STATE OF LOUISIANA

DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

OFFICE OF PUBLIC WORKS, HURRICANE FLOOD PROTECTION

AND INTERMODAL TRANSPORTATION

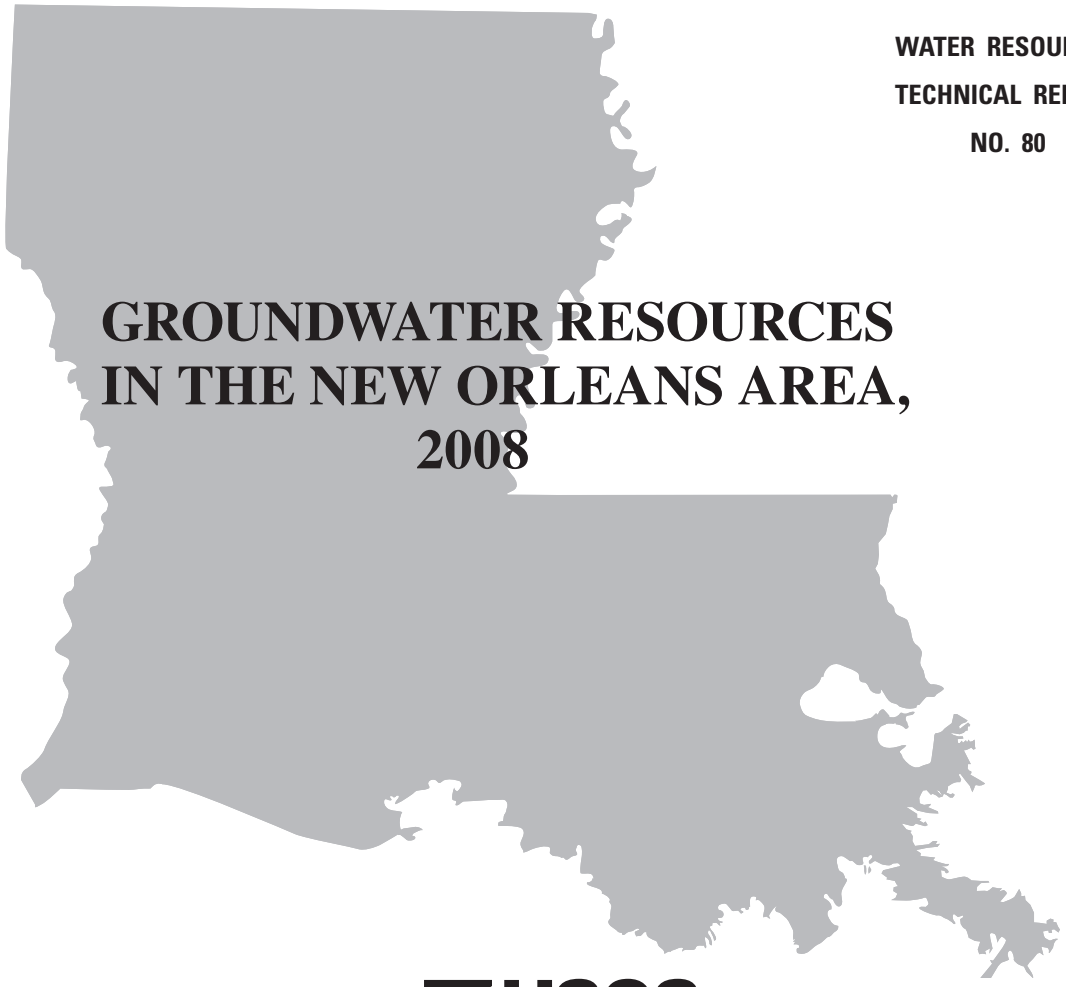
WATER RESOURCES PROGRAMS

WATER RESOURCES

TECHNICAL REPORT

NO. 80

GROUNDWATER RESOURCES IN THE NEW ORLEANS AREA, 2008



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2009

STATE OF LOUISIANA

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Groundwater Resources in the New Orleans Area, 2008

By

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Conversion Factors, Datums, and Abbreviated Water-Quality Units

Multiply	By	To obtain
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
foot per year (ft/yr)	0.3048	meter per year (m/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 Celsius (°C) can be converted to degrees Fahrenheit (°F) as follows:
°F = (1.8 x °C) + 32

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, formerly called Sea Level Datum of 1929.

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

Abbreviated water-quality units:

milligram per liter (mg/L)
milliliter (mL)
Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25°C).

Groundwater Resources in the New Orleans Area, 2008

By Lawrence B. Prakken

Abstract

Groundwater could be a viable emergency source of water in much of the New Orleans area. However, saltwater is present in some areas of the groundwater system, and saltwater intrusion into freshwater areas is a concern. Groundwater resources in the New Orleans area include Mississippi River point-bar deposits, shallow aquifers of the New Orleans area, Gramercy aquifer, Norco aquifer, Gonzales-New Orleans aquifer, and the "1,200-foot" sand of the New Orleans area. Together these aquifers make up the New Orleans aquifer system, which supplied about 20.5 million gallons per day of groundwater for industrial use, power generation, and irrigation in the New Orleans area in 2005.

Point-bar deposits contain freshwater in some areas adjacent to the Mississippi River. The shallow aquifers of the New Orleans area generally contain saltwater. The Gramercy aquifer contains only saltwater in the New Orleans area and is absent in much of Orleans Parish. The Norco aquifer contains freshwater within the New Orleans area in an area about 1 mile wide and 6 miles long along the Lake Pontchartrain shoreline in Jefferson Parish. In western Orleans Parish, the aquifer is generally thin or missing north of the Mississippi River. There were no reported withdrawals of water from the Norco aquifer for the New Orleans area in 2005.

Almost all of the groundwater withdrawals in the New Orleans area came from the Gonzales-New Orleans aquifer. Four major withdrawal centers pump water from the Gonzales-New Orleans aquifer in the New Orleans area. Generally, water in the Gonzales-New Orleans aquifer flows radially towards the largest withdrawal center, which is near Michoud, La. Water levels in the Gonzales-New Orleans aquifer generally have risen in the New Orleans area since the 1970s in response to reduced withdrawals.

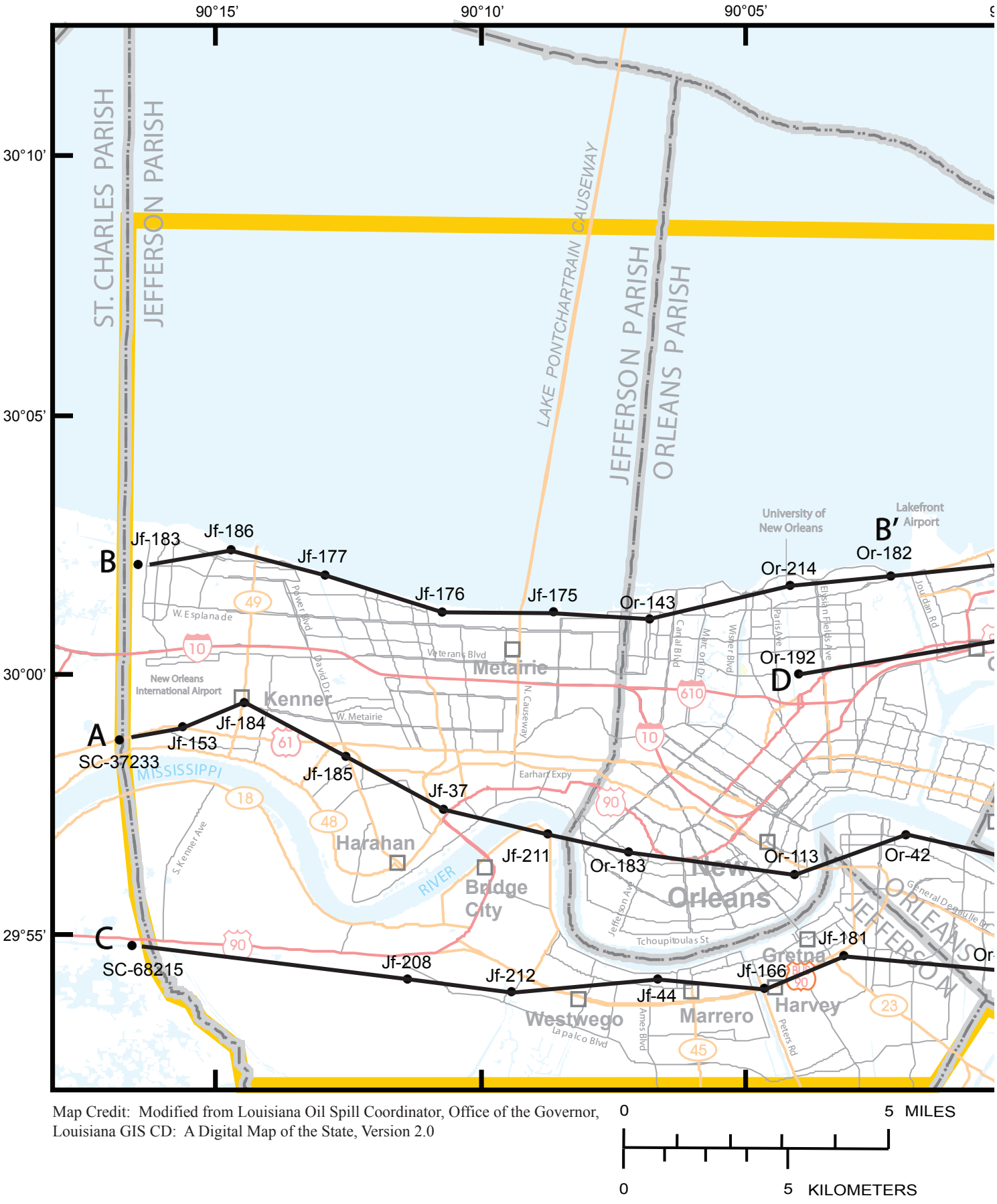
Generally, the Gonzales-New Orleans aquifer contains freshwater north of the Mississippi River or Intracoastal Waterway from Kenner to Michoud, and north of Highway 90 into the northeastern part of Orleans Parish. The aquifer generally contains saltwater south and west of the freshwater area.

In 2008, 34 wells screened in the Gonzales-New Orleans aquifer in the study area were sampled and analyzed for chloride concentration and specific conductance. Chloride concentrations have increased at four wells in western Jefferson Parish. These increases indicate that saltwater encroachment is probably occurring in the area. Chloride concentrations also increased at two wells located northeast of Bridge City in Jefferson Parish. Saltwater may be moving laterally into the area, upward from the base of the aquifer (upconing), or a combination of the two.

Introduction

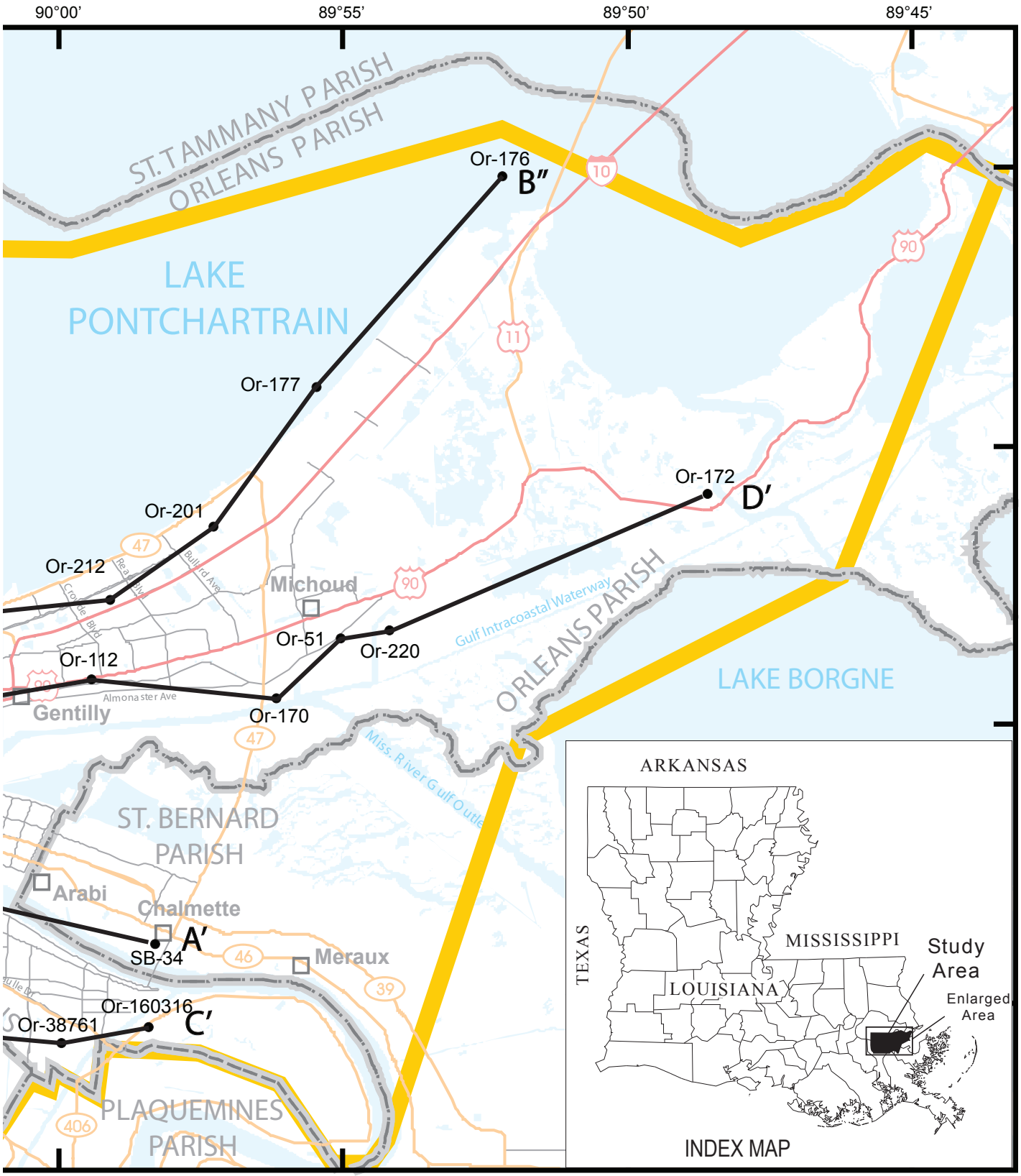
In August 2005, Hurricane Katrina caused significant flooding and damage to water-supply facilities (loss of electrical power, flooding of treatment facilities, and damage to water distribution lines) in the New Orleans area (Black and Veatch Corporation, 2008). The New Orleans area (fig. 1), which includes Orleans, northern Jefferson, and northwestern St. Bernard Parishes, currently (2009) uses water from the Mississippi River for public supplies. Groundwater could be a viable emergency source of water in much of the New Orleans area. However, saltwater[1] is present in some areas of the groundwater system, and saltwater intrusion into freshwater areas is a concern. To determine the availability and suitability of groundwater as an emergency source, current information is needed regarding aquifer depth and extent, water levels, the location of freshwater and saltwater, and general water-quality characteristics. To

[1] In this report, saltwater is defined as water containing chloride concentrations greater than 250 milligrams per liter (mg/L).



Map Credit: Modified from Louisiana Oil Spill Coordinator, Office of the Governor, Louisiana GIS CD: A Digital Map of the State, Version 2.0

Figure 1. Location of the study area and hydrogeologic sections, New Orleans area, southeastern Louisiana.



Explanation

BOUNDARY OF STUDY AREA

SB-34 ● CONTROL POINT--Water, oil, or gas well drill site

B ●——● B′ Location of hydrogeologic section (see figs. 3-7)

address these needs, the U.S. Geological Survey (USGS), in cooperation with the Louisiana Department of Transportation and Development (DOTD), conducted a study to identify the groundwater resources in the New Orleans area and map major freshwater areas. The study provides State and local water managers with information to help plan future groundwater development and assess the potential use of groundwater as an emergency supply in the New Orleans area.

