STATE OF LOUISIANA

DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

PUBLIC WORKS AND WATER RESOURCES DIVISION

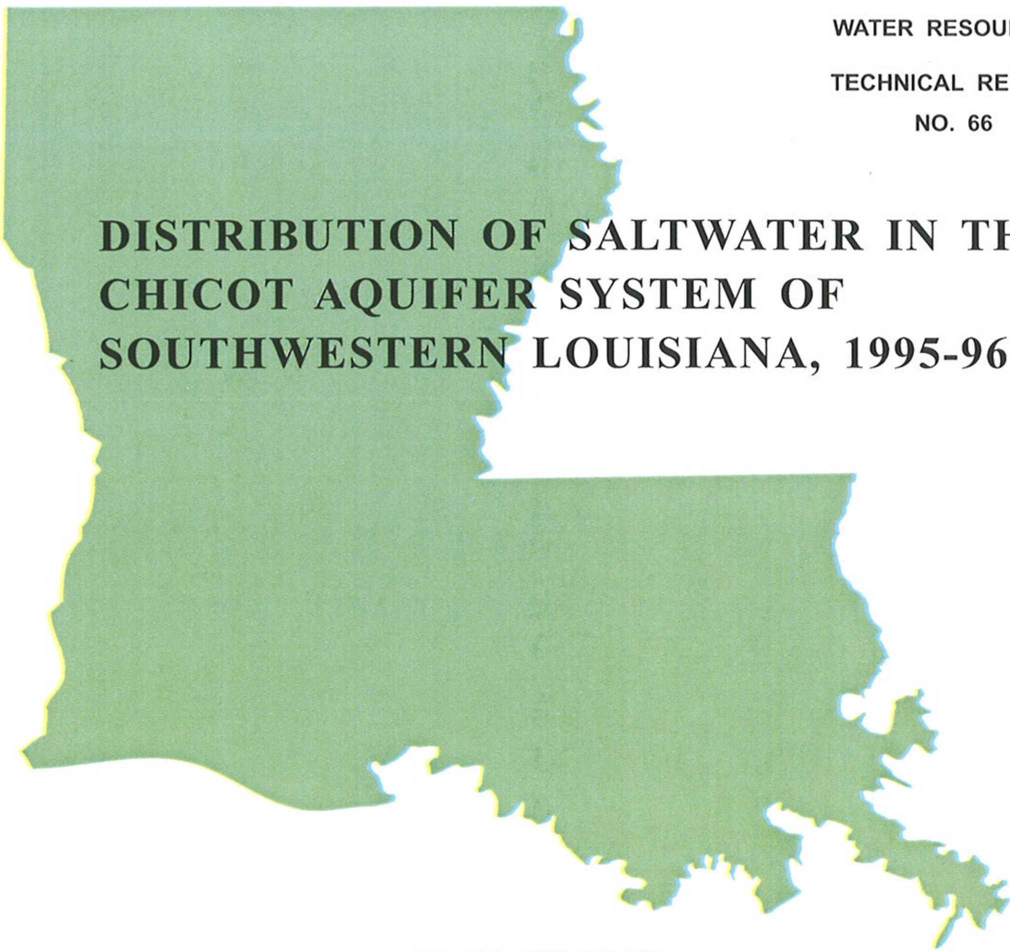
WATER RESOURCES SECTION

WATER RESOURCES

TECHNICAL REPORT

NO. 66

# DISTRIBUTION OF SALTWATER IN THE CHICOT AQUIFER SYSTEM OF SOUTHWESTERN LOUISIANA, 1995-96



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By

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## CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED WATER-QUALITY UNITS

| Multiply | By | To obtain |
|---|---|---|
| foot (ft) | 0.3048 | meter |
| foot per foot (ft/ft) | 0.3048 | meter per meter |
| foot per day (ft/d) | 0.3048 | meter per day |
| foot per year (ft/yr) | 0.3048 | meter per year |
| foot per mile (ft/mi) | 0.1894 | meter per kilometer |
| mile (mi) | 1.609 | kilometer |
| acre | 4,047 | square meter |
| square mile ($mi^2$) | 2.590 | square kilometer |
| million gallons per day (Mgal/d) | 3,785 | cubic meter per day |

**Temperature** in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) as follows: °F = 1.8(°C +32).

**Sea level:** In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929--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.

**Abbreviated water-quality units:**

milligrams per liter (mg/L)

milligrams per liter per year [(mg/L)/yr]

# DISTRIBUTION OF SALTWATER IN THE CHICOT AQUIFER SYSTEM OF SOUTHWESTERN LOUISIANA, 1995-96

*By* John K. Lovelace

## ABSTRACT

The Chicot aquifer system is the principal source of fresh ground-water supplies in southwestern Louisiana. The Chicot aquifer system is vulnerable to saltwater encroachment from the Atchafalaya River area, coastal areas near the Gulf of Mexico, and from underlying aquifers. In southwestern Louisiana, the Chicot aquifer system includes many sands, referred to as the shallow, massive, upper, lower, "200-foot," "500-foot," and "700-foot" sands. In 1995, approximately 550 Mgal/d (million gallons per day) were withdrawn from the Chicot aquifer system in southwestern Louisiana. More than one-half of the withdrawals were for rice irrigation. Heavy pumping from the Chicot aquifer system during the past several decades has substantially altered flow patterns from pre-development conditions, increasing the potential for saltwater encroachment. Water from all areas of the aquifer system now flows toward rice-growing areas in Acadia, Evangeline, and Jefferson Davis Parishes and towards the Lake Charles industrial district in Calcasieu Parish. Saltwater is present in the upper, lower, shallow, "500-foot," and "700-foot" sands.

Saltwater is present in the upper and "200-foot" sands in five areas which roughly encompass about 4,000 $mi^2$ (square miles). Chloride concentrations in water from wells in the Atchafalaya River area, Vermilion Parish area, and Cameron Parish area do not indicate that substantial movement of the freshwater-saltwater interface is occurring. Decreasing chloride concentrations at several wells screened in the upper sand may be due to increased recharge of freshwater into upper sands of the aquifer from the Atchafalaya River area or other surface sources. Saltwater also is present in areas near Iowa, Louisiana, and along the lower Vermilion River area near Abbeville, Louisiana.

Saltwater is present in the "500-foot" sand near the Calcasieu-Cameron Parish border between altitudes of about 500 and 600 feet below sea level and may be moving slowly northward in response to pumping in Calcasieu Parish. Chloride concentrations in water from wells along the interface have increased at rates less than or equal to 3 (mg/L)/yr (milligrams per liter per year), indicating that saltwater encroachment may be occurring at an extremely low rate near the Calcasieu-Cameron Parish border.

The central, northern, and southern chloride bodies have been defined in the "500-foot" sand in the Lake Charles industrial district. Intense pumping from the "500-foot" sand has lowered water levels and formed a deep cone of depression centered beneath the industrial district. Chloride concentrations in samples from wells located within the central chloride body of the Lake Charles industrial district have remained relatively stable since the mid-1970's. Chloride concentrations in water from most wells completed in or near the northern chloride body have not changed substantially since the early 1980's. Increasing chloride concentrations in water from wells screened in the southern chloride body, indicate that additional upconing of saltwater from the "700-foot" sand to the "500-foot" sand is probably occurring as a result of the lowered heads in the cone of depression. Chloride concentrations greater than 100 mg/L (milligrams per liter) also occur in the "500-foot" sand at public-supply wells in eastern and southern Lake Charles.

Saltwater is present in the lower and "700-foot" sands in the southern two-thirds of Calcasieu Parish. In general, chloride concentrations in samples from pumped wells or wells located near wells pumping from the "700-foot" sand have slightly increased. However, chloride concentrations in samples from well Cu-767, which is not pumped, have increased at an average rate of about 16 (mg/L)/yr since 1962. Well Cu-767 is located about 1.5 miles south of public-supply well Cu-661, which has experienced increases in chloride concentrations at an average rate of about 4 (mg/L)/yr. Chloride concentrations in samples from wells located away from pumping generally showed either no trends or slight decreases. Chloride concentrations in samples from well Cu-972, located near the leading edge of the freshwater-saltwater interface in the northeastern corner of Calcasieu Parish, decreased from 260 mg/L in 1979 to 120 mg/L in 1995. This may be an indication that freshwater is being drawn from the north in some areas within the cone of depression, causing the freshwater-saltwater interface to recede southward.

## INTRODUCTION

The Chicot aquifer system underlies an area of about 9,000 $mi^2$ in southwestern Louisiana (fig. 1) and is the principal source of fresh ground-water supplies in the region. In southwestern Louisiana, the Chicot aquifer system includes many sands, referred to as the Chicot aquifer, shallow sand unit; Chicot aquifer, undifferentiated; Chicot aquifer, upper sand unit; Chicot aquifer, lower sand unit; "200-foot" sand of Lake Charles area; "500-foot" sand of Lake Charles area; and "700 foot" sand of Lake Charles area. For the purposes of this report, these sands will hereinafter be referred to as the shallow, massive, upper, lower, "200-foot," "500-foot," and "700-foot" sands.

In 1995, approximately 550 Mgal/d of water were withdrawn from the Chicot aquifer system in southwestern Louisiana (Lovelace and Johnson, 1996, p. 90). More than one-half of the withdrawals were for rice irrigation. Dense surficial clays confine the upper sands of the Chicot aquifer system, making the region ideal for rice farming. In 1995, about 420,000 acres of rice were grown in southwestern Louisiana (Louisiana Cooperative Extension Service, 1996), primarily in a region roughly bounded by the southern extent of the recharge area of the Chicot aquifer system, the eastern and southern extents of freshwater in the Chicot aquifer system, and section line A-A′ shown on figure 1. Withdrawals for rice irrigation, which began around the turn of the century (Harris, 1904), have lowered water levels in the aquifer, creating an elongated cone of depression in the potentiometric surface that extends over much of the region (Harder and others, 1967, p. 16-17, pl. 4). In addition, water withdrawals for industrial uses have created a deep cone of depression in the potentiometric surface of the Chicot aquifer system in the Lake Charles area (Nyman and others, 1990, p. 14).

In 1995, water withdrawal rates from the individual aquifers were as follows: massive sand, 220 Mgal/d; shallow sand, 1.9 Mgal/d; upper sand, 210 Mgal/d; lower sand, 15 Mgal/d; "200-foot" sand, 9.2 Mgal/d; "500-foot" sand, 90 Mgal/d; "700-foot" sand, 10 Mgal/d. Water withdrawal rates from the Chicot aquifer system for various categories of use were as follows: public supply, 79 Mgal/d; industry, 84 Mgal/d; power generation, 9.1 Mgal/d; rural domestic, 12 Mgal/d; livestock, 1.0 Mgal/d; rice irrigation, 310 Mgal/d; general irrigation, 0.41 Mgal/d; and aquaculture, 2.6 Mgal/d (Lovelace and Johnson, 1996). These data were derived from a complete inventory of ground-water withdrawals from the Chicot aquifer system in southwestern Louisiana; the inventory was conducted in 1995 by the U.S. Geological Survey (USGS), in cooperation with the Louisiana Department of Transportation and Development (DOTD). Water withdrawal rates from the Chicot aquifer system from 1946-95 are shown in figure 2.

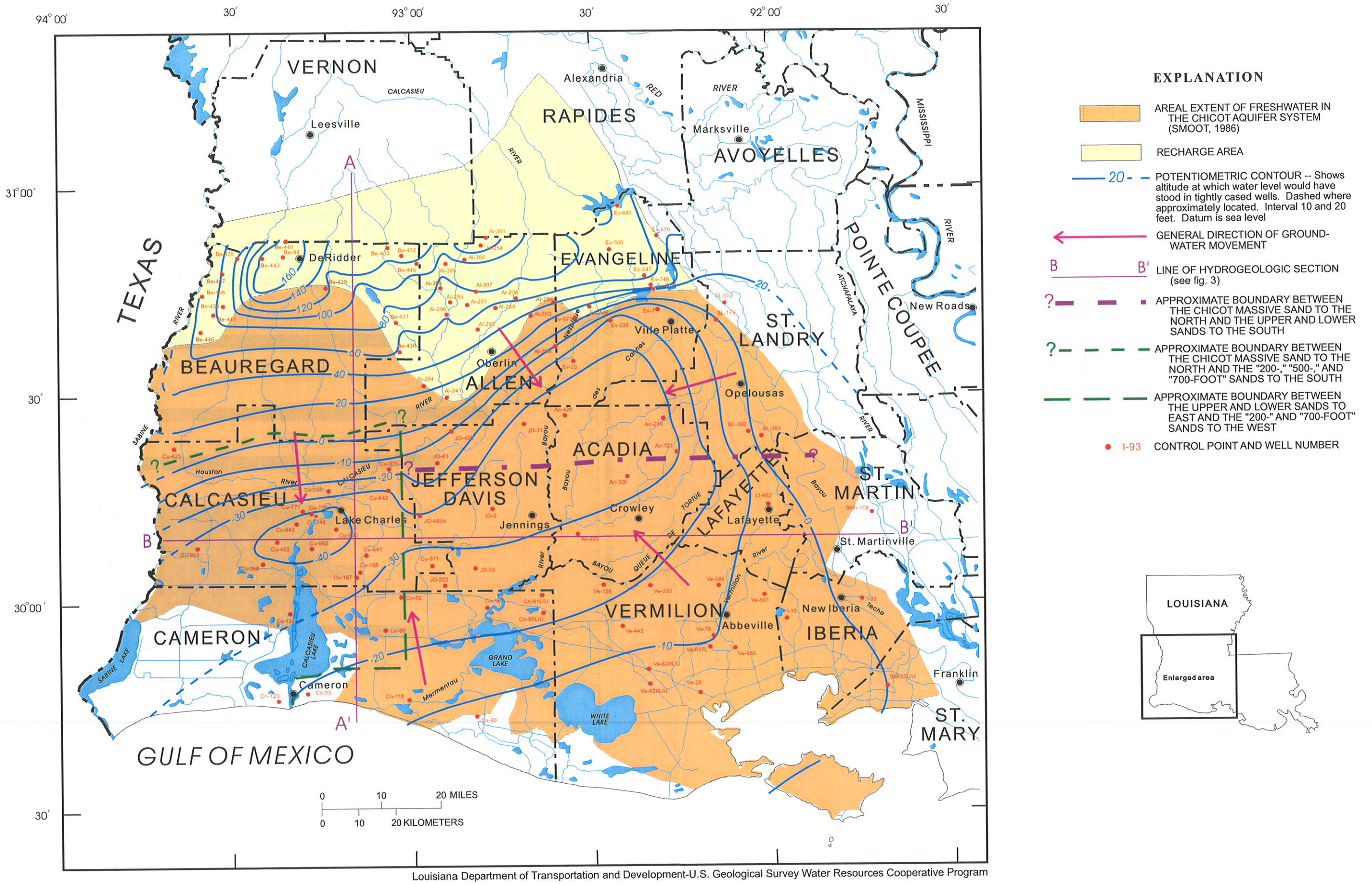



Figure 1. Location of study area and potentiometric surface of the massive, upper, and “200-foot” sands of the Chicot aquifer system in southwestern Louisiana, spring 1991 (Modified from Walters, 1996, sheet 1).

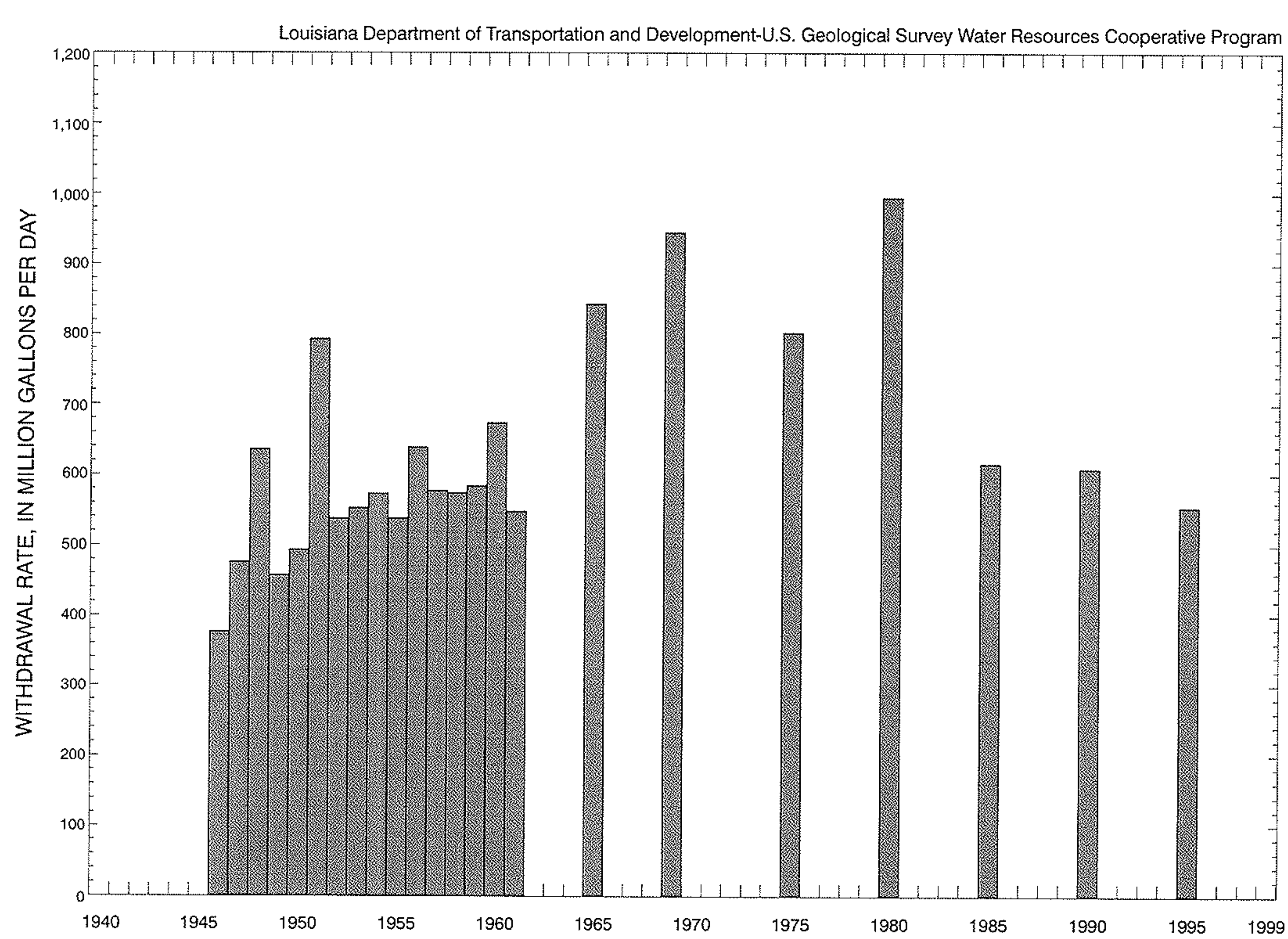



Figure 2. Ground-water withdrawal rates from the Chicot aquifer system in southwestern Louisiana, 1946-95 (modified from Nyman and others, 1990; Lovelace, 1991; Lovelace and Johnson, 1996).

## Background

Declining water levels and saltwater encroachment in the Chicot aquifer system of southwestern Louisiana have been concerns of water managers in the region since the 1930's. The Chicot aquifer system underlies all or part of Acadia, Allen, Beauregard, Calcasieu, Cameron, Evangeline, Iberia, Jefferson Davis, Lafayette, St. Landry, St. Martin, St. Mary, and Vermilion Parishes in southwestern Louisiana (fig. 1). The Chicot aquifer system is vulnerable to saltwater encroachment from the Atchafalaya River area, coastal areas near the Gulf of Mexico, and from underlying aquifers. Heavy pumping from the Chicot aquifer system during the past several decades has substantially altered flow patterns from pre-development conditions, increasing the potential for saltwater encroachment.

Since 1963, DOTD and USGS have maintained a cooperative agreement to monitor movement of saltwater in the Chicot aquifer system in southwestern Louisiana. Water samples have been collected semi-annually from wells in key areas of the aquifer system and analyzed for chloride concentration. Extensive sampling of additional wells to delineate saltwater movement also has been conducted periodically. In 1995, the USGS, in cooperation with DOTD, began a 2-year study to define current (1995-96) distribution of saltwater in the Chicot aquifer system of southwestern Louisiana. Because saltwater encroachment has occurred to some extent in many developed coastal areas of the United States, results of this study also may help improve understanding of conditions in similar coastal settings.

## Purpose and Scope

This report describes the current (1995-96) distribution of saltwater in the Chicot aquifer system, which includes many sands referred to as the shallow, massive, upper, lower, "200-foot," "500-foot," and "700-foot" sands in southwestern Louisiana. The report focuses on areas of the Chicot aquifer system that have experienced, or are at risk from, saltwater encroachment. The primary aquifers discussed are the upper and "200-foot" sands, shallow sand, "500-foot" sand, and "700-foot" sand.

Maps are presented that show the potentiomentric surface for the upper, "200-foot", and "massive sands during spring 1991, the "500-foot" sand during spring 1991, and the "700-foot" sand during fall 1995. Graphs of water-level data also are presented.

The report describes movement of the leading edge of saltwater and changes in chloride concentrations above and below the base of freshwater. Maps are presented that show the current (1995-96) distribution of saltwater in the "upper and 200-foot" sands, the shallow sand, the "500-foot" sand, and the "700-foot" sand. The maps are modified from Nyman (1984) based on chloride-concentration data from 181 wells, primarily collected during 1995-96. Wells were selected for sampling based on their depth and proximity to the freshwater-saltwater interface described by Nyman (1984). Water-level, specific conductance, and chloride data for wells sampled are presented in the appendix. Variations in density caused by the presence of saltwater in wells in some areas were not great enough to require adjustment of water levels to freshwater equivalents. Data for additional wells that are not shown on figures or mentioned in the text of this report, are included in the appendix for the purpose of completeness. Graphs of chloride-concentration data also are presented.

## Previous Investigations

Since the early 1900's, many studies have focused on the occurrence of ground water, declining water levels, and saltwater encroachment in the Chicot aquifer system of southwestern Louisiana. Harris (1904) presented information about the underground waters of southwestern Louisiana and included a section on their use for water supplies and rice irrigation. In 1944, Stanley and Maher reported on declining water levels in Acadia and Jefferson Davis Parishes due to pumpage for rice irrigation. The report also presents three cross-sections through southwestern Louisiana, which show the depth of the freshwater-saltwater interface in the Chicot aquifer system. Jones (1950a) discussed water quality and the occurrence of saltwater in the Chicot aquifer system and presented a map showing the depth of occurrence of fresh ground water throughout southwestern Louisiana. Jones (1950b) reported on ground-water conditions in the Lake Charles area, noting the rapid growth and increasing use of ground water in the Lake Charles industrial district and the increasing chloride concentrations in water from some wells completed in the "700-foot" sand. Jones and others (1954) presented the first comprehensive report on the geology and ground-water resources of southwestern Louisiana; the authors presented maps of the Chicot aquifer system and the base of freshwater and discussed the presence of saltwater and possibilities of saltwater encroachment in basal sands and coastal areas of the Chicot aquifer system. Saltwater encroachment in the lower Vermilion River area also is discussed. Harder (1960a) presented a detailed report on the geology and ground-water resources of Calcasieu Parish, including a discussion of the occurrence and mobility of saltwater in the "200-," "500-," and "700-foot" sands.

