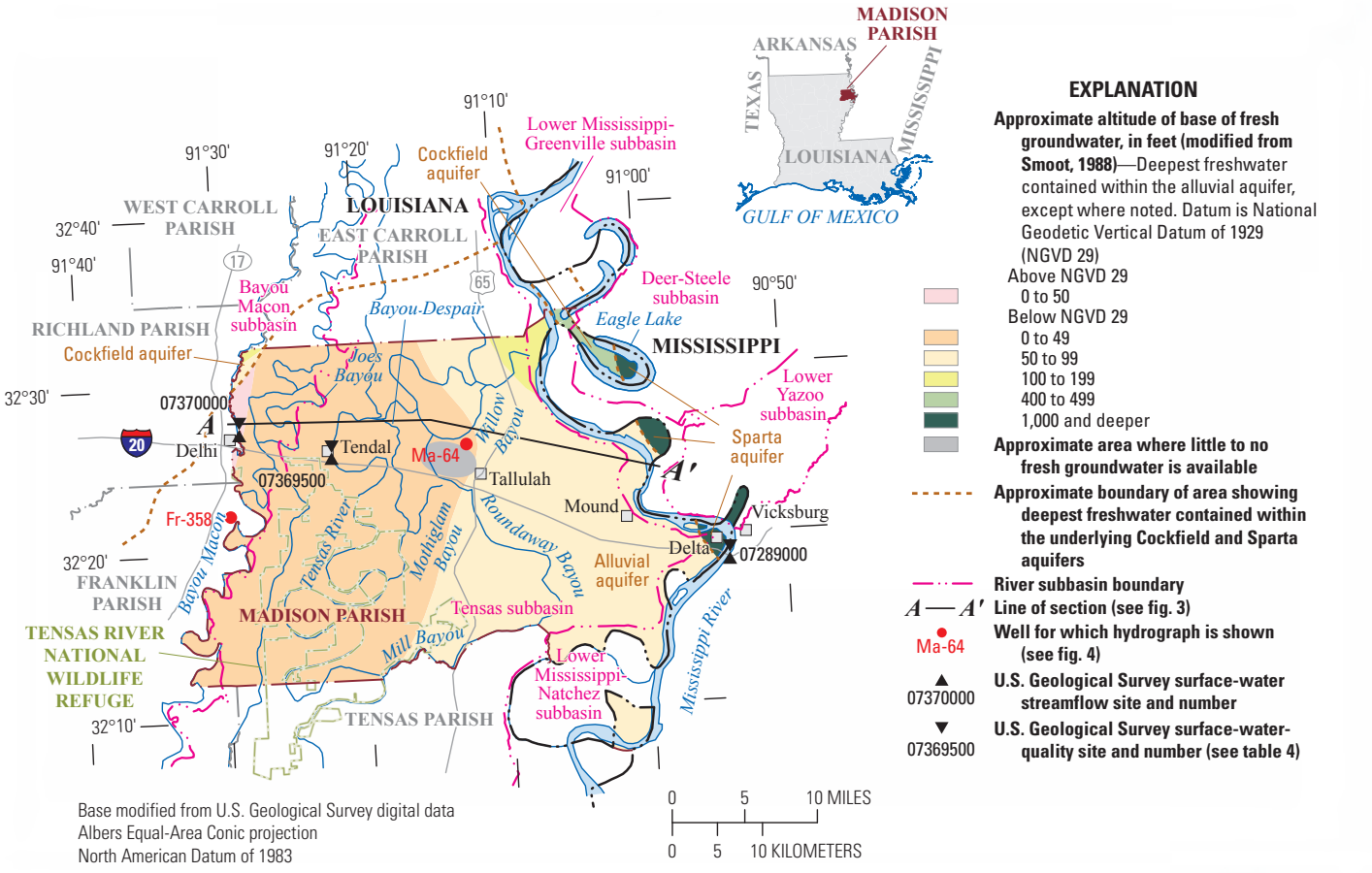

Figure 1. Location of study area, Madison Parish, Louisiana.

Table 1. Water withdrawals, in million gallons per day, by source in Madison Parish, Louisiana, 2014 (Collier, 2018).