Purpose and Scope

This report describes groundwater resources in the New Orleans area in 2008. These resources included point-bar deposits, shallow aquifers of the New Orleans area, Gramercy aquifer, Norco aquifer, Gonzales-New Orleans aquifer, and the "1,200-foot" sand of the New Orleans area (fig. 2). The thickness and location of major aquifers are shown on structural contour maps and hydrogeologic sections (based on geophysical logs). Water-use data have been consolidated and water withdrawal centers are shown on maps. Water levels and the direction of groundwater flow are shown on a potentiometric surface map of the Gonzales-New Orleans aquifer. Water level trends are discussed and illustrated with hydrographs. Maps show locations of freshwater in the Norco and Gonzales-New Orleans aquifers. Water-quality data from previous studies have been summarized. The "1,200-foot" sand of the New Orleans area is the deepest aquifer in the New Orleans aquifer system and contains saltwater throughout most of the study area. Because few data are available and no withdrawals are reported for the "1,200-foot" sand in the study area, it is only briefly discussed in this report.

Description of the Study Area

The study area is located in southeastern Louisiana along the southeastern shore of Lake Pontchartrain and includes most of Orleans Parish, the northern part of Jefferson Parish, and northwestern St. Bernard Parish (fig. 1). The climate is warm and temperate, often with high humidity. During the period 1971-2000, the mean relative humidity at New Orleans was 76 percent, the mean annual precipitation was

Louisiana Department of Transportation and Development—U.S. Geological Survey Water Resources Cooperative Program

<table>
<tr><th>System</th><th>Series</th><th colspan="3">Aquifer or aquifer system
(clay units separating aquifers are unnamed)</th></tr>
<tr><td rowspan="6">Quaternary</td><td rowspan="2">Holocene</td><td rowspan="6">New Orleans aquifer system</td><td rowspan="2">Shallow sands (aquifers)</td><td>Point-bar deposits</td></tr>
<tr><td>Shallow aquifers of New Orleans area</td></tr>
<tr><td>?</td><td colspan="2">Gramercy aquifer</td></tr>
<tr><td rowspan="3">Pleistocene</td><td colspan="2">Norco aquifer</td></tr>
<tr><td colspan="2">Gonzales-New Orleans aquifer</td></tr>
<tr><td colspan="2">"1,200-foot" sand (aquifer)</td></tr>
</table>

Figure 2. Hydrogeologic units in the New Orleans area, southeastern Louisiana (modified from Griffith, 2003).

about 64 inches, and the mean annual temperature was about 69°F (National Oceanic and Atmospheric Administration, 2006, 2007). The Mississippi River traverses the study area and is confined by levees that are designed to protect against a major flood stage of 20 feet (ft) (National Weather Service, 2008). The land surface in the study area generally is flat with altitudes of 0 to 5 ft above the National Geodetic Vertical Datum of 1929 (NGVD 29) although parts of Orleans Parish and northern Jefferson Parish are as much as 5 ft below NGVD 29.

Methods

For this report, a sand or aquifer is defined as material ranging from silty sand to gravel which is sufficiently permeable to conduct groundwater to wells. A confining unit is defined as material ranging from solid clay to sandy or silty clay which impedes or obstructs groundwater flow. Electric-log (e-log) data obtained from files of the USGS, drillers, DOTD, and the Louisiana Department of Natural Resources, were used to construct hydrogeologic cross sections. The location, depth, and thickness of sands and clays were determined by using different log types (when available): single-point resistance (POIR), spontaneous potential (SP), short normal resistivity (SN), medium induction resistivity (ILM), gamma-ray (GR), and drillers' lithologic logs. SP logs are graphic plots of small differences in voltage that occur at the contacts between shale or clay beds and a sand aquifer (Keys, 1990). GR logs record the amount of natural gamma radiation present in the formation; generally the natural gamma activity of clay-bearing sediments is much higher than that of quartz sands and carbonates (Keys and MacCary, 1971). The location of freshwater in sand primarily was determined by using resistivity logs. A resistivity value of 20 ohm-meters was used as an estimate of chloride concentration of about 250 mg/L (upper limit of freshwater) in the formation fluid. Generally, a sand with a resistivity of more than 20 ohm-meters is reported as a freshwater sand; a sand with a value of less than 20 ohm-meters is labeled as a saltwater sand.

Sands and clays less than 10 ft in thickness generally are not shown on cross sections. Thin sands are defined as sands which are generally 20 ft or less in thickness. Previously published maps of structural contours (Tomaszewski, 2003) were evaluated and revised on the basis of new data. Altitudes of aquifer tops and aquifer thicknesses shown on structural contour maps generally were selected on the basis of the location of relatively thick basal sands. Some local sand lenses above or below a thick basal sand are included as part of an aquifer.

Groundwater withdrawal data from a water-use database at the USGS office in Baton Rouge were evaluated to locate major withdrawal centers (sites withdrawing greater than 1 million gallons per day), help determine groundwater flow direction, and aid in interpretation of water-level trends. Water-level trends in the Gonzales-New Orleans aquifer were determined at selected sites. Water-withdrawal and water-level data for selected sites in the study area are routinely collected by USGS personnel as part of a cooperative program between the USGS and DOTD. Water levels were measured by using steel or electrical tapes marked with 0.01-ft gradations. Wells in which water levels were measured were not being pumped when measurements were made.

A previously published map showing the distribution of freshwater in the Gonzales-New Orleans aquifer (Tomaszewski, 2003) was revised on the basis of chloride-concentration data collected in 2008. A chloride concentration greater than 250 mg/L was used as an indicator of the presence of saltwater. The 250 mg/L concentration is the U.S. Environmental Protection Agency's Secondary Maximum Contaminant Level (SMCL)[2], established for chloride in public water systems (U.S. Environmental Protection Agency, 2009). Chloride data collected during this study were compared to historical data to determine whether chloride concentrations were changing over time. General descriptions of freshwater quality are from

[2]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 may also exist. SMCLs are not federally enforceable but are intended as guidelines for the States (U.S. Environmental Protection Agency, 2009).

previously published reports. Other SMCLs mentioned in this report are color (15 platinum-cobalt units), iron (0.3 mg/L), manganese (0.05 mg/L), and pH (6.5 to 8.5 standard units) (U.S. Environmental Protection Agency, 2009).

Wells generally were selected to sample on the basis of their proximity to saltwater areas delineated by Tomaszewski (2003) or to substantiate historical values. Before sample collection, wells were purged to remove stagnant water. Specific conductance and water temperature were monitored by using a calibrated field instrument and values were recorded after readings stabilized. Samples were collected at or near the wellhead before treatment, pressurization, or storage. A 250-mL filtered-water sample (using a 0.45-micrometer filter) was collected at each well for laboratory analysis of chloride concentration. Additionally, a 250-mL unfiltered water sample was collected for laboratory measurement of specific conductance.

Quality control (QC) samples were collected to ensure sample collection, sample processing, and laboratory analytical procedures did not introduce bias into results and to determine the precision associated with the samples. As part of the QC process, three replicate samples were collected and analyzed for chloride and specific conductance. These three replicate chloride sample values were within 5 percent of primary values and considered acceptable. All laboratory values of specific conductance were within 5 percent of field values and also considered acceptable. QC results which are not presented in this report are on file at the USGS office in Baton Rouge, La.

All samples were collected by using standard USGS protocols (U.S. Geological Survey, 1997-present) and shipped to the USGS National Water Quality Laboratory in Denver, Colo., for analysis by using methods described in Fishman and Friedman (1989). Water quality and water-level data presented in this report are stored in the USGS National Water Information System (http://waterdata.usgs.gov/nwis).

Previous Investigations

Previous reports have described groundwater resources in the study area. Eddards and others (1956) summarized groundwater information in the New Orleans area. Kolb (1962) documented the distribution of soils bordering the Mississippi River, including point-bar deposits and shallow sands throughout the study area. Cardwell and others (1963) presented basic groundwater data for parishes along the Mississippi River south of Baton Rouge. Cardwell and others (1967) appraised the quantity and quality of groundwater available beneath Lake Pontchartrain and the problems associated with groundwater development. Rollo (1966) evaluated the groundwater resources of the New Orleans area, principally the Gonzales-New Orleans aquifer system and the potential effects of increased water withdrawals.

Historical well-construction and water-quality data for the New Orleans area (Orleans Parish and five surrounding parishes) were presented by Dial (1983). Fendick (1989) mapped the January 1987 potentiometric surface of the Gonzales-New Orleans aquifer in southeastern Louisiana. Dial and Tomaszewski (1988) described the hydrogeology and effects of pumpage on the New Orleans aquifer system in northern Jefferson Parish. Dial and Sumner (1989) evaluated the potential of the New Orleans aquifer system as an alternative public water supply for New Orleans by using a groundwater flow model. Walters (1995) mapped the spring 1993 potentiometric surface of the Gonzales-New Orleans aquifer in the New Orleans area. Tomaszewski (2003) described the groundwater resources in the New Orleans aquifer system along the lower Mississippi River in southeastern Louisiana.

Acknowledgments

The author thanks Zahir “Bo” Bolourchi, Director, Water Resources Programs, Louisiana Department of Transportation and Development, and his staff for supplying well-construction, well-location, and e-log

data. Additionally, the assistance and cooperation of individuals and industries that allowed data collection from wells are greatly appreciated.

Groundwater Resources

Sediments in the study area consist of successive layers of clays, silts, sands, and gravels which form a thick wedge that dips southward (Tomaszewski, 2003). Aquifers in the study area consist of silt, sand, and gravel. The aquifers are separated by intervening and unnamed confining units of clay. Confining units thicken southward and generally range from a few feet to more than 200 ft thick but may be more than 400 ft thick in some areas (Dial and Sumner, 1989).

Groundwater resources in the New Orleans area include Mississippi River point-bar deposits, shallow aquifers of the New Orleans area, Gramercy aquifer, Norco aquifer, Gonzales-New Orleans aquifer, and the "1,200-foot" sand of the New Orleans area (fig. 2). Together these aquifers make up the New Orleans aquifer system, which supplied about 20.5 Mgal/d of groundwater for industrial use, power generation, and irrigation in the New Orleans area in 2005. Groundwater withdrawals from the shallow aquifers of the New Orleans area, the Gramercy aquifer, the Norco aquifer, and the "1,200-foot" sand, have been limited because of the presence of saltwater in many areas. Saltwater in the Norco and Gonzales-New Orleans aquifers has been partially flushed southward by freshwater from recharge areas to the north. Between the freshwater and saltwater areas within the Norco and Gonzales-New Orleans aquifers is a transition zone where denser saltwater underlies freshwater. In the transition zone, the saltwater forms a wedge at the base of the aquifer that generally increases in thickness away from the freshwater area. The location of the freshwater-saltwater transition zone in the aquifers indicates the extent of flushing (Tomaszewski, 2003). Discussions of the individual aquifers are presented in the following sections.

Point-bar Deposits and Shallow Aquifers of the New Orleans Area

Point-bar deposits contain freshwater in some areas adjacent to the Mississippi River (fig. 3). Point-bar deposits consist of fine to very fine sand and silt which are located on the inside of river bends along the Mississippi River (fig. 3). Thickness of point-bar deposits is variable and may approach 150 ft (Dial, 1983). Water levels in point-bar deposits generally fluctuate with the stage of the Mississippi River (Rollo, 1966). Freshwater in point-bar deposits generally is very hard[3] and has iron concentrations greater than the SMCL of 0.3 mg/L (Rollo, 1966).

The shallow aquifers of the New Orleans area (shallow aquifers) generally are shallower than 200 ft below NGVD 29 and overlie the Gramercy aquifer. The shallow aquifers consist of distributary-channel deposits and discontinuous, near-surface sands which are locally occurring in the study area. The near-surface sand beds often pinch out in short distances (Dial, 1983). Distributary-channel deposits consist of fine, silty sand and generally are less than 50 ft thick (Hosman, 1972) but they may approach about 100 ft (Dial, 1983). The shallow aquifers generally contain saltwater in the study area (figs. 4, 5, 6).

In 2008, the DOTD well registration database listed four active wells screened in point-bar deposits and 30 active wells screened in shallow aquifers in the study area. Thirty of the 34 wells were used for monitoring purposes (water chemistry and/or water levels). There were no reported withdrawals of water from the shallow aquifers or point-bar deposits in 2005 in the USGS water-use data base.

[3]The U.S. Geological Survey (Hem, 1985) classifies hardness as calcium carbonate as follows: Water having a hardness of 0 to 60 mg/L, considered soft; 61 to 120 mg/L, moderately hard; 121 to 180 mg/L, hard; and more than 180 mg/L, very hard.

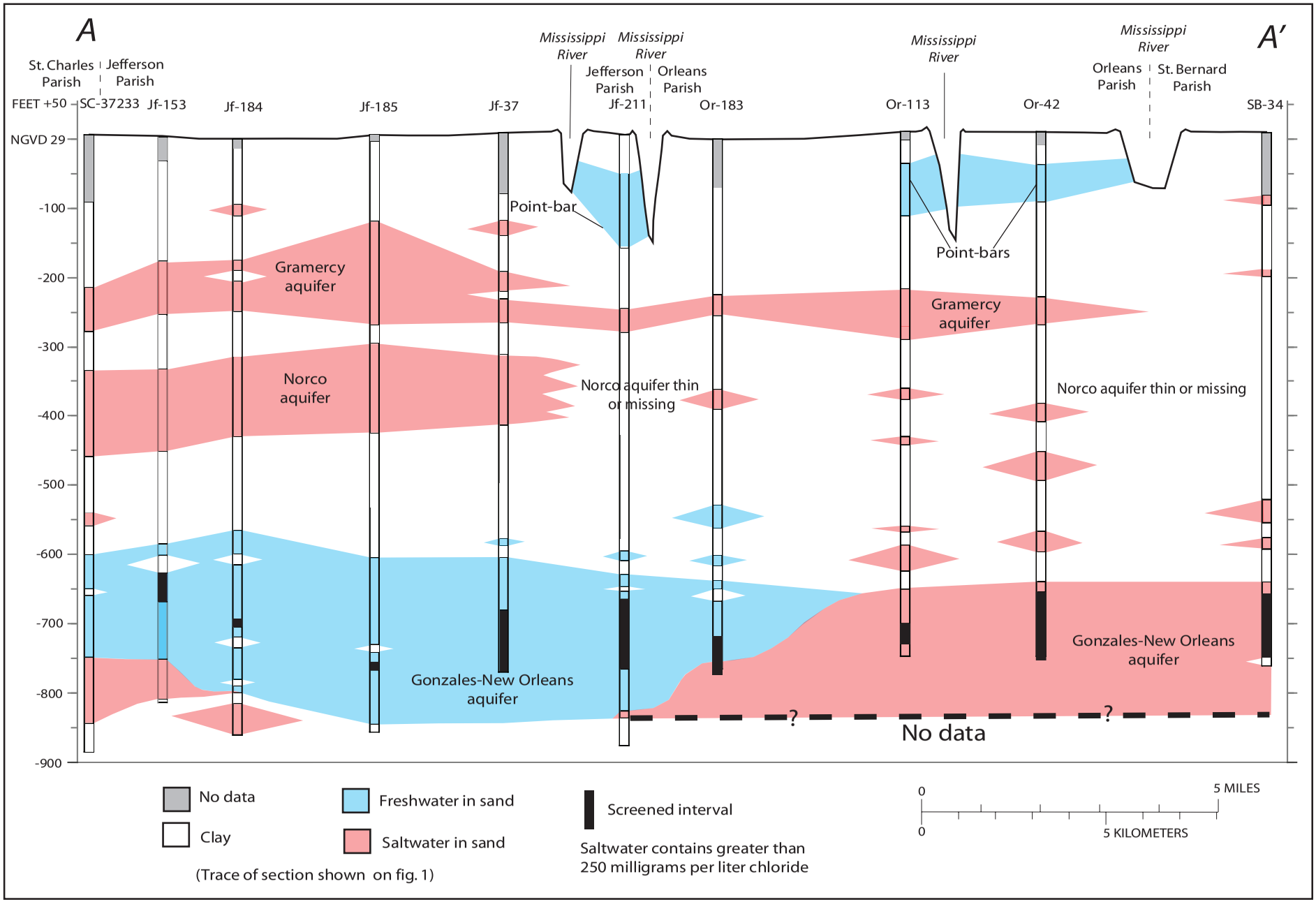


Figure 3. Hydrogeologic section *A-A′* showing major sand units from eastern St. Charles Parish to northwestern St. Bernard Parish, New Orleans area, southeastern Louisiana.

