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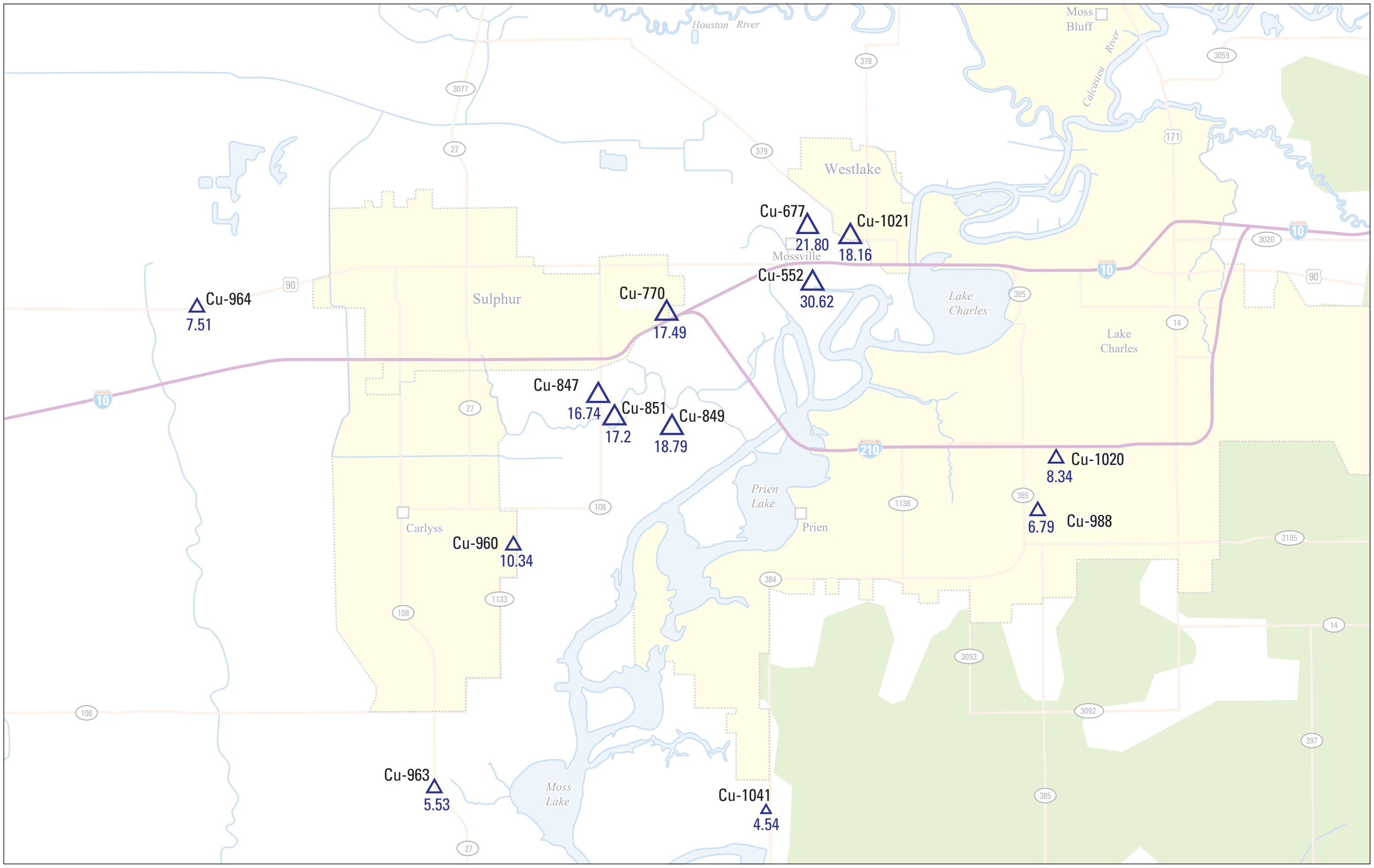
Prepared in cooperation with the Louisiana Department of Transportation and Development

Potentiometric Surfaces, 2011–12, and Water-Level Differences Between 1995 and 2011–12, in Wells of the "200-Foot," "500-Foot," and "700-Foot" Sands of the Lake Charles Area, Southwestern Louisiana



Pamphlet to accompany

Scientific Investigations Map 3460

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

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DAVID BERNHARDT, Secretary

U.S. Geological Survey
James F. Reilly II, Director

U.S. Geological Survey, Reston, Virginia: 2020

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Figures

[All sheets available at https://doi.org/10.3133/sim3460]

Tables

Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)

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

Datum

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

Altitude, as used in this report, refers to distance relative to the vertical datum.

Supplemental Information

Concentrations of chemical constituents in water are given in milligrams per liter (mg/L).