Aquifer or surface-water body	Groundwater	Surface water
Mississippi River alluvial aquifer	44.37	
Miscellaneous streams		6.30
Total	**44.37**	**6.30**

Table 2. Water withdrawals, in million gallons per day, by use category in Madison Parish, Louisiana, 2014 (Collier, 2018).

[<, less than]

Use category	Groundwater	Surface water	Total
Public supply	1.79	0.00	1.79
Rural domestic	0.02	0.00	0.02
Livestock	<0.01	<0.01	0.01
Rice irrigation	10.98	2.74	13.72
General irrigation	31.28	3.48	34.76
Aquaculture	0.29	0.07	0.36
Total	**44.37**	**6.30**	**50.66**

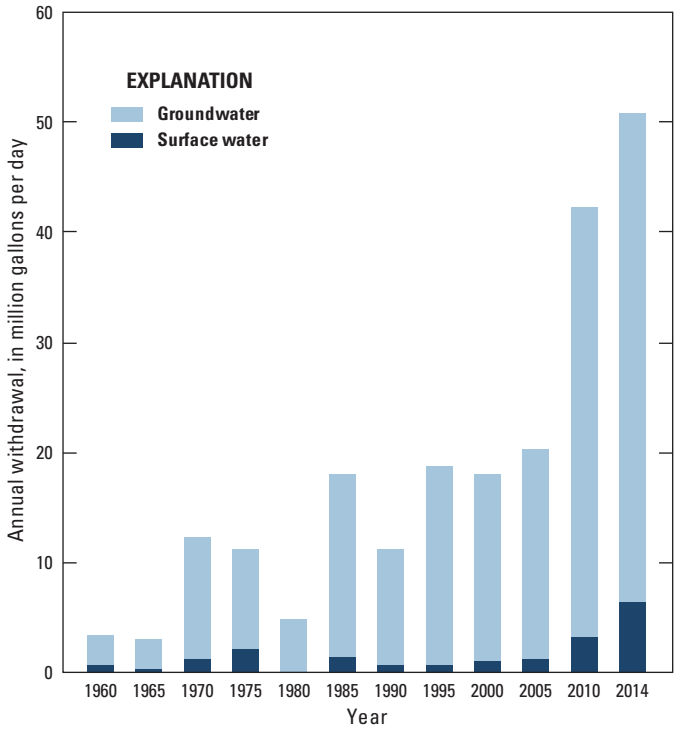

Figure 2. Water withdrawals in Madison Parish, Louisiana, 1960–2014 (U.S. Geological Survey, 2016a; Collier, 2018).

Groundwater Resources

The primary freshwater-bearing aquifer in Madison Parish is the Mississippi River alluvial aquifer (figs. 1 and 3). The Sparta aquifer may also contain freshwater in small areas along the eastern border of the parish (fig. 1), and the Cockfield aquifer may also contain a limited amount of freshwater in the northwestern and northeastern corners; however, these resources are not discussed further herein because of their limited extents in Madison Parish. The base of fresh groundwater (water with a chloride concentration of 250 milligrams per liter [mg/L] or less) is present primarily in the Mississippi River alluvial aquifer at an altitude that ranges from above the National Geodetic Vertical Datum of 1929 (NGVD 29) in the northwestern corner of the parish to deeper than 100 feet (ft) below NGVD 29 in the northeastern corner of the parish. The base of freshwater is present in most of the parish between zero and 100 ft below NGVD 29. Historically, the Mississippi River alluvial aquifer has contained little to no freshwater in a small area northwest of Tallulah (fig. 1; Smoot, 1988).

Mississippi River Alluvial Aquifer

The Mississippi River alluvial aquifer, which extends across Madison Parish, is a large regional aquifer that underlies various States and is called the Mississippi River Valley alluvial aquifer in many places and publications (Saucier, 1994). The Mississippi River alluvial aquifer is composed of the sand and gravel component of sediments deposited primarily by the Mississippi River. These deposits generally grade from silt and clay at land surface to coarse sand and gravel at the base. The thickness of the Mississippi River alluvial deposit ranges from less than 100 ft in the southwestern part of the parish to greater than 180 ft in the eastern part near Delta. The altitude of the base of the aquifer ranges from less than 20 ft below NGVD 29 in a small area northwest of Tallulah to greater than 80 ft below NGVD 29 near Delta (Whitfield, 1975).