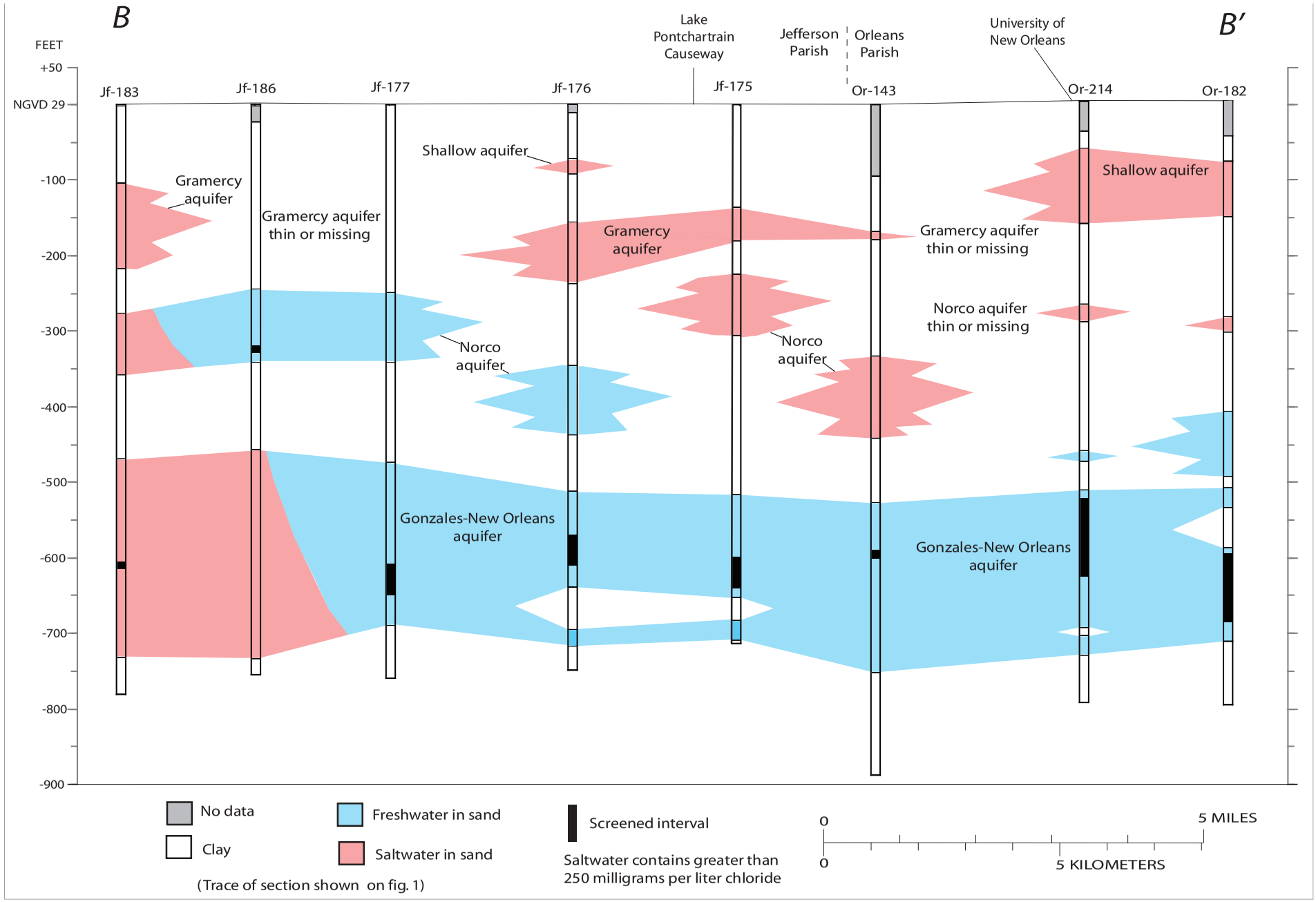


Figure 4. Hydrogeologic section *B-B′* showing major sand units near the Lake Pontchartrain shoreline from northwestern Jefferson Parish to northwestern Orleans Parish, New Orleans area, southeastern Louisiana.

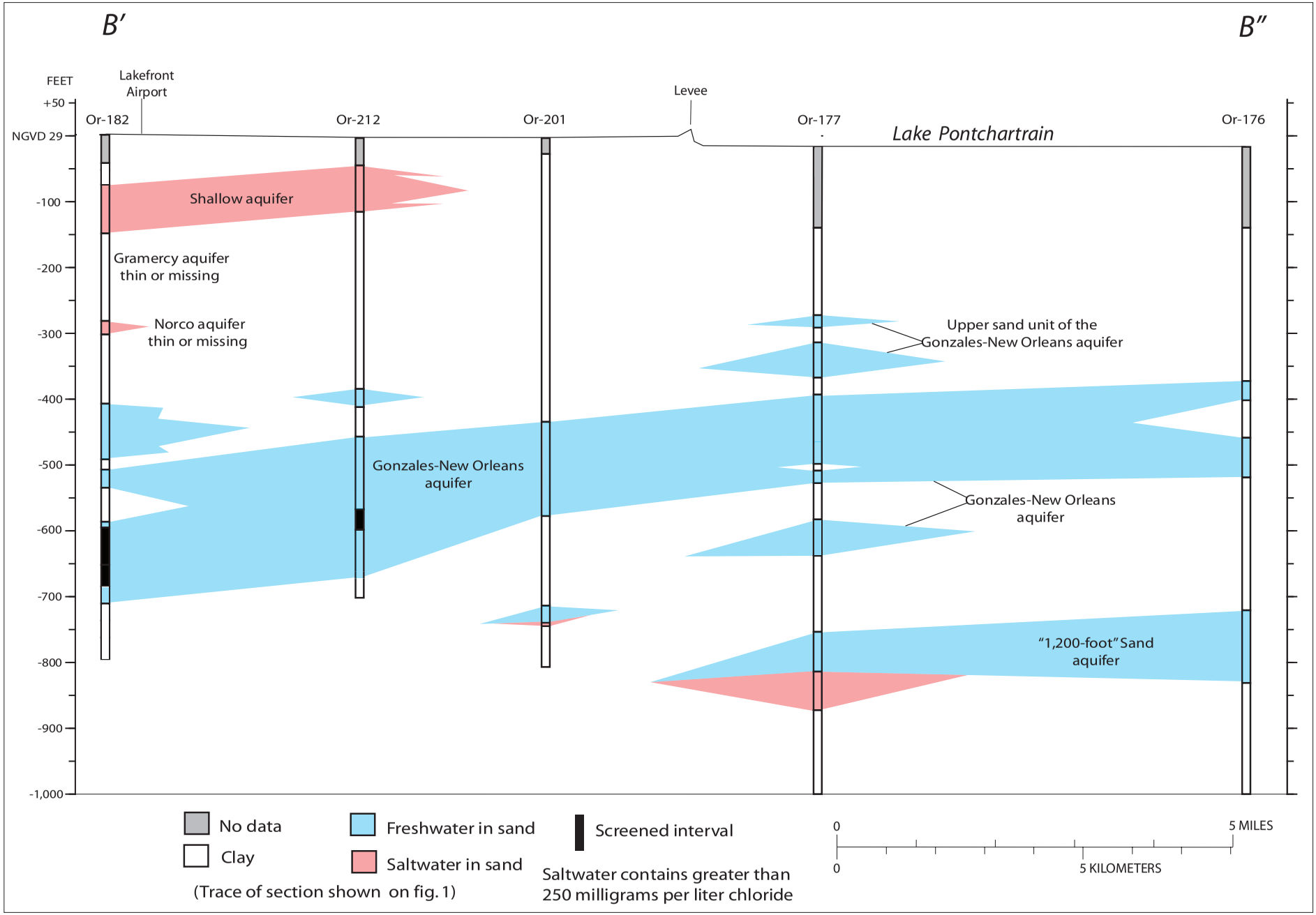


Figure 5. Hydrogeologic section *B′-B″* showing major sand units near the Lake Pontchartrain shoreline from northwestern Orleans Parish to northeastern Orleans Parish, New Orleans area, southeastern Louisiana.

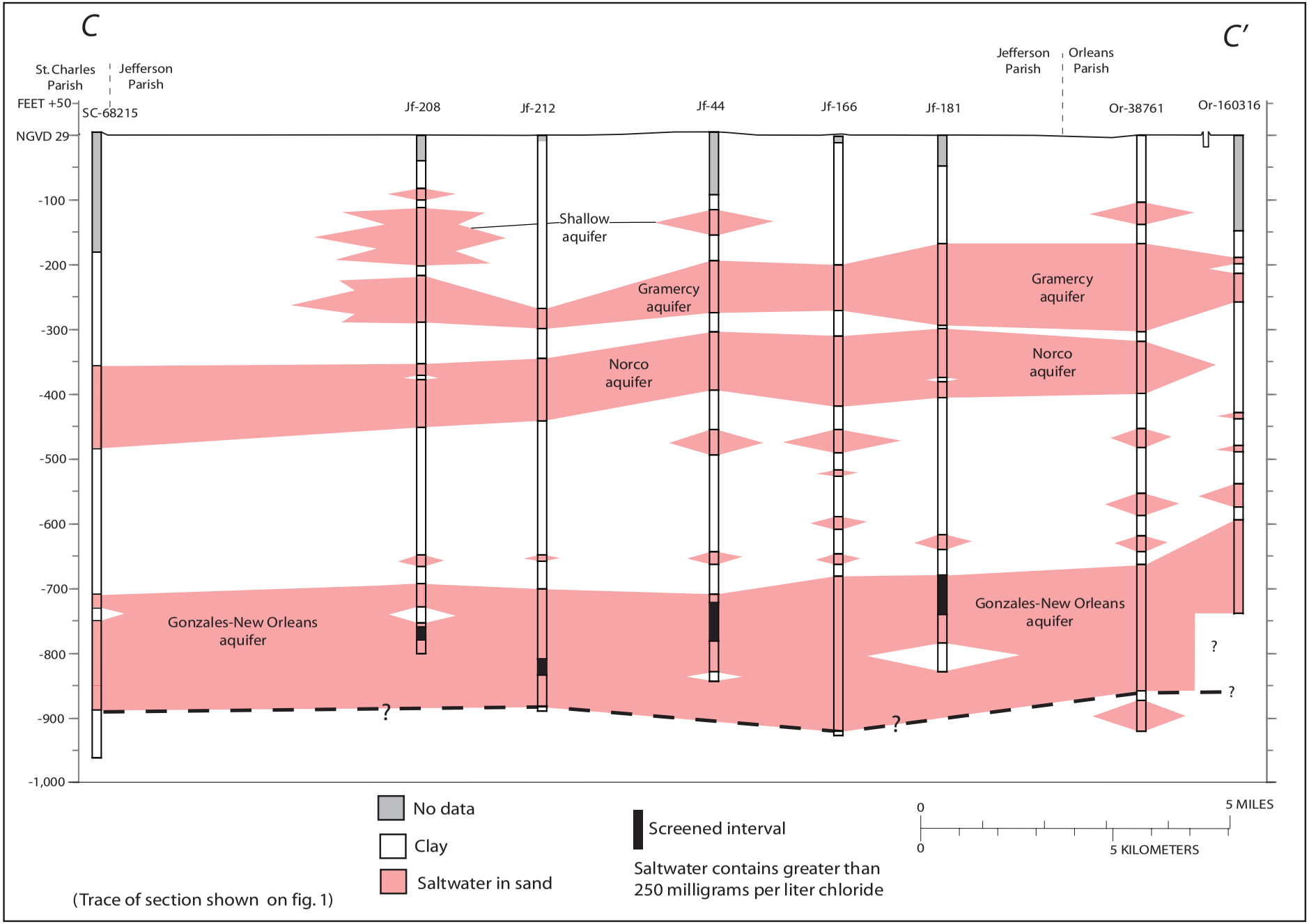


Figure 6. Hydrogeologic section *C-C′* showing major sand units south of the Mississippi River from eastern St. Charles Parish to eastern Orleans Parish, New Orleans area, southeastern Louisiana.

Gramercy Aquifer

The Gramercy aquifer contains only saltwater in the study area and is absent in much of Orleans Parish (Tomaszewski, 2003) (figs. 3, 4, 5, 6, 7). The aquifer consists of fine to coarse sand and locally occurring gravel (Hosman, 1972; Dial, 1983). A clay layer, generally ranging from about 10 to 80 ft thick (figs. 3, 6), separates the Gramercy aquifer from the underlying Norco aquifer. Regionally, the aquifer dips and thickens in a southerly direction (Tomaszewski, 2003). Work by Dial and Sumner (1989) suggested that the Gramercy aquifer pinches out north of the study area below Lake Pontchartrain. The altitude of the top of the aquifer, although variable, is generally between 100 and 250 ft below NGVD 29 (figs. 3, 4, 5, 6). Aquifer thickness is variable but can be as much as 150 ft (figs 3, 6). There were no reported withdrawals of water from the Gramercy aquifer in the study area in 2005.

Norco Aquifer

The Norco aquifer contains freshwater within the study area in an area about 1 mi wide and 6 mi long along the Lake Pontchartrain shoreline in Jefferson Parish (fig. 8). There is probably a transition zone along the southern and eastern edges of the freshwater area; however, no data are available to determine the location and extent of the transition zone. The aquifer is present in most of Jefferson Parish except for a small area west of Metairie and an area east of Bridge City (figs. 3, 8). In western Orleans Parish, the aquifer generally is thin or missing north of the Mississippi River (figs. 3, 4, 5, 7, 8). Sediments composing the aquifer include fine to coarse sand and possibly fine gravel (Hosman, 1972; Dial and Kilburn, 1980). A clay layer, generally ranging in thickness from about 100 ft in the northern part of the study area (fig. 4) to about 300 ft in the southern part (fig. 6) separates the Norco aquifer from the underlying Gonzales-New Orleans aquifer.

Regionally, the aquifer dips in a southerly direction (Tomaszewski, 2003). Work by Dial and Sumner (1989) suggested that the Norco aquifer outcrops or subcrops near the northern shore of Lake Pontchartrain. Depth to the top of the aquifer ranges from about 250 ft below NGVD 29 near Lake Pontchartrain (figs. 4, 8) to 350 ft below NGVD 29 in the southern part of the study area (figs. 6, 8). Where present in the study area, the Norco aquifer generally ranges from about 50–150 ft in thickness (fig. 8). There were no reported withdrawals of water from the Norco aquifer for the study area in 2005. Water levels ranged from about 0 to 9 ft below NGVD 29 from 1996 to 2008 at well Jf-186, located in northwestern Jefferson Parish (fig. 1). A 1986 analysis of water from well Jf-186 (Dial and Tomaszewski, 1988), screened in the Norco aquifer, indicated that freshwater at this site is moderately hard (61-120 mg/L as calcium carbonate), iron concentrations are high (exceed 0.3 mg/L), color exceeds 15 platinum-cobalt units, and manganese concentrations are low (less than 0.05 mg/L).