Abbreviations

DOTD	Louisiana Department of Transportation and Development
USGS	U.S. Geological Survey

Potentiometric Surfaces, 2011–12, and Water-Level Differences Between 1995 and 2011–12, in Wells of the “200-Foot,” “500-Foot,” and “700-Foot” Sands of the Lake Charles Area, Southwestern Louisiana

By Vincent E. White and Jason M. Griffith

Abstract

Water levels were determined in 90 wells to prepare 2011–12 potentiometric surfaces focusing primarily on the “200-foot,” 500-foot,” and “700-foot” sands of the Lake Charles area, which are part of the Chicot aquifer system underlying Calcasieu and Cameron Parishes of southwestern Louisiana. These three aquifers provided 34 percent of the total water withdrawn and 93 percent of the groundwater withdrawn in Calcasieu and Cameron Parishes in 2012 (84.5 million gallons per day [Mgal/d]). This work was completed by the U.S. Geological Survey, in cooperation with the Louisiana Department of Transportation and Development, to assist in developing and evaluating groundwater-resource management strategies. The highest water levels determined in wells screened in the “200-foot,” “500-foot,” and “700-foot” sands were about 8 feet (ft) above the National Geodetic Vertical Datum of 1929 (NGVD 29), 2 ft below NGVD 29, and 14 ft below NGVD 29, respectively, and were located in northwestern Calcasieu Parish. The lowest water levels determined in wells screened in the “200-foot,” “500-foot,” and “700-foot” sands were approximately 50, 80, and 70 ft below NGVD 29, respectively, and were located in the southern Lake Charles metropolitan area, to the west of Prien Lake, and between the cities of Lake Charles and Sulphur, respectively. The primary groundwater flow direction in these three aquifers was radially towards pumping centers overlying the water-level lows. Comparisons of water-level differences in 42 wells measured in 1995 and 2011–12 indicated that the maximum increases in water levels for wells screened in the “200-foot,” “500-foot,” and “700-foot” sands were approximately 7, 31, and 19 ft, respectively. Water-level increases coincided with a decline in total groundwater withdrawals during the period (about 25 Mgal/d from 1995 to 2012) from these sands. More specifically, withdrawals from the “500-foot” sand affected water levels in wells screened in the “200-foot” and “700-foot” sands because the three are hydraulically connected and withdrawals from the “500-foot” sand were greater by volume than withdrawals from the “200-foot” and “700-foot” sands.

Introduction

Increases in groundwater withdrawals can lead to declining water levels and changes in flow directions and can affect water quality. Withdrawals from the Chicot aquifer system in the Lake Charles area of southwestern Louisiana (fig. 1), primarily from the “500-foot” sand, have caused long-term (years to decades) potentiometric-surface declines resulting in a cone of depression in the “500-foot” sand that extends across Calcasieu Parish. Because the “200-foot” and “700-foot” sands are hydraulically connected to the “500-foot” sand in this area, withdrawals from the “500-foot” sand have lowered water levels in wells screened in the “200-foot” and “700-foot” sands (figs. 2–4). Withdrawals have also caused hydraulic gradients favorable for encroachment of saltwater[1] towards fresh groundwater in the Lake Charles area (Lovelace, 1999).

Additional knowledge about groundwater levels, groundwater flow, and the effects of withdrawals on the “200-foot,” “500-foot,” and “700-foot” sands of the Lake Charles area is needed to assess the effects of withdrawals, determine the direction of groundwater flow, and develop sustainable groundwater-resource management strategies. To meet this need, the U.S. Geological Survey (USGS), in cooperation with the Louisiana Department of Transportation and Development (DOTD), began a study in 2011 to measure depth to water in a network of 90 wells in order to determine and document water levels in wells screened in the “200-foot,” “500-foot,” and “700-foot” sands and to prepare potentiometric surfaces and evaluate differences in water levels.

[1]Saltwater in this report is defined as water that contains chloride at concentrations of more than 250 milligrams per liter (mg/L). Concentrations of chloride less than 250 mg/L are within the secondary maximum contaminant level (SMCL) and are considered freshwater. 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. The SMCLs were established as guidelines by the U.S. Environmental Protection Agency (2016).

Purpose and Scope

This report presents data, analysis, and maps that primarily describe the potentiometric surfaces of the “200-foot,” “500-foot,” and “700-foot” sands of the Lake Charles area during 2011–12. Water-level differences are calculated for select wells measured in both 1995 and 2011–12. In addition to the data presented in this report, water-level data are also available from the USGS National Water Information System database (U.S. Geological Survey, 2017a) and Louisiana Water-Use Program (U.S. Geological Survey, 2017b).

Description of Study Area

The study area (fig. 1) extends across about 2,300 square miles and includes all of Calcasieu Parish, the western two-thirds of Cameron Parish, and the extreme southwestern corner of Jefferson Davis Parish in southwestern Louisiana. The largest city in the study area, Lake Charles, had a 2010 population of about 72,000 (U.S. Census Bureau, 2019). Much of the study area is rural and agricultural, with rice production being a historically important agricultural sector (Louisiana State University AgCenter, 2015; fig. 1). Many and various industrial facilities are located near the Lake Charles metropolitan area, in the vicinity of the western bank of the Calcasieu River, and in Westlake. The climate is generally warm and temperate with high humidity and frequent rainfall. For the city of Lake Charles, the average annual temperature is 68 degrees Fahrenheit, and the average annual rainfall is about 56 inches (National Oceanic and Atmospheric Administration, 2011). Topographically, the study area is composed of a coastal plain, with the highest surface altitudes at about 90 feet (ft) above the National Geodetic Vertical Datum of 1929 (NGVD 29) at the northern border of the study area near DeQuincy and the lowest altitudes equivalent to about NGVD 29 at the southern border of the study area (U.S. Geological Survey, 2015).