Reports summarizing ground-water conditions in southwestern Louisiana were published regularly from 1948 to 1971. These reports document long-term water level declines in the upper sand and the "500-foot" and "700-foot" sands with hydrographs and potentiometric-surface maps. Most of the reports include an additional discussion of related topics concerning the Chicot aquifer system. For example, Meyer (1953) discussed saltwater encroachment in the lower Vermilion River area. The occurrence of saltwater in the "700-foot" sand and the subsequent abandonment of a well are mentioned in Fader (1954). Fader (1957) updated the base-of-freshwater map of Jones and others (1954) and suggested five possible reasons for the presence of saltwater in the Chicot aquifer system: (1) incomplete flushing of the aquifer by freshwater as the coastline moved southward, (2) lateral movement through formations, (3) downward seepage from surface sources, (4) vertical movement through underlying or overlying materials, and (5) upward movement along faults or around salt domes. Harder (1960b) mentioned the abandonment of several wells in the "700-foot" sand located in the Lake Charles industrial district due to the occurrence of brackish water at a nearby well. Whitman and Kilburn (1963) discussed the occurrence and inland movement of saltwater in coastal areas of the upper sand due to intense ground-water pumpage. Hodges and others (1963) discussed the occurrence of brackish water and methane in the "700-foot" sand at the Lockport oil field in the Lake Charles industrial district. Harder and others (1967) presented maps of freshwater-saltwater interfaces in the upper sand, the "500-foot" sand, and the "700-foot" sand and discussed the rates of encroachment.

Zack (1971) summarized the results of 10 years of monitoring chloride concentrations in water from 30 wells of a network established to monitor saltwater intrusion in the Chicot aquifer system. Nyman (1984) summarized chloride and specific-conductance data collected by the USGS from wells in the Chicot aquifer system since 1937, focusing on data from the network monitoring chloride concentrations. Nyman (1984) also used electric and drillers' log data to create detailed hydrogeologic maps showing thicknesses of intervals with freshwater and locations of saltwater in the Chicot aquifer system. In another study, Nyman and others (1990) presented the results of a digital ground-water flow model, which indicated that the largest component of recharge to the Chicot aquifer system during 1981 conditions was vertical leakage. Potentiomentric-surface maps of water levels in the Chicot aquifer system for 1984 and 1991 conditions also have been published (Fendick and Nyman, 1987; Walters, 1996).


### Acknowledgments

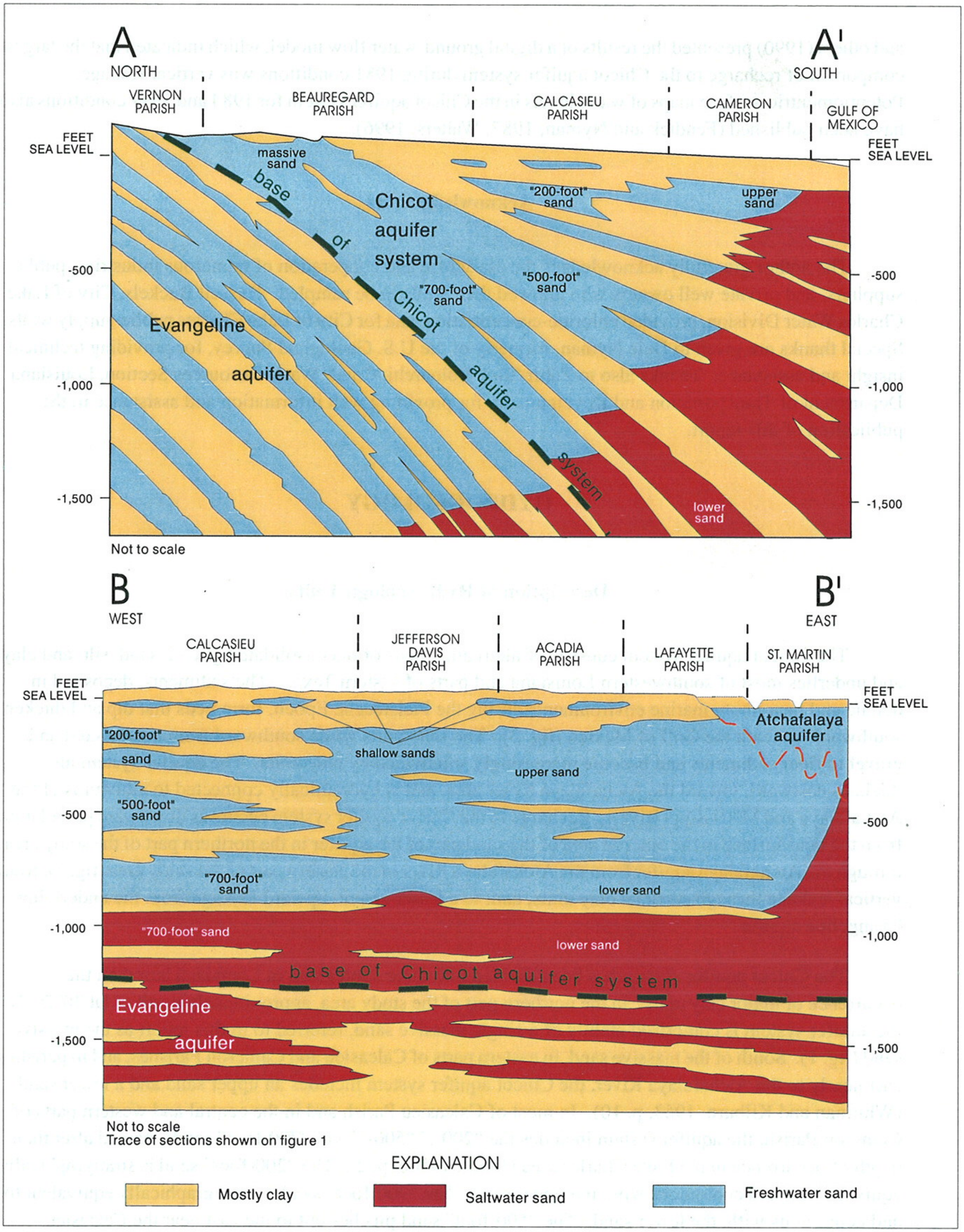
The author gratefully acknowledges the assistance and cooperation of numerous industries, public suppliers, and private well owners who allowed their wells to be sampled. Russell Buckels, City of Lake Charles Water Division, provided chloride-concentration data for City of Lake Charles public-supply wells. Special thanks are given to Dale Nyman, formerly of the U.S. Geological Survey, for providing technical insight and assistance. Thanks also to Zahir "Bo" Bolourchi, Chief, Water Resources Section, Louisiana Department of Transportation and Development, for providing well information and assistance in the publication of this report.


## HYDROGEOLOGY

### Description of Hydrogeologic Units

The Chicot aquifer system consists of alternating beds of unconsolidated gravel, sand, silt, and clay and underlies most of southwestern Louisiana and parts of eastern Texas. The sediments, deposited in deltaic and near-shore marine environments during the Pleistocene Epoch, form beds that dip and thicken southward, beneath the Gulf of Mexico (fig. 3). The sand units grade southward from coarse sand and gravel to finer sediments and become increasingly subdivided by clay units. The aquifer system also thickens eastward, toward the Atchafalaya River area, and is hydraulically connected to alluviums of the Atchafalaya and Mississippi Rivers. Recharge to the Chicot aquifer system occurs as downward percolation from the land surface in the outcrop area of the sand part of the aquifer in the northern part of the study area, through the Atchafalaya aquifer from the Atchafalaya River in the eastern part of the study area (fig. 1), from vertical leakage through surficial clay units, and, to a lesser extent, upward leakage from the underlying Evangeline aquifer.

The Chicot aquifer system has been divided into three subregions in Louisiana based on the occurrence of major clay units. In the northern part of the study area, approximately north of lat 30°20′N., the aquifer system is comprised mainly of a single massive sand, referred to in this report as the massive sand (fig. 1). South of the massive sand, in eastern parts of Calcasieu and Cameron Parishes, and in parishes east nearly to the Atchafalaya River, the Chicot aquifer system includes an upper sand and a lower sand (Whitman and Kilburn, 1963, p. 10). In most of Calcasieu Parish and in the central and western parts of Cameron Parish, the aquifer system includes the "200-," "500-," and "700-foot" sands, named after their depth of occurrence in the Lake Charles area (Jones, 1950b, p. 2). The "200-foot" sand is stratigraphically equivalent to, and continuous with, the upper sand. The "700-foot" sand is stratigraphically equivalent to, and continuous with, the lower sand. The "500-foot" sand pinches out to the east near the Calcasieu-Jefferson Davis Parish border.




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

Figure 3. Idealized hydrogeologic sections through southwestern Louisiana (modified from Nyman, 1984).

In addition, several relatively thin sands, generally less than 20 ft in thickness, that occur locally within a surficial confining unit are collectively termed the shallow sand. However, the shallow sand ranges in thickness from 100 to 250 ft (Harder and others, 1967, p. 35) throughout much of the lower Vermilion River area near Abbeville, La., and was formerly known as the Abbeville unit in this area (Harder and others, 1967, p. 35). The upper sand and the shallow sand generally are separated by a thin clay layer in this area. A partial hydrogeologic column for southwestern Louisiana is shown in figure 4.

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

| System | Series | Aquifer system | Aquifer | |
|---|---|---|---|---|
| | | | Lake Charles area | Rice growing area |
| Quaternary | Pleistocene | Chicot aquifer system | Shallow sand | Shallow sand |
| | | | "200-foot" sand | Upper sand |
| | | | "500-foot" sand "700-foot" sand | Lower sand |
| Tertiary | Pliocene ? Miocene | Evangeline aquifer | | |

Figure 4. Partial hydrogeologic column of an aquifer system and aquifers in southwestern Louisiana (modified from Lovelace and Lovelace, 1995, p. 10).

At the top of the Chicot aquifer system is a thick layer of clay that is a surficial confining unit and is areally extensive throughout most of southwestern Louisiana. Rice cultivation during the past 100 years has caused salts and fine clays to leach downward forming a low-permeability horizon in the surficial clay, called the "hard pan" by local farmers (D.J. Nyman, formerly of the U.S. Geological Survey, written commun., 1997). The surficial confining unit generally averages about 100 ft in thickness throughout most of the study area, but is more than 500 ft thick in parts of Calcasieu and Cameron Parishes (Jones and others, 1954, pl. 4). Surficial clays in southern Louisiana were once thought an impermeable barrier to downward movement of water from the surface (Stanley and Maher, 1944, p. 13; Meyer, 1953, p. 2). However, faulting and fracturing associated with salt domes and secondary porosity created by subaerial weathering after deposition have resulted in vertical hydraulic conductivities of the clays that may be several orders of magnitude higher than those measured from core samples in a laboratory (Hanor, 1993).

## Water Levels and Movement

Prior to development, recharge entered the Chicot aquifer system in the northern part of the study area and moved down-dip to discharge in the Atchafalaya, Sabine, and lower Vermilion River area (fig. 1) and in the coastal marshes (Nyman and others, 1990, p. 11-12). Springs and flowing wells completed in the Chicot aquifer system were common in parts of Calcasieu Parish and coastal areas from Cameron Parish to St. Mary Parish (Harris, 1904, p. 28).

By 1946, large withdrawals for rice farming and, in the Lake Charles area, for manufacturing purposes during World War II, had substantially altered the pattern of flow in the Chicot aquifer system (Jones and others, 1954). Water from all areas of the aquifer then flowed towards rice-growing areas in Acadia, Evangeline, and Jefferson Davis Parishes and towards the Lake Charles industrial district in Calcasieu Parish. This pattern of flow has continued to the present (1995-96); water levels in the upper and "200-foot" sands are lower than 30 ft below sea level in much of Calcasieu, Jefferson Davis, and Acadia Parishes (fig. 1) (Fendick and Nyman, 1987; Walters, 1996). A computer simulation of flow in the Chicot aquifer system indicated that, under 1981 conditions, the largest component of recharge to the aquifer was from vertical leakage, primarily from the overlying water table, throughout southwestern Louisiana (Nyman and others, 1990, p. 33). More than 90 percent of this water entering the aquifer system was discharged as pumpage (Nyman and others, 1990, p. 33).

The completion of the Sabine River Diversion Canal in 1982, and the subsequent decreased use of ground water by industries in the Lake Charles industrial district (just west of Lake Charles), caused water levels in the "500-foot" sand, the most intensely pumped of the three sands underlying that area, to rise from a low of more than 150 ft below sea level to about 100 ft below sea level in the deepest part of the cone of depression beneath the industrial district. Water levels in wells in the "200-foot" sand and "700-foot" sand also rose in the industrial district by as much as 20 ft and 30 ft, respectively.

During spring 1991, water levels in the "500-foot" sand ranged from less than 30 ft below sea level to more than 90 ft below sea level in Calcasieu Parish (fig. 5). The cone of depression, centered beneath the Lake Charles industrial district, is the result of intense local pumping. The general lateral movement of water in the "500-foot" sand in all areas of Calcasieu Parish is toward the Lake Charles industrial district.

Water levels in the lower and "700-foot" sands ranged from less than 20 ft below sea level to more than 80 ft below sea level in Calcasieu Parish during fall 1995 (fig. 6). A cone of depression, centered beneath the Lake Charles industrial district, is primarily the result of pumping from the "500-foot" sand. The "500-foot" sand and the "700-foot" sand are hydraulically connected in numerous areas throughout the parish where the confining unit between the two sands is thin or missing. Upward leakage of water from the "700-foot" sand to the "500-foot" sand has resulted in much lower water levels in the "700-foot" sand than could be attributed to pumping from the "700-foot" sand.

Prior to large-scale pumping from the upper sand for irrigation, the shallow sand supplied base flow to the Vermilion River along its lower reaches near Abbeville. However, pumping from the upper sand has lowered water levels in the shallow sand, which is now recharged by water from the Vermilion River in this area (Nyman, 1984, p. 21).

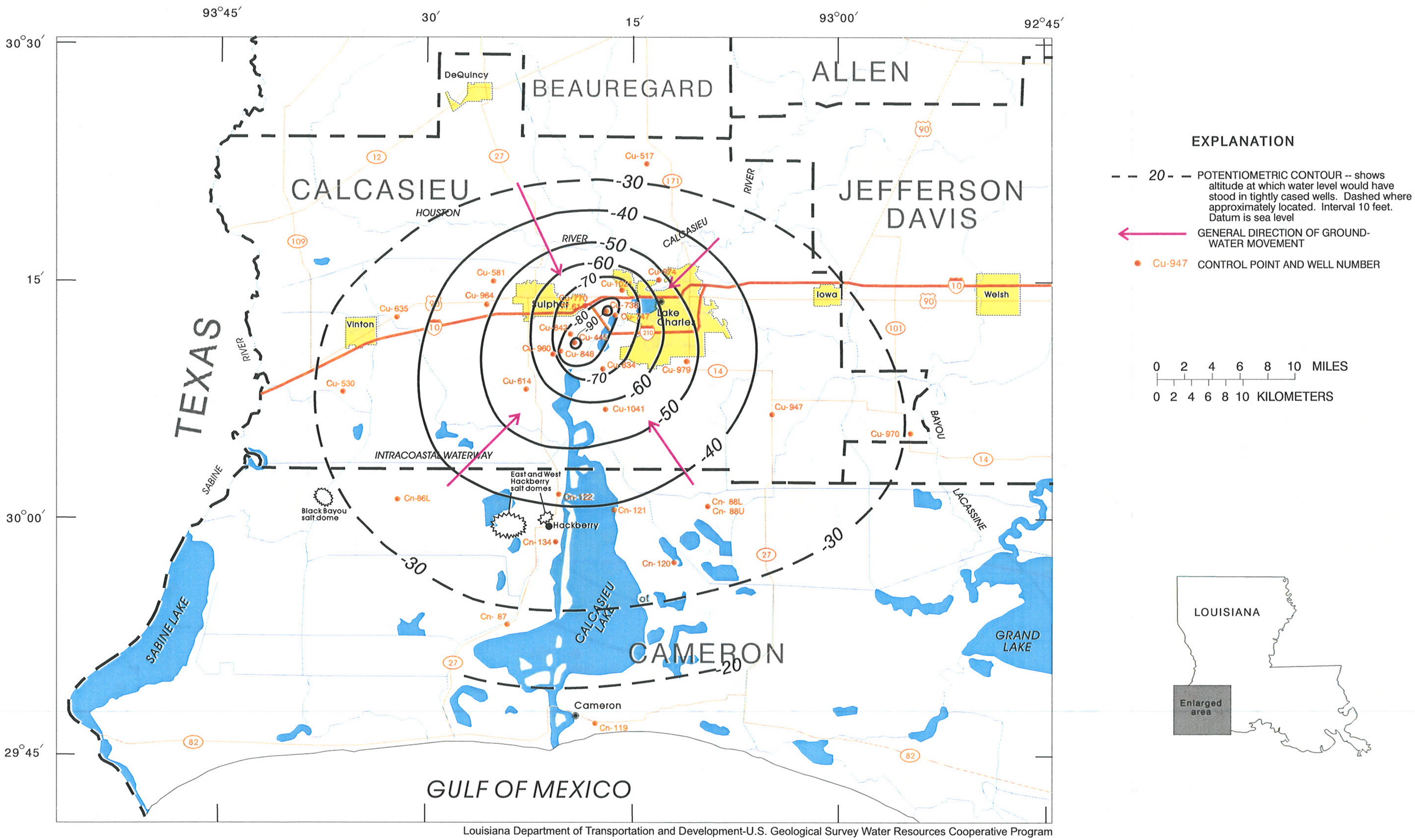



Figure 5. Potentiometric surface of the "500-foot" sand in part of southwestern Louisiana, spring 1991 (modified from Walters, 1996, sheet 1).

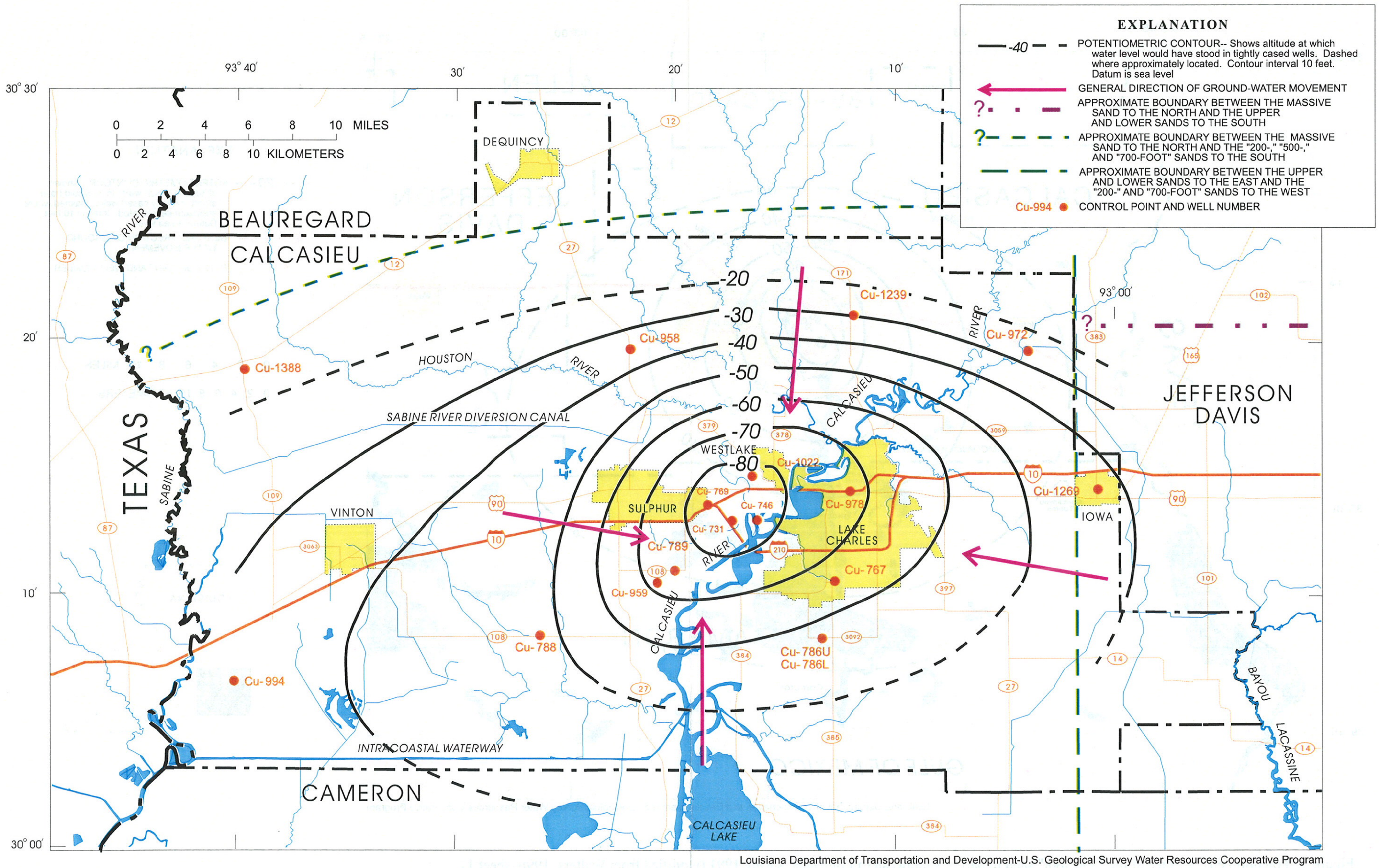



Figure 6. Potentiometric surface of the lower and "700-foot" sands in the Calcasieu Parish area, southwestern Louisiana, fall 1995.

## DISTRIBUTION OF SALTWATER IN THE CHICOT AQUIFER SYSTEM

The occurrence of saltwater in the Chicot aquifer system primarily has been attributed to incomplete flushing by freshwater as the coastline moved southward and encroachment (lateral movement inland from coastal areas and upward movement from underlying aquifers). For this report, saltwater is defined as water containing greater than 250 mg/L of chloride[1]. Chloride concentrations in water from the Chicot aquifer system generally range from 20 to 75 mg/L (background concentrations) (Tomaszewski, 1992, pl. 2). Water with higher chloride concentrations (greater than 75 mg/L) occurs in the Chicot aquifer system in small areas not associated with saltwater encroachment, such as in very shallow sands and locally near salt domes.

Because highly saline water is denser than freshwater, two distinct layers may be formed because of the density difference, and the contact between a freshwater body and a saltwater body within an aquifer may form a mixing zone or interface. In Louisiana's coastal areas, the freshwater-saltwater interface typically resembles a low-angle wedge. The leading edge of the saltwater wedge, known as the "toe," lies at the base of each sand and generally extends many miles inland from the main body of saltwater (Nyman, 1984, p. 10). For the purpose of this report, a chloride body is an area within an aquifer in which the water has a substantially higher chloride concentration than is typically found in the aquifer.

Hydrogeologic factors and the effects of pumping on hydraulic and salinity gradients determine the rate and direction of saltwater encroachment in the Chicot aquifer system. Properties of the individual sands, such as permeability and porosity, affect the rate of flow through the aquifer. Hydrogeologic factors, such as the configuration of the base of the aquifer and faulting, can affect the direction and rate of movement of saltwater.