The primary source of recharge for the alluvial aquifer is the infiltration of precipitation, with secondary sources of recharge from streams and rivers during high stage. Groundwater discharge is by way of natural flow into streams and rivers, evapotranspiration, and well withdrawals. In Madison Parish, the direction of groundwater movement in the alluvial aquifer has been generally towards the south, southeast, or southwest, depending on location (Whitfield, 1975; Seanor and Smoot, 1995).

In 1990, a regional survey of water-level altitudes indicated that water levels in wells screened in the Mississippi River alluvial aquifer ranged from less than 50 ft above NGVD 29 in the southwestern part of the parish to greater than 70 ft above NGVD 29 in the northeastern part of the parish (Seanor and Smoot, 1995). Water levels at well Ma-64 (USGS site number 322614091122001), located near Tallulah (fig. 1), often fluctuated more than 4 ft seasonally and declined less than about 10 ft during 1975–2016 (fig. 4). Water levels at well Fr-358 (fig. 1; USGS site number 322210091290901), located near the border with Franklin Parish and south of Delhi also fluctuated seasonally and declined less than 10 ft during 1975–2016 (fig. 4). Groundwater use in Madison Parish increased during 1975–2014 from 9.04 Mgal/d to 44.37 Mgal/d (USGS, 2016a).

State well-registration records listed 603 active water wells screened in the Mississippi River alluvial aquifer in Madison Parish in 2016: 526 irrigation wells, 61 domestic wells, 14 public-supply wells, and 2 industrial wells. Depths of these wells ranged from 27 to 153 ft below land surface, and reported yields ranged from 3 to 3,500 gallons per minute (gal/min) (Louisiana Department of Natural Resources, 2016). In 2014, about 44.37 Mgal/d were withdrawn from the Mississippi River alluvial aquifer: 0.29 Mgal/d for aquaculture, 0.02 Mgal/d for rural domestic, 31.28 Mgal/d for general irrigation, less than 0.01 Mgal/d for livestock, 10.98 Mgal/d for rice irrigation, and 1.79 Mgal/d for public supply (Collier, 2018).