Hydrogeologic Setting

The Chicot aquifer system underlies southwestern Louisiana and parts of southeastern Texas and is composed of a sequence of deposits of silt, sand, and gravel interbedded with clay and sandy clay that dips and thickens towards the south and southeast (fig. 3) (Nyman, 1984). The sand deposits grade southward from coarse sand and gravel to finer sediments and become increasingly subdivided by clay layers. A surficial clay confining layer overlies most of the Chicot aquifer system in southwestern Louisiana. Underlying the study area, the Chicot aquifer system is composed of various aquifers including the “200-foot,” “500-foot,” and “700-foot” sands, the upper and lower sands, and the undifferentiated sand (figs. 1 and 3). In addition, various shallow sands are present within a surficial confining layer (Lovelace, 1999).

The “200-foot,” “500-foot,” and “700-foot” sands are named for their general depths of occurrence in the Lake Charles area (Jones, 1950) and are located beneath central and western Calcasieu and Cameron Parishes (fig. 1) (Lovelace, 1998). Along the northern border of Calcasieu Parish, these sands merge into a single massive undifferentiated sand unit. The upper and lower sand units are in the eastern parts of Calcasieu and Cameron Parishes and are stratigraphically equivalent and hydraulically connected to the “200-foot” and the “700-foot” sands, respectively, in the Lake Charles area. Although the “500-foot” sand is stratigraphically equivalent to the lower sand unit of the Chicot aquifer system, it generally pinches out (disappears) to the east where it is commonly not directly hydraulically connected with the lower sand unit of the Chicot aquifer system (Lovelace, 1999).

Recharge to the Chicot aquifer system results from infiltration of precipitation primarily north of the study area (fig. 1 index map), where the aquifer system is at or near ground surface. In the recharge area, water percolates down into and through sandy surficial soil eventually reaching the “200-foot,” “500-foot,” and “700-foot” sands of the Lake Charles area (Nyman and others, 1990; Lovelace and others, 2001). Additional recharge is from leakage through vertically adjacent clay confining units (fig. 3).

Prior to extensive groundwater development in the study area during the 1940s, the movement of groundwater in the Chicot aquifer system as a whole was generally downgradient from north to south, and groundwater discharged into shallower aquifers or to the surface along the Sabine River and the Gulf of Mexico (Nyman and others, 1990). Since the 1940s, large withdrawals for industrial use, agriculture, and public supply primarily from the “200-foot,” “500-foot,” and “700-foot” sands of the Lake Charles area have caused water-level declines and altered the flow of groundwater in the study area. These declines have resulted in groundwater flowing towards the concentrated pumping in the vicinity of Lake Charles in Calcasieu Parish and towards agricultural areas (fig. 1) (Jones and others, 1954; Lovelace, 1998).

Methods

Potentiometric-surface maps were prepared based on water levels determined from 90 wells screened primarily in the “200-foot,” “500-foot,” and “700-foot” sands (table 1). Water levels were calculated by subtracting the depth-to-water measurement from the land-surface altitude and are referenced to NGVD 29. Seven nearby wells (Cu-971, Cu-5866Z, JD-485A, Cu-11708Z, Cu-10260Z, Cu-970, and Cu-1269) that were not screened in the “200-foot,” “500-foot,” and “700-foot” sands, but which were screened in hydraulically connected and stratigraphically equivalent sands (upper sand, lower sand, and undifferentiated sand) were used to create more complete potentiometric surfaces and water-level difference maps. Although used to present a more complete potentiometric surface, well Cu-11708Z was not used for analysis of minimum and maximum water levels because this well is screened in the undifferentiated sand in the northern part of the study area, where the “200-foot,” “500-foot,” and “700-foot” sands have merged. Cu-10260Z is coded as screened in the undifferentiated sand but is south of the approximate boundary between the undifferentiated sand and “200-foot” sand (fig. 1) and was treated accordingly.

Depth to water in each well was measured by using a steel or electrical tape marked with 0.01-ft gradations and were reported to one-hundredths of a foot, following procedures in Cunningham and Schalk (2011). Wells in which depth to water was measured were not being pumped at the time the measurements were made. If wells had been recently pumped, depth to water was measured after an appropriate recovery period. Water-level data were collected from December 2011 through March 2012; water levels in the study area typically decline (because of seasonal withdrawals) to their yearly low in June. Potentiometric contours were drawn as approximate around individual wells if the water levels differed appreciably from water levels in nearby wells or if data were sparse. Water levels determined during 1995 and 2011–12 at selected wells (table 1) were used to prepare water-level difference maps. When more than one measurement had been made at a selected well during those years, measurements made during the same time of year were preferentially chosen to minimize potential differences resulting from seasonal water-level fluctuations; however, same-season measurements were not always available.