Lateral flow velocities, which indicate the potential lateral rate of saltwater movement through the Chicot aquifer system, were estimated using potentiometric-surface maps for 1991 and 1995. Water levels in the Chicot aquifer system have not changed substantially since 1991. The rate of ground-water flow, and therefore, the potential rate of saltwater movement, were estimated based on hydraulic properties of the aquifer, hydraulic gradient, and the following application of Darcy's law:

$$V = \frac{KI}{\Theta}, \qquad \text{(Eq. 1)}$$

where

V is ground-water velocity, in foot per day;
K is aquifer hydraulic conductivity, in foot per day;
I is hydraulic gradient, in foot per foot; and
$\Theta$ is aquifer porosity, dimensionless.

Use of Darcy's Law for this estimate assumes no dispersion or density effects.

[1]Concentrations of chloride greater than 250 mg/L exceed the secondary maximum contaminant level (SMCL) for drinking water (U.S. Environmental Protection Agency, 1977, 1992). SMCL's are established for contaminants that can adversely affect the aesthetic quality of drinking water. At high concentrations or values, health implications as well as aesthetic degradation may also exist. SMCL's are not federally enforceable, but are intended as guidelines for the states.

## Upper and "200-Foot" Sands

Saltwater is present in the upper and "200-foot" sands in five areas which roughly encompass about 4,000 $mi^2$ (fig. 7). The Atchafalaya River area, Vermilion Parish area, and Cameron Parish area are broad, adjacent areas where saltwater is present. Saltwater potentially could move northward from coastal areas and westward from the Atchafalaya River area towards areas of heavy pumping in Acadia, Jefferson Davis, and Calcasieu Parishes. Saltwater has been documented in areas near Iowa, La., and along the lower Vermilion River area near Abbeville. The location of the freshwater-saltwater interface in the upper sand has not changed substantially since the interface was defined by Nyman (1984).

Water in the "200-foot" sand in western Cameron Parish is generally salty in all but the northernmost parts of the parish (Nyman, 1989, pl. 9). Most of northwestern Cameron Parish and southwestern Calcasieu Parish is relatively undeveloped and, because the "200-foot" sand is thin and subdivided by layers of clay (Harder, 1960a, p. 27-28), few wells are completed in the sand. There has been no indication of saltwater movement in the "200-foot" sand in this region.

### Atchafalaya River Area

A tongue of saltwater extends northward from the Gulf of Mexico beneath the Atchafalaya River area in western Iberville and eastern Iberia, St. Martin, and St. Mary Parishes; no major aquifers contain freshwater in this area (fig. 7) (Smoot, 1986). A freshwater-saltwater interface in the upper sand extends westward from the tongue, at altitudes between about 200 and 400 ft below sea level, into central Iberia and St. Martin Parishes and across St. Mary Parish (Nyman, 1984). The base of the upper sand dips southward from an altitude of about 300 ft below sea level in northern St. Martin Parish to an altitude of about 800 ft below sea level near Franklin, La., in St. Mary Parish (Harder and others, 1967, pl. 3; Nyman, 1989, pl. 9).

Intense pumping from the upper sand, primarily for rice irrigation in parishes west of St. Martin Parish, has resulted in a hydraulic gradient for potential westward movement of the saltwater interface (fig. 1). The hydraulic gradient in the Atchafalaya River area ranges from about 1.0 ft/mi in northern St. Martin Parish to about 0.3 ft/mi in southern Iberia Parish. Assuming an average lateral hydraulic conductivity of 200 ft/d (Harder and others, 1967, p. 7) and an average porosity of 0.25, the average lateral velocity of ground-water flow along the interface ranges from 55 ft/yr (0.15 ft/d) in northern St. Martin Parish to 18 ft/yr (0.05 ft/d) in southern Iberia Parish.

Chloride concentrations in water from area wells, however, do not indicate that substantial movement of the freshwater-saltwater interface is occurring. Three wells, SMn-109, I-93, and SM-57U, were constructed in the mid-1960's to monitor potential westward movement of saltwater. Water levels at these wells indicate no definitive long-term trends, indicating that hydraulic gradients and the potential rate of saltwater movement have not changed substantially since the wells were constructed (fig. 8).

Chloride concentrations in water from well SMn-109 have risen at a rate of about 1 [(mg/L)/yr] since the mid-1960's (fig. 8). Well SMn-109 is used to monitor salinity changes above the freshwater-saltwater interface in central St. Martin Parish and locally near the Section 28 salt dome. The Section 28 salt dome is located beneath the closed -400-ft contour immediately west of well SMn-109 (fig. 7). The Section 28 salt dome contains salt to an altitude of 1,178 ft below sea level (Beckman and Williamson, 1990) and the mound in the freshwater-saltwater interface, indicated by the -400-ft contour, may be the result of upward

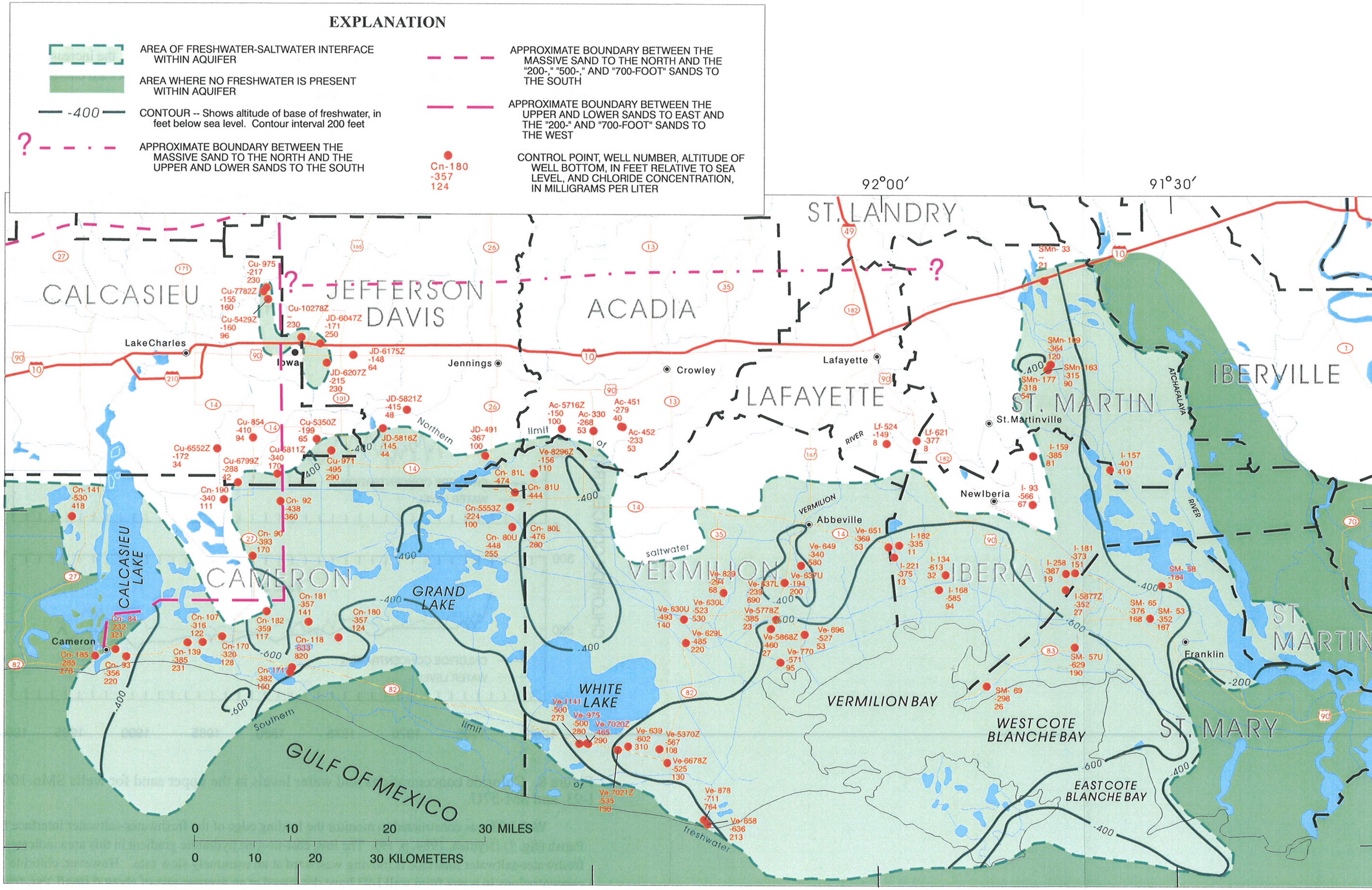



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Figure 7. Distribution of chloride in the upper and "200-foot" sands in southwestern Louisiana, 1995-96 (modified from Nyman, 1984, pl. 2).

movement of saltwater from the salt dome. Because of the location of the well, the increasing chloride concentration could be the result of westward movement of the interface or eastward encroachment of the saltwater associated with the Section 28 salt dome.

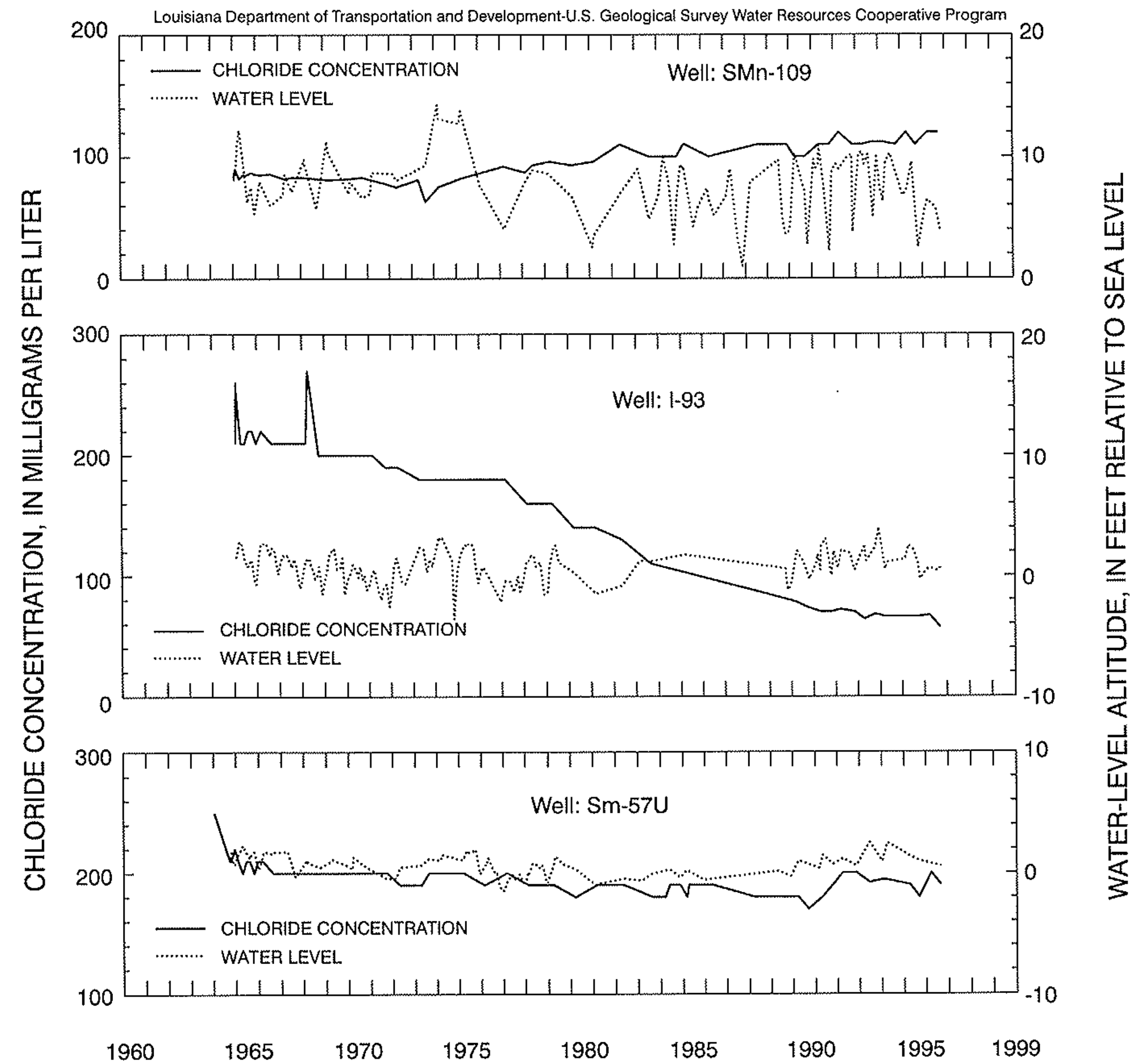


Figure 8. Chloride concentrations and water levels in the upper sand for wells SMn-109, I-93, and SM-57U.

Well I-93 was constructed to monitor the leading edge of the freshwater-saltwater interface in Iberia Parish (fig. 7) (Nyman, 1984, p. 19). The low, east-to-west hydraulic gradient in this area indicates that the freshwater-saltwater interface is moving westward at an extremely slow rate. However, chloride concentrations in water from well I-93 have decreased at an average rate of about 6 (mg/L)/yr, from about 220 mg/L in the mid-1960's to about 70 mg/L in the 1990's (fig. 8). Zack (1971) theorized that decreasing chloride concentrations in wells located in Iberia, St. Martin, and St. Mary Parishes could be due to recharge into the upper sands of the aquifer by low-salinity water from alluvium in the Atchafalaya River area. In addition, well I-93 is very near, possibly directly above, the Iberia salt dome (not shown in fig. 7), which contains salt to an altitude of 1,075 ft below sea level (Beckman and Williamson, 1990). However, there is no evidence of increased chloride concentrations in the upper sand associated with the Iberia salt dome.

Chloride concentrations in water from well SM-57U are monitored to detect changes in salinity at the base of freshwater in western St. Mary Parish (fig. 7). The well is located near the eastern edge of a large body of freshwater in the upper sand which underlies Vermilion and West Cote Blanche Bays (fig. 7). Chloride concentrations in water from well SM-57U have remained relatively unchanged since the mid 1960's (fig. 8). This lack of change suggests no discernible movement of saltwater in the area, which is consistent with the very slow ground-water flow velocities that have been estimated.

### Vermilion Parish Area

The Vermilion Parish area includes Vermilion Parish, western Iberia Parish, and the southern tips of Acadia and Lafayette Parishes. The freshwater-saltwater interface in the upper sand in the Vermilion Parish area extends inland from the Gulf of Mexico at altitudes ranging from about 400 to 600 ft below sea level (fig. 7).

Intense pumping for rice irrigation in Acadia and Jefferson Davis Parishes could cause the freshwater-saltwater interface in the Vermilion Parish area to move northwestward (figs. 1 and 7). The hydraulic gradient in the Vermilion Parish area averages about 1 ft/mi towards the northwest. Assuming an average lateral hydraulic conductivity of 200 ft/d (Harder and others, 1967, p. 7) and an average porosity of 0.25, the average lateral velocity of ground-water flow along most of the interface in the Vermilion Parish area is about 55 ft/yr (0.15 ft/d).

Long-term records of chloride concentrations in water from wells located above and below the base of freshwater in the Vermilion Parish area show no indication that the position of the freshwater-saltwater interface in the Vermilion Parish area has changed substantially since the mid-1960's. However, few wells are located near the leading edge of the freshwater-saltwater interface and screened at an appropriate depth to determine if northward movement of the interface is occurring.

Well Ve-630L, located near the center of Vermilion Parish and screened below the base of freshwater, has shown long-term chloride-concentration increases of 6 (mg/L)/yr (figs. 7 and 9). However, chloride concentrations in water from well Ve-630U, screened only 30 ft above well Ve-630L and located at the same site, have not changed substantially since the well was constructed. Chloride concentrations in water from well Ve-639, located about 10 mi south of Ve-630L and screened below the base of freshwater, also show little long-term change. The increasing chloride concentrations in water from well Ve-630L and little change at well Ve-630U may indicate that saltwater is encroaching in lower parts of the aquifer, but not in the upper parts. Water levels at these wells show no long-term changes, indicating the potential for saltwater movement has not changed substantially since the wells were constructed in the mid 1960's (fig. 9).

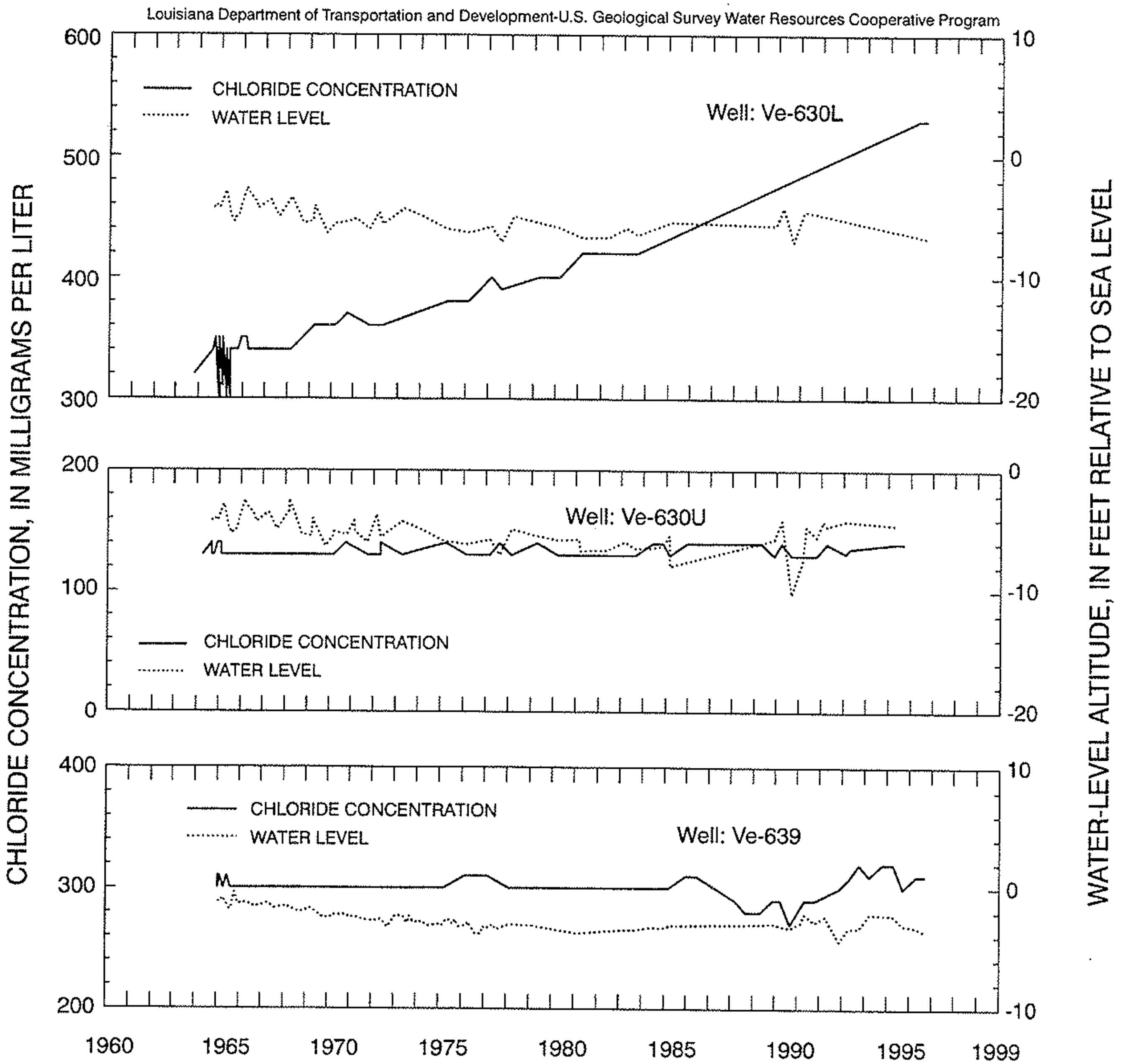


Figure 9. Chloride concentrations and water levels in the upper sand for wells Ve-630L, Ve-630U, and Ve-639.

**Cameron Parish Area**

The Cameron Parish area includes eastern Cameron Parish, southeastern Calcasieu Parish, and southern Jefferson Davis Parish. The freshwater-saltwater interface in the upper sand and "200-foot" sands extends inland from the Gulf of Mexico at altitudes ranging from about 400 to 600 ft below sea level throughout much of this area (fig. 7).

Intense pumping for rice irrigation and industrial uses in Jefferson Davis and Calcasieu Parishes could cause the freshwater-saltwater interface in the upper and "200-foot" sands in the Cameron Parish area to move northward towards areas of intense pumping in Jefferson Davis and Calcasieu Parishes (figs. 1 and 7). In most of the Cameron Parish area, the hydraulic gradient in the upper and "200-foot" sands is about 1 ft/mi. Assuming the same hydraulic conductivity and porosity values as used previously, the average lateral velocity of ground-water flow along the freshwater-saltwater interface is about 55 ft/yr (0.15 ft/d). Near the leading edge of the interface in Calcasieu and Jefferson Davis Parishes, water levels experience seasonal declines of more than 30 ft and the hydraulic gradient increases to more than 3.3 ft/mi. In this area, the average lateral velocity of ground-water flow along the interface may be greater than 180 ft/yr (0.5 ft/d) during spring and summer months. However, chloride-concentration data from wells located near the leading edge of the freshwater-saltwater interface in Cameron Parish generally show decreasing trends. Water levels in wells screened in the upper sand in the Cameron Parish area show little long-term change, indicating that the potential for saltwater movement has not changed substantially since the wells were constructed in the early 1960's (figs. 10, 11, and 12).

Chloride concentrations in water from wells Cn-80L, Cn-81U, and Cn-81L, located near the Cameron-Jefferson Davis Parish border and screened below the base of freshwater, decreased at an average rate of about 6 (mg/L)/yr from the mid-1960's to the mid-1980's (fig. 10). Unfortunately, obstructions and hairline breaks in the well casings prevent further sampling of those wells. Chloride concentrations in water from well JD-491, a public-supply well located about 5 mi north of Cn-81U and screened above the base of freshwater near the leading edge of the interface, have remained relatively unchanged since 1968 (fig. 10). Chloride concentrations in water from wells Cu-854, Cu-971, and Cn-92, located at or near the leading edge of the interface along the Cameron-Calcasieu Parish border, also have not increased. Chloride concentrations in water from well Cn-92, screened near the base of freshwater, increased from 200 mg/L to 400 mg/L during 1964-75, but have fluctuated between 300 and 400 mg/L since 1975 (fig. 11).

Well Cn-90 is located near the freshwater-saltwater interface in central Cameron Parish in an area where a large tongue of freshwater extends southward. Chloride concentrations in water from Cn-90 decreased at a steady rate of about 4 (mg/L)/yr during 1964-82, but have changed little since 1982 (fig. 12). Chloride concentrations in water from well Cn-93, located just east of the town of Cameron, have steadily decreased at a rate of about 3 (mg/L)/yr since 1964 (fig. 12).

The reason for the decreasing chloride concentrations in water from wells screened in the upper sand in the Cameron Parish area is uncertain. Water-level gradients indicate that the general movement of the freshwater-saltwater interface should be northward in this area; water near the freshwater-saltwater interface would be expected to become increasingly salty. It is possible that vertical leakage of freshwater through surficial clay units may be recharging the upper sand, displacing saltwater, and resulting in the decreasing chloride concentrations observed in this area.