Gonzales-New Orleans Aquifer

The Gonzales-New Orleans aquifer is continuous throughout the study area (fig. 9), dips in a southerly direction (Tomaszewski, 2003), and consists of mostly fine to medium sand of uniform texture (Dial and Sumner, 1989). Work by Dial and Sumner (1989) suggested that the aquifer outcrops or subcrops north of Lake Pontchartrain. In the study area, the altitude of the top of the aquifer ranges from about 400 ft below NGVD 29 in the northeast to 700 ft below NGVD 29 in the south (fig. 9). Generally, the thickness of the aquifer north of the Mississippi River ranges from about 150 to 250 ft (figs. 3, 4, 5, 7, 9). South of the Mississippi River, the thickness varies, ranging from about 150 to possibly 300 ft (Rollo, 1966) (fig. 6). Rollo (1966) noted that in northeastern Orleans Parish, the Gonzales-New Orleans aquifer is composed of two distinct hydrologic units: a thick basal sand and a thinner upper sand. Neither Rollo (1966) nor Tomaszewski (2003) included the upper sand unit in aquifer thickness or depth maps. Similarly, in this report the upper sand unit is not included in thickness or depth maps but is included on cross-sections (figs. 5, 7).

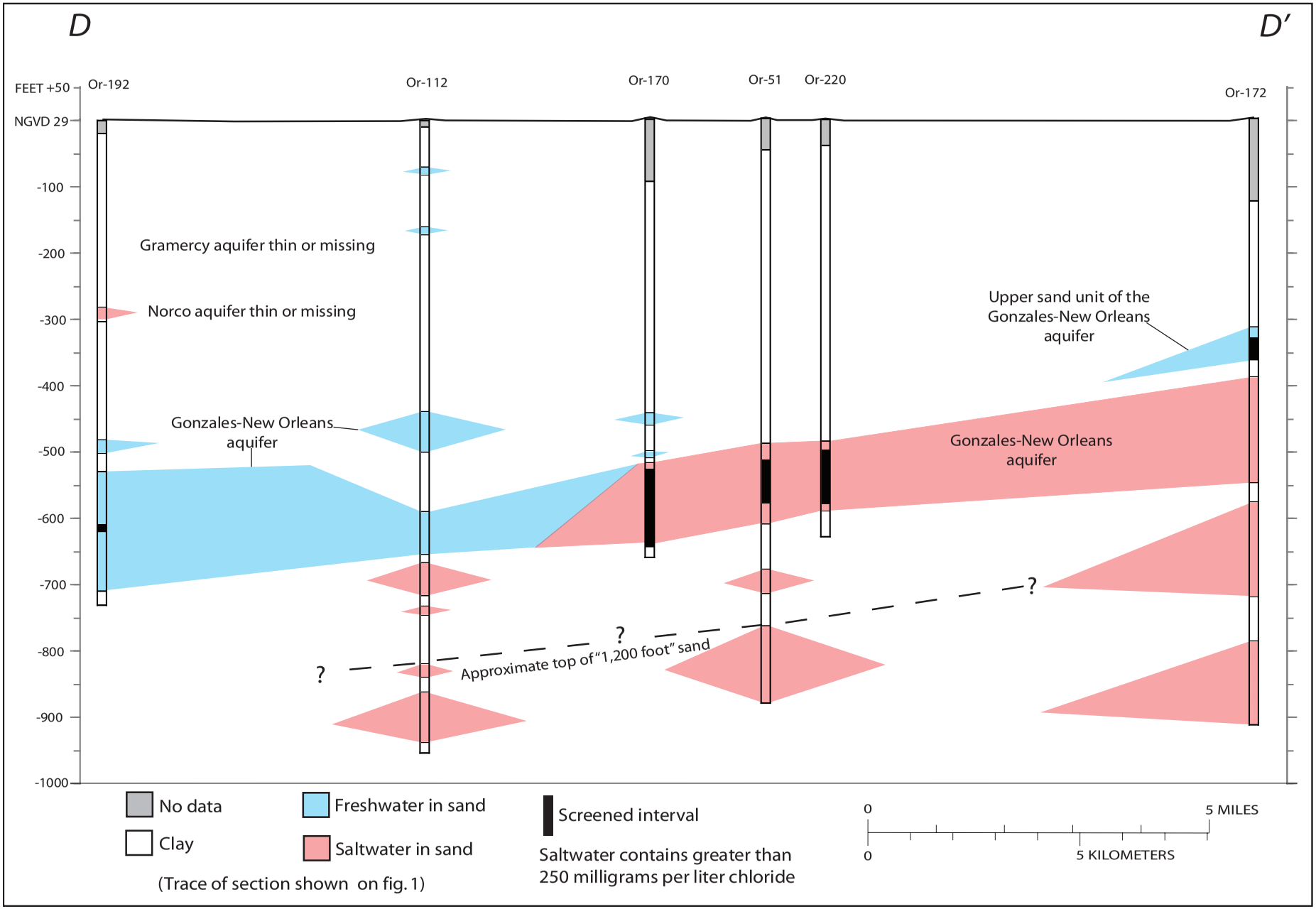
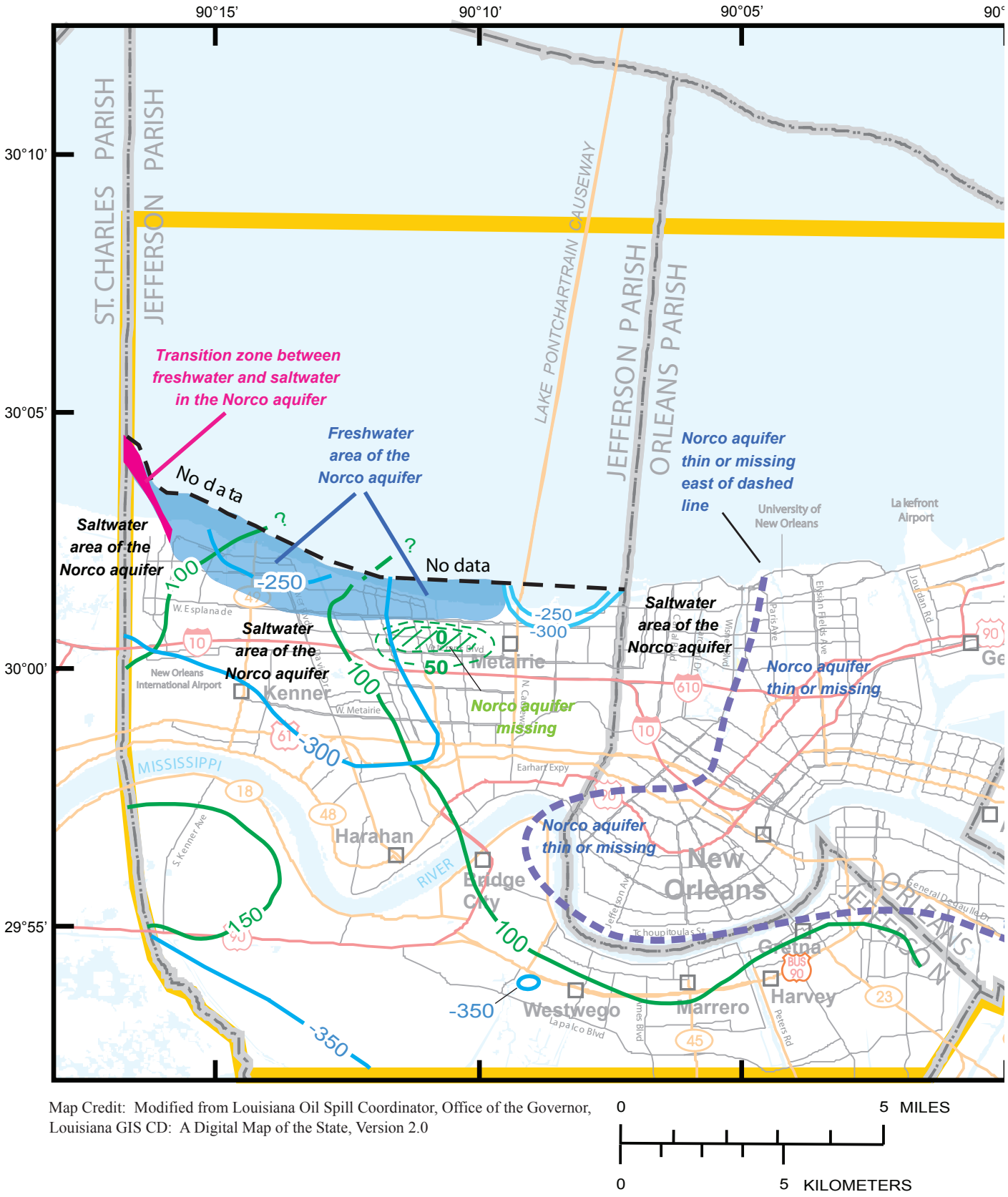


Figure 7. Hydrogeologic section *D-D′* showing major sand units from central Orleans Parish to northeastern Orleans Parish, New Orleans area, southeastern Louisiana.

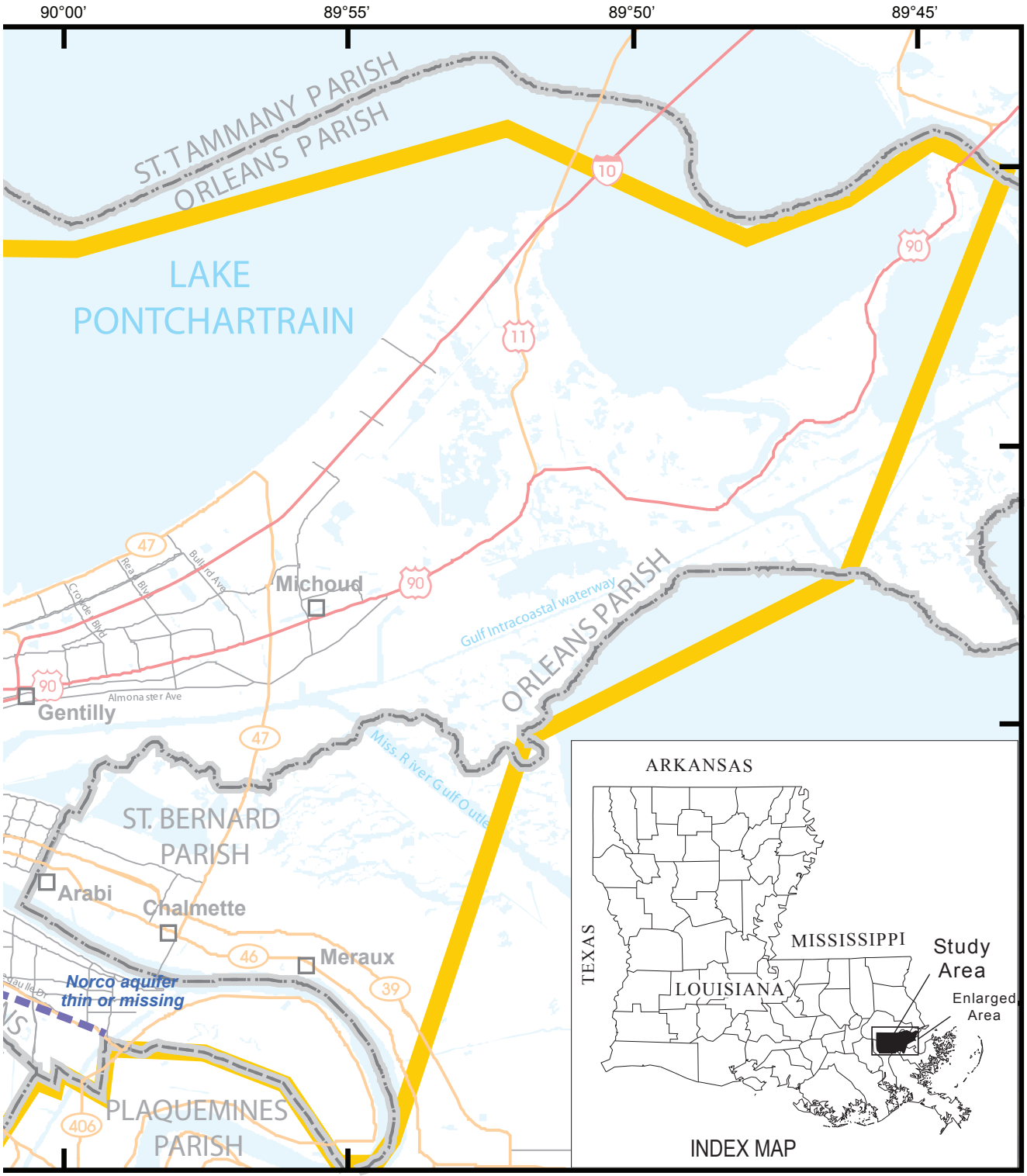


Map Credit: Modified from Louisiana Oil Spill Coordinator, Office of the Governor, Louisiana GIS CD: A Digital Map of the State, Version 2.0

0 5 MILES

0 5 KILOMETERS

Figure 8. Altitude of the top, thickness, and distribution of freshwater in the Norco aquifer, New Orleans area, southeastern Louisiana, 2008.



Explanation

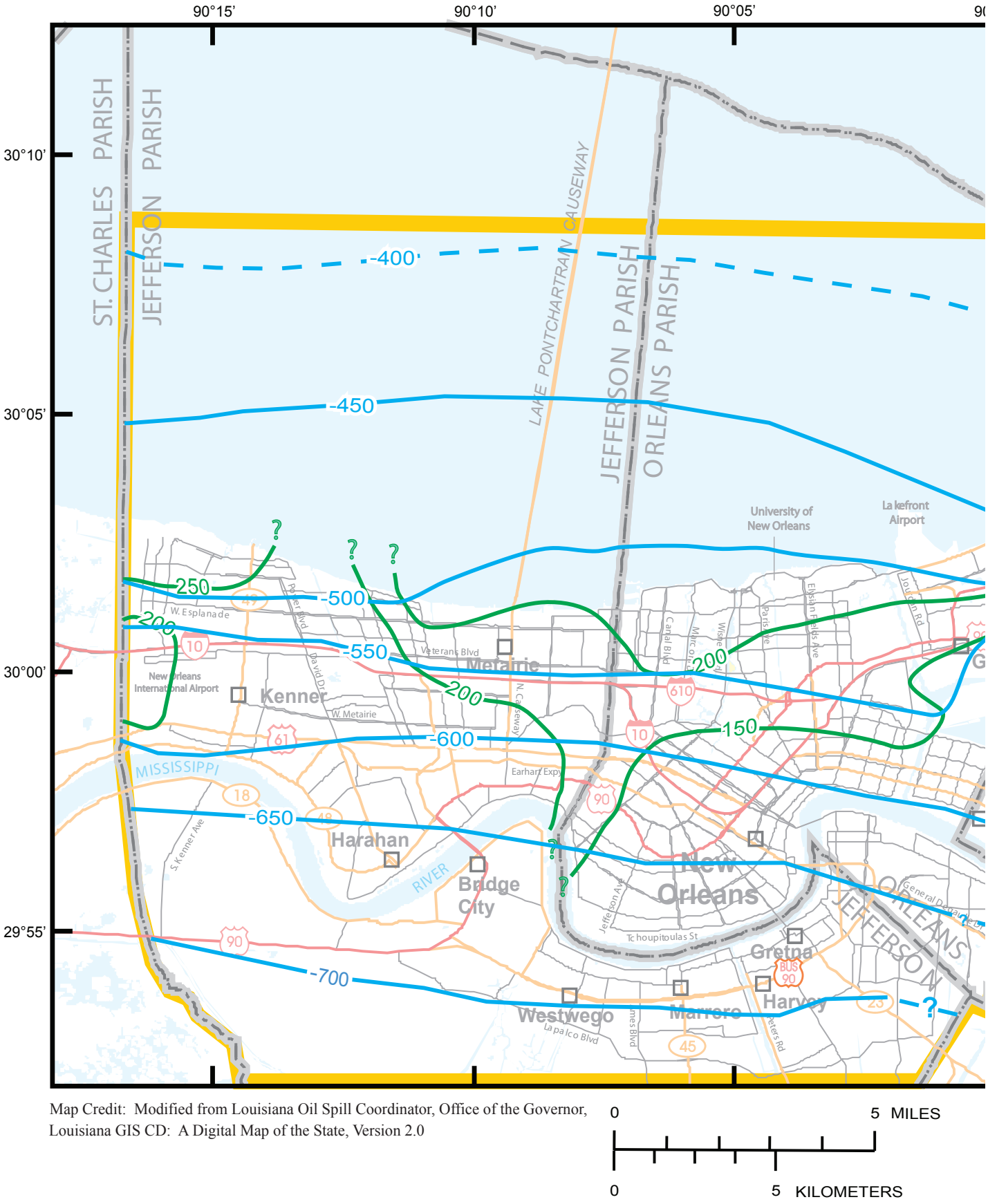
Area where the Norco aquifer contains freshwater (modified from Rollo, 1966; Hosman, 1972; and Tomaszewski, 2003)

Area where the Norco aquifer contains freshwater underlain with saltwater (modified from Rollo, 1966; Hosman, 1972; and Tomaszewski, 2003)

BOUNDARY OF STUDY AREA

-250 — TOP-OF-AQUIFER CONTOUR--Shows altitude relative to NGVD 29 of the top of the Norco aquifer (modified from Rollo, 1966; Hosman, 1972; andTomaszewski, 2003)
Queried where uncertain.
Contour interval, 50 feet

100 — ? LINE OF EQUAL THICKNESS--Shows thickness of the Norco aquifer (modified from Rollo, 1966; Hosman, 1972; Dial and Sumner, 1989; and Tomaszewski, 2003)
Dashed where approximately located.
Queried where uncertain.
Contour Interval. 50 ft.