Water-withdrawal data are collected collaboratively between the Louisiana DOTD and the USGS and made possible by the USGS Water Resources Cooperative Program: Louisiana Water-Use Program (U.S. Geological Survey, 2017b). Through this program, water-withdrawal data are collected from users or determined indirectly based on population size, agricultural-use types, and water-use coefficients. Totals are analyzed, compiled, and published by USGS on behalf of the Louisiana DOTD (U.S. Geological Survey, 2017b). Withdrawal data are provided to the public in several different combinations, such as by parish and aquifer, by State and aquifer, and by groundwater and parish; however, certain combinations and information are not published. Data that would reveal the exact location, such as address or latitude-longitude of withdrawal points, are not published in order to protect proprietary information. In addition, withdrawal data for individual sands within a larger aquifer or aquifer system are not published. For the purposes of this report, water use from each sand, the “200-foot,” 500-foot,” and “700-foot” sands, are disaggregated from the total withdrawal values from the Chicot aquifer. This facilitates a clearer understanding of the effects of withdrawals on the water-level altitude surfaces for each respective sand unit. For further information, contact either the Louisiana Water-Use Program USGS Lower Mississippi-Gulf Water Science Center, Baton Rouge office or the Louisiana DOTD Water Supply Availability and Use Program (Louisiana Department of Transportation and Development, 2018).

As with water-level data, withdrawal maps for the “200-foot,” “500-foot,” and “700-foot” sands included withdrawals from the relevant upper, lower, and undifferentiated sands of the Chicot aquifer system. In this report, the withdrawal maps only included values that were greater than an average of 0.1 million gallons per day (Mgal/d) at an individual well or a group of closely located wells. These values were provided to the Louisiana Water-Use Program and did not include indirectly determined values. Historical totals for groundwater withdrawals in the study area for 1960–2010 included the total groundwater withdrawals from all groundwater sources for Calcasieu and Cameron Parishes and have been provided to enable the reader to see current water-use values in their historical context. Historical totals for groundwater withdrawals in the study area for 1995–2012 included only withdrawals from the “200-foot,” “500-foot,” and “700-foot” sands.

Table 1. Water-level data from wells used to prepare the potentiometric surfaces (2011–12) and water-level difference (between 1995 and 2011–12) of the "200-foot," "500-foot," and "700-foot" sands of the Lake Charles area, southwestern Louisiana.

[USGS, U.S. Geological Survey; NGVD 29, National Geodetic Vertical Datum of 1929; mm, month; dd, day; yyyy, year; –, measurement not available during relevant time period; *, indicates that the well is screened in either the upper, lower, or undifferentiated sands of the Chicot aquifer system]

Well site name	USGS site number	Altitude of land surface, in feet above NGVD 29	Well depth, in feet below land surface	Date measured, mm/dd/yyyy	Depth to water level, in feet below land surface	Water-level altitude, in feet above or below (-) NGVD 29	Date measured, mm/dd/yyyy	Depth to water level, in feet below land surface	Water-level altitude, in feet above or below (-) NGVD 29	Difference, in feet between 1995 and 2011–12 value
"200-foot" sand										
				2011–12			1995			
Cu- 529	300818093361601	18	276	12/30/2011	51.88	-33.88	12/7/1995	53.91	-35.91	2.03
Cu- 768	301036093124402	11.53	306	12/15/2011	61.42	-49.89	–	–	–	–
Cu- 771	301336093183002	17.76	241	12/16/2011	55.40	-37.64	10/12/1995	60.73	-42.97	5.33
Cu- 798	300919093055601	25.43	345	3/7/2012	59.08	-33.65	–	–	–	–
Cu- 843	301148093193202	12	205	2/20/2012	48.23	-36.23	2/13/1995	51.74	-39.74	3.51
Cu- 946	301356093171001	15	198	3/6/2012	54.25	-39.25	9/28/1995	61.68	-46.68	7.43
Cu- 962	300812093165801	11	287	12/19/2011	48.60	-37.60	–	–	–	–
Cu- 975	301941093035602	20	237	12/21/2011	37.83	-17.83	11/29/1995	37.20	-17.20	-0.63
Cu- 984	300406093070001	15	325	3/7/2012	46.20	-31.20	–	–	–	–
Cu- 990	301059093125103	14	183	12/15/2011	57.73	-43.73	11/2/1995	60.68	-46.68	2.95
Cu-1101	301157093250501	12	260	2/14/2012	58.33	-46.33	–	–	–	–
Cu-11429Z	300545093163101	7	255	3/7/2012	40.35	-33.35	–	–	–	–
Cu-11872Z	301416093153501	11	202	2/21/2012	47.19	-36.19	–	–	–	–
Cu-12305Z	301445093164601	12	155	3/6/2012	43.51	-31.51	–	–	–	–
Cu-12600Z	300836093281801	11	280	12/29/2011	35.79	-24.79	–	–	–	–
Cu-12284Z	301016093224101	16	250	3/7/2012	51.11	-35.11	–	–	–	–
Cu-12933Z	301725093224101	22	110	3/7/2012	23.46	-1.46	–	–	–	–
Cu-1332	301033093205402	16	240	1/5/2012	58.69	-42.69	–	–	–	–
Cu-13320Z	301709093334401	27	280	2/21/2012	44.42	-17.42	–	–	–	–
Cu-13362Z	301201093404201	12	280	12/30/2011	34.02	-22.02	–	–	–	–
Cu-13571Z	301703093090501	13	180	3/5/2012	37.69	-24.69	–	–	–	–
Cu-6750Z	301512093171501	16	150	3/6/2012	48.71	-32.71	–	–	–	–
Cu-9584Z	301335093344401	23	280	1/12/2012	47.49	-24.49	–	–	–	–
Cn- 90	295611093044801	3.19	396	3/6/2012	31.62	-28.43	4/11/1995	23.92	-20.73	-7.70
Cn- 92	300104093015601	5.5	443	12/21/2011	38.99	-33.49	4/11/1995	29.66	-24.16	-9.33
Cu- 971*	300534092564402	5	500	12/22/2011	42.63	-37.63	11/21/1995	39.93	-34.93	-2.70
Cu-5866Z*	301118093004801	24	265	1/3/2012	61.22	-37.22	–	–	–	–
JD- 485A*	301300092584503	21	290	2/7/2012	57.57	-36.57	2/14/1995	50.95	-29.95	-6.62
Cu-11708Z*	302828093265801	88	260	1/10/2012	69.08	18.92	–	–	–	–
Cu-10260Z*	302059093402001	34	220	2/21/2012	26.36	7.64	–	–	–	–

