U.S. Department of the Interior
U.S. Geological Survey

Prepared in cooperation with the
Louisiana Department of Transportation and Development

Scientific Investigations Map 3313
Sheet 1 of 2

Introduction

The Sparta aquifer is used in 15 parishes in north-central Louisiana (fig. 1), primarily for public supply and industrial purposes. Of those parishes, eight (Bienville, Claiborne, Jackson, Lincoln, Ouachita, Union, Webster, and Winn) rely on the Sparta aquifer as their principal source of groundwater. In 2010, withdrawals from the Sparta aquifer in Louisiana totaled 63.11 million gallons per day (Mgal/d) (Sargent, 2011), a reduction of more than 11 percent from 1995, when the highest rate of withdrawals (71.32 Mgal/d) from the Sparta aquifer were documented (Lovelace and Johnson, 1996). The Sparta aquifer provides water for a variety of purposes which include public supply (34.61 Mgal/d), industrial (25.60 Mgal/d), rural domestic (1.50 Mgal/d), and various agricultural (1.40 Mgal/d) (Sargent, 2011). Of the 13 major aquifers or aquifer systems in Louisiana, the Sparta aquifer is currently (2012) the sixth most heavily pumped. The Sparta aquifer is the second most heavily pumped aquifer in Arkansas, which borders Louisiana to the north. In 2005, 170 Mgal/d were withdrawn from the Sparta aquifer in eastern and southern Arkansas; of that total, about 15.55 Mgal/d were withdrawn from the aquifer in Union County, which borders Claiborne and Union Parishes to the north (Holland, 2007) (fig. 1). By 1997, a large cone of depression (a cone-shaped depression in the potentiometric surface caused by and centered on a pumping well or wells) in the Sparta aquifer centered over Union County had merged with the cone of depression at West Monroe (Joseph, 1997). In 2004, the rate of withdrawal from the Sparta aquifer in Union County began to decline and water levels in the aquifer began to rise in nearby areas of Arkansas and Louisiana (Freiwald and Johnson, 2007).

Withdrawals from the Sparta aquifer have caused water-level declines throughout much of the aquifer in Louisiana. By 1996, water levels in the aquifer underlying West Monroe, La. (fig. 1), had declined about 300 feet (ft) from prepumping conditions (Ryals, 1980; Brantly and others, 2002). Water-level declines had also occurred at pumping centers near Minden, Ruston, Hodge, and Winnfield (fig. 1) (Ryals, 1980), and by 1997, water levels were below the top of the aquifer in several parishes in Louisiana (McKee and others, 2004). The decline of water levels below the top of the aquifer could result in unsaturated conditions, which could possibly lead to aquifer compaction and reduced well yields. Although land-surface subsidence can result from aquifer compaction, land-surface subsidence has not been documented in the Sparta aquifer (McKee and Hays, 2002). The water-level declines also have created conditions favorable for saltwater[1] encroachment into freshwater areas of the aquifer (Brantly and others, 2002).

Additional knowledge about water levels and flow directions in the Sparta aquifer are needed to assess the current condition of the aquifer. In 2011, the U.S. Geological Survey (USGS), in cooperation with the Louisiana Department of Transportation and Development, began a study to document current (2012) water levels, differences in water levels between 2005 and 2012, and areas where water levels were at or below the top of the aquifer.

This report presents data and maps that describe the potentiometric surface of the Sparta aquifer during March–April 2012, hydrographs of water levels from selected wells, water-level differences between 2005 and 2012, and areas where the water levels were at or below the top of the Sparta aquifer during March–April 2012. The potentiometric map can be used to determine direction of groundwater flow, hydraulic gradients, and effects of withdrawals on water levels. Water-level data collected for this study are stored in the USGS National Water Information System (http://waterdata.usgs.gov/nwis) and are on file at the USGS office in Ruston, La.

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

Description of Study Area

The study area includes the freshwater extent of the Sparta aquifer in north-central Louisiana, which extends across about 7,000 square miles and includes all or parts of Bienville, Bossier, Caddo, Caldwell, Claiborne, Jackson, Lincoln, Morehouse, Natchitoches, Ouachita, Richland, Sabine, Union, Webster, and Winn Parishes (fig. 1). The climate is generally warm and temperate with high humidity and frequent rain. The average annual temperature is about 66 degrees Fahrenheit, and the average annual rainfall is about 57 inches (National Oceanic and Atmospheric Administration, 2013).