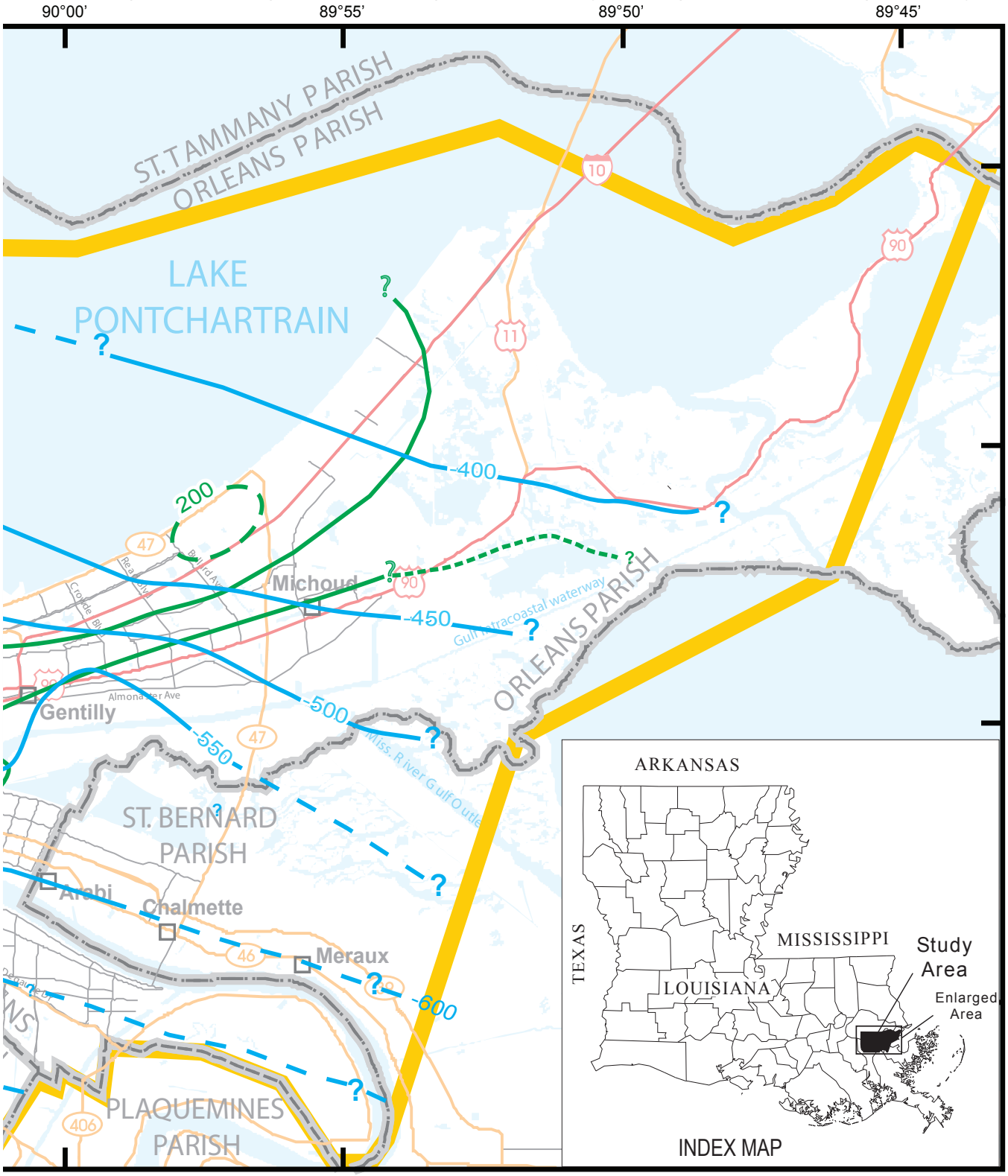


Map Credit: Modified from Louisiana Oil Spill Coordinator, Office of the Governor, Louisiana GIS CD: A Digital Map of the State, Version 2.0

0 5 MILES

0 5 KILOMETERS

Figure 9. Altitude of the top and thickness of the Gonzales-New Orleans aquifer, New Orleans area, southeastern Louisiana.



Explanation

BOUNDARY OF STUDY AREA

-150 ? TOP-OF-AQUIFER CONTOUR--Shows altitude relative to NGVD 29 of the top of the Gonzales-New Orleans aquifer (modified from Rollo, 1966; Hosman, 1972; and Tomaszewski, 2003)
Dashed where approximately located.
Queried where uncertain.
Contour interval. 50 ft.

200 ? LINE OF EQUAL THICKNESS--Shows thickness of the Gonzales-New Orleans aquifer north of the Mississippi River (modified from Rollo, 1966; Hosman, 1972; Dial and Sumner, 1989, and Tomaszewski, 2003).
Dashed where approximately located.
Queried where uncertain.
Contour Interval, 50 ft.

Withdrawals and Water Levels

Groundwater withdrawals in the study area totaled about 20.5 Mgal/d in 2005. Almost all of the groundwater withdrawals in the New Orleans area came from the Gonzales-New Orleans aquifer. During the period 1960-2005, more water was withdrawn annually in Orleans Parish than in Jefferson Parish (fig. 10). Recent withdrawals in St. Bernard Parish have been minimal.

Four major withdrawal centers pump water from the Gonzales-New Orleans aquifer in the study area. Two of the withdrawal centers are located in Jefferson Parish. One, located southwest of Bridge City, pumped about 1.8 Mgal/d in 2007 and the other, northeast of Bridge City, pumped an estimated 3.9 Mgal/d in 2007 (fig. 11). The other two withdrawal centers are located in Orleans Parish. One, located south of Michoud near the Gulf Intracoastal Waterway, pumped an estimated 9.7 Mgal/d in 2007, and the other, southeast of Michoud, pumped about 1.9 Mgal/d in 2007. All four of these pumping centers withdrew saltwater. Prior to September 2005, an additional withdrawal center (a power plant pumping about 2.0 Mgal/d in 2004) was operating west of Gentilly between the Lakefront Airport and the Gulf Intracoastal Waterway near well Or-206 (fig. 11).

In 2008, water levels were measured in 35 wells (table 1) screened in the Gonzales-New Orleans aquifer and used to create a potentiometric surface map (fig. 11). Generally, water levels are highest away from withdrawal centers and lowest at withdrawal centers. The highest water level measured, 15.69 feet below NGVD 29, was in northwestern Jefferson Parish at well Jf-178. The lowest water level measured, 146.87 feet below NGVD 29, was in Orleans Parish near Michoud at well Or-208. Groundwater moves through the study area from areas of higher hydraulic head (higher water levels) to areas of lower hydraulic head. The direction of groundwater flow is perpendicular to the potentiometric contour lines, as indicated by the flow arrows on the potentiometric surface map. Generally, water in the Gonzales-New Orleans aquifer flows radially towards the largest withdrawal center, which is near Michoud.

Water levels in the Gonzales-New Orleans aquifer generally have risen since the 1970s in response to reduced withdrawals (figs. 10, 12). Water levels at wells close to pumping centers generally fluctuate in response to changes in withdrawals and have risen more in response to reduced withdrawals than water levels at wells farther from pumping centers. Water levels in the Gonzales-New Orleans aquifer at well Jf-156 (fig. 12), located north of Bridge City and the Mississippi River (fig. 11), have risen about 40 ft since 1974. Water levels at well Jf-178 (fig. 12), located in northwestern Jefferson Parish on the shore of Lake Pontchartrain (fig. 11), have risen about 20 ft since 1984.

Water levels at well Or-42 (fig. 12), located south of the Mississippi River and east of New Orleans (fig. 11), have risen about 60 ft since 1979 in response to decreasing water withdrawals. The water-level rise is partly due to a major reduction of withdrawals from about 21 Mgal/d in 1979 to about 2 Mgal/d in 1985 at a power-generation plant located about 2 mi southwest of well Or-42.

Water levels in well Or-206, located west of Gentilly (fig. 11), have risen about 117 ft from 1972 to 2008 (fig. 12). The water-level rise is partly due to a reduction of withdrawals from about 6 Mgal/d in 1979 to less than 0.1 Mgal/d in 1985 by the University of New Orleans (located about 3 mi northwest of well Or-206). Water levels at well Or-206 rose abruptly about 18 ft in 2005 after Hurricane Katrina caused a power-generation plant, located about 0.6 mi north of well Or-206, to cease operations and groundwater withdrawals.

Water levels in well Or-203, located north of Michoud near the Lake Pontchartrain shoreline (fig. 11), rose less than 5 feet from the mid-1980s to 2005 (fig. 12). Water levels at well Or-203 rose about 27 ft from a pre-Hurricane Katrina water level of about 69 ft below NGVD 29 in March 2005 to about 42 ft below NGVD 29 in March of 2006, but then declined as groundwater withdrawals resumed. Water levels in well Or-175, located in northeastern Orleans Parish about 8 mi from any withdrawal center, generally have changed less than 5 feet since the late 1970s.