Table 1. Water-level data from wells used to prepare the potentiometric surfaces (2011–12) and water-level difference (between 1995 and 2011–12) of the “200-foot,” “500-foot,” and “700-foot” sands of the Lake Charles area, southwestern Louisiana.—Continued

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Well site name	USGS site number	Altitude of land surface, in feet above NGVD 29	Well depth, in feet below land surface	Date measured, mm/dd/yyyy	Depth to water level, in feet below land surface	Water-level altitude, in feet above or below (-) NGVD 29	Date measured, mm/dd/yyyy	Depth to water level, in feet below land surface	Water-level altitude, in feet above or below (-) NGVD 29	Difference, in feet between 1995 and 2011–12 value
“500-foot” sand										
				2011–12			1995			
Cu- 463B	301106093203202	17	516	1/5/2012	89.59	-72.59	–	–	–	–
Cu- 552	301359093162202	13	517	1/11/2012	85.63	-72.63	9/6/1995	116.25	-103.25	30.62
Cu- 677	301445093162201	10	568	3/6/2012	77.89	-67.89	9/20/1995	99.69	-89.69	21.80
Cu- 770	301336093183003	17.54	490	12/16/2011	85.05	-67.51	10/12/1995	102.54	-85.00	17.49
Cu-787	300353093210201	4.33	734	3/28/2012	48.60	-44.27	4/11/1995	50.59	-46.26	1.99
Cu- 828	301149093190801	10	560	1/5/2012	89.64	-79.64	–	–	–	–
Cu- 847	301230093193202	13	522	12/16/2011	81.87	-68.87	10/12/1995	98.61	-85.61	16.74
Cu- 849	301205093182501	10	564	1/4/2012	79.20	-69.20	10/11/1995	97.99	-87.99	18.79
Cu- 851	301213093191701	10	555	12/21/2011	80.75	-70.75	5/24/1995	97.9	-87.9	17.2
Cu- 895	301707093211601	18	355	12/13/2011	62.36	-44.36	–	–	–	–
Cu- 947	300643093044701	20	600	12/15/2011	59.78	-39.78	11/29/1995	58.89	-38.89	-0.89
Cu- 957	301120093191002	17	500	1/5/2012	90.37	-73.37				
Cu- 960	301031093204902	21	598	12/16/2011	85.48	-64.48	10/11/1995	95.82	-74.82	10.34
Cu- 961	301214093223201	14	540	2/20/2012	55.86	-41.86	–	–	–	–
Cu- 963	300718093220001	10	399	12/29/2011	61.53	-51.53	12/7/1995	67.06	-57.06	5.53
Cu- 964	301339093253901	16	360	12/29/2011	56.43	-40.43	11/22/1995	63.94	-47.94	7.51
Cu- 977	301944093170402	20	515	12/20/2011	47.83	-27.83	11/22/1995	54.44	-34.44	6.61
Cu- 988	301059093125101	14	523	12/15/2011	74.69	-60.69	11/2/1995	81.48	-67.48	6.79
Cu-1018	301800093121701	20	398	12/13/2011	54.47	-34.47	–	–	–	–
Cu-1019	300354093205501	5	700	3/6/2012	53.84	-48.84	–	–	–	–
Cu-1020	301141093123501	18	375	12/15/2011	77.68	-59.68	11/2/1995	86.02	-68.02	8.34
Cu-1021	301435093154601	12	487	12/19/2011	75.27	-63.27	10/12/1995	93.43	-81.43	18.16
Cu-1041	300702093165801	9	560	12/15/2011	65.18	-56.18	11/2/1995	69.72	-60.72	4.54
Cu-1051	301401093302401	20	410	2/2/2012	53.23	-33.23	12/13/1995	57.42	-37.42	4.19
Cu-1055	301450093251501	15	520	2/2/2012	55.27	-40.27	–	–	–	–
Cu-11500Z	302127093102801	34	250	12/14/2011	54.97	-20.97	–	–	–	–
Cu-1160	301559093374601	25	526	2/1/2012	46.50	-21.50	–	–	–	–
Cu-11708Z*	302828093265801	88	260	1/10/2012	69.08	18.92	–	–	–	–
Cu-12287Z	300822093321201	10	460	2/2/2012	43.44	-33.44	–	–	–	–
Cu-12469Z	301753093300501	26	250	2/1/2012	59.47	-33.47	–	–	–	–
Cu-12489Z	301401093063201	17	460	12/14/2011	56.77	-39.77	–	–	–	–