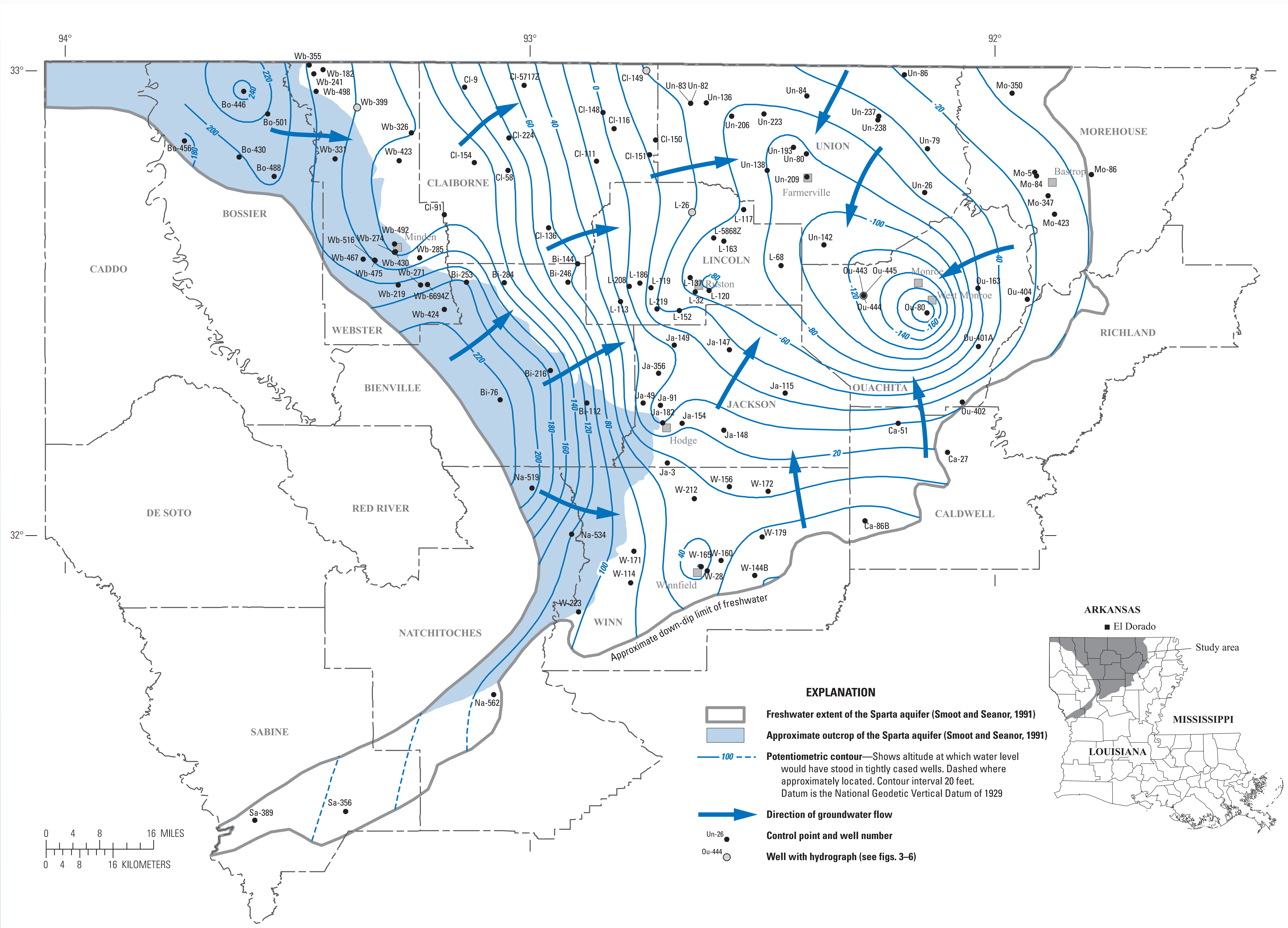

Figure 1. Potentiometric surface of the Sparta aquifer in north-central Louisiana, March–April 2012.

Hydrogeology

The Sparta aquifer, of Eocene age, is within the Mississippi embayment, a geosyncline plunging gently to the south whose axis approximately follows the present course of the Mississippi River (Cushing and others, 1970). A sequence of alternating sand and clay beds make up the Sparta aquifer, which is situated between and confined by the massive clay layers of the overlying Cook Mountain and underlying Cane River confining units (fig. 2).

The Sparta aquifer outcrops in northwestern Louisiana (fig. 1) and generally dips toward the east and southeast except along the northern border of the State where the dip is northeasterly. The aquifer ranges in thickness from 50 to 500 ft in north-central and northwestern Louisiana (McWreath and others, 1991). The regional dip is 25–50 ft per mile to the east and southeast (Payne, 1968).