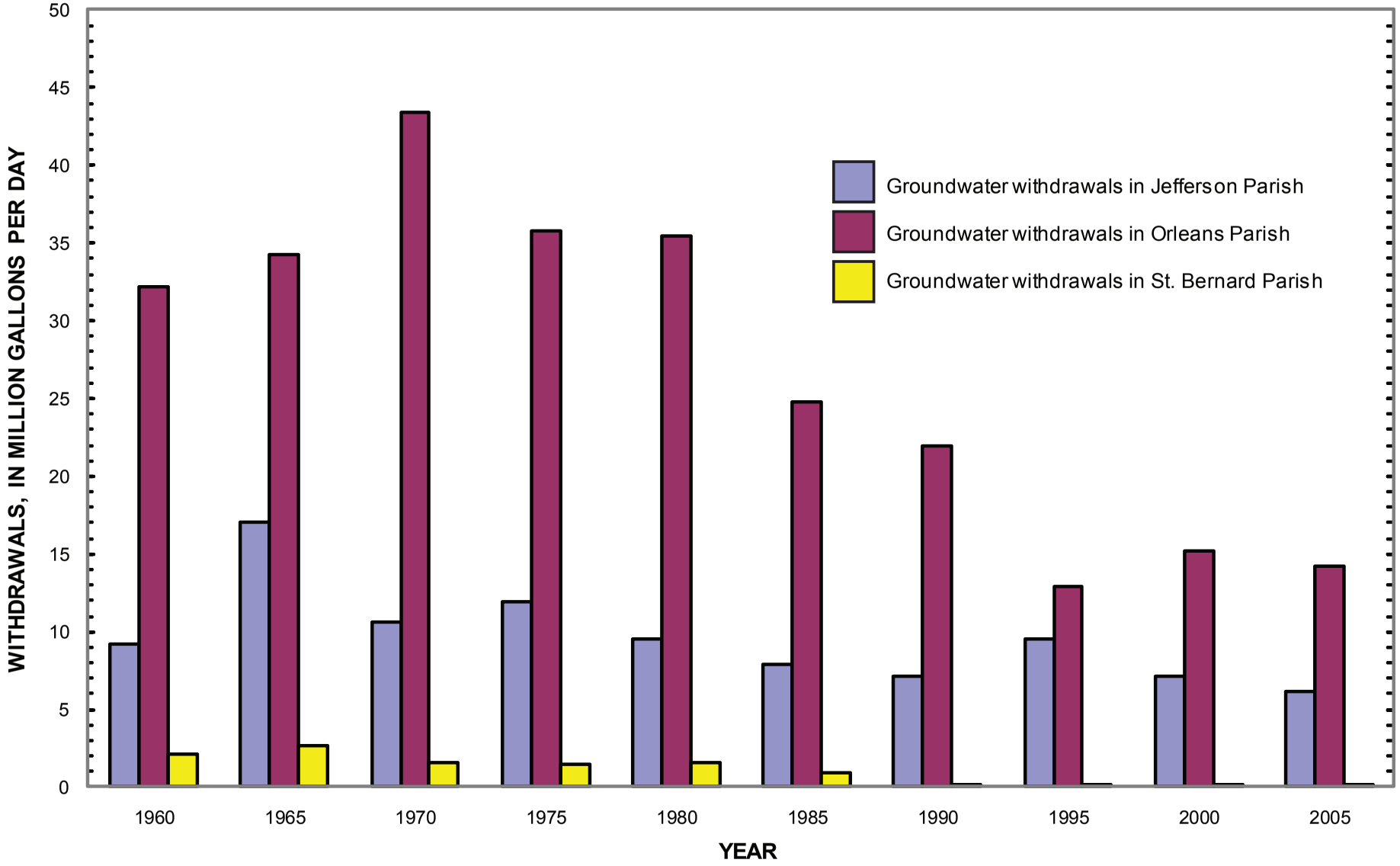
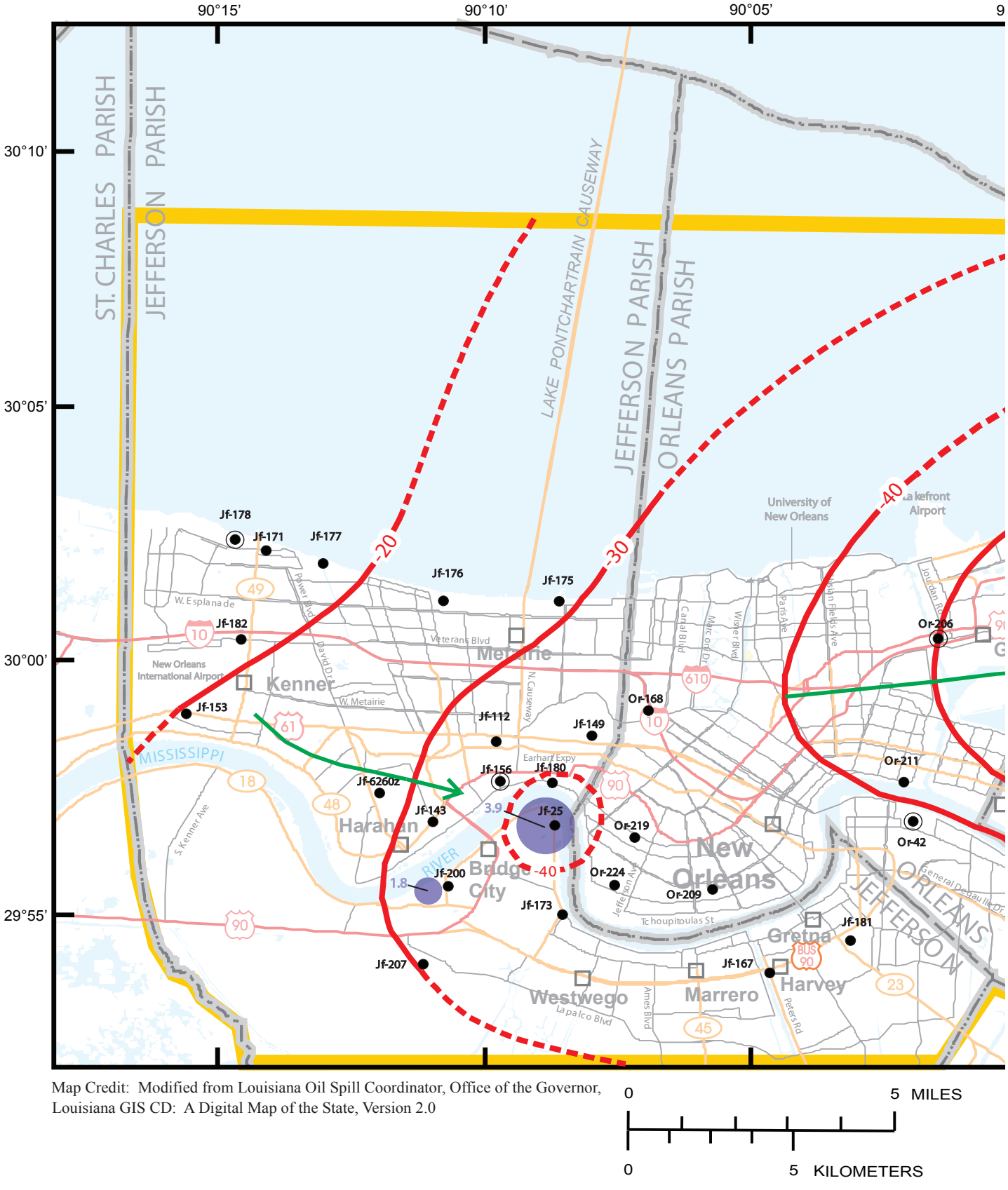
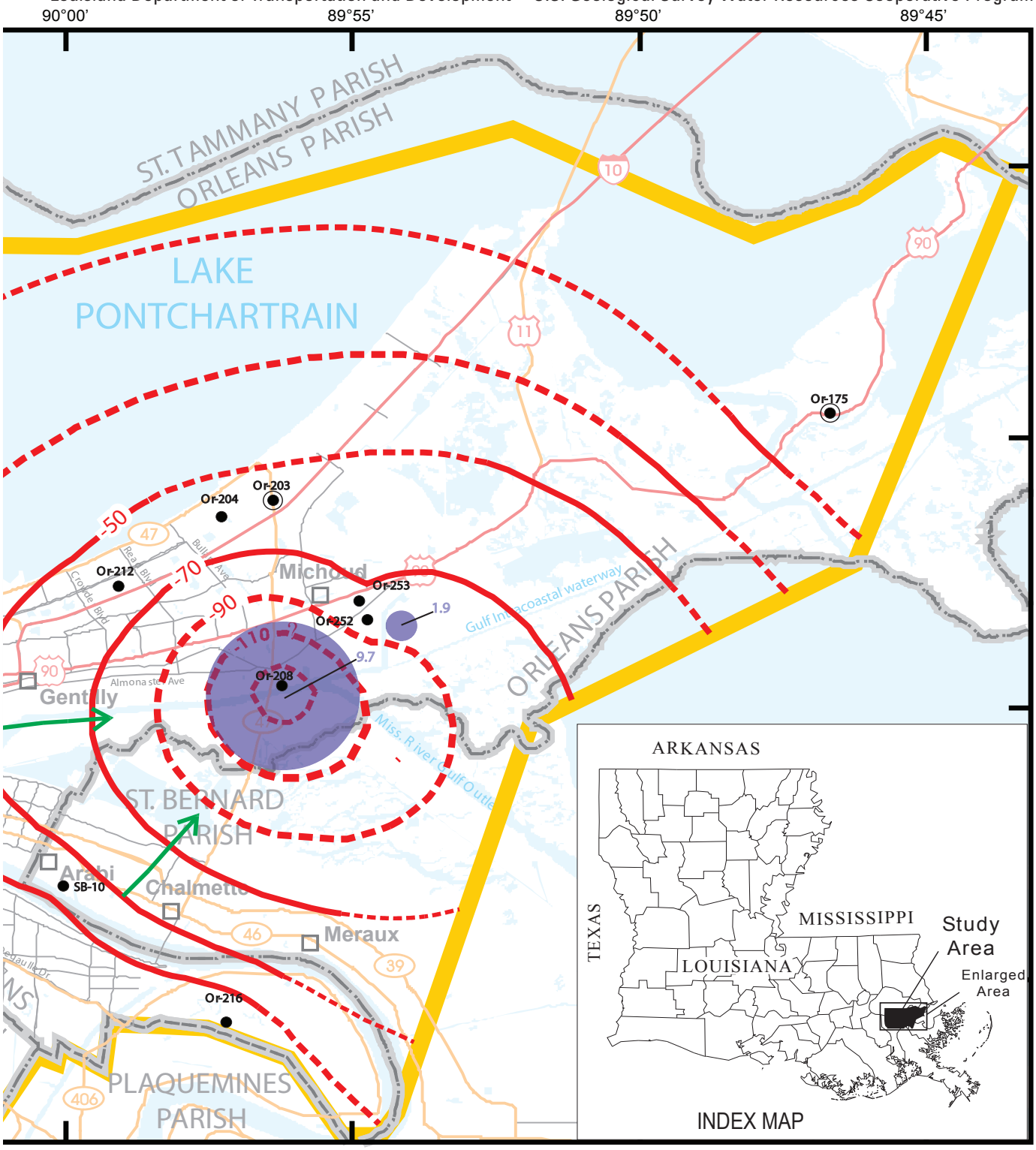


Figure 10. Groundwater withdrawal rates in Jefferson, Orleans, and St. Bernard Parishes, Louisiana, 1960-2005.



Map Credit: Modified from Louisiana Oil Spill Coordinator, Office of the Governor, Louisiana GIS CD: A Digital Map of the State, Version 2.0

Figure 11. Potentiometric surface of the Gonzales-New Orleans aquifer, and ground-water withdrawal centers, New Orleans area, southeastern Louisiana, 2008.



Explanation

- BOUNDARY OF STUDY AREA
- -70 — POTENTIOMETRIC CONTOUR--Shows altitude at which water level would have stood in tightly cased wells. Dashed where approximately located. Contour interval, in feet, varies. Datum is National Geodetic Vertical Datum of 1929
- FLOW ARROWS --Shows general direction of ground-water movement
- Or-216 — CONTROL POINT AND WELL NUMBER
- Or-175 — CONTROL POINT AND WELL NUMBER FOR WHICH HYDROGRAPH IS SHOWN (see fig. 12)
- 1.9 — WATER WITHDRAWAL CENTER--Average withdrawal rate in million gallons per day (Mgal/d) for 2007

Table 1. Water-level data used to construct the potentiometric surface map of the Gonzales-New Orleans aquifer, New Orleans area, 2008.

[NGVD 29, National Geodetic Vertical Datum of 1929]

Well number	Altitude of land surface (in feet relative to NGVD 29)	Water-level measurement date	Water level below land surface (in feet)	Altitude of water level (in feet relative to NGVD 29)
Jefferson Parish				
Jf-25	14	5/6/2008	61.44	-47.44
Jf-112	5	4/29/2008	40.67	-35.67
Jf-143	8	4/25/2008	40.44	-32.44
Jf-149	0	4/29/2008	34.68	-34.68
Jf-153	2	4/25/2008	22.27	-20.27
Jf-156	9	4/21/2008	46.00	-37.00
Jf-167	2	3/11/2008	35.71	-33.71
Jf-171	-1	4/29/2008	15.64	-16.64
Jf-173	5	5/6/2008	39.35	-34.35
Jf-175	0	5/9/2008	28.85	-28.85
Jf-176	0	5/9/2008	23.44	-23.44
Jf-177	0	5/9/2008	18.12	-18.12
Jf-178	0	4/21/2008	15.69	-15.69
Jf-180	5	5/12/2008	46.16	-41.16
Jf-181	0	5/6/2008	33.39	-33.39
Jf-182	-5	4/29/2008	14.13	-19.13
Jf-200	5	5/12/2008	39.90	-34.90
Jf-207	0	5/6/2008	30.17	-30.17
Jf-6260Z	2	5/9/2008	29.34	-27.34
Orleans Parish				
Or-42	10	5/8/2008	46.84	-36.84
Or-168	2	4/17/2008	40.00	-38.00
Or-175	10	4/21/2008	31.45	-21.45
Or-203	-5	3/11/2008	49.81	-54.81
Or-204	-5	4/10/2008	51.85	-56.85
Or-206	4	4/17/2008	53.84	-49.84
Or-208	5	4/30/2008	151.87	-146.87
Or-209	5	4/15/2008	38.40	-33.40
Or-211	5	4/24/2008	47.97	-42.97
Or-212	-5	4/30/2008	51.88	-56.88
Or-216	0	4/24/2008	31.35	-31.35
Or-219	0	4/15/2008	38.48	-38.48
Or-224	9	4/15/2008	43.72	-34.72
Or-252	0	4/17/2008	77.54	-77.54
Or-253	0	4/7/2008	71.59	-71.59
St. Bernard Parish				
SB-10	8	5/12/2008	49.87	-41.87

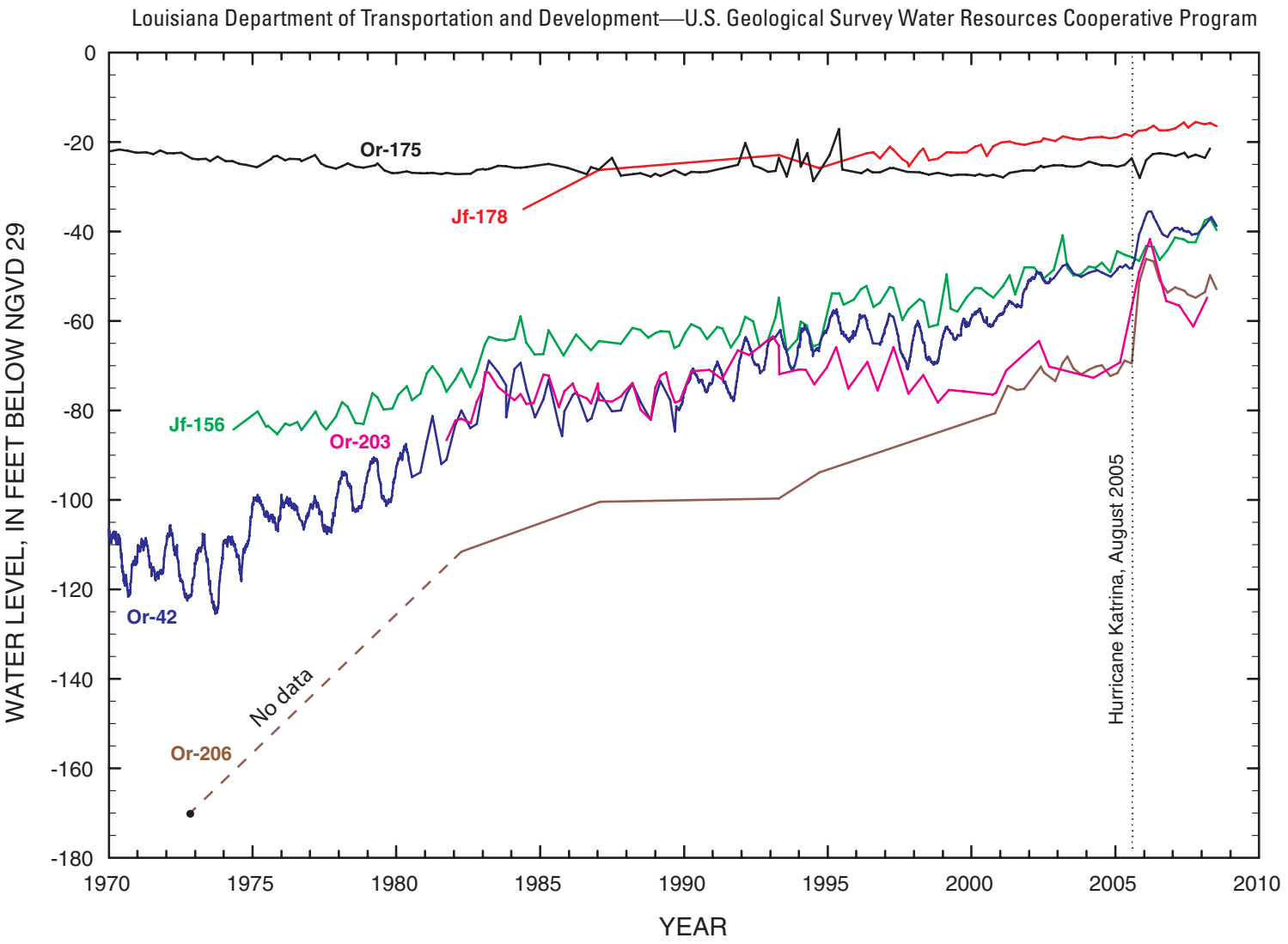
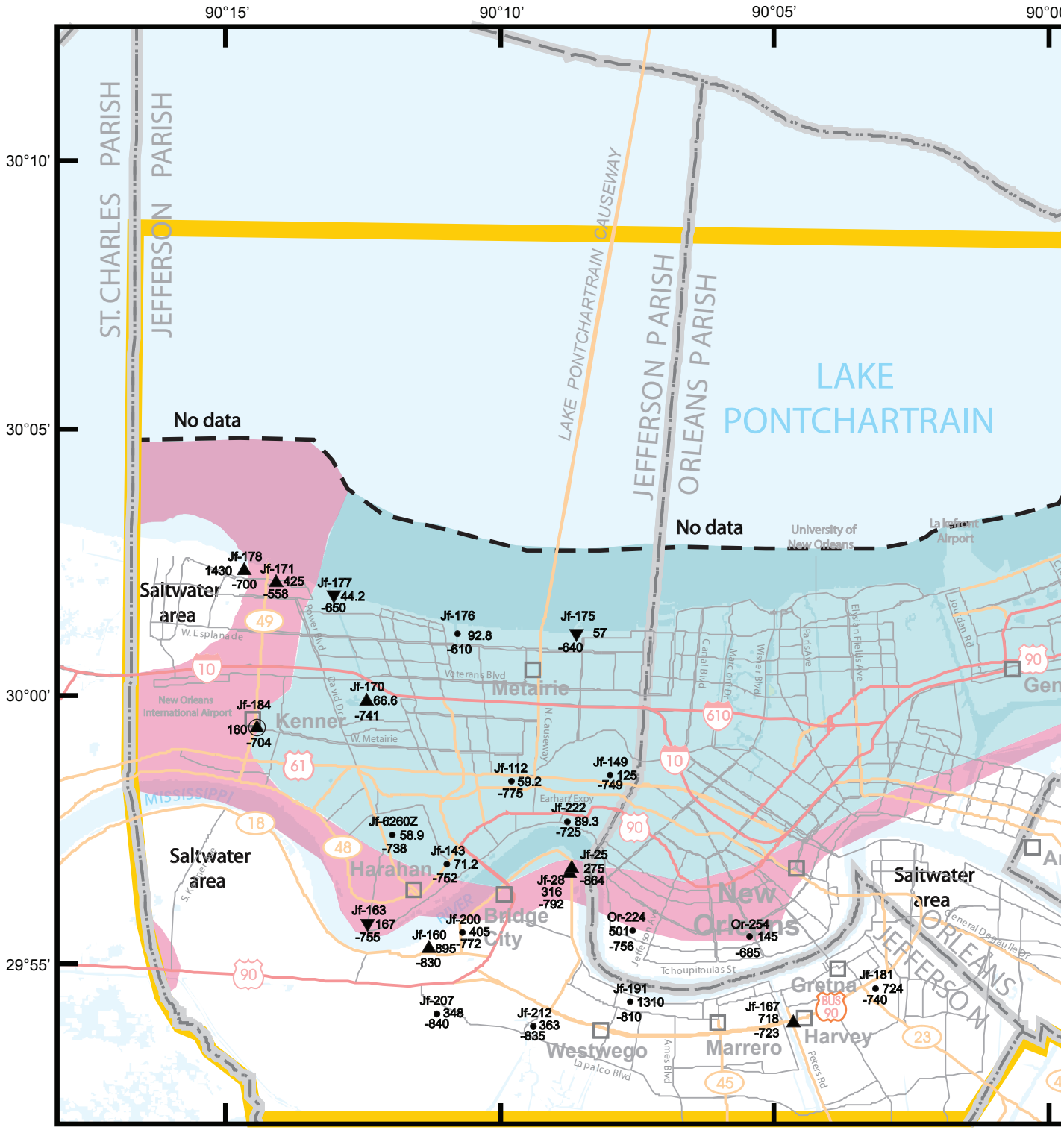


Figure 12. Water levels at selected wells screened in the Gonzales-New Orleans aquifer, New Orleans area, southeastern Louisiana (see fig. 11 for well locations).