Table 1. Water-level data from wells used to prepare the potentiometric surfaces (2011–12) and water-level difference (between 1995 and 2011–12) of the “200-foot,” “500-foot,” and “700-foot” sands of the Lake Charles area, southwestern Louisiana.—Continued

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“500-foot” sand—Continued										
				2011–12—Continued			1995			
Cu-1267	301852093393901	30	405	12/14/2011	32.43	-2.43	–	–	–	–
Cu-1319	301359093160701	15	510	1/11/2012	85.35	-70.35	–	–	–	–
Cu-1328	301420093130301	16	495	3/8/2012	79.70	-63.70	–	–	–	–
Cu-13524Z	301031093255301	10	470	2/20/2012	54.23	-44.23	–	–	–	–
Cu-13585Z	301628093073601	15	300	12/14/2011	44.49	-29.49	–	–	–	–
Cn- 87	295324093240602	8.46	804	3/6/2012	44.26	-35.80	–	–	–	–
Cn- 88L	300055093093004	8.86	804	12/15/2011	48.49	-39.63	4/11/1995	45.49	-36.63	-3.00
Cn- 120	295721093115701	3	764	3/6/2012	37.50	-34.50	–	–	–	–
Cn- 134	295839093203501	5	710	3/6/2012	43.16	-38.16	–	–	–	–
“700-foot” sand										
				2011–12			1995			
Cu- 746	301300093161601	4.09	780	1/11/2012	70.16	-66.07	10/20/1995	89.51	-85.42	19.35
Cu- 767	301036093124401	11.42	850	12/15/2011	68.31	-56.89	4/10/1995	69.46	-58.04	1.15
Cu- 769	301336093183001	17.62	642	12/16/2011	84.85	-67.23	4/10/1995	97.52	-79.90	12.67
Cu- 788	300825093260801	6.11	805	12/19/2011	52.37	-46.26	11/22/1995	54.67	-48.56	2.30
Cu- 811	300812093165802	11	923	12/19/2011	65.71	-54.71	–	–	–	–
Cu- 958	301944093170401	20	707	12/20/2011	46.23	-26.23	11/30/1995	52.55	-32.55	6.32
Cu- 959	301031093204901	21	733	12/16/2011	82.22	-61.22	10/11/1995	92.01	-71.01	9.79
Cu- 972	301941093035601	20	595	12/21/2011	43.27	-23.27	11/29/1995	42.38	-22.38	-0.89
Cu- 978	301409093120301	15	645	12/20/2011	68.14	-53.14	11/1/1995	77.24	-62.24	9.10
Cu- 994	300634093400401	5	757	12/20/2011	40.77	-35.77	12/8/1995	33.00	-28.00	-7.77
Cu-1022	301444093162901	11	618	1/4/2012	77.48	-66.48	9/28/1995	95.78	-84.78	18.30
Cu-11708Z*	302828093265801	88	260	1/10/2012	69.08	18.92	–	–	–	–
Cu-1239	302106093115401	25	502	3/5/2012	47.83	-22.83	11/30/1995	54.08	-29.08	6.25
Cu-12894Z	300404093115801	10	520	2/20/2012	50.91	-40.91	–	–	–	–
Cu-1388	301852093393902	30	585	12/30/2011	44.13	-14.13	12/12/1995	44.50	-14.50	0.37
Cu-1419	301331093172801	12	620	3/6/2012	81.59	-69.59	–	–	–	–
Cn- 94	294543093391401	6.22	1,118	3/6/2012	37.98	-31.76	–	–	–	–
Cn- 119	294709093174302	3.5	910	3/6/2012	25.62	-22.12	–	–	–	–
Cu- 970*	300534092564401	5	780	12/22/2011	43.33	-38.33	11/21/1995	40.19	-35.19	-3.14
[1]Cu-1269*	301414093004501	22	503	1/3/2012	86.60	-64.60	12/12/1995	63.84	-41.84	-22.76

[1]Nearby site that taps the same aquifer was being pumped for both the 1995 and 2011–12 values.

Potentiometric Surfaces and Water-Level Differences in Wells of the “200-Foot” Sand

Water levels in the “200-foot” sand generally were highest in northern Calcasieu Parish and lowest in the southern part of the city of Lake Charles; the highest water level was 7.64 ft above NGVD 29 at well Cu-10260Z (table 1; fig. 5),[2] and the lowest water level was 49.89 ft below NGVD 29 at well Cu-768 (fig. 5). The direction of groundwater flow in much of the aquifer was generally from north to south and radially towards a shallow cone of depression delineated by the −40-ft contour on figure 5. Although there are water-withdrawal sites in the “200-foot” sand in the vicinity of the cone of depression (fig. 6; table 2), the cone is primarily the result of much heavier pumping in this same area from the “500-foot” sand (fig. 7; table 3), which is hydraulically connected to and affects water levels in wells screened in the “200-foot” sand as can be seen in the historical water use and water levels in the “200-foot,” “500-foot,” and “700-foot” sands (fig. 4; table 4).