### Iowa Area

Saltwater is present in the upper sand over about a 40 $mi^2$ area in the vicinity of Iowa, in eastern Calcasieu Parish (fig. 7). The localized occurrence of saltwater in this area is probably the result of incomplete flushing by freshwater after the sediments were deposited. Nyman (1984, p. 26-30) determined that this saltwater has been static, neither moving nor increasing in salinity, since the early 1960's. Wells sampled in the area during 1995-96 confirm the presence of the high-chloride water. However, because none of these wells had been previously sampled, no trends could be established.

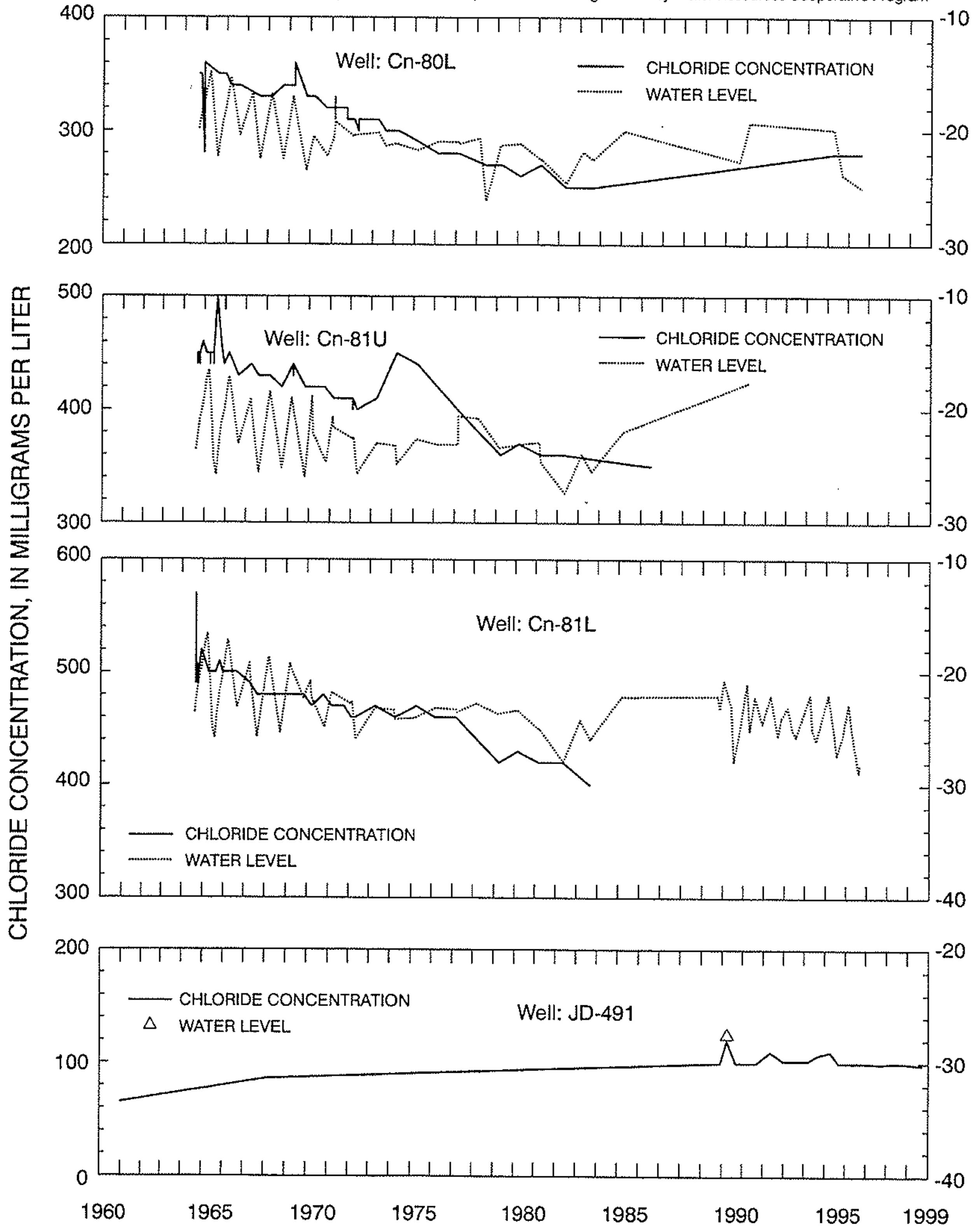


Figure 10. Chloride concentrations and water levels in the upper sand for wells Cn-80L, Cn-81U, Cn-81L, and JD-491.

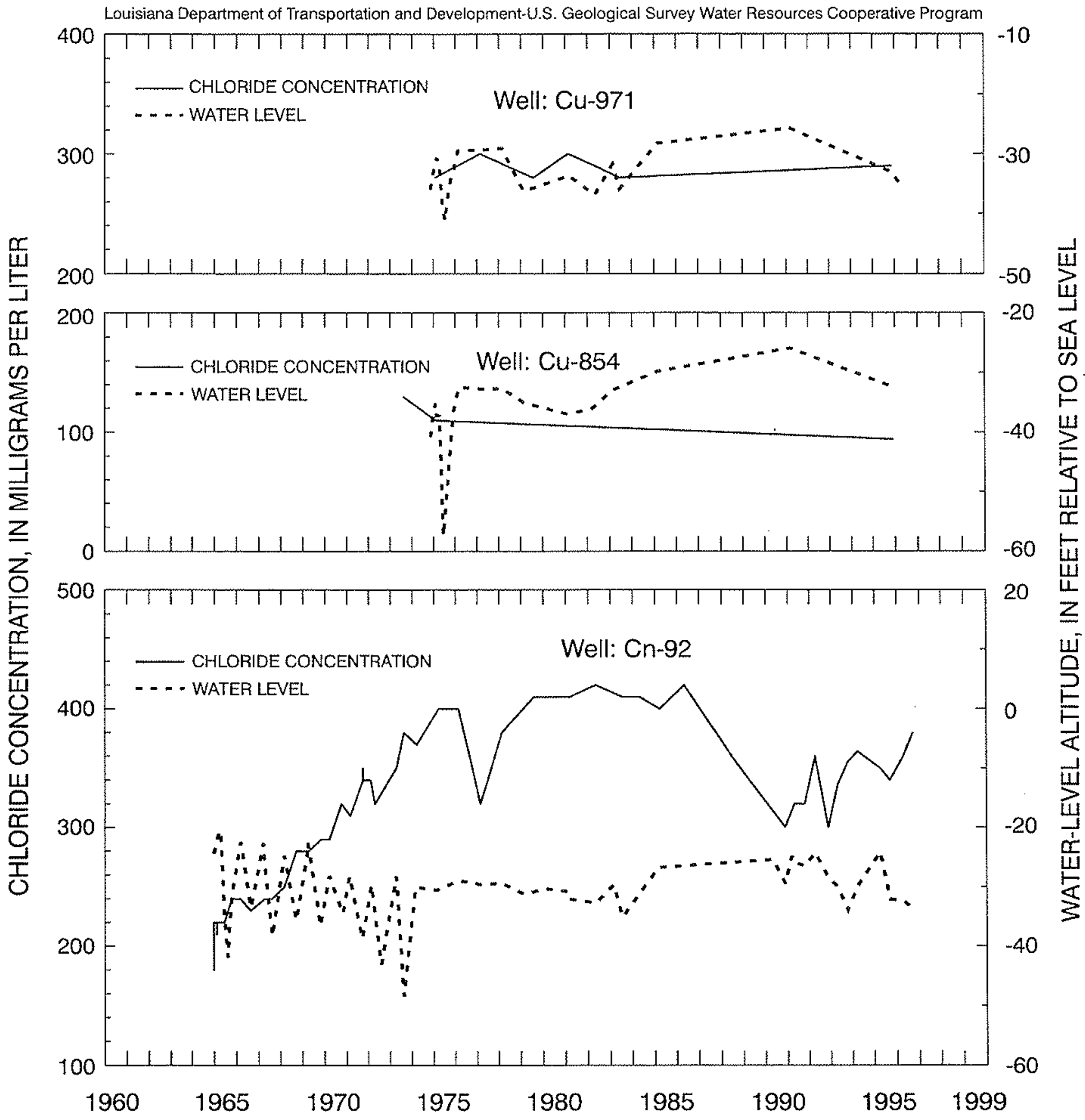


Figure 11. Chloride concentrations and water levels in the upper sand for well Cu-971 and in the "200-foot" sand for wells Cu-854 and Cn-92.

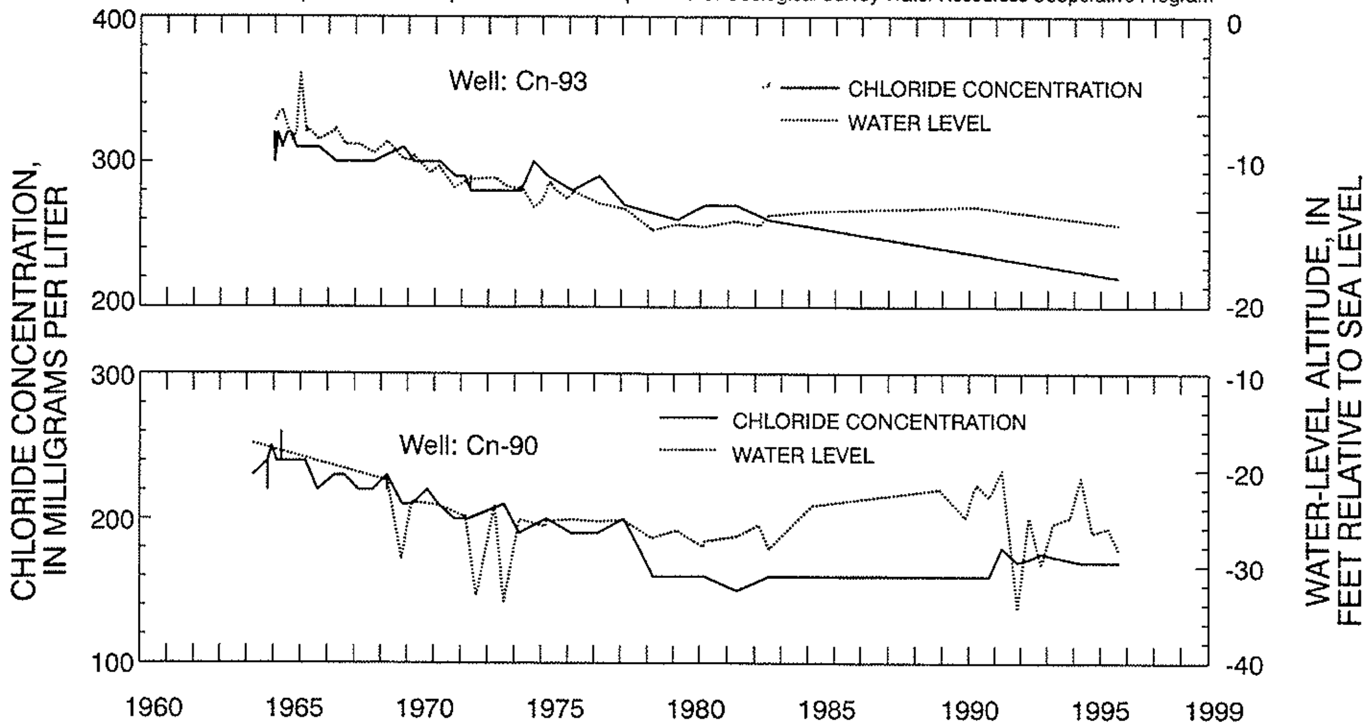


Figure 12. Chloride concentrations and water levels in the upper sand for well Cn-93 and in the "200-foot" sand for well Cn-90..

It is probable that any saltwater movement in the area would be in a southward direction. The base of the upper sand dips to the south about 20 ft/mi in this area (Nyman, 1984, pl. 3), and the potentiometric-surface map, shown in figure 1, indicates a southward hydraulic gradient of about 2 ft/mi in the Iowa area. Using equation 1 and assuming the same hydraulic conductivity and porosity values previously used, the average lateral velocity of ground-water flow along the freshwater-saltwater interface in the Iowa area is about 110 ft/yr (0.30 ft/d) towards the south.

### Lower Vermilion River area

Saltwater is present in the upper sand in an irregularly shaped area located south of Abbeville, along the lower Vermilion River area (fig. 7). The saltwater occurs beneath an area of approximately 50 $mi^2$ in extent and coincides approximately with the area enclosed by the -400-ft contour marking the base of freshwater in the upper sand near Abbeville (fig. 7). Pumping from the upper sand has lowered water levels and induced the upward movement of saltwater from the lower sand into the upper sand through a sandy zone in the confining unit between the sands (Nyman, 1984, p. 26). Nyman (1984, p. 25-26) expected that the saltwater in the upper sand in this area would continue to expand at a slow, steady rate in response to continued pumping from the upper sand.

Chloride concentrations in water from wells Ve-637L and Ve-637U have increased at an average rate of about 3 [(mg/L)/yr] since the mid-1960's (fig. 13). However, much of this increase occurred during a short period in the 1970's. Chloride concentrations in water from well Ve-649 have increased at an average rate of about 13 (mg/L)/yr from 180 mg/L in 1964 to 580 mg/L in 1996. Although several wells are located in this area, few wells are screened deep enough to be affected by the saltwater. Chloride-concentration data are insufficient to determine whether the saltwater has encroached beyond the extent estimated by Nyman (1984, p. 26). Water levels measured at wells show no substantial changes since 1964, indicating that gradients that induce vertical movement of saltwater from the lower sand have remained about the same since 1964 (fig. 13).

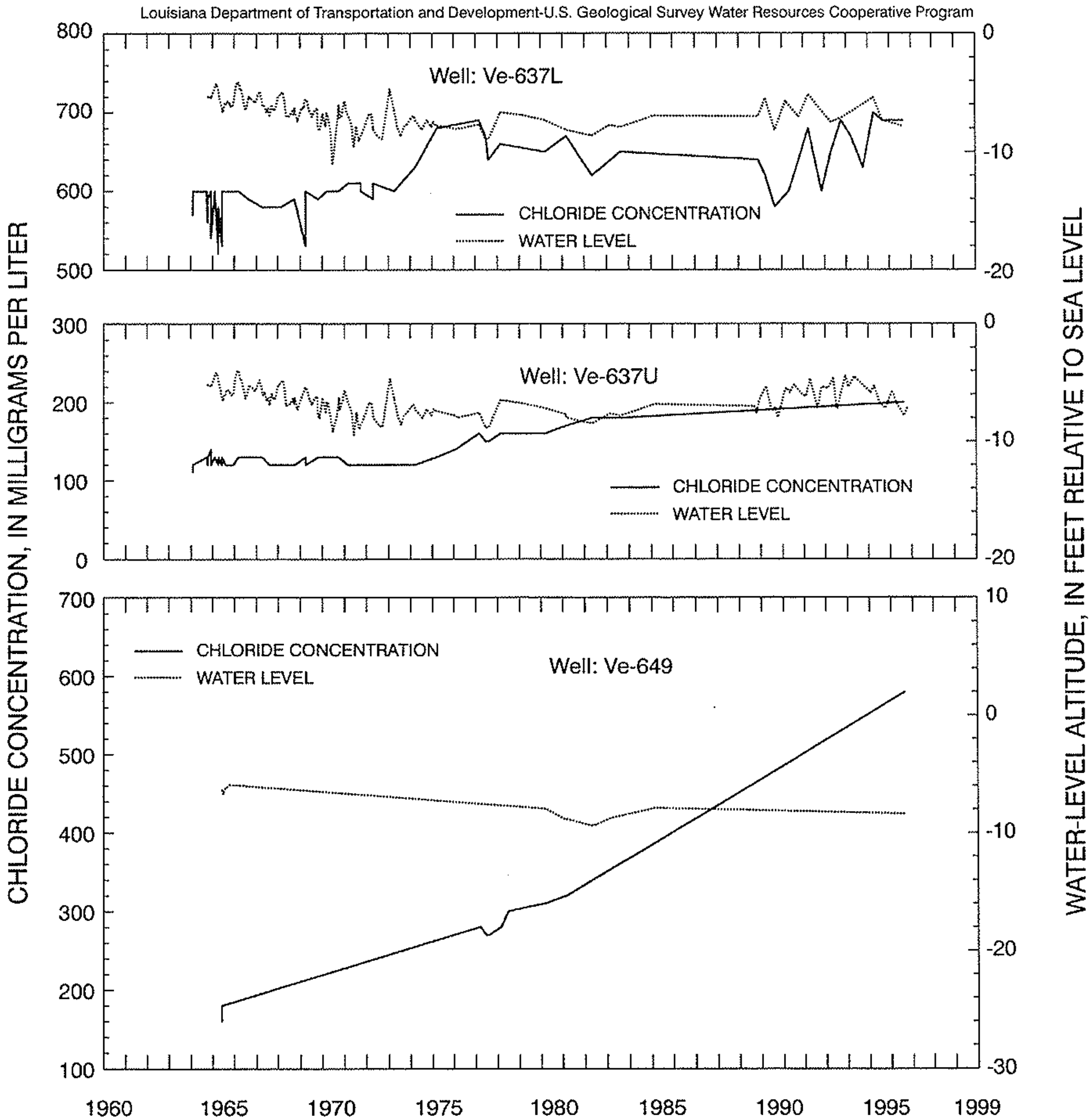


Figure 13. Chloride concentrations and water levels in the upper sand for wells Ve-637L, Ve-637U, and Ve-649.

## Shallow Sand

An irregularly-shaped body of high-chloride water, with an areal extent of about 20 $mi^2$, is present in the shallow sand near the lower Vermilion River between Abbeville and the Intracoastal Waterway (fig. 14). The shallow sand is recharged by water from the Vermilion River in this area (Harder and others, 1967, p. 37-40). During periods of unusually high tides and droughts, the shallow sand is recharged by saltwater that has intruded into the Vermilion River from the Gulf of Mexico.

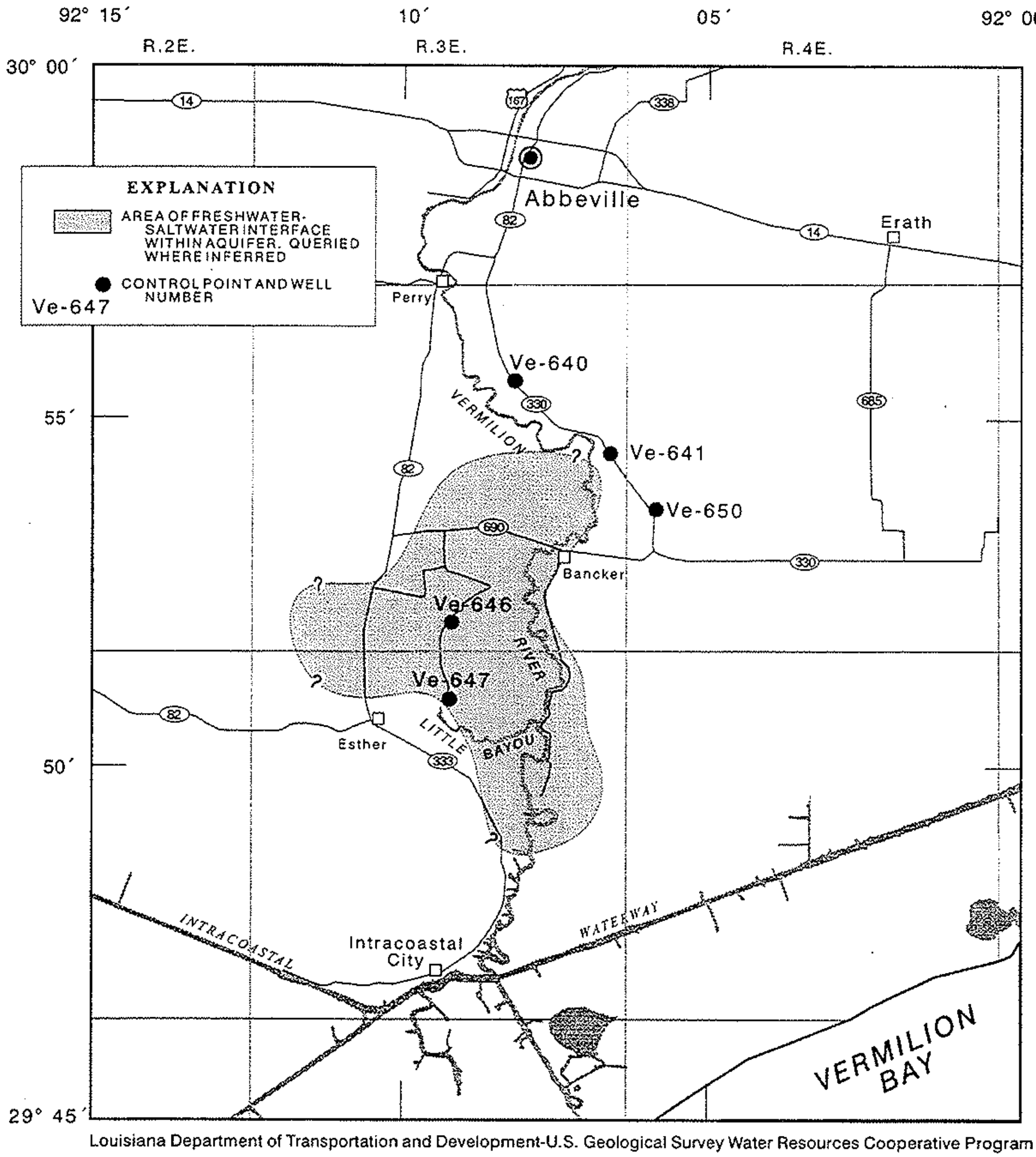


Figure 14. Distribution of chloride in the shallow sand in the lower Vermilion River area (modified from Nyman, 1984, p. 22).

Chloride-concentrations in water from wells Ve-646 and Ve-647, which are screened in the saltwater body in the shallow sand, have not changed substantially since 1965 (fig. 15). Chloride concentrations in water from wells Ve-640, Ve-641, and Ve-650, located north of the saltwater body, also have not changed substantially, indicating that saltwater has not moved northward discernibly. No wells along the southern edge of the saltwater body were available for sampling to determine whether high-chloride water has moved southward.