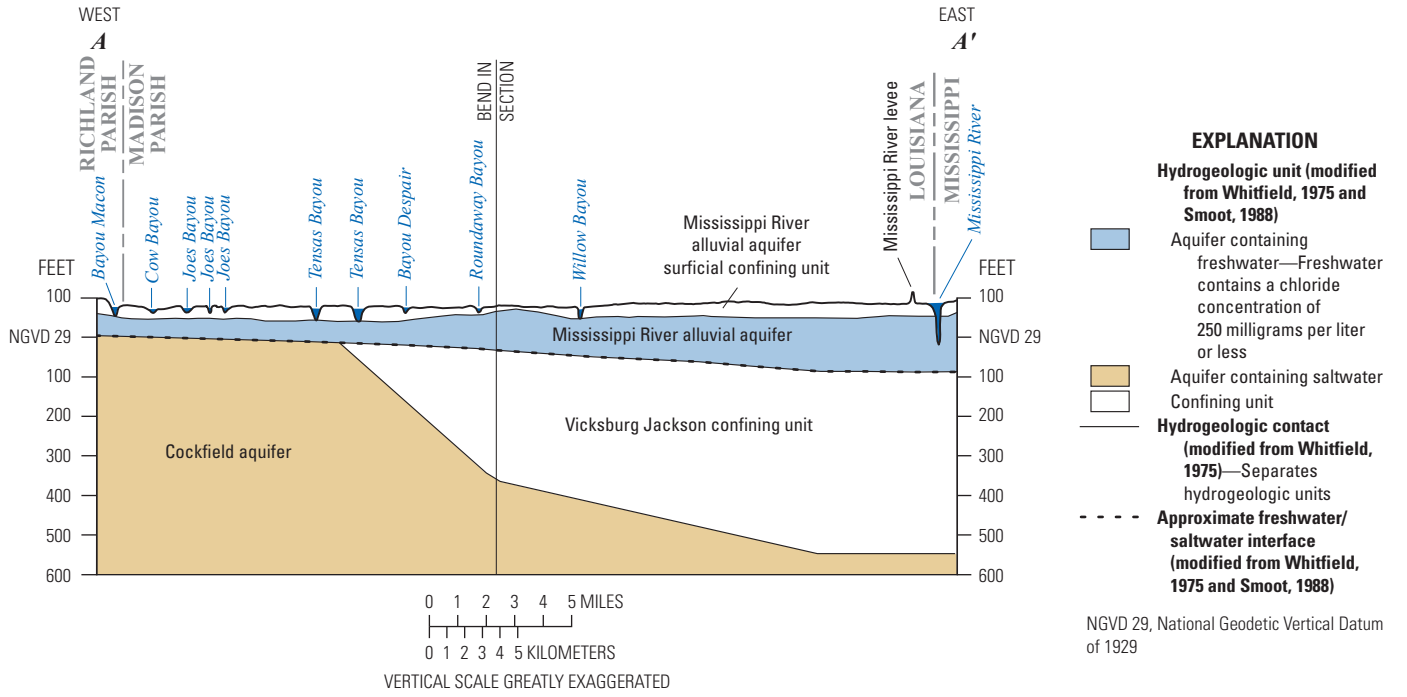

Figure 3. Idealized west-to-east hydrogeologic section through Madison Parish, Louisiana, showing aquifer and confining unit intervals (individual sand and clay layers not shown). Trace of section shown on figure 1.

Groundwater Quality

Groundwater samples were collected in Madison Parish during 1945–2016 from 51 wells screened in the Mississippi River alluvial aquifer as part of a long-term monitoring program for the State's groundwater resources. These samples were within the U.S. Environmental Protection Agency's Secondary Maximum Contaminant Level[2] (SMCL) for pH (table 3). The median value for hardness of 370 milligrams per liter (mg/L) as calcium carbonate was within the very hard[3] range. Iron and manganese concentrations exceeded the SMCLs of 300 micrograms per liter (µg/L) for iron and 50 µg/L for manganese for at least 95 percent of samples. The median value for color, 5 platinum cobalt units (PCU), was below the SMCL of 15 PCU, whereas the median value for dissolved solids, 541 mg/L, exceeded the SMCL of 500 mg/L. Note that this sample set included 116 of 170 chloride samples from 6 wells in the Tallulah area which have had chloride values greater than 250 mg/L.

Surface-Water Resources

Numerous surface-water resources in Madison Parish are present primarily in four drainage subbasins (fig. 1). The Lower Mississippi-Greenville subbasin (Hydrologic Unit Code [HUC] 08030100) drains the land adjacent to the Mississippi River along the northeastern border of the parish, and the Lower Mississippi-Natchez subbasin (HUC 08060100) drains the narrow strip of land adjacent to the Mississippi River in the southeast corner of the parish. The central part and majority of the parish is drained by the Tensas subbasin (HUC 08050003). The Bayou Macon subbasin (HUC 08050002) drains the land adjacent to the western border of the parish (fig. 1). In addition to these resources, relatively small parts of Madison Parish are present on the eastern side of the Mississippi River including part of Eagle Lake. In 2014, 6.30 Mgal/d were withdrawn from miscellaneous surface waters in Madison Parish: less than 0.01 Mgal/d for livestock, 3.48 Mgal/d for general irrigation, 2.74 Mgal/d for rice irrigation, and 0.07 Mgal/d for aquaculture (table 2) (Collier, 2018).