Water-level differences in wells screened primarily in the “200-foot” sand indicate increases of as much as 7.4 ft at wells in the Lake Charles metropolitan area and in western Calcasieu Parish (fig. 8; table 1) from 1995 to 2011, whereas water levels declined as much as 9 ft at wells near the eastern border of the study area during the same period. The water-level increases were primarily the result of reduced withdrawals from the “500-foot” sand; withdrawals from the “200-foot” sand changed little from 1995 to 2011–12 (fig. 4). The water-level declines along the eastern border of the study area could be the result of seasonal fluctuations or increased withdrawals from the Chicot aquifer upper sand in neighboring Jefferson Davis Parish, where groundwater withdrawals increased from 66.03 Mgal/d in 1995 to 90.18 Mgal/d in 2012 (U.S. Geological Survey, 2017b).

[2]As mentioned previously in Methods, well Cu-11708Z was not included in the max-min analysis.

Table 2. Withdrawals from the "200-foot" sand of the Lake Charles area and upper and undifferentiated sands of the Chicot aquifer system, southwestern Louisiana, 2010.

Site number[1]	Parish	Withdrawal rate, in million gallons per day (Mgal/d)	Aquifer
A2	Calcasieu	0.6	undifferentiated sand
B2	Calcasieu	0.5	“200-foot” sand
C2	Calcasieu	0.1	“200-foot” sand
D2	Calcasieu	1.0	“200-foot” sand
E2	Calcasieu	0.3	“200-foot” sand
F2	Calcasieu	0.1	“200-foot” sand
G2	Calcasieu	0.1	“200-foot” sand
H2	Cameron	0.2	“200-foot” sand
I2	Cameron	0.2	“200-foot” sand
J2	Cameron	0.1	upper sand
K2	Cameron	0.4	upper sand

[1]See figure 6.

Table 3. Withdrawals from the “500-foot” sand of the Lake Charles area, southwestern Louisiana, 2010.

Site number[1]	Parish	Withdrawal rate, in million gallons per day (Mgal/d)	Aquifer
A5	Calcasieu	2.3	“500-foot” sand
B5	Calcasieu	0.6	“500-foot” sand
C5	Calcasieu	1.5	“500-foot” sand
D5	Calcasieu	2.8	“500-foot” sand
E5	Calcasieu	6.5	“500-foot” sand
F5	Calcasieu	1.6	“500-foot” sand
G5	Calcasieu	1.5	“500-foot” sand
H5	Calcasieu	0.4	“500-foot” sand
I5	Calcasieu	20.7	“500-foot” sand
J5	Calcasieu	0.7	“500-foot” sand
K5	Calcasieu	0.5	“500-foot” sand
L5	Calcasieu	1.0	“500-foot” sand
M5	Calcasieu	1.4	“500-foot” sand
N5	Calcasieu	0.1	“500-foot” sand
O5	Calcasieu	9.7	“500-foot” sand
P5	Calcasieu	11.6	“500-foot” sand
Q5	Calcasieu	2.5	“500-foot” sand
R5	Calcasieu	1.7	“500-foot” sand
S5	Calcasieu	0.4	“500-foot” sand
T5	Cameron	0.1	“500-foot” sand
U5	Cameron	0.2	“500-foot” sand
V5	Cameron	0.2	“500-foot” sand
W5	Cameron	0.2	“500-foot” sand

[1]See figure 7.

Table 4. Withdrawals, in million gallons per day (Mgal/d), from the “200-foot,” “500-foot,” and “700-foot” sands of the Lake Charles area, southwestern Louisiana, 1994–2012.

Year	“200-foot” sand (Mgal/d)	“500-foot” sand (Mgal/d)	“700-foot” sand (Mgal/d)	Total (Mgal/d)
1995	9.18	90.37	9.82	109.36
2000	19.45	95.74	9.79	124.97
2005	11.76	71.11	4.81	87.68
2010	9.68	72.38	3.22	85.28
2012	9.34	71.93	3.24	84.51

Potentiometric Surfaces and Water-Level Differences in Wells in the "500-Foot" Sand

Water levels in the "500-foot" sand generally were highest in northern Calcasieu Parish and lowest between Carlyss and Prien. The highest of the 40 water levels determined in wells screened in the "500-foot" sand was 2.43 ft below NGVD 29 at well Cu-1267 in northwestern Calcasieu Parish (fig. 9).[3] The lowest water level in the "500-foot" sand, 79.64 ft below NGVD 29, was determined at well Cu-828, located about 2 miles west-northwest of Prien Lake (fig. 10). Water levels were more than 40 ft below NGVD 29 in most of the Lake Charles metropolitan area. A large cone of depression centered on the area between Lake Charles and Prien Lake comprises two smaller cones of depression underlying major pumping centers (fig. 7), where water levels were 70–80 ft below NGVD 29. The general direction of flow in the "500-foot" sand during 2011–12 was radially towards these pumping centers.