The lithology of the Sparta aquifer is highly variable both laterally and vertically. Beds in the lower half of the aquifer generally consist of fine to medium sand; the beds in the upper half of the aquifer generally consist of sand, clay, and lignite. The existing pattern of lineations of sand concentrations in the aquifer has been attributed to the depositional processes of a system of braiding, constantly shifting stream channels, interlacing lakes, marshes, and swamps of a large deltaic-fluvial plain (Payne, 1968). The sand bodies may act locally and, for short periods, as separate hydraulic units, but over longer periods and larger areas, these units act as an integral part of the unified Sparta aquifer (Payne, 1968).

The Sparta aquifer is recharged by direct infiltration of rainfall in the outcrop area (fig. 1) and by leakage from alluvium and adjacent aquifers. Discharge is by withdrawal from wells and leakage through adjacent confining beds (Payne, 1968). Prior to development of the aquifer in Louisiana, which began in the early 1900s (McWreath and others, 1991), water levels were above the top of the aquifer in most areas, and water generally flowed in a southeasterly direction from the outcrop area toward areas of discharge in the southeast (Ryals, 1980). By 1965, development around the aquifer had resulted in local and regional water-level declines, and the general direction of flow in much of the aquifer was radially toward a large regional cone of depression centered over West Monroe.

The Sparta aquifer contains only saltwater in areas east and south of the down-dip limit of freshwater shown on figure 1. Saltwater extends several miles west of the down-dip limit of freshwater into the freshwater extent of the aquifer as a low-angle wedge along the base of the aquifer (Brantly and others, 2002). Regional water-level declines have altered the direction of flow and created gradients favorable for encroachment as lateral movement into freshwater areas or as upconing from the base of the aquifer toward pumping wells.

System	Series	Stratigraphic unit		Aquifer or confining unit
Tertiary	Eocene	Claiborne Group	Cockfield Formation	Cockfield aquifer or surficial confining unit
			Cook Mountain Formation	Cook Mountain aquifer or surficial confining unit
			Sparta Sand	Sparta aquifer or confining unit
			Cane River Formation	Cane River aquifer or confining unit
			Carrizo Sand	Carrizo-Wilcox aquifer or surficial confining unit
		? Wilcox Group, Undifferentiated		
	Paleocene	Midway Group, Undifferentiated		Midway confining unit

Figure 2. Partial column of stratigraphic and hydrogeologic units in north-central Louisiana.

Potentiometric Surface

The potentiometric surface of the Sparta aquifer during March–April 2012 was constructed by using water levels from 117 wells completed in the aquifer (fig. 1). Altitudes of water levels ranged from more than 248 ft above the National Geodetic Vertical Datum of 1929 (NGVD 29) at well Bo-446 in the outcrop area of northern Bossier Parish to more than 203 ft below NGVD 29 at well Ou-80 in Ouachita Parish (table 1). Water levels were measured by using steel or electric tapes marked with 0.01-ft graduations; the wells were not being pumped at the time of the measurements.

Water levels are lowest in areas affected by major pumping centers (cones of depression). Flow lines show that movement of groundwater in much of the Sparta aquifer is generally eastward or northeastward from areas of recharge toward areas of discharge. Flow in much of the eastern half of the aquifer is radially toward a large regional cone of depression over the West Monroe area, where the withdrawal rate was about 13.49 Mgal/d in 2010 (Sargent, 2011). Flow is locally influenced by small cones of depression near pumping centers that include Farmerville (1.57 Mgal/d), Minden (2.15 Mgal/d), Ruston (4.18 Mgal/d), Hodge (2.45 Mgal/d), and Winnfield (1.21 Mgal/d) (withdrawal rates from Sargent, 2011).

Water levels at well Wb-399 (fig. 3), located near the outcrop area of the Sparta aquifer in Webster Parish, show seasonal fluctuations of about 0.8 ft but show no long-term trends since 1978. This seasonal fluctuation is typical of wells located in or near the outcrop area of the Sparta aquifer. Water levels at wells L-26 (fig. 4) in Lincoln Parish and Ou-444 (fig. 5) in Ouachita Parish show long-term declines with little seasonal fluctuation, typical of wells located in areas that are minimally influenced by local withdrawals, but are heavily influenced by long-term regional declines. Water levels at well Cl-149 (fig. 6), located in the northeastern corner of Claiborne Parish near the Arkansas-Louisiana State line, also show long-term declines between 1980 and 1999; however, water levels have risen more than 24 ft since about 2000, primarily because of reduced withdrawals from the Sparta aquifer in and around El Dorado, Ark. (Freiwald and Johnson, 2007).