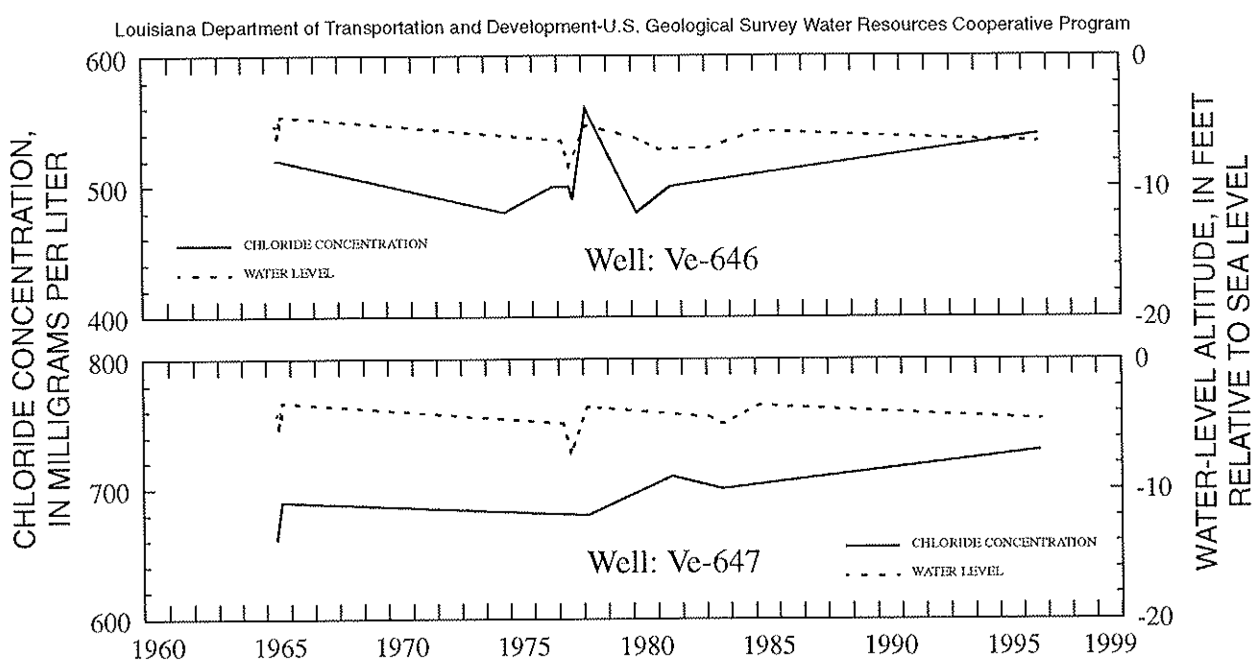


Figure 15. Chloride concentrations and water levels in the shallow sand for wells Ve-646 and Ve-647.

## "500-Foot" Sand

Saltwater is present in the "500-foot" sand near the Calcasieu-Cameron Parish border (fig. 16) between altitudes of about 500 and 600 ft below sea level (Nyman, 1984, pl. 4) and may be moving slowly northward in response to pumping in Calcasieu Parish. Saltwater also occurs in the "500-foot" sand in the Lake Charles industrial district, where intense pumping has caused saltwater to migrate vertically upward from the saltier "700-foot" sand in areas where the aquifers are interconnected

### Coastal Area

Chloride concentrations in wells Cn-86L, Cn-88L, and Cu-787 indicate that saltwater encroachment in the "500-foot" sand may be occurring at an extremely low rate near the Calcasieu-Cameron Parish border. These wells have been sampled semi-annually since 1964 to track the northward progress of saltwater in this area, and graphs for all three wells indicate long-term increases in chloride concentrations (fig. 17).

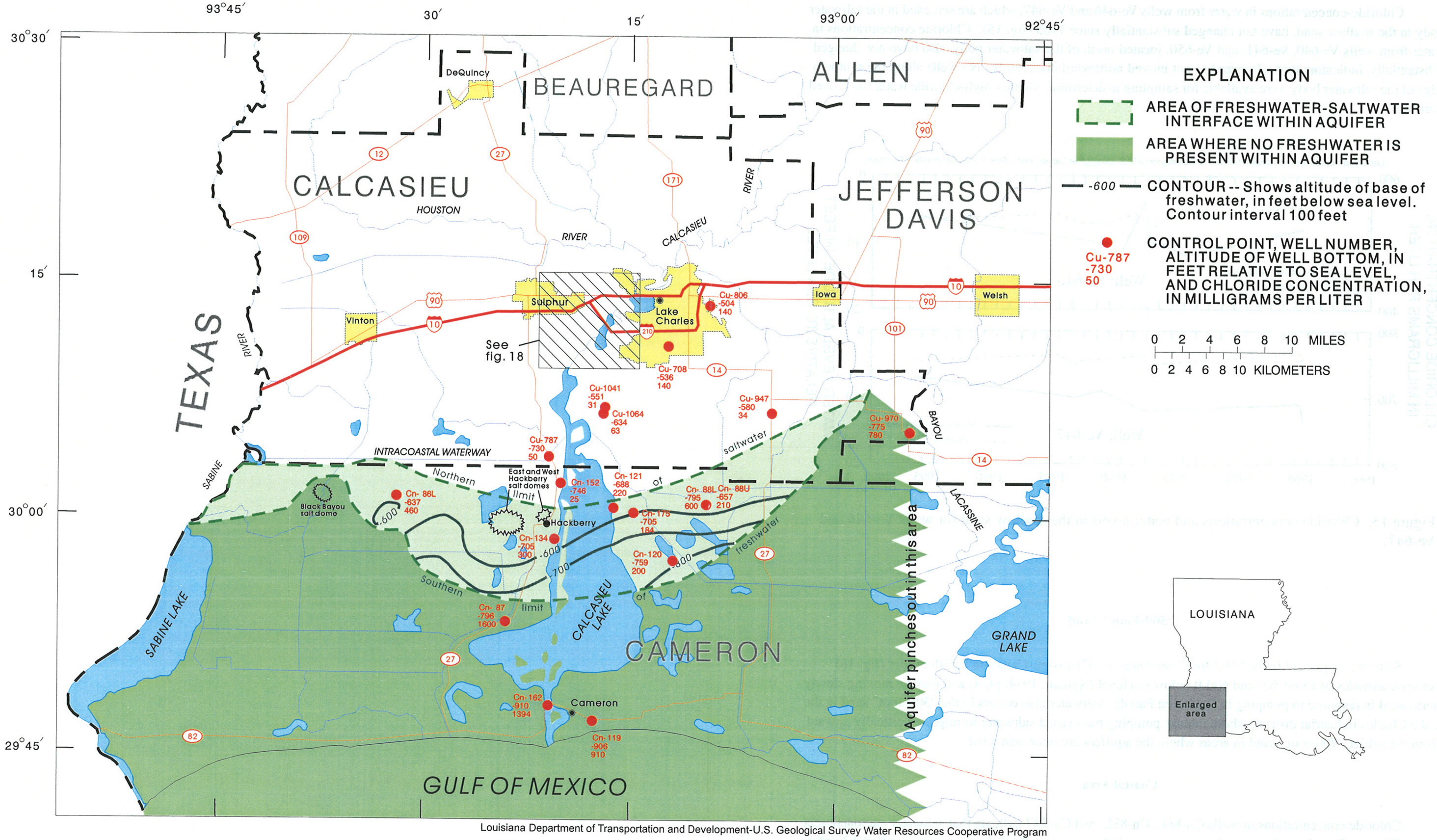


Figure 16. Distribution of chloride in the "500-foot" sand in southwestern Louisiana, 1995-96 (modified from Nyman, 1984, pl. 4).

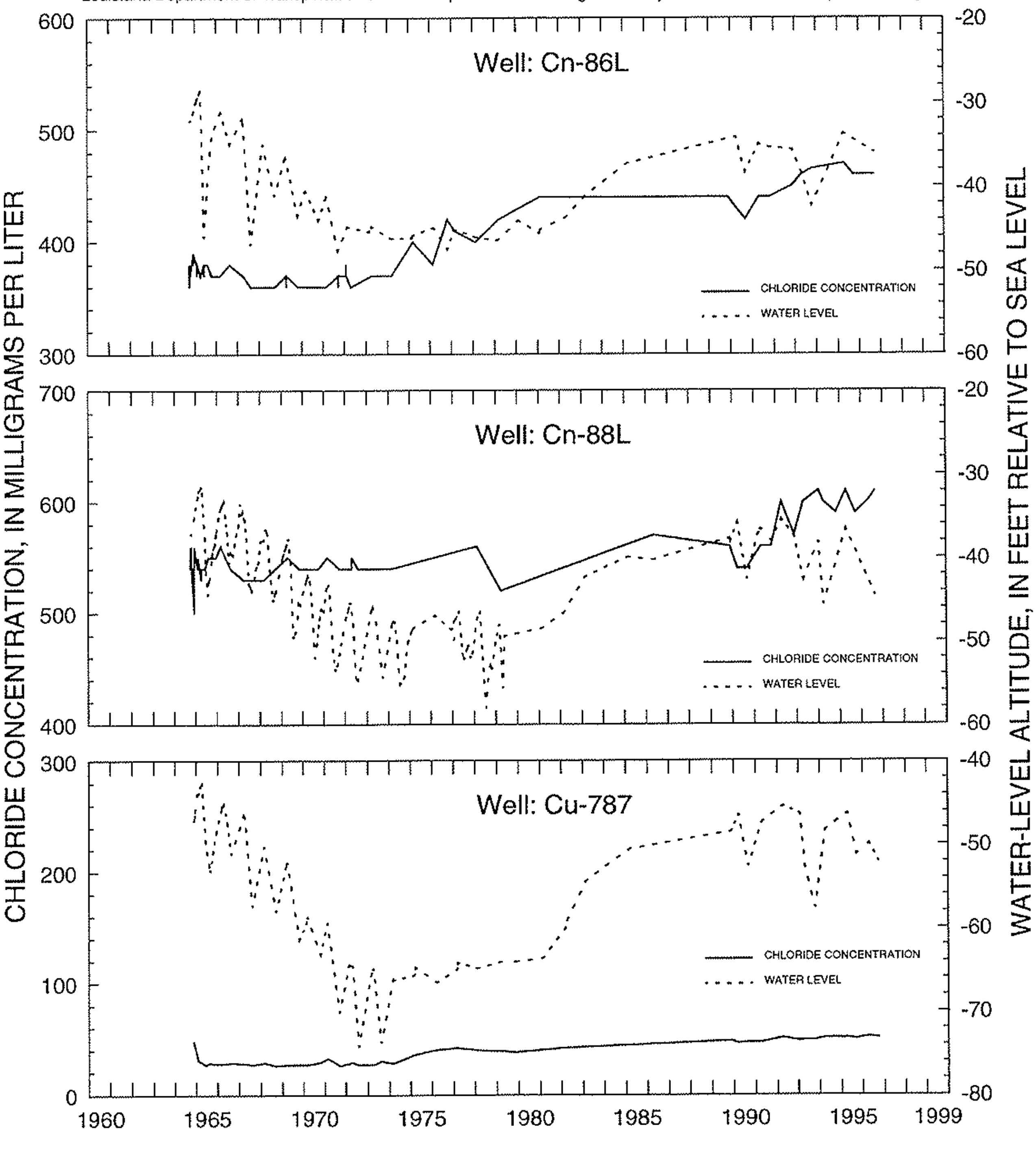


Figure 17. Chloride concentrations and water levels in the "500-foot" sand for wells Cn-86L, Cn-88L, and Cu-787.

Chloride concentrations in wells Cn-86L and Cn-88L, completed below the base of freshwater at the freshwater-saltwater interface, increased at rates of about 3 (mg/L)/yr and 2 (mg/L)/yr. These rates are relatively low, but could increase in response to increased pumping and lowered water levels in the Lake Charles area. Well Cu-787, which is located north of the leading edge of saltwater and completed about 35 ft above the base of the aquifer, experienced an extremely low rate of increase of 0.7 mg/L per year (fig. 17). Chloride trends at other wells completed in the "500-foot" sand near the freshwater-saltwater interface generally have shown no substantial long-term changes.

Flow in the "500-foot" sand is radially inward toward the Lake Charles area, and the hydraulic gradient averages about 2 ft/mi along the Calcasieu-Cameron Parish border (fig. 5). Using equation 1, assuming an average porosity of 0.25 and an average lateral hydraulic conductivity of 130 ft/d for the "500-foot" sand (Harder, 1960a, p. 32), the average lateral velocity of ground-water flow along the freshwater-saltwater interface is about 70 ft/yr (0.2 ft/d) along the Calcasieu-Cameron Parish border.

The base of the "500-foot" sand occurs at altitudes between 500 and 600 ft below sea level in the Lake Charles area and ranges from about 600 ft below sea level at the western end of the Calcasieu-Cameron Parish border to about 800 ft below sea level at the center and the eastern end of the border (Nyman, 1984, pl. 6; Nyman, 1989, pl. 11). The freshwater-saltwater interface in the "500-foot" sand is present at altitudes between about 600 and 800 ft below sea level in northern Cameron Parish and parts of southern Calcasieu Parish. Saltwater could move laterally northward toward Lake Charles, controlled by hydraulic gradients. However, the volume of saltwater moving northward in western and central parts of the interface is somewhat diminished by decreased transmissivity in the "500-foot" sand in areas where it thins near the East and West Hackberry and Black Bayou salt domes (fig. 16) (Nyman, 1984, p. 33).

**Lake Charles Area**

In the Lake Charles area, saltwater probably is entering the "500-foot" sand through aquifer interconnections with the underlying, saltier "700-foot" sand. Because water levels in the "700-foot" sand are higher than those in the "500-foot" sand, saltwater from the "700-foot" sand can move into the "500-foot" sand in areas where the confining unit between the two sands is thin or missing. Intense pumping may also create a situation referred to as upconing, in which saltwater is drawn upward from the "700-foot" sand or the base of the "500-foot" sand toward pumped wells.

Three high-chloride bodies of water have been defined in the "500-foot" sand in the Lake Charles industrial district (fig. 18) (Nyman, 1984, p. 33-37). In the northern and southern chloride bodies, saltwater probably is moving into the "500-foot" sand from the "700-foot" sand and then upconing due to intense localized pumping from the "500-foot" sand in these areas. In the central chloride body, little pumping occurs and the source of the saltwater is unknown, but could be associated with oil and gas exploration that occurred in the early 1900's at the Lockport oil field near the Lockport salt dome. The base of the "500-foot" sand occurs at an average altitude of 500 ft below sea level in the northern part of the industrial district and generally dips southward to an altitude of about 600 ft below sea level at the southern edge of the industrial district (Nyman, 1984, pl. 6).

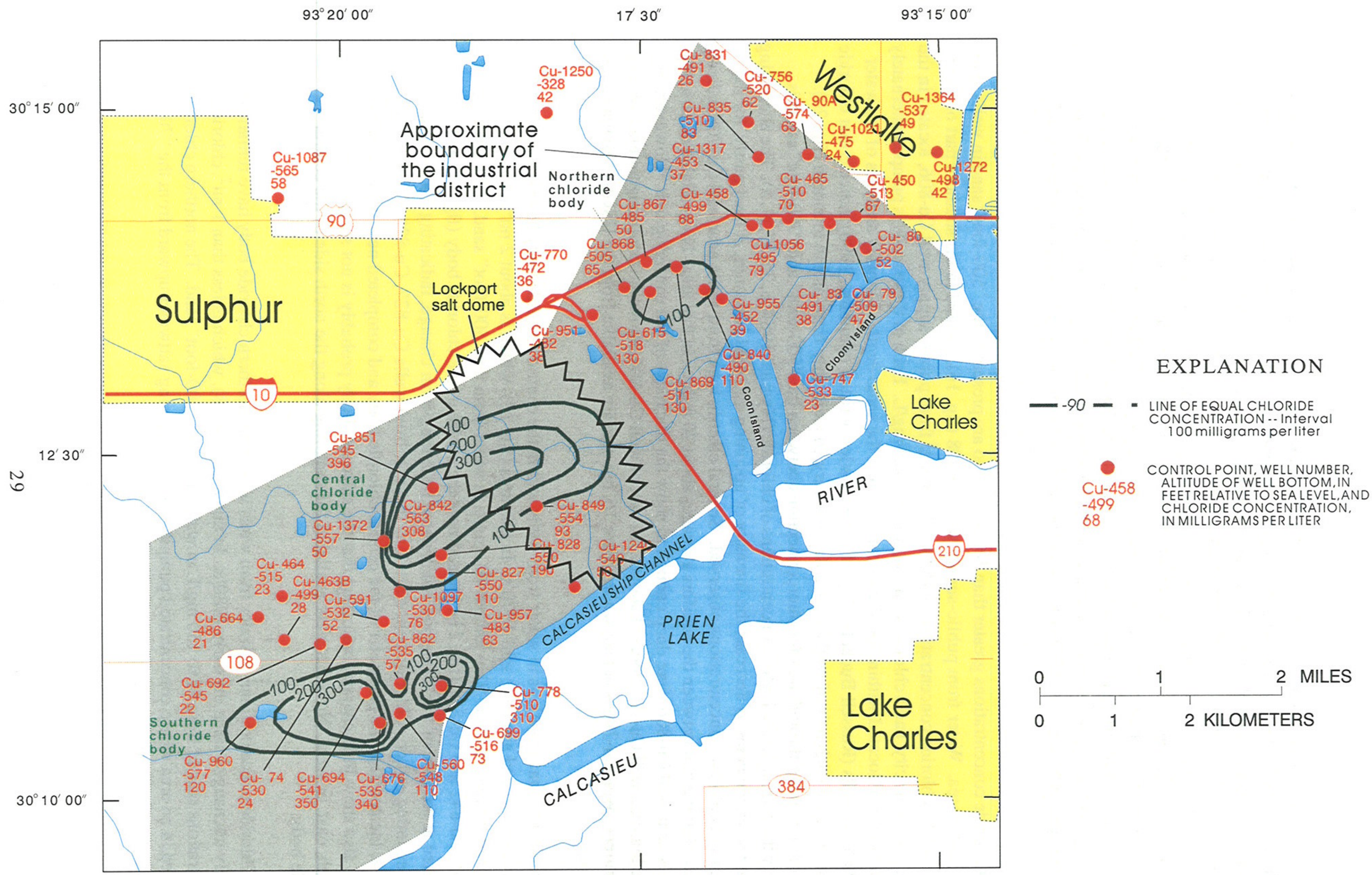


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Figure 18. Chloride concentrations in water in the "500-foot" sand in the Lake Charles industrial district, Calcasieu Parish, Louisiana, 1996 (modified from Nyman, 1984).

The potentiometric surface of the "500-foot" sand in the Lake Charles industrial district during the fall of 1995 indicates that water in the aquifer flows radially inward toward two separate cones of depression that approximately coincide with the northern and southern chloride bodies (figs. 18 and 19). The hydraulic gradient ranges from about 5 ft/mi at the edges of the industrial district to 50 ft/mi near the deepest water levels. Using equation 1, assuming an average porosity of 0.25, and using an average lateral hydraulic conductivity of 130 ft/d for the "500-foot" sand (Harder, 1960a, p. 32), the average lateral velocity of ground-water flow along the freshwater-saltwater interface in the Lake Charles industrial district ranges from about 180 to 1,800 ft/yr (0.5 to 5 ft/d). Considering that the high chloride concentrations occur near the pumping centers, the strong hydraulic gradient toward the pumping centers probably prevents the saltwater from moving away from the industrial district.

Chloride concentrations greater than 100 mg/L also are present in the "500-foot" sand in wells in the Lake Charles area. Water from public-supply well Cu-708 (fig. 16), located in the southern part of Lake Charles, had a chloride concentration of 152 mg/L. Water from public-supply well Cu-806, located in the eastern part of the city, had a chloride concentration of 163 mg/L. Each of these wells is pumped alternately with another well located within 300 ft and completed at the same depth. Monthly analyses of the water from the four wells (Russell Buckels, City of Lake Charles, written commun., 1996) indicate that chloride concentrations at each pair of wells are similar, but vary considerably from month to month (fig. 20). Localized upconing through aquifer interconnections between the "500-foot" and "700-foot" sands is probably the reason for the higher concentrations of chloride (Nyman, 1984, p. 35-37, pl. 5). The alternating pumping schedule helps to decrease the intensity of upconing and could account, at least partly, for the variations in chloride concentrations observed. Several electric logs from wells near well Cu-708 indicate that the confining unit between the aquifers averages about 70 ft thick in this area. No available electric logs for wells near well Cu-806 were deep enough to show the thickness of the confining unit. However, an electric log for a well Cu-796, located about 2 mi east of well Cu-806, shows no confining unit between the two aquifers. Well Cu-796 is not shown in figure 16, but data are available from the USGS in Baton Rouge, Louisiana.

Chloride concentrations in water from wells within the central chloride body have remained relatively unchanged since the mid-1970's. In this area (fig. 18), which is about 2 $mi^2$, chloride concentrations ranged from 50 to almost 400 mg/L in water from the "500-foot" sand. The graphs for wells Cu-842 and Cu-851 (fig. 21), located near the center of the chloride body (fig. 18) and completed at the base of the "500-foot" sand, show little long-term change, indicating that the water is not becoming saltier. Chloride concentrations in water from wells Cu-827, Cu-828, Cu-849, and Cu-1372, located near the perimeter of the central chloride body and completed near the base of the aquifer, also show little change, indicating that the saltwater body probably is not spreading toward the south, east, or west. No wells were available for sampling along the north side of the central chloride body.

Chloride concentrations in water from wells within the northern chloride body have remained relatively unchanged since the early 1980's. In this area (fig. 18), which is less than 1 $mi^2$, chloride concentrations ranged from 50 to 150 mg/L in water from the "500-foot" sand. The northern chloride body is located in an area where concentrated pumping may be drawing saltwater upward from the "700-foot" sand into the "500-foot" sand.

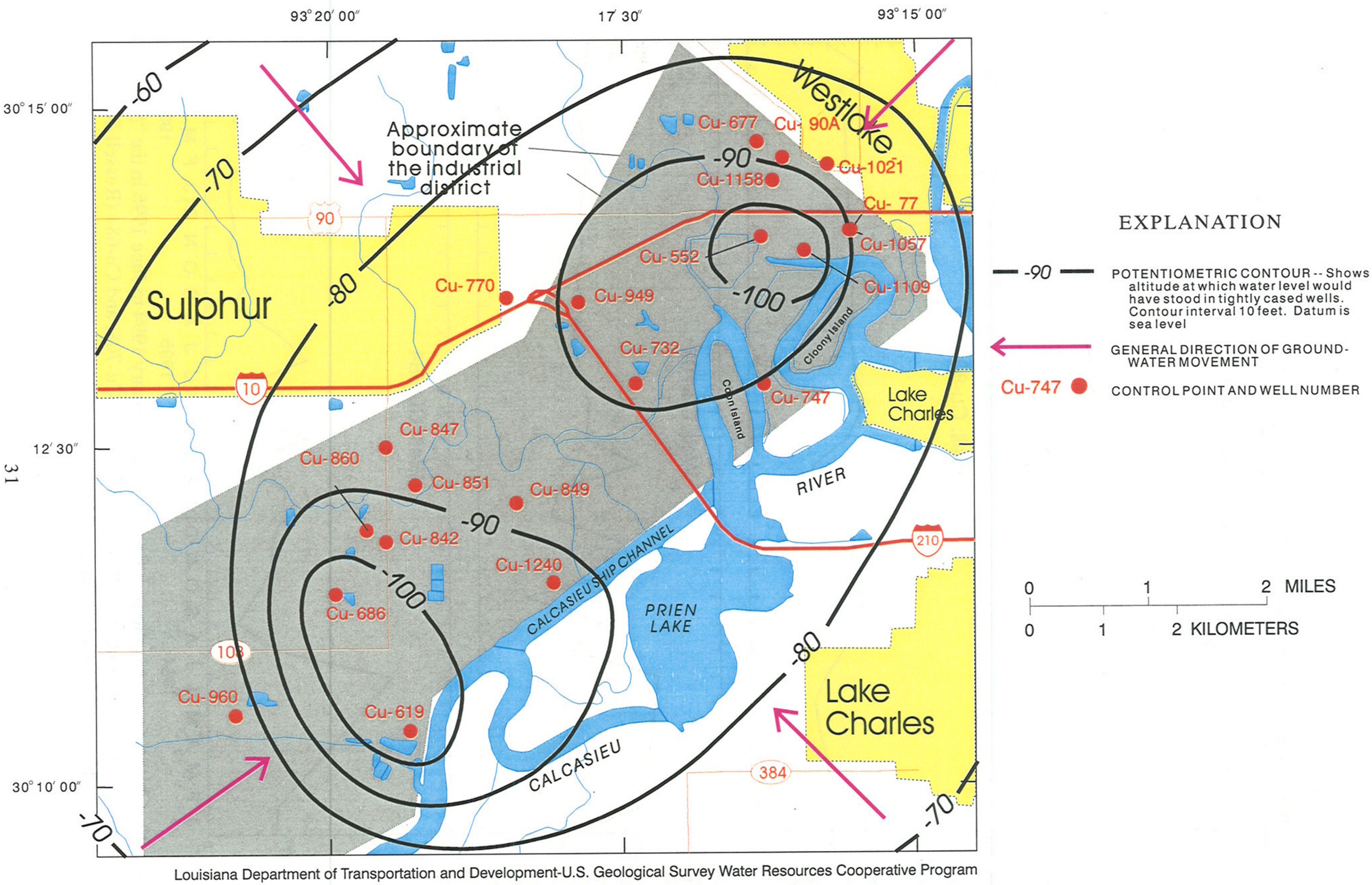


Figure 19. Potentiometric surface of the "500-foot" sand in the Lake Charles industrial district, Calcasieu Parish, Louisiana, fall 1995.