Lower Mississippi-Natchez and Lower Mississippi-Greenville Subbasins

The Mississippi River follows much of the eastern boundary of Madison Parish. The river is sustained by drainage from more than 40 percent of the conterminous United States, but drains little land area in Madison Parish because of levees built along the river for flood protection. The annual average flow of the Mississippi River at Vicksburg, Mississippi (USGS site number 07289000; fig. 1), was about 689,700 cubic feet per second (ft^3/s) during the period 2007–14 from a drainage area of 1,144,500 square miles (mi^2) (USGS, 2016b). The highest and lowest monthly average flows at the site were during May (1,199,000 ft^3/s) and September (393,500 ft^3/s), respectively. During this period, extreme high and extreme low streamflows were measured. In 2011, a high of 2,310,000 ft^3/s was recorded, and in 2012, a low of 191,000 ft^3/s was recorded.

Tensas Subbasin

The Tensas River (called Tensas Bayou in the northern part of the parish) flows southward into Madison Parish from East Carroll Parish, meanders through the central part of the parish, and flows into Tensas Parish (fig. 1). Numerous tributaries flow directly or indirectly into the Tensas River in Madison Parish, including Mothiglam Bayou, Mill Bayou, and Roundaway Bayou. The annual average streamflow of the Tensas River at Tendal (USGS site number 07369500; fig. 1) was about 358 ft^3/s during 1935–2015 (USGS, 2016b). During this period, the highest monthly average flow occurred during February (666 ft^3/s), and the lowest occurred

[2]The SMCLs are Federal guidelines regarding cosmetic effects (such as tooth or skin discoloration), aesthetic effects (such as taste, odor, or color), or technical effects (such as damage to water equipment or reduced effectiveness of treatment for other contaminants) of potential constituents of drinking water. SMCLs were established as guidelines by the U.S. Environmental Protection Agency (2016).

[3]Hardness ranges, expressed as milligrams per liter of calcium carbonate, are as follows: 0–60, soft; 61–120, moderately hard; 121–180, hard; greater than 180, very hard (Hem, 1985).

Table 3. Summary of selected water-quality characteristics for 51 wells screened in the Mississippi River alluvial aquifer in Madison Parish, Louisiana, 1945–2016 (U.S. Geological Survey, 2016b).

[Values are in milligrams per liter, except as noted. °C, degrees Celsius; µS/cm, microsiemens per centimeter; SU, standard unit; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; <, less than; SMCL, Secondary Maximum Contaminant Level established by the U.S. Environmental Protection Agency (2016); NA, not applicable]

	Temperature (°C)	Color (platinum cobalt units)	Specific conductance, field (µS/cm at 25 °C)	pH, field (SU)	Hardness (as $CaCO_3$)	Calcium, filtered (as Ca)	Magnesium, filtered (as Mg)	Sodium, filtered (as Na)	Chloride, filtered (as Cl)	Sulfate, filtered (as SO_4)	Iron, filtered, in µg/L (as Fe)	Manganese, filtered, in µg/L (as Mn)	Dissolved solids, filtered
Median	20.3	5	6,600	7.2	370	96	30	42.5	1,750	7.1	7,100	476	541
10th percentile	19.5	0	737	6.9	278	66	23.8	16	9.1	<0.2	1,400	167	331
90th percentile	22.7	48	9,690	7.8	784	210	62.2	1,280	2,840	32.1	13,900	1,100	4,180
Number of samples	96	35	145	31	59	49	49	42	170	40	42	38	35
Percentage of samples that do not exceed SMCLs	NA	80	NA	100	NA	NA	NA	NA	32	95	5	3	46
SMCLs	NA	15	NA	6.5–8.5	NA	NA	NA	NA	250	250	300	50	500