Distribution of Freshwater and Water Quality

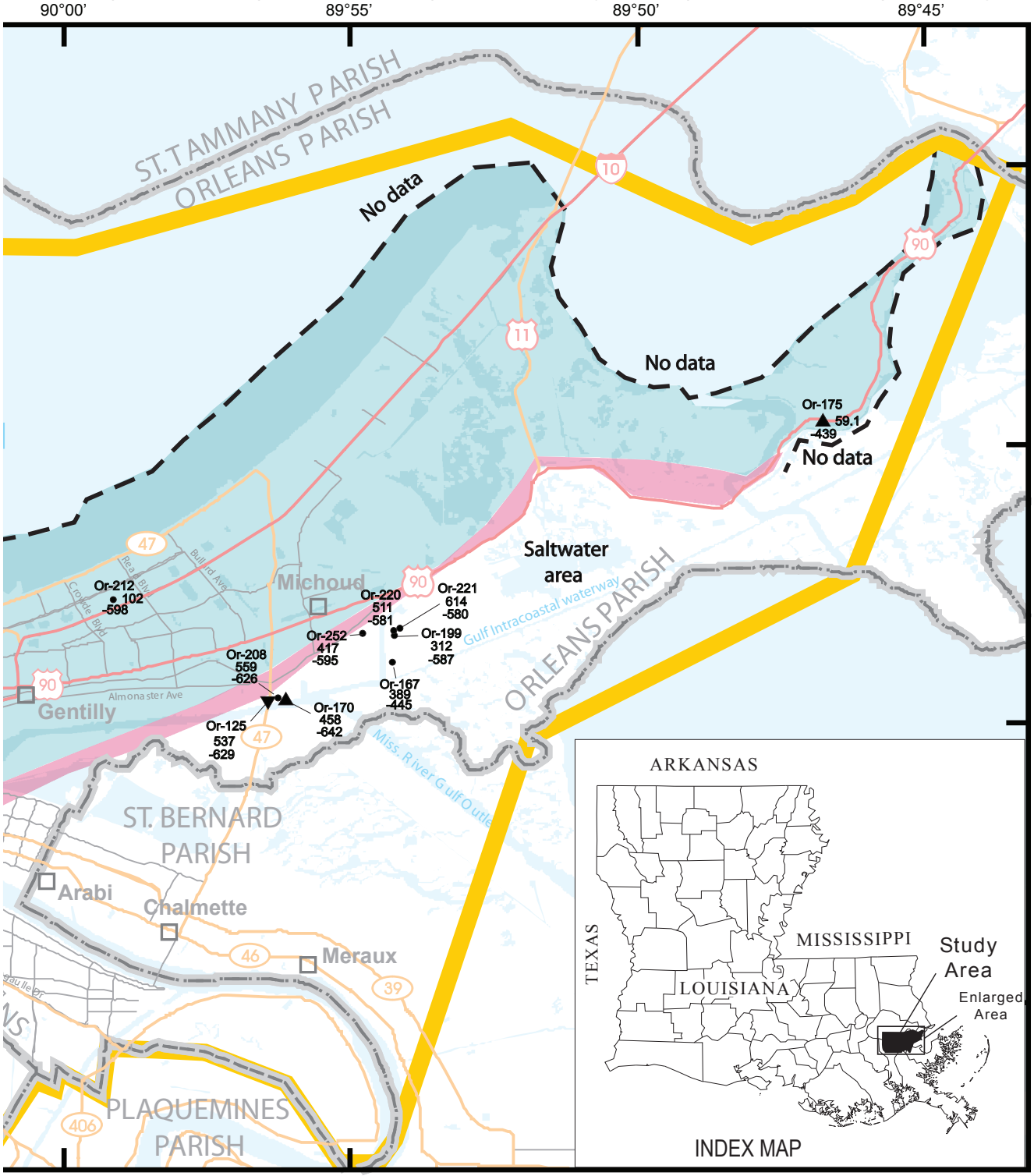
Large volumes of freshwater are available in the Gonzales-New Orleans aquifer in Jefferson and Orleans Parishes. Generally, the aquifer contains freshwater north of the Mississippi River or Gulf Intracoastal Waterway from Kenner to Michoud, and north of Highway 90 into the northeastern part of Orleans Parish. The aquifer generally contains saltwater south and west of the freshwater area (fig. 13). There is probably a transition zone along the southern boundary of the freshwater area in northeastern Orleans Parish; however, no data are available to determine the location and extent of the transition zone in the area.

In 2008, 34 wells screened in the Gonzales-New Orleans aquifer in the study area were sampled and analyzed for chloride concentration and specific conductance (fig. 13). Chloride concentrations exceeded the SMCL of 250 mg/L in 20 of the 34 wells sampled in 2008. Data collected during 2008 and historical data for sampled wells are presented in table 2. Well-construction details for wells measured for water level or sampled for chloride and specific conductance are presented in table 3.



Map Credit: Modified from Louisiana Oil Spill Coordinator, Office of the Governor, Louisiana GIS CD: A Digital Map of the State, Version 2.0

Figure 13. Distribution of freshwater in the Gonzales-New Orleans aquifer, New Orleans area, southeastern Louisiana, 2008.



Explanation

Area where the Gonzales-New Orleans aquifer contains freshwater (modified from Rollo, 1966; Hosman, 1972; Dial, 1983; and Tomaszewski, 2003)

Area where the Gonzales-New Orleans aquifer contains freshwater underlain with saltwater (modified from Rollo, 1966; Hosman, 1972; Dial, 1983; and Tomaszewski, 2003)

BOUNDARY OF STUDY AREA

Or-212
102
-598

CONTROL POINT--Water well, chloride concentration in milligrams per liter, and bottom of well elevation, NGVD 29. An upward triangle indicates chloride concentrations are increasing at the well site (saltier); downward, decreasing (fresher) Round dot, indeterminate

Jf-184
160
-704

OBSERVATION WELL WITH CHLOROGRAPH (see fig. 14)

Saltwater contains greater than 250 milligrams per liter chloride

Table 2. Specific conductance, water temperature, and chloride concentrations for water samples from selected wells screened in the Gonzales-New Orleans aquifer in the New Orleans area.

[µS/cm, microsiemens per centimeter; --, no data]

Well number	Date sampled	Specific conductance, field (µS/cm at 25°C)	Specific conductance, laboratory (µS/cm at 25°C)	Water temperature, degrees Celsius	Chloride, dissolved, in milligrams per liter
			Jefferson Parish		
Jf- 25	5/30/1951	--	--	--	120
	9/18/1951	--	--	--	210
	1/20/1959	1100	--	25.5	160
	11/10/1960	1110	--	25.0	150
	4/11/1962	1150	--	25.0	200
	10/27/1966	1170	--	25.0	160
	6/10/1969	1210	--	--	170
	10/17/1974	1230	--	--	190
	6/28/1985	--	1330	--	220
	3/12/2008	1550	1540	24.5	275
Jf- 28	9/28/1951	--	--	--	210
	11/23/1953	--	--	--	130
	5/28/1954	--	--	--	160
	11/10/1960	1110	--	25.0	150
	8/25/1981	1420	--	--	240
	3/11/2008	1660	1650	24.5	316
Jf- 112	5/28/1957	--	--	--	170
	9/15/1960	921	--	25.0	120
	2/22/2008	670	668	24.6	59.2[1]
Jf- 143	2/29/2008	738	734	23.6	71.2
Jf- 149	8/20/1981	1040	--	--	130
	5/19/1986	971	970	25.5	120
	2/26/2008	970	962	25.3	125
Jf- 160	10/17/1974	2630	--	--	670
	8/25/1981	2890	--	--	710
	6/28/1985	--	2840	--	720
	1/1/1986	--	2910	--	740
	9/24/1986	--	2960	--	740
	12/11/1987	--	2980	--	780
	3/28/1988	--	2930	--	730
	1/5/1989	--	3070	--	720
	7/12/1989	--	3010	--	740
	3/11/2008	3300	3330	24.9	895
Jf- 163	5/19/1986	920	926	24.5	120
	10/30/1997	917	905	24.5	120
	3/14/2005	1000	943	23.8	144
	3/27/2006	1140	1110	24.6	191
	10/2/2006	1360	1350	25.0	260
	4/9/2007	1330	1320	23.8	240
	9/24/2007	1090	1150	24.4	176
	3/10/2008	1060	1050	24.3	167

Table 2. Specific conductance, water temperature, and chloride concentrations for water samples from selected wells screened in the Gonzales-New Orleans aquifer in the New Orleans area.—Continued

[µS/cm, microsiemens per centimeter; --, no data]

Well number	Date sampled	Specific conductance, field (µS/cm at 25°C)	Specific conductance, laboratory (µS/cm at 25°C)	Water temperature, degrees Celsius	Chloride, dissolved, in milligrams per liter
Jf- 167	12/17/1981	--	2760	24.0	680
	3/11/2008	2820	2830	23.1	718
Jf- 170	1/16/1986	621	617	25.0	48
	2/22/2008	657	653	24.7	66.6
Jf- 171	1/17/1986	1450	1460	24.5	340
	3/14/2008	1750	1740	24.4	425
Jf- 175	5/7/1986	719	723	25.5	100
	1/30/2008	561	573	24.7	57
Jf- 176	1/17/1986	672	684	24.0	88
	1/30/2008	716	718	23.9	92.8
Jf- 177	5/7/1986	622	623	25.0	59
	1/30/2008	591	586	23.9	44.2
Jf- 178	5/7/1986	3660	3700	26.0	1100
	10/30/1997	4540	4530	26.2	1300
	1/28/2008	4750	4740	25.9	1430
Jf- 181	3/6/2008	2880	2880	24.7	724
Jf- 184	9/26/1986	661	643	24.0	63
	12/11/1990	656	653	--	74
	8/5/1991	606	676	26.0	74
	12/3/1991	663	657	--	80
	6/1/1992	673	673	--	89
	12/2/1992	681	685	22.5	94
	4/6/1993	684	682	23.5	85
	10/26/1993	704	702	24.0	94
	12/20/1994	710	713	23.2	98
	5/3/1995	726	721	24.3	100
	9/6/1995	732	735	25.1	100
	5/9/1996	742	743	24.6	100
	9/19/1996	748	749	24.6	110
	4/14/1997	768	755	23.6	110
	10/8/1997	766	753	24.6	110
	10/30/1997	761	752	23.9	110
	10/28/1998	761	762	25.2	110
	3/19/1999	767	757	24.1	120
	9/24/1999	779	777	24.6	120
	3/9/2000	770	758	24.5	110
	9/6/2000	745	769	24.7	120
	3/20/2001	782	770	23.8	120
	9/25/2001	803	782	24.8	120
	4/5/2002	815	795	23.9	130
	9/4/2002	819	790	24.9	120
	3/19/2003	906	870	24.4	150

Table 2. Specific conductance, water temperature, and chloride concentrations for water samples from selected wells screened in the Gonzales-New Orleans aquifer in the New Orleans area.—Continued

[µS/cm, microsiemens per centimeter; --, no data]

Well number	Date sampled	Specific conductance, field (µS/cm at 25°C)	Specific conductance, laboratory (µS/cm at 25°C)	Water temperature, degrees Celsius	Chloride, dissolved, in milligrams per liter
Jf- 184	9/5/2003	811	790	24.9	120
	3/1/2004	827	811	24.6	130
	9/2/2004	832	804	24.9	133
	3/16/2005	847	816	23.9	141
	3/13/2006	865	856	24.9	148
	10/3/2006	874	854	25.2	148
	3/20/2007	896	920	24.2	164
	9/11/2007	881	896	24.8	154
	3/10/2008	901	885	24.7	160
Jf- 191	3/4/2008	4660	4680	25.0	1310
Jf- 200	3/11/2008	1900	1890	24.5	405
Jf- 207	3/6/2008	1760	1760	24.7	348
Jf- 212	3/4/2008	1860	1860	24.6	363
Jf- 222	2/26/2008	804	805	23.9	89.3
Jf-6260Z	1/22/2008	690	688	--	58.9
			Orleans Parish		
Or- 125	9/27/1956	1520	--	--	130
	10/19/1960	1650	--	--	310
	3/16/1962	1600	--	--	320
	9/18/1963	1750	--	--	350
	10/15/1964	1750	--	25.0	340
	5/27/1965	1770	--	--	350
	6/9/1969	1860	--	--	360
	11/2/1971	2100	--	--	430
	12/2/1976	2770	--	25.0	660
	4/29/1982	--	2530	25.0	600
	6/19/1985	--	2590	--	600
	4/7/2008	2360	2350	25.0	537
Or- 167	4/10/2008	2250	2230	22.9	389
Or- 170	1/28/1963	--	--	--	250
	9/18/1963	1540	--	--	270
	10/15/1964	1550	--	--	300
	5/27/1965	1640	--	--	300
	10/27/1966	1820	--	--	370
	6/9/1969	1810	--	--	350
	11/2/1971	1690	--	--	320
	12/2/1976	1980	--	24.0	410
	8/20/1981	2150	--	--	450
	11/4/1983	--	1890	--	400
	6/19/1985	--	1830	--	380
	4/7/2008	2090	2080	24.8	458

Table 2. Specific conductance, water temperature, and chloride concentrations for water samples from selected wells screened in the Gonzales-New Orleans aquifer in the New Orleans area.—Continued

[µS/cm, microsiemens per centimeter; --, no data]

Well number	Date sampled	Specific conductance, field (µS/cm at 25°C)	Specific conductance, laboratory (µS/cm at 25°C)	Water temperature, degrees Celsius	Chloride, dissolved, in milligrams per liter
Or- 175	10/27/1972	741	--	--	50
	6/2/1977	722	--	--	42
	1/6/1983	--	730	--	44
	6/26/1985	--	719	--	48
	3/11/2008	813	786	21.6	59.1
Or- 199	3/24/2008	1690	1690	23.6	312
Or- 208	4/7/2008	2390	2400	25.0	559
Or- 212	4/17/2008	1040	1020	24.6	102
Or- 220	3/24/2008	2210	2200	23.7	511
Or- 221	3/24/2008	2520	2520	24.0	614
Or- 224	3/17/2008	2270	2300	24.4	501
Or- 252	4/17/2008	1880	1850	23.9	417
Or- 254	4/3/2008	--	1240	--	145

[1] Well screen raised 10 ft in 1995. Trends in chloride concentrations were not analyzed.

Table 3. Description of selected wells screened in the Gonzales-New Orleans aquifer in the New Orleans area.