Water-level differences at wells screened in the "500-foot" sand indicate increases of as much as 6.6 ft outside of the Lake Charles metropolitan area, with minor decreases at two wells located southeast of the metropolitan area (fig. 11). In the metropolitan area, water-level increases were more substantial, rising over 30 ft (fig. 12). The water-level increases in wells screened in the metropolitan area resulted from reduced withdrawals from the "500-foot" sand, which declined from 90.37 Mgal/d in 1995 to 71.93 Mgal/d in 2012 (fig. 4; table 4).

[3]As mentioned previously in *Methods*, well Cu-11708Z was not included in the max-min analysis.

Potentiometric Surfaces and Water-Level Differences in Wells in the "700-Foot" Sand

Water levels in the "700-foot" sand generally were highest in northern Calcasieu Parish and lowest near the Calcasieu River north of Prien. The highest water level was 14.13 ft below NGVD 29 at well Cu-1388 (fig. 13; table 1),[4] and the lowest water level was 69.59 ft below NGVD 29 at well Cu-1419. The potentiometric surface was more than 50 ft below NGVD 29 in most of the Lake Charles metropolitan area. The direction of groundwater flow in much of the aquifer was generally radial towards the cone of depression underlying the metropolitan area (fig. 13). Comparatively, there was little pumping from the "700-foot" sand or lower sand within the cone of depression (fig. 14; table 5), and the cone is the result of heavier pumping from the "500-foot" sand (fig. 7; table 3), which is hydraulically connected to and affects water levels in the "700-foot" sand.

Water-level differences at wells screened primarily in the "700-foot" sand of the Lake Charles area indicate increases of about 19 ft in the north-central part of the study area; however, water levels decreased at wells near the eastern edge of the study area and in southwestern Calcasieu Parish (fig. 15). Although withdrawals from the "700-foot" sand decreased from 9.82 Mgal/d in 1995 to 3.24 Mgal/d in 2012 (fig. 4), the water-level increases were primarily the result of reduced withdrawals from the "500-foot" sand. The large water-level decline at well Cu-1269 at the town of Iowa (fig. 15) was probably the result of pumping at a nearby well when the 2011 water level was determined and not indicative of broader declines in the aquifer in that area. The other declines near the eastern border were relatively small and could have resulted from seasonal water-level variation. The cause of the 7.77-ft decline in southwestern Calcasieu Parish is undetermined.

[4]As mentioned previously in *Methods*, well Cu-11708Z was not included in the max-min analysis.

Table 5. Withdrawals from the "700-foot" sand of the Lake Charles area and lower sand of the Chicot aquifer system, southwestern Louisiana, 2010.

Site number[1]	Parish	Withdrawal rate, in million gallons per day (Mgal/d)	Aquifer
A7	Calcasieu	0.9	"700-foot" sand
B7	Calcasieu	1.0	"700-foot" sand
C7	Calcasieu	0.3	lower sand

[1]See figure 14.

Summary

The “200-foot,” “500-foot,” and “700-foot” sands of the Chicot aquifer system underlying southwestern Louisiana are an important source of freshwater in the Lake Charles metropolitan area and the surrounding communities in Calcasieu and Cameron Parishes in southwestern Louisiana. Potentiometric surfaces, water-level difference maps, and concurrent water-withdrawal data are important to help assess the effects of withdrawals, determine the direction of groundwater flow, and develop sustainable groundwater-resource management strategies. To meet this need, the U.S. Geological Survey, in cooperation with the Louisiana Department of Transportation and Development, began a study in 2011 to measure depth to water in a network of 90 wells in order to determine and document water levels in wells screened in the “200-foot,” “500-foot,” and “700-foot” sands; prepare potentiometric-surface maps; and evaluate differences in the water levels between 1995 and 2011–12.

The lowest water levels in Calcasieu and Cameron Parishes in wells screened in the “200-foot,” “500-foot,” and “700-foot” sands were approximately 50, 80, and 70 feet (ft) below the National Geodetic Vertical Datum of 1929 (NGVD 29), respectively, and were located specifically in the southern Lake Charles metropolitan area, to the west of Prien Lake, and between the cities of Lake Charles and Sulphur, respectively. The highest water levels in Calcasieu and Cameron Parishes occurring in wells screened in the “200-foot,” “500-foot,” and “700-foot” sands were approximately 8 ft above NGVD 29, 2 ft below NGVD 29, and 14 ft below NGVD 29, respectively, and were all located in northwestern Calcasieu Parish.

The distribution of water levels in the “200-foot,” “500-foot,” and “700-foot” sands indicates a primary flow direction towards pumping centers overlying the water-level lows. Between 1995 and 2011–12, maximum water-level increases were approximately 7 ft in the “200-foot” sand, approximately 31 ft in the “500-foot” sand, and approximately 19 ft in the “700-foot” sand. Water-level increases are consistent with a reduction in total withdrawals from these aquifers of about 25 million gallons per day from about 109 million gallons per day in 1995 to about 85 million gallons per day in 2012. Groundwater withdrawals from the “500-foot” sand are the highest by volume and the most influential over water levels in the “200-foot” and “700-foot” sands.

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