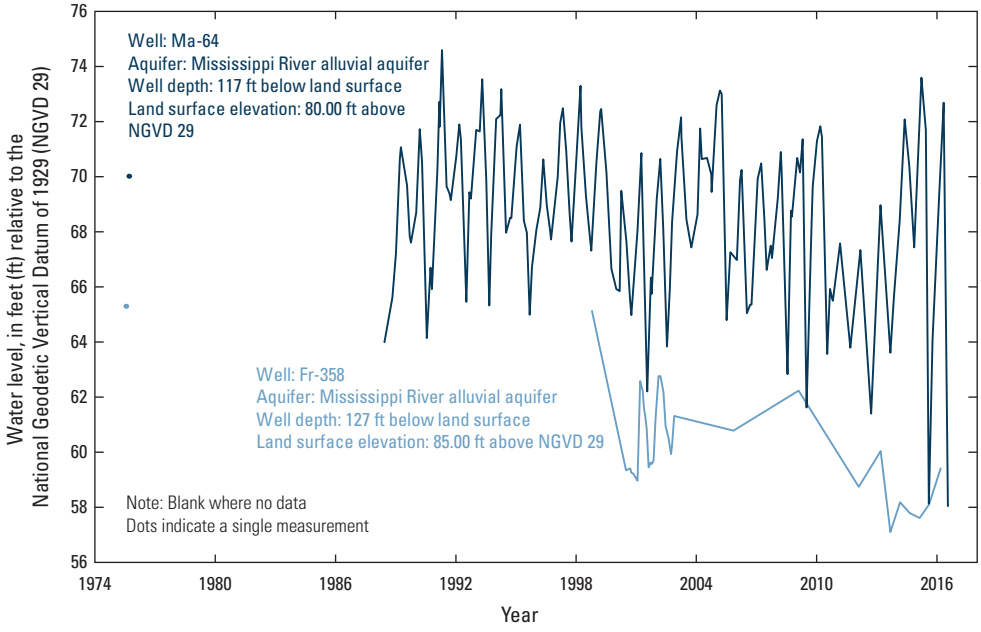

Figure 4. Water levels in well Ma-64 and Fr-358 screened in the Mississippi River alluvial aquifer in Madison Parish and Franklin Parish, Louisiana (see figure 1 for well locations; U.S. Geological Survey, 2016b).

during August (83.9 ft^3/s). This river serves as an important source of water and habitat for the Tensas River National Wildlife Refuge, which is present in southwestern Madison Parish and surrounding parishes. The refuge covers nearly 80,000 acres and contains a wide diversity of habitats that serve as home to more than 400 different species of amphibians, birds, fish, mammals, and reptiles (U.S. Fish and Wildlife Service, 2016).

Bayou Macon Subbasin

Bayou Macon flows along and forms most of the western border of Madison Parish. The bayou originates north of the Louisiana State border and flows in a general southerly direction, receiving flow in Madison Parish from Joes Bayou. The average streamflow during 1934–92 was 975 ft^3/s at Bayou Macon near Delhi (USGS site number 07370000; fig. 1) (USGS, 2016b).

Eagle Lake

Eagle Lake is located at the northeastern end of Madison Parish, along the border with the State of Mississippi, on the eastern side of the Mississippi River. The 4,700-acre oxbow lake is a remnant of a historical channel of the Mississippi River. Levees now separate the lake from the Mississippi River, and water levels in the lake are maintained by a control structure. Survey data updated in 2012 indicate that the lake's depth reaches 27 ft along its eastern shore (Mississippi Department of Wildlife, Fisheries, and Parks, 2012, 2016).

Surface-Water Quality

Water samples were collected from the Mississippi River at Vicksburg (USGS site number 07289000) during 1961–99, Tensas River at Tendal (USGS site number 07369500) during 1943–2000, and Bayou Macon near Delhi (USGS site number 07370000) during 1952–98 (fig. 1) as part of a long-term program to monitor the State's surface-water resources. Theses samples were generally within SMCLs for pH and concentrations of chloride, iron, and dissolved solids (table 4). Median values for hardness were within the moderately hard range for Bayou Macon and within the hard range for the Mississippi and Tensas Rivers. Median values for dissolved-oxygen concentration were greater than 6.5 mg/L in the

Table 4. Summary of selected water-quality characteristics for the Mississippi River at Vicksburg, Mississippi, Tensas River at Tendal, Louisiana, and Bayou Macon near Delhi, Louisiana (U.S. Geological Survey, 2016b).