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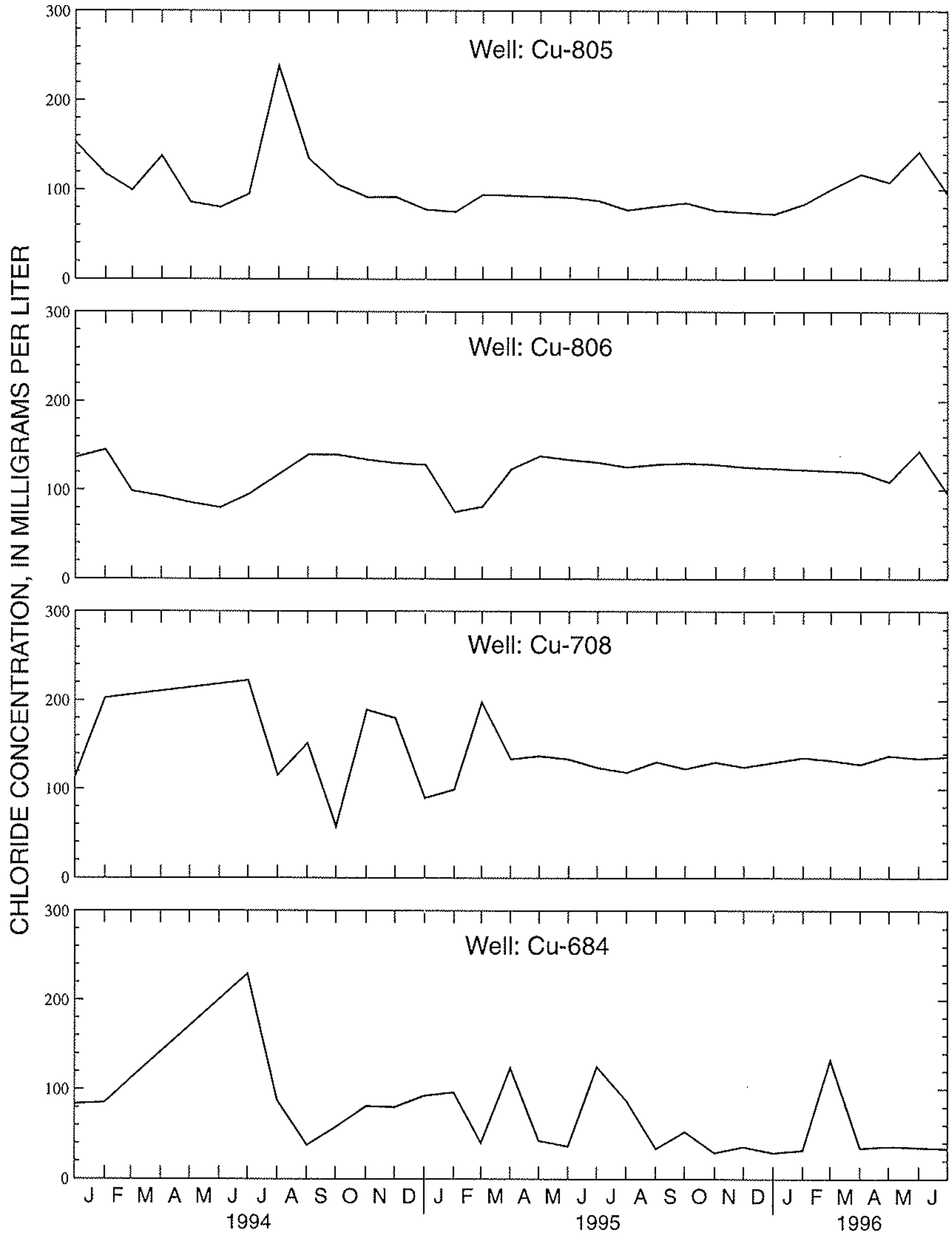


Figure 20. Chloride concentrations during the period January 1994 to June 1996 in the "500-foot" sand in water from public supply wells Cu-805, Cu-806, Cu-708, and Cu-684 (Russell Buckels, City of Lake Charles, written commun., 1996).

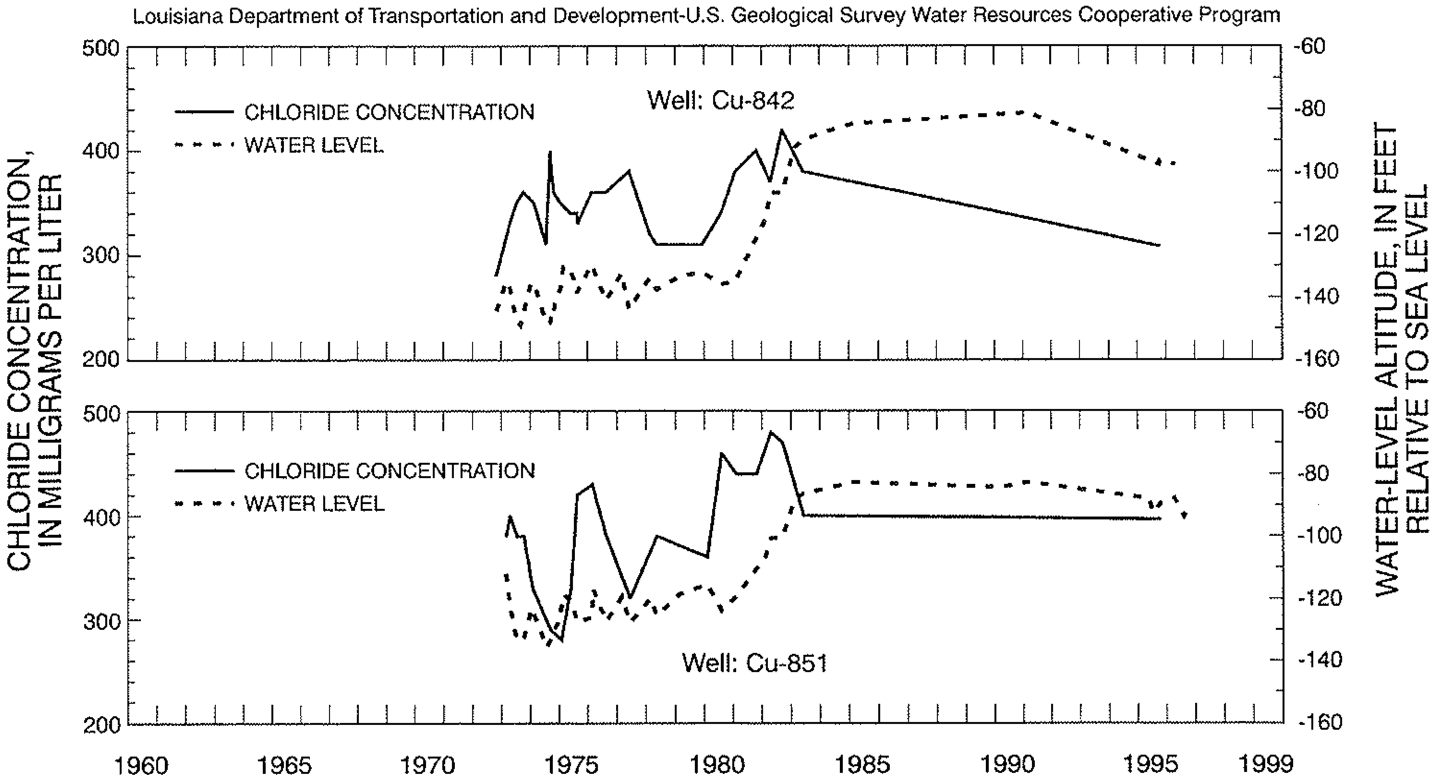


Figure 21. Chloride concentrations and water levels in the central chloride body of the "500-foot" sand for wells Cu-842 and Cu-851.

Chloride concentrations in water from well Cu-615, which is completed at the base of the "500-foot" sand and sampled semi-annually, have increased at a rate of about 4 (mg/L)/yr, from 25 mg/L in 1966 to 140 mg/L in 1995 (fig. 22). Chloride concentrations in wells Cu-840 and Cu-869, which also are completed at the base of the aquifer, increased during the 1970's, but have shown little definitive change since about 1980. Other wells sampled in the area have had no substantial increases in chloride concentrations. The increase in chloride concentrations in well Cu-615 probably is due to upconing of saltwater at the pumped well and apparently has affected only a small area. However, no wells located immediately south of well Cu-615 were available for sampling to determine whether additional upconing could be occurring in this area.

Chloride concentrations in water from wells within and near the southern chloride body have increased, indicating that the body may be expanding. In this area, which is about 1.5 $mi^2$, chloride concentrations ranged from 57 to 350 mg/L in water from the "500-foot" sand (fig. 18). The southern chloride body is located in an area where intense pumping may be drawing saltwater upward from the "700-foot" sand into the "500-foot" sand.

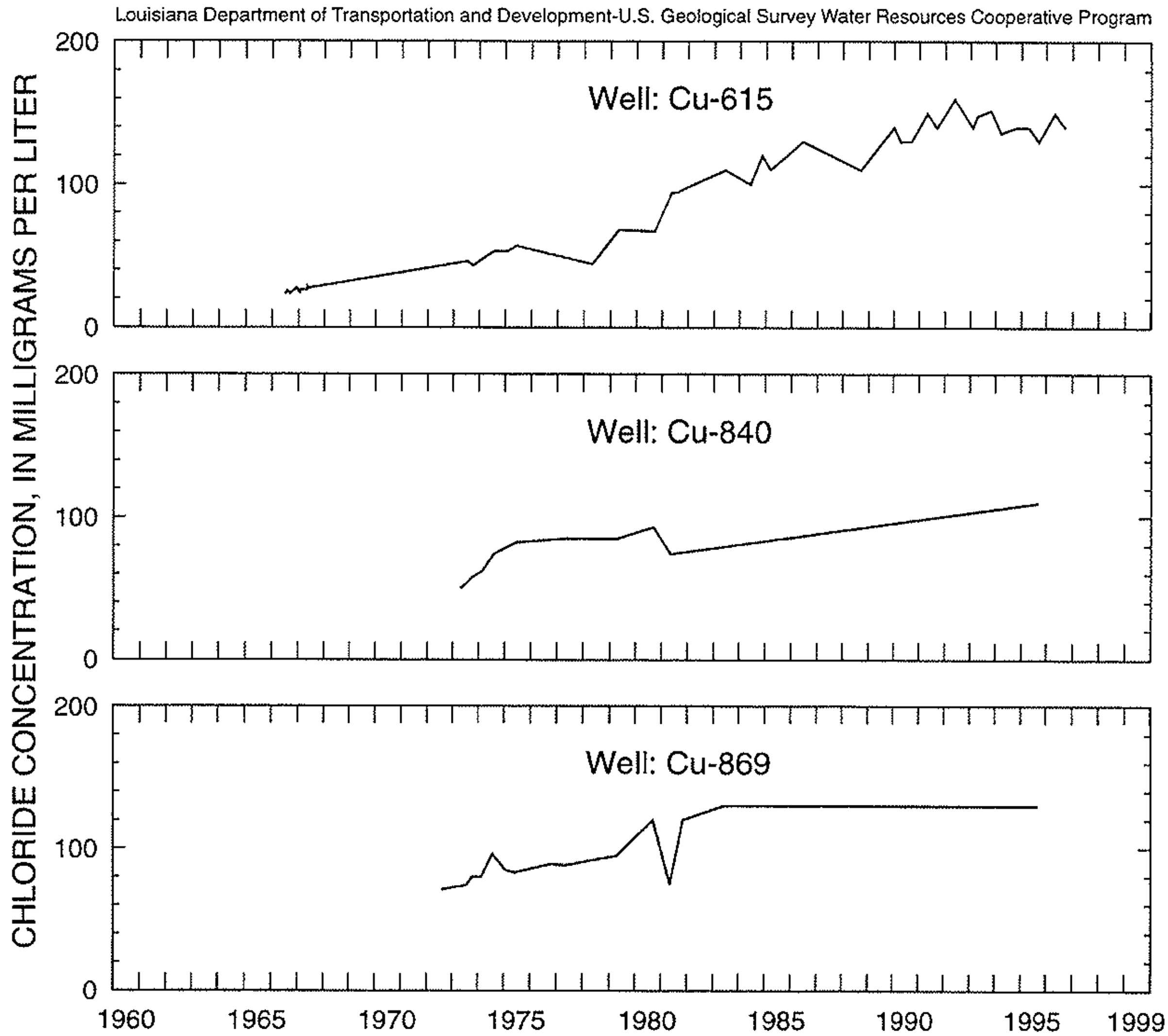


Figure 22. Chloride concentrations in the northern chloride body of the "500-foot" sand for wells Cu-615, Cu-840, and Cu-869.

Well Cu-694 is located near the center of the southern chloride body and is completed about 30 ft above the base of the "500-foot" sand. Chloride concentrations in water from well Cu-694 increased rapidly from about 230 to about 350 mg/L during the early 1970's, but have shown little net change since the late 1970's (fig. 23). Well Cu-694 has been sampled semi-annually since 1972.

Chloride concentrations in water samples from wells located east, west, and south of well Cu-694 have increased substantially since the wells were last sampled in the 1970's or early 1980's. The concentration of chloride in water from well Cu-778, located about 0.7 mi east of well Cu-694 and also completed about 30 ft above the base of the aquifer, increased from 180 to 310 mg/L during 1982-95 (fig. 23). However, chloride concentrations in water from well Cu-862, which is located between wells Cu-694 and Cu-778 and completed at the base of the aquifer, decreased from 130 to 57 mg/L during the same period (fig. 23). The chloride concentration in water from well Cu-676, located along the south side of the southern chloride body and completed at the base of the aquifer, increased from 130 mg/L in 1972 to 340 mg/L in 1995 (fig. 23).

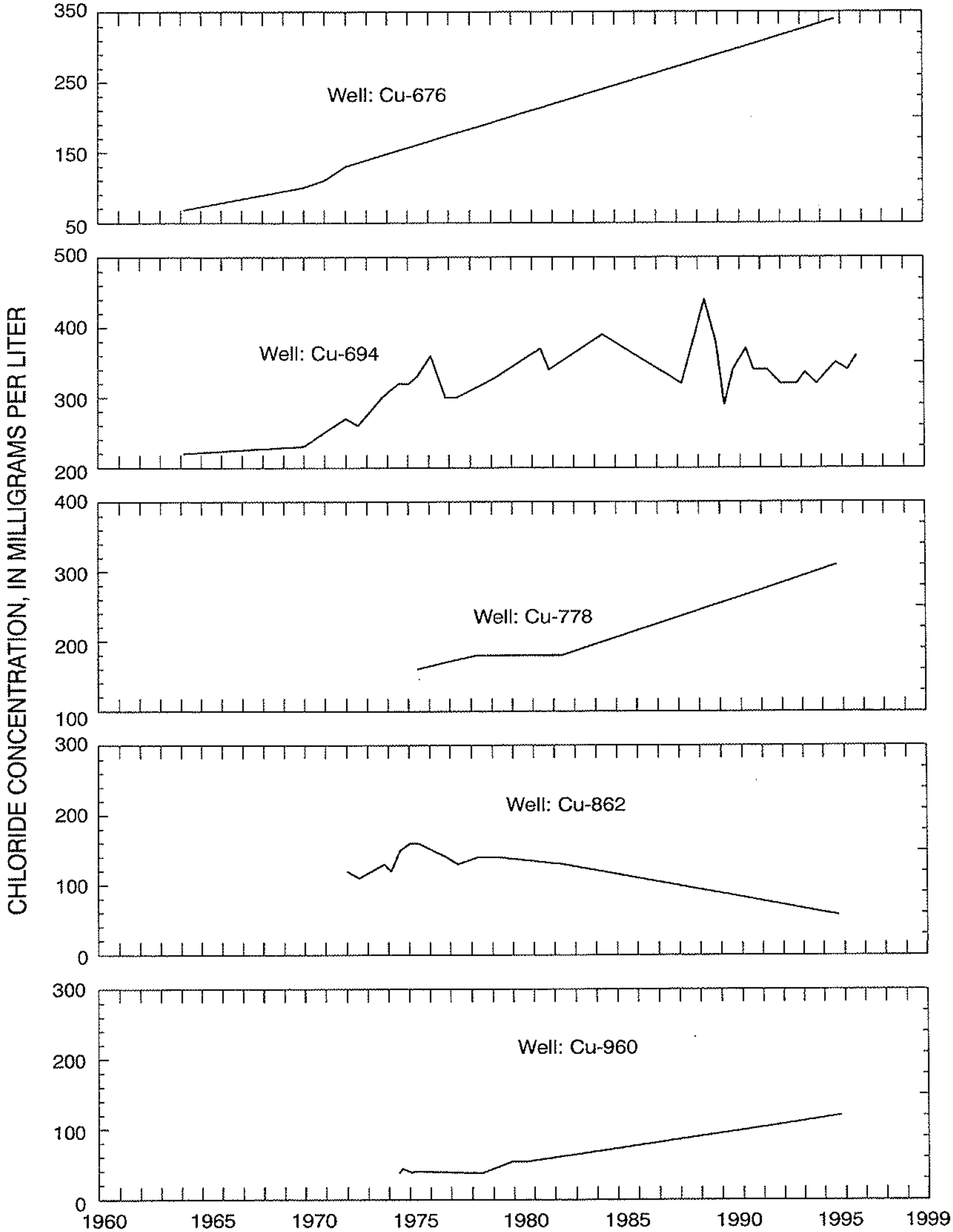


Figure 23. Chloride concentrations in the southern chloride body of the "500-foot" sand for wells Cu-676, Cu-694, Cu-778, Cu-862, and Cu-960.

Because interim data are not available, it is not possible to determine whether the increase has been continuous or occurred during the early and mid-1970's, when chloride concentrations increased rapidly at well Cu-694.

On the western side of the southern chloride body, chloride concentrations in water from well Cu-960 increased from 66 mg/L in 1983 to 120 mg/L in 1995 (fig. 23). Well Cu-960 is completed at the base of the aquifer and saltwater movement in that area could be detected based on water samples from this well. Chloride concentrations in samples from wells located immediately northeast of the southern chloride body have remained at background concentrations.

Increased chloride concentrations in water from wells Cu-778 and Cu-676 probably are the result of upconing in the vicinity of the wells and are apparently localized. The lack of change in chloride concentrations in water from well Cu-694 is an indication that water in that part of the body is not becoming saltier. However, the increase in chloride concentrations in water from well Cu-960, which is located west of the pumping center, indicates that additional upconing of saltwater from the "700-foot" sand to the "500-foot" sand is probably occurring near well Cu-960 as a result of the lowered heads in the cone of depression.

## Lower and "700-Foot" Sands

Saltwater in the lower sand extends inland from the Gulf of Mexico into much of Acadia, Calcasieu, Jefferson Davis, Lafayette, and St. Martin Parishes (Nyman, 1989, pl. 9). Because freshwater is generally available from the overlying upper sand, the lower sand is relatively unused, and saltwater encroachment has not been an issue. In Calcasieu Parish, however, saltwater from the "700-foot" sand may be moving upward into the "500-foot" sand in response to intense pumping. Because of this, and withdrawals from the "700-foot" sand in Calcasieu Parish for public supply and industrial purposes, movement of saltwater in the "700-foot" sand has continued to be monitored.

The saltwater wedge in the "700-foot" sand and the stratigraphically equivalent lower sand is present in the southern two-thirds of Calcasieu Parish (fig. 24) between altitudes of about 600 to 800 ft below sea level. The base of the "700-foot" sand occurs at an altitude of about 500 ft below sea level at the northern border of Calcasieu Parish (Nyman, 1984, p. 40). The aquifer dips southward and slightly eastward so that the base of the aquifer ranges from 800 ft below sea level at the western end of the Calcasieu-Cameron Parish border to 1,200 ft below sea level at the eastern end of the border. In the Lake Charles area, the base of the aquifer occurs at an average altitude of 800 ft below sea level. No substantial amounts of freshwater occur in the "700-foot" sand south of the Calcasieu-Cameron Parish border.

Hydraulic gradients in the "700-foot" sand during the fall of 1995 ranged from about 1.5 ft/mi in southern and western areas to 7.5 ft/mi in north-central and northeastern areas of Calcasieu Parish (fig. 6). Using equation 1, assuming an average porosity of 0.25 and an average lateral hydraulic conductivity of 160 ft/d (Harder, 1960a, p. 35), the average lateral velocity of ground-water flow towards the Lake Charles industrial district along the freshwater-saltwater interface in the "700-foot" sand ranged from 66 ft/yr (0.18 ft/d) in southern and western areas to 330 ft/yr (0.9 ft/d) in north-central and northeastern areas of Calcasieu Parish. The southward hydraulic gradient in the "700-foot" sand probably hinders northward movement of the toe.