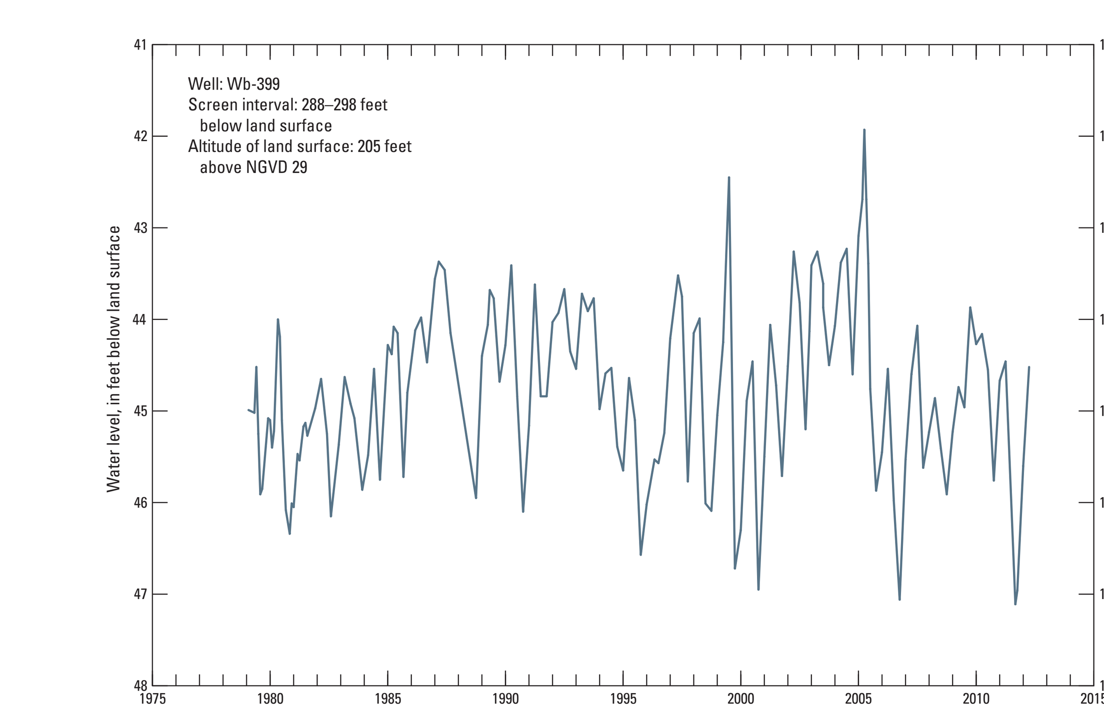

Figure 3. Water levels in well Wb-399, Webster Parish, Louisiana.

Water-Level Differences

Differences in water levels at 70 wells in the Sparta aquifer measured during the period March–April 2005 to March–May 2012 are shown on figure 7. Water-level differences were calculated by subtracting the 2012 water-level altitude measurement from the 2005 water-level altitude measurement. Water-level differences do not necessarily indicate a water-level trend but are intended to show where water-level altitudes declined or increased from 2005 to 2012 (table 1). In general, water levels declined between 1 and 10 ft throughout the southern half of the aquifer. The largest declines, 21.8 ft at well Bi-284 and 38.3 ft at Bi-246, occurred in northeast Bienville Parish (table 1). The large declines at both of these wells were localized and caused by withdrawals for industrial and public-supply purposes at or near the measured well and do not reflect the magnitude of regional water-level changes as indicated by other wells in the general area. Water levels generally increased throughout the northern half of the Sparta aquifer in Louisiana, primarily because of reduced withdrawals for industrial purposes at Bastrop, La., and near El Dorado, Ark. The largest water-level increase, 34.83 ft, occurred at well Mo-5 at Bastrop in Morehouse Parish (table 1).

Water Levels Below the Top of the Aquifer

Potentiometric-surface altitude of the Sparta aquifer for March–April 2012 was compared to the altitude of the top of the Sparta aquifer in Louisiana (Brantly and others, 2002), and an area was delineated where water levels were at or below the top of the aquifer (fig. 7). Water levels were at or below the top of the Sparta aquifer in all or part of nine parishes, including Bienville, Claiborne, Jackson, Lincoln, Natchitoches, Ouachita, Union, Webster, and Winn. All of these parishes, except Natchitoches Parish, obtain the majority of their groundwater from the Sparta aquifer. Water levels were farthest, more than 150 ft, below the top of the aquifer along the Bienville-Jackson Parish line northwest of the town of Hodge, where withdrawals for industrial purposes have caused a local cone of depression.

Potentiometric Surface, 2012, and Water-Level Differences, 2005–12, of the Sparta Aquifer in North-Central Louisiana

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