[Values are in milligrams per liter, except as noted. µS/cm, microsiemens per centimeter; °C, degrees Celsius; SU, standard unit; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; <, less than; SMCL, Secondary Maximum Contaminant Level established by the U.S. Environmental Protection Agency (2016); NA, not applicable]

	Color (platinum cobalt units)	Specific conductance, field (µS/cm at 25 °C)	Dissolved oxygen	pH, field (SU)	Hardness (as $CaCO_3$)	Chloride, filtered (as Cl)	Iron, filtered, in µg/L (as Fe)	Manganese, filtered, in µg/L (as Mn)	Dissolved solids, filtered
Mississippi River at Vicksburg, Mississippi (1961–99)[1]									
Median	15	370	8.2	7.7	147	18	20	<10	228
10th percentile	7	280	6.5	7.3	120	13	<6.3	<2	170
90th percentile	20	440	11.5	8	170	26	90	20	271
Number of samples	5	160	146	158	155	156	89	72	154
Percentage of samples that do not exceed SMCLs	60	NA	NA	97	NA	100	98	99	100
Tensas River at Tendal, Louisiana (1943–2000)[2]									
Median	20	271	6.8	7.3	130	10	11	80	187
10th percentile	5	88	4.6	6.6	37.6	2.2	<4.2	<5.8	65.3
90th percentile	100	608	10.1	7.9	241	28	89.4	306	377
Number of samples	177	360	302	352	277	277	139	135	244
Percentage of samples that do not exceed SMCLs	46	NA	NA	95	NA	100	99	39	100
Bayou Macon near Delhi, Louisiana (1952–98)[3]									
Median	20	298	8.2	7.3	120	15	100	125	174
10th percentile	10	105	5.2	6.8	42	3.5	58	113	81.1
90th percentile	60	556	10.1	7.8	225	36	184	137	336
Number of samples	51	75	33	73	66	66	5	2	48
Percentage of samples that do not exceed SMCLs	45	NA	NA	97	NA	100	100	0	100
SMCLs	15	NA	NA	6.5–8.5	NA	250	300	50	500

[1]U.S. Geological Survey site number 07289000 (see fig. 1).

[2]U.S. Geological Survey site number 07369500 (see fig. 1).

[3]U.S. Geological Survey site number 07370000 (see fig. 1).

Tensas River and greater than 8 mg/L in the Mississippi River and Bayou Macon; 5 mg/L is considered the minimum value for a diverse population of fresh, warmwater biota, including sport fish (Louisiana Department of Environmental Quality, 2008). More than 60 percent of Tensas River samples exceeded the SMCL for manganese of 50 µg/L.

Natural processes and agricultural, municipal, and industrial activities in the Mississippi River Basin upstream of Madison Parish affect the quality of Mississippi River water available to the parish. Water-quality constituents, such as agricultural pesticides and nutrients, are generally highest in late spring-early summer, commonly called the "spring flush," which results from the runoff of upstream applications of these pesticides and nutrients (Demcheck and others, 2004). Suspended-sediment concentrations are generally highest in late winter and early spring and lowest in late summer and fall (Wells, 1980).

References Cited

Collier, A.L., 2018, Water withdrawals by source and category in Louisiana Parishes, 2014–2015: U.S. Geological Survey data release, https://doi.org/10.5066/F78051VM.

Demcheck, D.K., Tollett, R.W., Mize, S.V., Skrobialowski, S.C., Fendick, R.B., Jr., Swarzenski, C.M., and Porter, Stephen, 2004, Water quality in the Acadian-Pontchartrain Drainages, Louisiana and Mississippi, 1999–2001: U.S. Geological Survey Circular 1232, 41 p. [Also available at http://pubs.water.usgs.gov/cir1232.]

Hem, J.D., 1985, Study and interpretation of the chemical characteristics of natural water (3d ed.): U.S. Geological Survey Water-Supply Paper 2254, 264 p., accessed February 20, 2013, at http://pubs.er.usgs.gov/publication/wsp2254.

Louisiana Department of Environmental Quality, 2008, Environmental Regulatory Code, Title 33, Part IX, Subpart 1: Baton Rouge, Louisiana Department of Environmental Quality, accessed June 9, 2009, at http://www.deq.louisiana.gov/portal/tabid/1674/Default.aspx.

Louisiana Department of Natural Resources, 2016, Strategic Online Natural Resources Information System (SONRIS): Louisiana Department of Natural Resources database, accessed August 31, 2016, at http://sonris.com/.