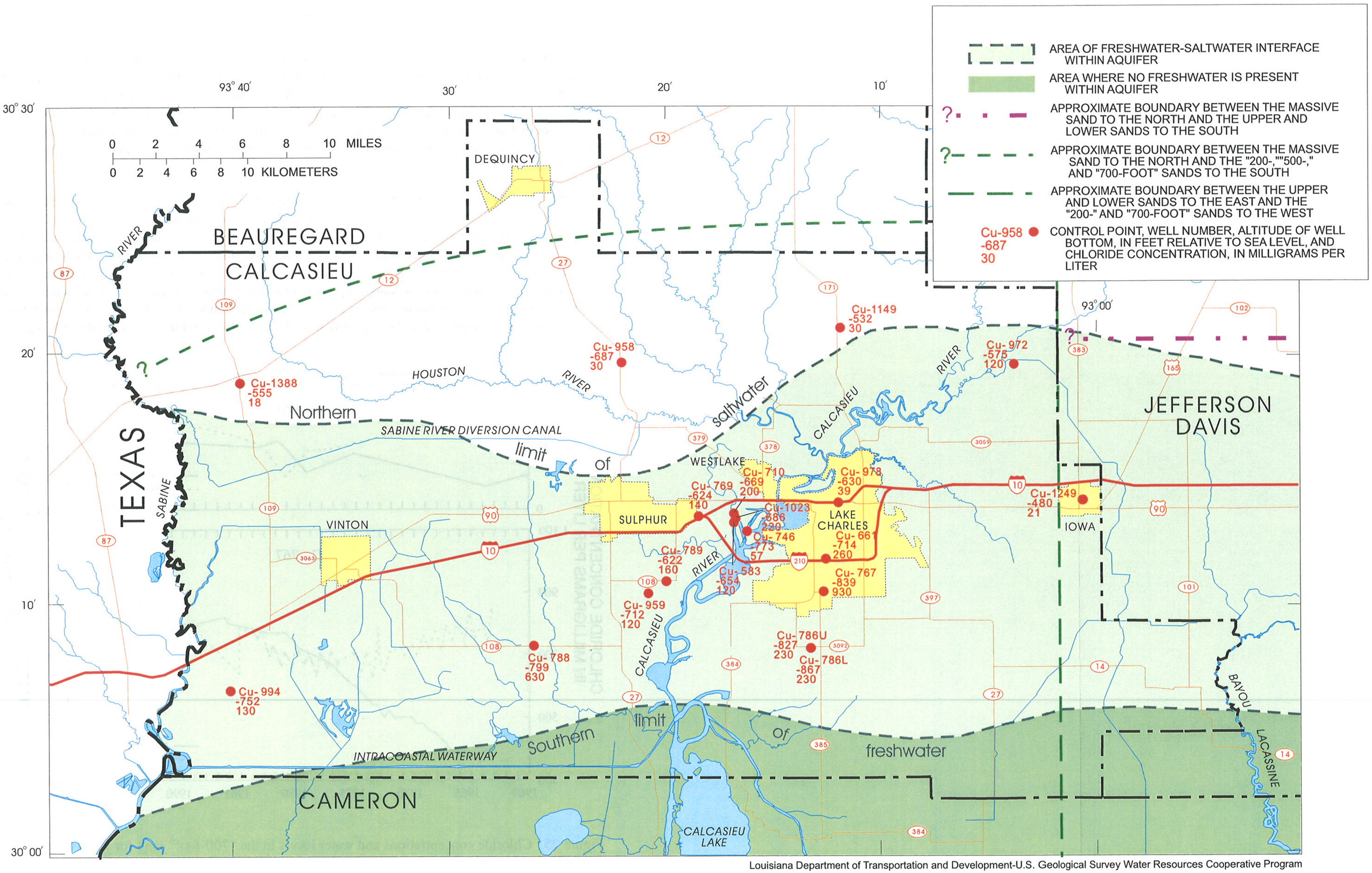


Figure 24. Distribution of chloride in the lower and "700-foot" sands in the Calcasieu Parish area, southwestern Louisiana, 1995-96 (modified from Nyman, 1984).

Few facilities in Calcasieu Parish have continued to use water from the "700-foot" sand since chloride concentrations in samples from wells completed in the aquifer in the Lake Charles industrial district began to increase in the late 1940's (Jones, 1950a). Wells still pumping water from the "700-foot" sand usually are completed near the top of the aquifer. In general, chloride concentrations in samples from pumped wells or wells located near wells pumping from the "700-foot" sand slightly increased, and concentrations in samples from wells located more distant from pumped wells have shown either no trends or slight to moderate decreases.

Well Cu-767 is completed in the "700-foot" sand and located south of the Lake Charles area, about 1.5 mi south of public-supply well Cu-661 (fig. 24). Chloride concentrations in water from well Cu-767, completed near the middle of aquifer, have increased at an average rate of about 16 (mg/L)/yr since 1962 (fig. 25). However, the rate has almost doubled to 30 (mg/L)/yr since 1991. This rate of increase is similar to the rate of increase during the 1970's, indicating that the sharp rise in water levels after the completion of the Sabine River Diversion Canal only temporarily relieved the stresses causing saltwater encroachment in this area. Chloride concentrations in water from well Cu-661, completed near the top of the aquifer, have increased at an average rate of about 4 (mg/L)/yr since the mid-1950's and are now near 250 mg/L (fig. 25).

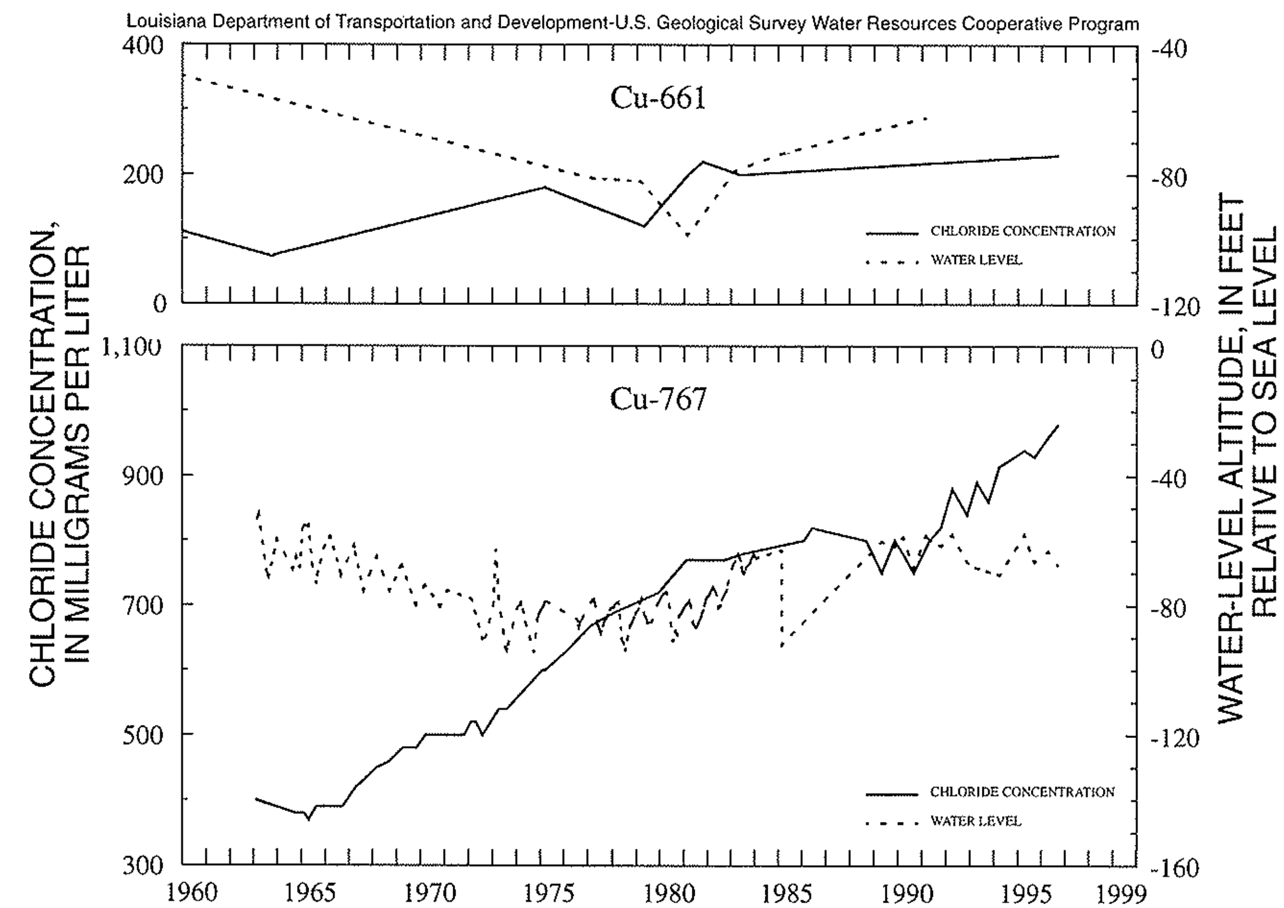


Figure 25. Chloride concentrations and water levels in the "700-foot" sand for wells Cu-661 and Cu-767.

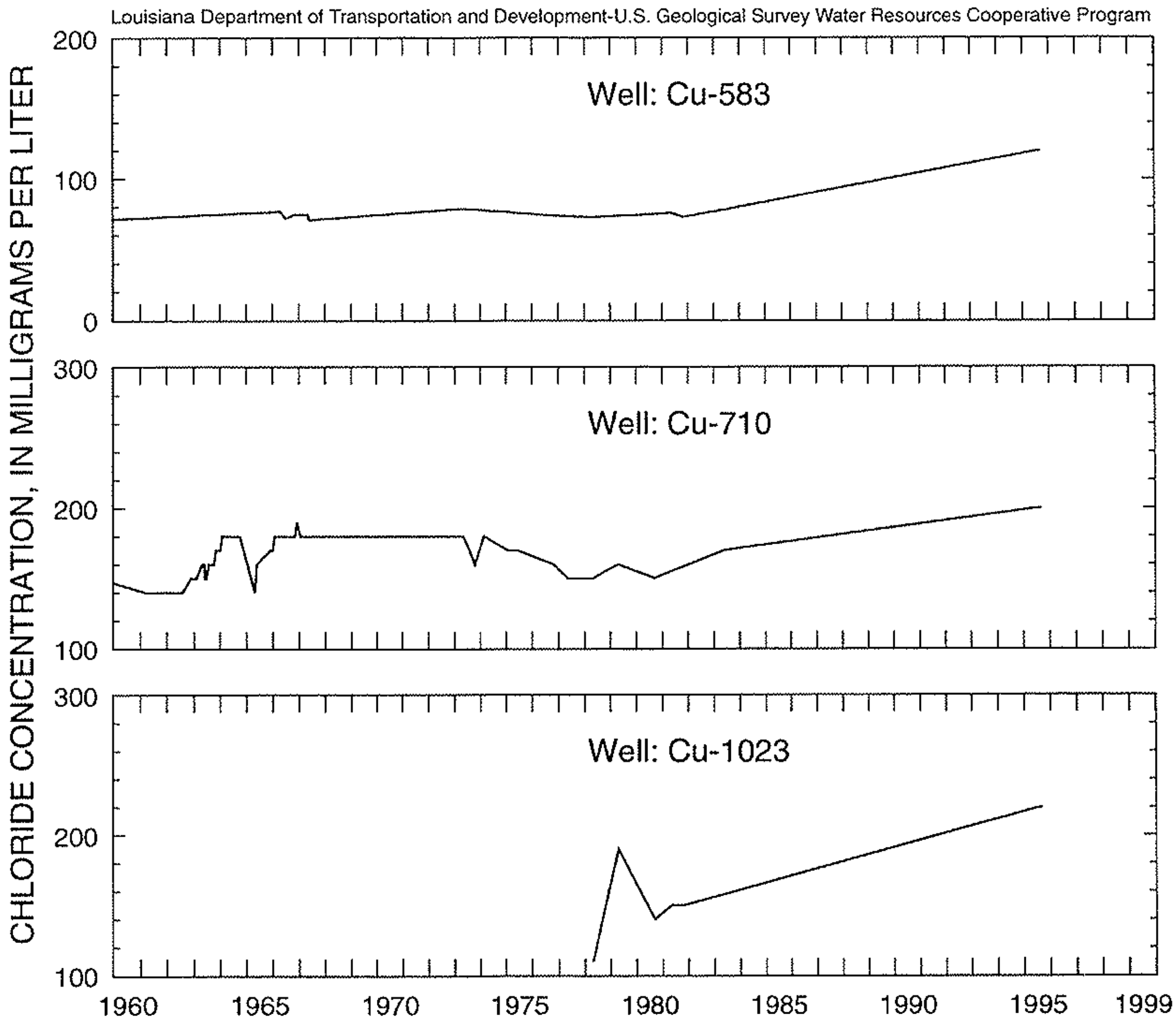


Figure 26. Chloride concentrations in the "700-foot" sand for wells Cu-583, Cu-710, and Cu-1023.

Pumped wells Cu-583, Cu-710, and Cu-1023, completed in the upper one-half of the "700-foot" sand and located in the industrial district (fig. 24), had slight to moderate increases in chloride concentrations ranging from 2 to 4 (mg/L)/yr since the early 1980's (fig. 26). However, the chloride concentrations in samples from wells Cu-746, Cu-769, Cu-789, and Cu-972, which are not pumped, showed either no change or slight to moderate decreases (fig. 27). Chloride concentrations in water from well Cu-769, an unused well about 1.5 mi west of the pumped wells and completed immediately above the base of freshwater at the freshwater-saltwater interface in the "700-foot" sand, have decreased during the past 20 years from 260 mg/L in 1975 to 140 mg/L in 1996. Chloride concentrations in water from well Cu-789, completed at the top of the "700-foot" sand and located in the southern part of the industrial district where no pumping from the aquifer occurs, also have decreased since the early 1970's. Chloride concentrations in water from well Cu-972, near the leading edge of the freshwater-saltwater interface in the northeast corner of the parish and completed at the base of the "700-foot" sand, decreased from 260 mg/L in 1979 to 120 mg/L in 1995. This may be an indication that freshwater is being drawn from the north in some areas within the cone of depression (fig. 6), causing the freshwater-saltwater interface to recede southward.

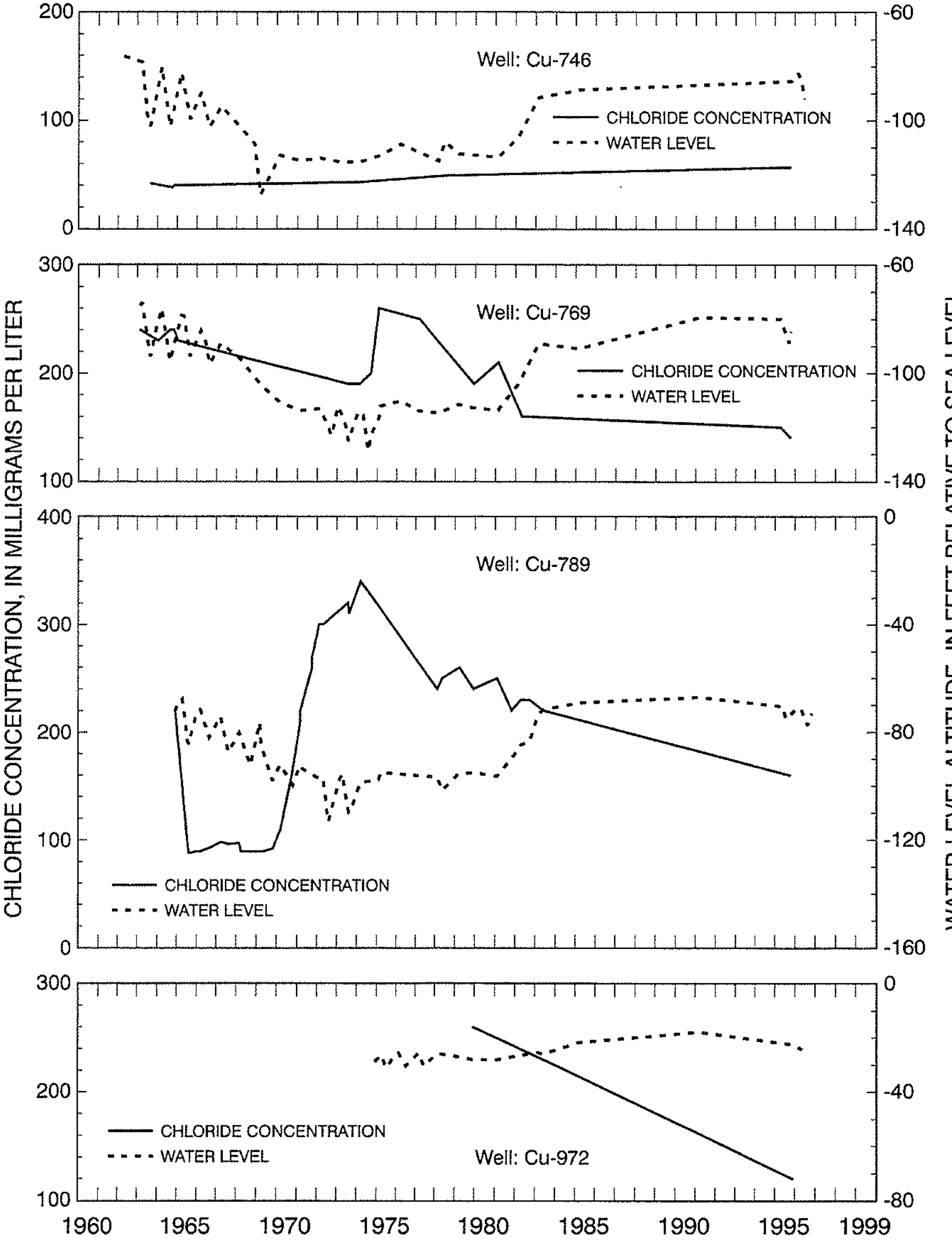


Figure 27. Chloride concentrations and water levels in the "700-foot" sand for wells Cu-746, Cu-769, Cu-789, and Cu-972.

# SUMMARY

The Chicot aquifer system underlies an area of about 9,000 $mi^2$ (square miles) in southwestern Louisiana and is the principal source of fresh ground-water supplies in the region. In southwestern Louisiana, the Chicot aquifer system includes many sands, referred to as the shallow, massive, upper, lower, "200-foot," "500-foot," and "700-foot" sands. In 1995, approximately 550 Mgal/d (million gallons per day) were withdrawn from the Chicot aquifer system in southwestern Louisiana. More than one-half of the withdrawals were for rice irrigation.

The Chicot aquifer system is vulnerable to saltwater encroachment from the Atchafalaya River area, coastal areas near the Gulf of Mexico, and from underlying aquifers. Heavy pumping from the Chicot aquifer system during the past several decades has substantially altered flow patterns from pre-development conditions, increasing the potential for saltwater encroachment. Water from all areas of the aquifer now flows toward rice-growing areas in Acadia, Evangeline, and Jefferson Davis Parishes and towards the Lake Charles industrial district in Calcasieu Parish. Saltwater is present in the upper, lower, shallow, "500-foot," and "700-foot" sands.

Saltwater is present in the upper and "200-foot" sands in five areas which roughly encompass about 4,000 $mi^2$. The Atchafalaya River area, Vermilion Parish area, and Cameron Parish area are broad, adjacent areas where saltwater is present. Saltwater potentially could move northward from coastal areas and westward from the Atchafalaya River area towards areas of heavy pumping in Acadia, Jefferson Davis, and Calcasieu Parishes. Saltwater has been documented in areas near Iowa, Louisiana, and along the lower Vermilion River area near Abbeville, Louisiana.

A tongue of saltwater extends northward from the Gulf of Mexico beneath the Atchafalaya River area in western Iberville and eastern Iberia, St. Martin, and St. Mary Parishes; no major aquifers contain freshwater in this area. A freshwater-saltwater interface in the upper sand extends westward from the tongue, at altitudes between about 200 and 400 feet below sea level, into central Iberia and St. Martin Parishes and across St. Mary Parish. Chloride concentrations in water from area wells do not indicate that substantial westward movement of the freshwater-saltwater interface is occurring. Chloride concentrations have increased at well SMn-109. Because of the location of this well, however, the increases could be the result of either westward movement of the interface or eastward expansion of saltwater associated with a nearby salt dome. Decreasing chloride concentrations in water from well I-93 in Iberia Parish could be due to recharge into the upper sands of the aquifer by low-salinity water from the Atchafalaya River area.

Saltwater in the upper sand in the Vermilion Parish and Cameron Parish areas could move northward in response to heavy pumping in Acadia, Calcasieu, and Jefferson Davis Parishes. Few wells located near the leading edge of the freshwater-saltwater interface in the Vermilion Parish area are screened at an appropriate depth to determine whether northward movement of the freshwater-saltwater interface is occurring. Chloride concentrations in water from wells located above and below the base of freshwater in Vermilion Parish indicate that the position of the interface has not changed substantially since the mid-1960's. Chloride concentrations in water from many wells screened in the upper and "200-foot" sands in the Cameron Parish area have decreased at average rates between 3 and 6 (mg/L)/yr (milligrams per liter per year). It is possible that vertical leakage of freshwater through surficial clay units may be recharging the upper sand, displacing saltwater, and resulting in the decreasing chloride concentrations observed in this area.

Saltwater is present in the upper sand over a 40 $mi^2$ area in the vicinity of Iowa, Louisiana, in eastern Calcasieu Parish. Wells sampled in the area confirm the presence of high-chloride water. However, because none of these wells had been previously sampled, no trends could be established.

Saltwater from the lower sand has moved upward into the upper sand, affecting an area of about 50 $mi^2$ near Abbeville, Louisiana. Chloride concentrations in water from wells screened within the saltwater in this area have increased at rates as high as 13 (mg/L)/yr. Above the upper sand in this area, the shallow sand has been recharged by saltwater from the Vermilion River. Data from wells screened in the saltwater body in the shallow sand do not indicate that chloride concentrations are increasing or that the saltwater is spreading.

Saltwater is present in the "500-foot" sand near the Calcasieu-Cameron Parish border between altitudes of about 500 and 600 feet below sea level and may be moving slowly northward in response to pumping in Calcasieu Parish. Chloride concentrations in water from wells along the interface have increased at low rates, indicating that saltwater encroachment may be occurring at an extremely low rate near the Calcasieu-Cameron Parish border. However, the volume of saltwater moving northward in western and central parts of the interface is somewhat diminished by decreased transmissivity in the "500-foot" sand in areas where it thins near the East and West Hackberry and Bayou Black salt domes.

The central, northern, and southern chloride bodies have been defined in the "500-foot" sand in the Lake Charles industrial district. Saltwater from the "700-foot" sand may be moving upward into the "500-foot" sand through aquifer interconnections due to intense pumping in the industrial district. Chloride concentrations greater than 100 mg/L (milligrams per liter) also occur in the "500-foot" sand at public-supply wells in eastern and southern Lake Charles. Each of these wells is pumped alternately with another well located within 300 feet and completed at the same depth, which helps to decrease the intensity of upconing.

The central chloride body extends across an area of about 2 $mi^2$ and contains water with concentrations of chloride of almost 400 mg/L. Chloride concentrations in samples from wells located within the central chloride body of the Lake Charles industrial district have remained relatively stable since the mid-1970's. Chloride concentrations in samples from wells along the perimeter of the body have not increased — an indication that the body is not spreading. Little pumping occurs in the central chloride body area and the presence of saltwater could be associated with oil and gas exploration activities during the early 1900's at the nearby Lockport oil field.

The northern chloride body extends across an area of about 1 $mi^2$ and contains water with chloride concentrations ranging from 50 to 150 mg/L. Chloride concentrations in water from well Cu-615, completed in the "500-foot" sand at the northern chloride body, increased at a rate of about 4 (mg/L)/yr during 1966-95. This increase probably is due to upconing of saltwater at the pumped well and has affected only a small area. Chloride concentrations in water from other wells completed in or near the northern chloride body have not changed substantially since the early 1980's.