[NAD 27, North American Datum of 1927; NGVD 29, National Geodetic Vertical Datum of 1929]

Well number	Latitude (NAD 27)	Longitude (NAD 27)	Year well constructed	Altitude of land surface (in feet relative to NGVD 29)	Well depth, in feet below land surface	Depth to top of screen(s), in feet	Depth to bottom of screen(s), in feet	Screen length, in feet
Jefferson Parish								
Jf-25	295647	900845	1949	14	875	754	875	121
Jf-28	295643	900847	1949	15.11	807	685	807	122
Jf-112	295825	900952	1956	5	780 [1]	750	780 [1]	30
Jf-143	295652	901103	1986	8	760	740	760	20
Jf-149	295832	900803	1965	0	749	679	749	70
Jf-153	295858	901541	1968	2	670	630	670	40
Jf-156	295739	900946	1973	9	780	660	780	120
Jf-160	295518	901123	1968	6	836	777.2	835.8	58.6
Jf-162	300135	901517	1973	-5	628	588.5	628.5	40
Jf-163	295545	901230	1966	13	768	708.3	768.1	59.8
Jf-167	295355	900442	1981	2	725	715	725	10
Jf-170	295956	901231	1981	-4	737	702	737	35
Jf-171	300209	901411	1979	-1	557	526	557.1	31.1
Jf-173	295504	900836	1980	5	783	732	783	51
Jf-175	300110	900840	1984	0	640	600	640	40
Jf-176	300110	901051	1984	0	610	570	610	40
Jf-177	300153	901307	1984	0	650	610	650	40
Jf-178	300222	901446	1984	0	700	660	700	40
Jf-180	295738	900847	1984	5	730	649	730	81
Jf-181	295433	900311	1985	0	740	680	740	60
Jf-182	300025	901439	1986	-5	605	595	605	10
Jf-184	295926	901432	1986	0	704	694	704	10
Jf-191	295418	900741	1988	5	815	735	815	80
Jf-200	295536	901046	1999	5	775	713	775	62
Jf-207	295405	901114	2002	0	840	760	840	80
Jf-212	295351	900928	2004	0	835	810	835	25
Jf-222	295740	900850	2006	5	730	650	730	80
Jf-6260Z	295725	901203	1996	2	740	715	740	25
Orleans Parish								
Or-42	295652	900201	1906	10	775	664	775	111
Or-125	300024	895617	1955	3	632	542	632	90
Or-167	300107	895413	1993	5	440	400	440	40
Or-168	295902	900700	1962	2	720	680	720	40
Or-170	300026	895611	1962	3	645	530	645	115
Or-175	300525	894640	1963	10	449	439	449	10
Or-199	300136	895411	1974	0	587	517	587	70
Or-203	300349	895624	1981	-5	453	448	453	5
Or-204	300331	895718	1981	-5	572	452	572	120
Or-206	300027	900132	1967	4	647	557	647	90
Or-208	300027	895614	1982	5	631	535	631	96

Table 3. Description of selected wells screened in the Gonzales-New Orleans aquifer in the New Orleans area.—Continued

[NAD 27, North American Datum of 1927; NGVD 29, National Geodetic Vertical Datum of 1929]

Well number	Latitude (NAD 27)	Longitude (NAD 27)	Year well constructed	Altitude of land surface (in feet relative to NGVD 29)	Well depth, in feet below land surface	Depth to top of screen(s), in feet	Depth to bottom of screen(s), in feet	Screen length, in feet
Or-209	295533	900547	1983	5	815	764	815	51
Or-211	295738	900211	1984	5	745	694	745	51
Or-212	300214	895907	1984	-5	593	562	593	31
Or-216	295416	895714	1987	0	750	700	750	50
Or-219	295634	900715	1990	0	775	730	775	45
Or-220	300140	895412	1988	2	583	502	583	81
Or-221	300143	895406	1994	2	582	499	582	83
Or-224	295538	900738	2001	9	765	685	765	80
Or-252	300138	895445	2005	0	595	495	595	100
Or-253	300159	895454	2005	0	590	490	590	100
Or-254	295531	900529	2006	5	690	610 675	655 690	45 15
St. Bernard Parish								
SB-10	295646	900004	1950	8	791	711	791	80

[1] Prior to July 1995, well depth and depth to bottom of screen were 590 ft.

In the freshwater area of the Gonzales-New Orleans aquifer (fig. 13), chloride concentrations at 11 wells ranged from 44.2 mg/L at well Jf-177 to 125 mg/L at well Jf-149 and had a median concentration of 66.6 mg/L. In the freshwater-saltwater transition zone, chloride concentrations at six wells ranged from 145 mg/L at well Or-254 to 425 mg/L at well Jf-171 and had a median concentration of 221 mg/L. In the saltwater area of the Gonzales-New Orleans aquifer chloride concentrations at 17 wells ranged from 312 mg/L at well Or-199 to 1,430 mg/L at well Jf-178 and had a median concentration of 511 mg/L.

Chloride concentrations increased at four wells (Jf-170, Jf-171, Jf-178, and Jf-184) in western Jefferson Parish (table 2, fig. 13). These increases indicated that saltwater encroachment is probably occurring in the area. Chloride concentrations at well Jf-178, located in the saltwater area of northwestern Jefferson Parish, have increased about 15 mg/L per year, from 1,100 mg/L in 1986 to 1,430 mg/L in 2008. Chloride concentrations at well Jf-171, located in the transition zone of northwestern Jefferson Parish, have increased about 4 mg/L per year, from 340 mg/L in 1986 to 425 mg/L in 2008. Chloride concentrations at well Jf-184, located in the transition zone near Kenner, have increased about 4 mg/L per year, from 63 mg/L in 1986 to 160 mg/L in 2008 (fig. 14). Saltwater is intruding into freshwater at this site, slowly moving from northwest to southeast, following the general direction of groundwater flow (figs. 11, 13).

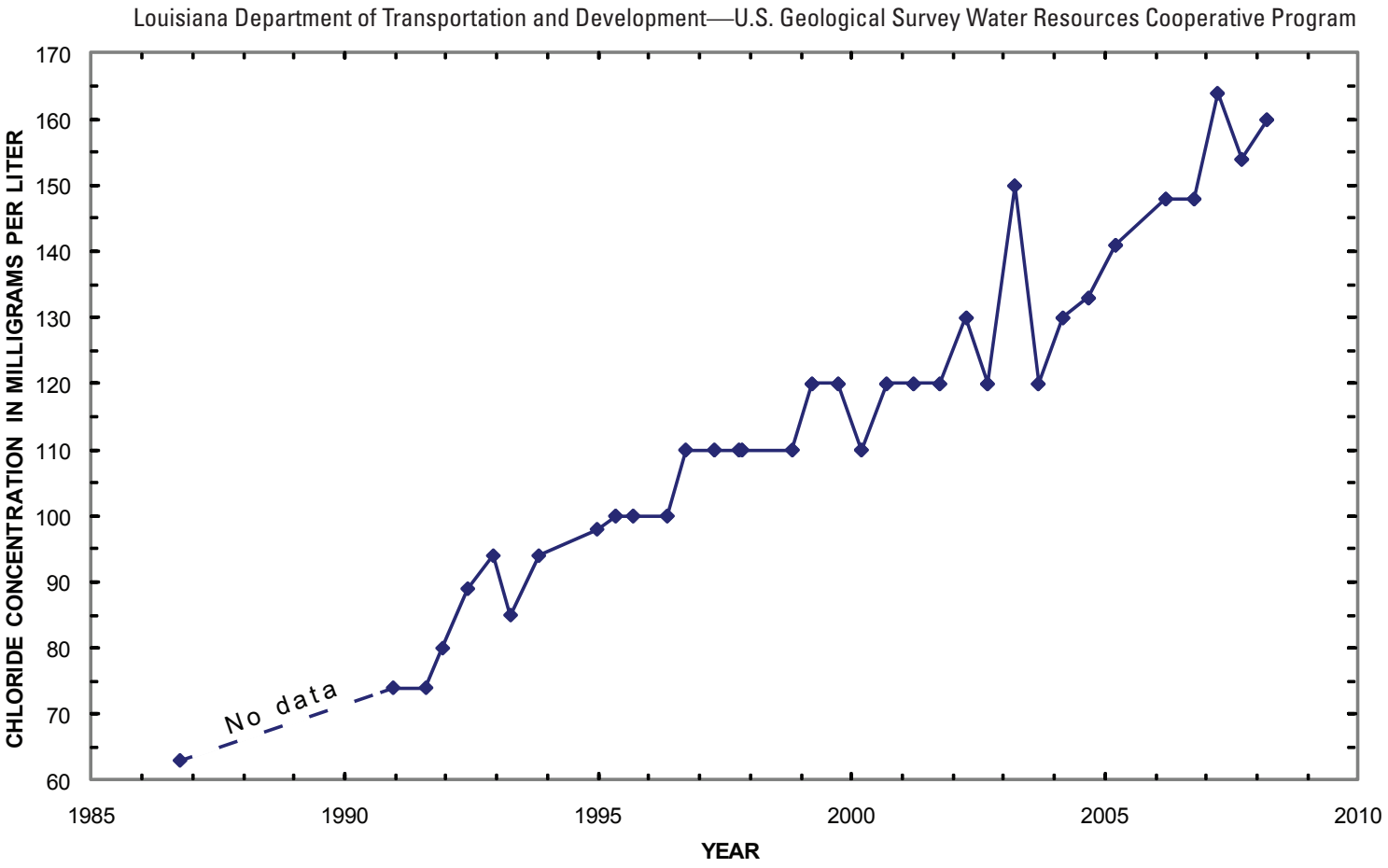


Figure 14. Chloride concentrations in water from well Jf-184, located in Kenner, La. (see fig. 13 for location).

Chloride concentrations also increased at wells Jf-25 and Jf-28, located in the transition zone northeast of Bridge City in Jefferson Parish (fig. 13). In 1960, chloride concentrations at the wells were 150 mg/L (freshwater) (table 2). In 2008, chloride concentrations at the wells were greater than 250 mg/L (saltwater). Saltwater at this withdrawal center (figs. 11, 13) may be moving laterally into the area, upward from the base of the aquifer (upconing), or a combination of the two.

Freshwater in the Gonzales-New Orleans aquifer is a mixed sodium bicarbonate-chloride type (Dial and Tomaszewski, 1988). The water generally is soft and low in iron and manganese concentrations (less than 0.3 and .05 mg/L) although locally iron concentrations may be higher; pH averages about 8.0 (Dial, 1983). Freshwater in the aquifer has a yellow color; color in freshwater from the aquifer in Jefferson Parish generally ranges from 50 to 120 platinum-cobalt units (Dial and Tomaszewski, 1988). In Orleans Parish, color may exceed 250 platinum-cobalt units (Dial, 1983). In saltwater areas, the water is a sodium-chloride type and hardness is greater than in freshwater areas (Hosman, 1972).

The "1,200-foot" Sand of the New Orleans Area

The "1,200-foot" sand contains saltwater throughout the study area with the possible exception of northeastern Orleans Parish. Rollo (1966) indicated an area in the "1,200-foot" sand near the intersection of U.S. Highway 11 and Interstate 10 where dissolved solids are less than 1,000 mg/L and freshwater may exist. Water quality data from two wells provided supporting evidence that freshwater may exist in the "1,200-foot" sand: the chloride concentration in well Or-176 (figs. 1, 5), located in Lake Pontchartrain, was measured at 140 mg/L in 1964, and water in well Or-104, located a few miles northeast of Venetian Isles, had a chloride concentration of 160 mg/L in 1961. Limited data indicate that freshwater may exist in the "1,200-foot" sand in northeastern Orleans Parish, but additional data are needed to identify the location of the freshwater/saltwater interface. In 2008 there were no reported withdrawals of water from the "1,200-foot" sand in the study area.

Summary

Groundwater could be a viable emergency source of water in much of the New Orleans area. However, saltwater is present in some areas of the groundwater system, and saltwater intrusion into freshwater areas is a concern. Groundwater resources in the New Orleans area include Mississippi River point-bar deposits, shallow aquifers of the New Orleans area, Gramercy aquifer, Norco aquifer, Gonzales-New Orleans aquifer, and the "1,200-foot" sand of the New Orleans area. Together these aquifers make up the New Orleans aquifer system, which supplied about 20.5 million gallons per day of groundwater for industrial use, power generation, and irrigation in the New Orleans area in 2005.

Point-bar deposits contain freshwater in some areas adjacent to the Mississippi River. Water levels in point-bar deposits generally fluctuate with the stage of the Mississippi River. Freshwater in point-bar deposits generally is very hard and has iron concentrations greater than the Secondary Maximum Contaminant Level of 0.3 milligrams per liter. The shallow aquifers generally contain saltwater in the study area. The Gramercy aquifer contains only saltwater in the study area and is absent in much of Orleans Parish.

The Norco aquifer contains freshwater within the study area in an area about 1 mile wide and 6 miles long along the Lake Pontchartrain shoreline in Jefferson Parish. In western Orleans Parish, the aquifer is generally thin or missing north of the Mississippi River. There were no reported withdrawals of water from the Norco aquifer for the study area in 2005. Water levels ranged from about 0 to 9 feet below the National Geodetic Vertical Datum of 1929 from 1996 to 2008 at well Jf-186, located in northwestern Jefferson Parish. A 1986 analysis of water from well Jf-186, screened in the Norco aquifer, indicated that

freshwater at this site is moderately hard, iron concentrations are high, color exceeds 15 platinum-cobalt units, and manganese concentrations are low.

The Gonzales-New Orleans aquifer is continuous throughout the study area. Generally, the thickness of the aquifer north of the Mississippi River ranges from about 150 to 250 feet. South of the Mississippi River, the thickness varies, ranging from about 150 to possibly 300 feet. Almost all of the groundwater withdrawals in the New Orleans area came from the Gonzales-New Orleans aquifer. Four major withdrawal centers pump water from the Gonzales-New Orleans aquifer in the study area and water levels in the aquifer generally are highest away from withdrawal centers and lowest at withdrawal centers. Generally, water in the Gonzales-New Orleans aquifer flows radially towards the largest withdrawal center, which is near Michoud. Water levels in the Gonzales-New Orleans aquifer generally have risen since the 1970s in response to reduced withdrawals.

Large volumes of freshwater are available in the Gonzales-New Orleans aquifer in Jefferson and Orleans Parishes. Generally, the aquifer contains freshwater north of the Mississippi River or Gulf Intracoastal Waterway from Kenner to Michoud, and north of Highway 90 into the northeastern part of Orleans Parish. The aquifer generally contains saltwater south and west of the freshwater area.

In 2008, 34 wells screened in the Gonzales-New Orleans aquifer in the study area were sampled and analyzed for chloride concentration and specific conductance. Chloride concentrations increased at four wells in western Jefferson Parish. These increases indicated that saltwater encroachment is probably occurring in the area. Chloride concentrations at well Jf-178, located in the saltwater area of northwestern Jefferson Parish, have increased about 15 mg/L (milligrams per liter) per year, from 1,100 mg/L in 1986 to 1,430 mg/L in 2008. Chloride concentrations at well Jf-171, located in the transition zone of northwestern Jefferson Parish, have increased about 4 mg/L per year, from 340 mg/L in 1986 to 425 mg/L in 2008. Chloride concentrations at well Jf-184, located in the transition zone near Kenner, have increased about 4 mg/L per year, from 63 mg/L in 1986 to 160 mg/l in 2008. Saltwater is intruding into freshwater at this site, slowly moving from northwest to southeast, following the general direction of groundwater flow.

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The “1,200-foot” sand contains saltwater throughout the study area with the possible exception of northeastern Orleans Parish. Water quality data from two wells provide supporting evidence that freshwater may exist in the “1,200-foot” sand: the chloride concentration in well Or-176, located in Lake Pontchartrain, was measured at 140 mg/L in 1964, and water in well Or-104, located a few miles northeast of Venetian Isles, had a chloride concentration of 160 mg/L in 1961. Limited data indicate that freshwater may exist in the “1,200-foot” sand in northeastern Orleans Parish, but additional data are needed to identify the location of the freshwater/saltwater interface.

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