Mississippi Department of Wildlife, Fisheries, and Parks, 2012, Fishing and boating—Lake depth maps, Eagle Lake, accessed October 6, 2016, at https://www.mdwfp.com/fishing-boating/lake-depth-maps.aspx.

Mississippi Department of Wildlife, Fisheries, and Parks, 2016, Fishing and boating—Reel facts, Eagle Lake, accessed October 6, 2016, at https://www.mdwfp.com/fishing-boating/reel-facts.aspx.

Sargent, B.P., 2011, Water use in Louisiana, 2010: Louisiana Department of Transportation and Development Water Resources Special Report no. 17, 135 p. [Also available at https://la.water.usgs.gov/publications/pdfs/WaterUse2010.pdf.]

Saucier, R.T., 1994, Geomorphology and Quaternary geologic history of the lower Mississippi Valley: Vicksburg, Miss., U.S. Army Corps of Engineers, v. 1–2, 364 p., 28 pls. [Also available at http://lmvmapping.erdc.usace.army.mil/.]

Seanor, R.C., and Smoot, C.W., 1995, Louisiana ground-water map no. 6—Potentiometric surface, 1990, and water-level changes, 1974–90, of the Mississippi River alluvial aquifer in northeastern Louisiana: U.S. Geological Survey Water-Resources Investigations Report 95–4146, 2 sheets. [Also available at https://pubs.er.usgs.gov/publication/wri954146.]

Smoot, C.W., 1988, Louisiana hydrologic atlas map no. 3—Altitude of the base of freshwater in Louisiana: U.S. Geological Survey Water-Resources Investigations Report 86–4314, 1 sheet, accessed November 2, 2011, at https://pubs.er.usgs.gov/publication/wri864314.

U.S. Environmental Protection Agency, 2016, Secondary Drinking Water Standards—Guidance for nuisance chemicals, accessed April 13, 2016, at https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.

U.S. Fish and Wildlife Service, 2016, Tensas River National Wildlife Refuge, Louisiana, accessed September 16, 2016, at https://www.fws.gov/refuge/Tensas_River/.

U.S. Geological Survey [USGS], 2016a, U.S. Geological Survey Water Resources Cooperative Program—Louisiana Water Use Program, accessed November 28, 2016, at https://la.water.usgs.gov/WaterUse/default.asp.

U.S. Geological Survey [USGS], 2016b, USGS water data for the Nation: U.S. Geological Survey National Water Information System database, accessed October 2016 at https://doi.org/10.5066/F7P55KJN.

Wells, F.C., 1980, Hydrology and water quality of the lower Mississippi River: Louisiana Department of Transportation and Development, Office of Public Works Water Resources Technical Report no. 21, 83 p. [Also available at http://la.water.usgs.gov/publications/pdfs/TR21.pdf.]

Whitfield, M.S., Jr., 1975, Geohydrology and water quality of the Mississippi River alluvial aquifer, northeastern Louisiana: Louisiana Department of Public Works Water Resources Technical Report no. 10, 29 p. [Also available at https://la.water.usgs.gov/publications/pdfs/TR10.pdf.]

This fact sheet has been prepared by the USGS, in cooperation with the Louisiana Department of Transportation and Development (DOTD), as part of a program to document water use, availability, and quality in the parishes of Louisiana. Information on the availability, past and current water use, use trends, and water quality from groundwater and surface-water sources in the parish is presented here. Previously published reports (see References Cited section) and data stored in the USGS National Water Information System (USGS, 2016b) are the primary sources of the information presented here. Special thanks are given to Doug Taylor, Director, and Zahir "Bo" Bolourchi (retired), DOTD Cooperative Program with the USGS.

By Vincent E. White

For additional information, contact:

Director, USGS Lower Mississippi-Gulf Water Science Center
3535 S. Sherwood Forest Blvd., Suite 120
Baton Rouge, LA 70816
E-mail: gs-w-lmg_center_director@usgs.gov
Fax: (225) 298–5490
Telephone: (225) 298–5481
Home Page: http://la.water.usgs.gov

ISSN 2327-6916 (print) ISSN 2327-6932 (online) https://doi.org/10.3133/fs20193018