The southern chloride body covers an area of about 1.5 $mi^2$ and contains water with chloride concentrations greater than 300 mg/L. Chloride concentrations in wells located east, west, and south of the southern chloride body have increased, although chloride concentrations in water from well Cu-694, located near the center of the body, have shown little net change since the late 1970's. Chloride concentrations in water from wells Cu-676 and Cu-778, located on the south and east sides of the chloride body, have increased at a rate of almost 10 (mg/L)/yr. The increase in chloride concentrations at these wells probably is due to upconing in the vicinity of the wells and is localized. However, the rise in chloride concentrations in water from well Cu-960, which is located west of the pumping center, indicates that additional upconing of saltwater from the "700-foot" sand to the "500-foot" sand is probably occurring near well Cu-960 as a result of the lowered heads in the cone of depression.

Saltwater occurs in the lower and "700-foot" sands in the southern two-thirds of Calcasieu Parish at altitudes between about 600 and 800 feet below sea level. Although few facilities continue to pump water from the aquifer, pumping from the "500-foot" sand strongly affects water levels in the "700-foot" sand, and the general lateral movement of water in the "700-foot" sand in all areas of Calcasieu Parish is toward the Lake Charles industrial district. In general, chloride concentrations in samples from pumped wells or wells located near wells pumping from the "700-foot" sand have slightly increased. However, chloride concentrations in samples from well Cu-767, which is not pumped, have increased at an average rate of about 16 (mg/L)/yr since 1962. This rate has almost doubled to 30 (mg/L)/yr since 1991. This rate of increase is similar to the rate of increase during the 1970's, indicating that the sharp rise in water levels after the completion of the Sabine River Diversion Canal in 1982 only temporarily relieved the stresses causing saltwater encroachment in the area. Well Cu-767 is located about 1.5 miles south of public-supply well Cu-661, which has experienced increases in chloride concentrations at an average rate of about 4 (mg/L)/yr. Chloride concentrations in samples from wells located away from pumping generally showed either no trends or slight decreases. Chloride concentrations in samples from well Cu-972, located near the leading edge of the freshwater-saltwater interface in the northeastern corner of Calcasieu Parish, decreased from 260 mg/L in 1979 to 120 mg/L in 1995. This may be an indication that freshwater is being drawn from the north in some areas within the cone of depression, causing the freshwater-saltwater interface to recede southward.

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# APPENDIX:

Selected data for wells in southwestern Louisiana, including water-level measurements, specific conductance, and chloride concentrations

Appendix. Selected data for wells in southwestern Louisiana, including water-level measurements, specific conductance, and chloride concentrations

[Aquifer code: 112CHCTU, upper sand; 11205LC, "500-foot" sand; 11202LC, "200-foot" sand; 11207LC, "700-foot" sand; 112CHCTL, lower sand; 112CHCT, Chicot aquifer system; 112ACFL, Atchafayala aquifer; CHCTS, Chicot aquifer, shallow sand unit.]

| Well number | Latitude (degrees) | Longitude (degrees) | Aquifer code | Altitude of land surface (feet relative to sea level) | Depth of well (feet) | Depth to top of screen (feet) | Depth to bottom of screen (feet) | Date sampled | Altitude of water level (feet relative to sea level) | Specific conductance (micro-siemens per centimeter at 25 degrees Celsius) | Chloride concentration (milligrams per liter) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ACADIA PARISH | | | | | | |
| Ac-330 | 300719 | 922949 | 112CHCTU | 12.00 | 280 | 230 | 280 | 06-12-96 | -- | 766 | 53 |
| Ac-451 | 300740 | 922650 | 112CHCTU | 14.00 | 293 | 212 | 293 | 06-12-96 | -- | 787 | 45 |
| Ac-452 | 300742 | 922659 | 112CHCTU | 13.00 | 246 | 206 | 246 | 04-12-95 | -- | 811 | 53 |
| Ac-5716Z | 300731 | 923304 | 112CHCTU | 8.00 | 160 | 154 | 160 | 02-14-95 | -- | 831 | 100 |
| | | | | | CALCASIEU PARISH | | | | | | |
| Cu-1 | 301133 | 933445 | 11205LC | 15.00 | 585 | 535 | 585 | 12-08-95 | -- | 470 | 59 |
| Cu-74 | 301107 | 932001 | 11205LC | 15.00 | 545 | 415 | 545 | 09-19-95 | -- | 386 | 24 |
| Cu-77 | 301405 | 931535 | 11205LC | 9.61 | 512 | 448 | 512 | 10-20-95 | -87.87 | -- | -- |
| Cu-79 | 301356 | 931602 | 11205LC | 10.00 | 519 | 399 | 519 | 09-06-95 | -- | 437 | 47 |
| Cu-80 | 301354 | 931552 | 11205LC | 10.00 | 512 | 442 | 512 | 09-06-95 | -- | 451 | 52 |
| Cu-83 | 301406 | 931552 | 11205LC | 16.00 | 501 | 421 | 501 | 09-06-95 | -- | 375 | 38 |
| Cu-90A | 301438 | 931609 | 11205LC | 12.00 | 584 | 464 | 584 | 09-20-95 | -87.42 | 467 | 63 |
| Cu-168 | 300440 | 930845 | 11202LC | 7.81 | 375 | -- | -- | 04-30-96 | -57.69 | -- | -- |
| Cu-395 | 301634 | 931402 | 11202LC | 12.00 | 200 | -- | -- | 04-22-96 | -25.34 | -- | -- |
| Cu-450 | 301423 | 931551 | 11205LC | 10.00 | 523 | 393 | 523 | 09-06-95 | -- | 476 | 67 |
| Cu-453 | 300910 | 932240 | 11202LC | 13.18 | 345 | 261 | 345 | 04-22-96 | -43.61 | -- | -- |
| Cu-458 | 301422 | 931606 | 11205LC | 10.00 | 509 | -- | -- | 09-06-95 | -- | 540 | 68 |
| Cu-463B | 301106 | 932032 | 11205LC | 17.00 | 516 | 400 | 516 | 09-08-95 | -- | 412 | 28 |
| Cu-464 | 301129 | 932020 | 11205LC | 15.00 | 530 | 406 | 530 | 09-08-95 | -- | 370 | 23 |
| Cu-465 | 301407 | 931617 | 11205LC | 10.00 | 520 | 437 | 520 | 09-06-95 | -- | 507 | 70 |
| Cu-510 | 301714 | 932345 | 11205LC | 19.75 | 450 | 370 | 450 | 12-01-95 | -46.60 | -- | -- |
| Cu-515 | 300641 | 932425 | 11205LC | 11.15 | 573 | 554 | 573 | 12-07-95 | -50.96 | -- | -- |
| Cu-517 | 302228 | 931403 | 11205LC | 38.80 | 439 | 357 | 439 | 12-13-95 | -22.30 | -- | -- |
| Cu-529 | 300818 | 933616 | 11202LC | 18.00 | 276 | -- | -- | 12-07-95 | -35.91 | -- | -- |

Appendix. Selected data for wells in southwestern Louisiana, including water-level measurements, specific conductance, and chloride concentrations—Continued

| Well number | Latitude (degrees) | Longitude (degrees) | Aquifer code | Altitude of land surface (feet relative to sea level) | Depth of well (feet) | Depth to top of screen (feet) | Depth to bottom of screen (feet) | Date sampled | Altitude of water level (feet relative to sea level) | Specific conductance (micro-siemens per centimeter at 25 degrees Celsius) | Chloride concentration (milligrams per liter) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CALCASIEU PARISH -- continued | | | | | | | | | | | |
| Cu-530 | 300806 | 933606 | 11205LC | 9.32 | 595 | 515 | 595 | 12-07-95 | -21.07 | -- | -- |
| Cu-552 | 301359 | 931622 | 11205LC | 10.00 | 517 | -- | -- | 09-06-95 | -106.25 | -- | -- |
| Cu-560 | 301035 | 931934 | 11205LC | 15.00 | 563 | 433 | 563 | 09-19-95 | -- | 703 | 110 |
| Cu-583 | 301320 | 931657 | 11207LC | 15.00 | 669 | 569 | 669 | 09-07-95 | -- | 716 | 120 |
| Cu-588 | 300922 | 932029 | 11205LC | 12.00 | 586 | 506 | 586 | 09-16-96 | -- | 485 | 51 |
| Cu-589 | 300917 | 932029 | 11205LC | 12.00 | 585 | 505 | 585 | 09-16-96 | -- | 485 | 46 |
| Cu-591 | 301118 | 931950 | 11205LC | 15.00 | 547 | 427 | 547 | 09-19-95 | -- | 464 | 52 |
| Cu-615 | 301339 | 931725 | 11205LC | 15.00 | 533 | 413 | 533 | 09-07-95 | -- | 748 | 130 |
| Cu-619 | 301035 | 931911 | 11205LC | 15.00 | 586 | -- | -- | 09-19-95 | -103.74 | -- | -- |
| Cu-622 | 301355 | 931523 | 11202LC | 4.00 | 219 | 187 | 219 | 09-20-95 | -- | 433 | 42 |
| Cu-641 | 300711 | 930745 | 11202LC | 11.50 | 368 | 268 | 368 | 04-23-96 | -51.32 | -- | -- |
| Cu-642 | 301641 | 930359 | 11202LC | 19.00 | 287 | -- | -- | 04-23-96 | -38.59 | -- | -- |
| Cu-655 | 301403 | 932246 | 11205LC | 15.00 | 578 | 498 | 578 | 09-16-96 | -- | 367 | 44 |
| Cu-661 | 301154 | 931238 | 11207LC | 15.00 | 729 | 649 | 729 | 09-17-96 | -- | 1,060 | 230 |
| Cu-664 | 301115 | 932036 | 11205LC | 15.00 | 501 | 401 | 501 | 09-08-95 | -- | 387 | 21 |
| Cu-676 | 301029 | 931944 | 11205LC | 15.00 | 550 | 430 | 550 | 09-19-95 | -- | 1,430 | 340 |
| Cu-677 | 301445 | 931622 | 11205LC | 10.00 | 568 | 468 | 568 | 09-20-95 | -89.69 | -- | -- |
| Cu-683 | 301155 | 931238 | 11205LC | 17.50 | 497 | 417 | 497 | 09-17-96 | -- | 441 | 37 |
| Cu-686 | 301125 | 931958 | 11205LC | 15.00 | 530 | 430 | 530 | 09-19-95 | -102.72 | -- | -- |
| Cu-692 | 301112 | 932016 | 11205LC | 15.00 | 560 | 435 | 560 | 09-08-95 | -- | 384 | 22 |
| Cu-694 | 301044 | 931951 | 11205LC | 15.00 | 556 | 446 | 556 | 09-19-95 | -- | 1,520 | 350 |
| Cu-698 | 301852 | 933940 | 11205LC | 30.00 | 425 | 405 | 425 | 12-12-95 | -15.36 | -- | -- |
| Cu-699 | 301027 | 931915 | 11205LC | 14.00 | 530 | 425 | 530 | 09-19-95 | -- | 593 | 73 |
| Cu-708 | 301036 | 931243 | 11205LC | 13.00 | 549 | 489 | 549 | 09-17-96 | -- | 778 | 140 |
| Cu-710 | 301349 | 931652 | 11207LC | 15.00 | 684 | 584 | 684 | 09-07-95 | -- | 972 | 200 |

Appendix. Selected data for wells in southwestern Louisiana, including water-level measurements, specific conductance, and chloride concentrations—Continued

| Well number | Latitude (degrees) | Longitude (degrees) | Aquifer code | Altitude of land surface (feet relative to sea level) | Depth of well (feet) | Depth to top of screen (feet) | Depth to bottom of screen (feet) | Date sampled | Altitude of water level (feet relative to sea level) | Specific conductance (microsiemens per centimeter at 25 degrees Celsius) | Chloride concentration (milligrams per liter) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CALCASIEU PARISH -- continued | | | | | | | | | | | |
| Cu-731 | 301258 | 931724 | 11207LC | 11.79 | 660 | 650 | 659 | 09-07-95 | -89.60 | -- | -- |
| | | | | | | | | 05-13-96 | -87.55 | -- | -- |
| Cu-732 | 301258 | 931724 | 11205LC | 12.08 | 492 | 480 | 492 | 09-07-95 | -92.04 | -- | -- |
| | | | | | | | | 05-13-96 | -90.35 | -- | -- |
| Cu-733 | 301258 | 931724 | 11202LC | 12.16 | 201 | 191 | 201 | 09-07-95 | -43.00 | -- | -- |
| | | | | | | | | 05-13-96 | -43.52 | -- | -- |
| Cu-746 | 301300 | 931616 | 11207LC | 7.22 | 780 | 770 | 780 | 10-20-95 | -85.42 | 477 | 57 |
| | | | | | | | | 04-30-96 | -85.57 | -- | -- |
| Cu-747 | 301300 | 931616 | 11205LC | 7.17 | 540 | 530 | 540 | 10-20-95 | -89.85 | 386 | 23 |
| | | | | | | | | 04-30-96 | -90.30 | -- | -- |
| Cu-748 | 301300 | 931616 | 11202LC | 7.15 | 280 | 270 | 280 | 10-20-96 | -44.81 | 428 | 27 |
| | | | | | | | | 04-30-96 | -44.97 | -- | -- |
| Cu-756 | 301452 | 931639 | 11205LC | 10.00 | 530 | 430 | 530 | 09-20-95 | -- | 465 | 62 |
| Cu-767 | 301036 | 931244 | 11207LC | 11.42 | 850 | 840 | 850 | 09-12-95 | -66.61 | 3,320 | 930 |
| Cu-769 | 301336 | 931830 | 11207LC | 17.62 | 642 | 632 | 642 | 10-12-95 | -84.71 | 822 | 140 |
| Cu-770 | 301336 | 931830 | 11205LC | 17.54 | 490 | 480 | 490 | 10-12-95 | -85.13 | 388 | 36 |
| Cu-771 | 301336 | 931830 | 11202LC | 17.76 | 241 | 231 | 241 | 09-13-95 | -43.32 | 425 | 16 |
| | | | | | | | | 04-16-96 | -42.81 | -- | -- |
| Cu-778 | 301046 | 931912 | 11205LC | 15.00 | 525 | 415 | 525 | 09-19-95 | -- | 1,360 | 310 |
| Cu-779 | 301438 | 932217 | 11205LC | 15.00 | 530 | 450 | 530 | 09-16-96 | -- | 273 | 21 |
| Cu-786L | 300820 | 931319 | 11207LC | 13.25 | 880 | 870 | 880 | 12-07-95 | -55.70 | 1090 | 230 |
| Cu-786U | 300820 | 931319 | 11207LC | 13.25 | 840 | 830 | 840 | 12-07-95 | -55.78 | 1,080 | 230 |
| Cu-787 | 300353 | 932102 | 11205LC | 4.33 | 734 | 729 | 734 | 09-12-95 | -51.20 | 535 | 50 |
| Cu-788 | 300825 | 932608 | 11207LC | 6.11 | 805 | 800 | 805 | 11-22-95 | -48.56 | 2,530 | 630 |
| Cu-789 | 301100 | 932000 | 11207LC | 18.42 | 640 | 635 | 640 | 10-11-95 | -73.28 | 848 | 160 |

Appendix. Selected data for wells in southwestern Louisiana, including water-level measurements, specific conductance, and chloride concentrations—Continued

| Well number | Latitude (degrees) | Longitude (degrees) | Aquifer code | Altitude of land surface (feet relative to sea level) | Depth of well (feet) | Depth to top of screen (feet) | Depth to bottom of screen (feet) | Date sampled | Altitude of water level (feet relative to sea level) | Specific conductance (micro-siemens per centimeter at 25 degrees Celsius) | Chloride concentration (milligrams per liter) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CALCASIEU PARISH -- continued | | | | | | | | | | | |
| Cu-798 | 300919 | 930556 | 11202LC | 25.43 | 345 | 265 | 345 | 05-13-96 | -57.42 | -- | -- |
| Cu-806 | 301312 | 930941 | 11205LC | 12.00 | 516 | 416 | 516 | 09-17-96 | -- | 749 | 160 |
| Cu-811 | 300812 | 931658 | 11207LC | 11.00 | 923 | 912 | 923 | 04-22-96 | -61.50 | -- | -- |
| Cu-827 | 301134 | 931911 | 11205LC | 10.00 | 560 | 480 | 560 | 09-27-95 | -- | 680 | 110 |
| Cu-828 | 301149 | 931908 | 11205LC | 10.00 | 560 | 500 | 560 | 09-27-95 | -- | 973 | 190 |
| Cu-831 | 301510 | 931601 | 11205LC | 6.00 | 497 | 397 | 497 | 09-28-95 | -- | 331 | 26 |
| Cu-835 | 301437 | 931634 | 11205LC | 10.00 | 520 | 410 | 520 | 09-20-95 | -- | 548 | 83 |
| Cu-840 | 301339 | 931655 | 11205LC | 10.00 | 500 | 380 | 500 | 09-07-95 | -- | 685 | 110 |
| Cu-842 | 301148 | 931932 | 11205LC | 12.00 | 575 | 572 | 575 | 10-19-95 | -96.62 | 1,340 | 310 |
| | | | | | | | | 04-30-96 | -97.76 | -- | -- |
| Cu-843 | 301148 | 931932 | 11202LC | 12.00 | 205 | 200 | 205 | 10-19-95 | -41.64 | 387 | 17 |
| | | | | | | | | 04-30-96 | -41.21 | -- | -- |
| Cu-847 | 301230 | 931932 | 11205LC | 13.00 | 522 | 517 | 522 | 10-12-95 | -85.61 | -- | -- |
| Cu-849 | 301205 | 931825 | 11205LC | 10.00 | 564 | 559 | 564 | 10-11-95 | -87.99 | 614 | 93 |
| Cu-851 | 301213 | 931917 | 11205LC | 10.00 | 555 | 550 | 555 | 10-19-95 | -89.59 | 1,630 | 400 |
| Cu-853 | 300806 | 933603 | 11202LC | 18.00 | 230 | 220 | 230 | 05-06-96 | -39.27 | -- | -- |
| Cu-854 | 300643 | 930447 | 11202LC | 20.00 | 430 | 420 | 430 | 11-29-95 | -32.37 | 1,170 | 94 |
| Cu-860 | 301052 | 931944 | 11205LC | 12.00 | 566 | 446 | 566 | 09-27-95 | -98.60 | -- | -- |
| Cu-862 | 301048 | 931934 | 11205LC | 15.00 | 550 | 420 | 550 | 09-19-95 | -- | 516 | 57 |
| Cu-866 | 301350 | 931712 | 11202LC | 15.00 | 192 | -- | -- | 09-28-95 | -- | 412 | 18 |
| Cu-867 | 301350 | 931729 | 11205LC | 15.00 | 500 | 380 | 500 | 09-07-95 | -- | 437 | 50 |
| Cu-868 | 301341 | 931740 | 11205LC | 15.00 | 520 | 400 | 520 | 09-07-95 | -- | 509 | 65 |
| Cu-869 | 301348 | 931714 | 11205LC | 15.00 | 526 | 406 | 526 | 09-07-95 | -- | 755 | 130 |
| Cu-871 | 301914 | 931816 | 11202LC | 25.60 | 114 | 106 | 114 | 05-08-96 | -10.24 | -- | -- |
| Cu-882 | 301907 | 931801 | 11202LC | 20.00 | 110 | 100 | 110 | 05-01-96 | -10.65 | -- | -- |

Appendix. Selected data for wells in southwestern Louisiana, including water-level measurements, specific conductance, and chloride concentrations—Continued

| Well number | Latitude (degrees) | Longitude (degrees) | Aquifer code | Altitude of land surface (feet relative to sea level) | Depth of well (feet) | Depth to top of screen (feet) | Depth to bottom of screen (feet) | Date sampled | Altitude of water level (feet relative to sea level) | Specific conductance (micro-siemens per centimeter at 25 degrees Celsius) | Chloride concentration (milligrams per liter) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CALCASIEU PARISH -- continued | | | | | | | | | | | |
| Cu-946 | 301356 | 931710 | 11202LC | 15.00 | 198 | 178 | 198 | 09-28-95 | -46.68 | -- | -- |
| | | | | | | | | 04-30-96 | -46.39 | -- | -- |
| Cu-947 | 300643 | 930447 | 11205LC | 20.00 | 600 | 595 | 600 | 11-29-95 | -38.89 | 481 | 34 |
| Cu-949 | 301334 | 931753 | 11205LC | 18.00 | 504 | 474 | 504 | 09-27-95 | -91.56 | -- | -- |
| Cu-951 | 301328 | 931757 | 11205LC | 18.00 | 500 | 430 | 500 | 09-27-95 | -- | 420 | 38 |
| Cu-955 | 301335 | 931651 | 11205LC | 7.00 | 459 | 339 | 459 | 09-07-95 | -- | 441 | 39 |
| Cu-957 | 301120 | 931910 | 11205LC | 17.00 | 500 | 440 | 500 | 09-27-95 | -- | 536 | 63 |
| Cu-958 | 301944 | 932204 | 11207LC | 20.00 | 707 | 702 | 707 | 11-30-95 | -32.55 | 296 | 30 |
| Cu-959 | 301031 | 932049 | 11207LC | 21.00 | 733 | 727 | 733 | 10-11-95 | -71.01 | 737 | 120 |
| Cu-960 | 301031 | 932049 | 11205LC | 21.00 | 598 | 592 | 598 | 10-11-95 | -74.82 | 689 | 120 |
| Cu-962 | 300812 | 931658 | 11202LC | 11.00 | 287 | 281 | 287 | 04-22-96 | -38.26 | -- | -- |
| Cu-963 | 300718 | 932200 | 11202LC | 10.00 | 399 | 393 | 399 | 12-07-95 | -57.06 | -- | -- |
| Cu-964 | 301339 | 932539 | 11205LC | 16.00 | 360 | 354 | 360 | 11-21-95 | -47.94 | 373 | 25 |
| Cu-966 | 301350 | 930450 | 11202LC | 18.00 | 235 | 229 | 235 | 04-30-96 | -47.90 | -- | -- |
| Cu-967 | 301147 | 931419 | 11202LC | 12.00 | 240 | 234 | 240 | 11-02-95 | -44.19 | 435 | 18 |
| | | | | | | | | 04-30-96 | -43.73 | -- | -- |
| Cu-968 | 300557 | 932504 | 11202LC | 10.00 | 276 | 270 | 276 | 11-22-95 | -29.68 | 433 | 12 |
| | | | | | | | | 04-22-96 | -29.53 | -- | -- |
| Cu-970 | 300534 | 925437 | 112CHCTL | 5.00 | 780 | 770 | 780 | 11-21-95 | -35.39 | 2,880 | 780 |
| | | | | | | | | 04-30-96 | -34.21 | -- | -- |
| Cu-971 | 300534 | 925437 | 112CHCTU | 5.00 | 500 | 490 | 500 | 11-21-95 | -33.03 | 1,410 | 290 |
| | | | | | | | | 04 30-96 | -35.51 | -- | -- |
| Cu-972 | 301941 | 930356 | 11207LC | 20.00 | 595 | 585 | 595 | 11-29-95 | -22.38 | 696 | 120 |
| | | | | | | | | 04-30-96 | -24.18 | -- | -- |
| Cu-974 | 301601 | 931306 | 11205LC | 5.00 | 466 | 456 | 466 | 11-30-95 | -61.39 | 331 | 27 |

Appendix. Selected data for wells in southwestern Louisiana, including water-level measurements, specific conductance, and chloride concentrations—Continued

| Well number | Latitude (degrees) | Longitude (degrees) | Aquifer code | Altitude of land surface (feet relative to sea level) | Depth of well (feet) | Depth to top of screen (feet) | Depth to bottom of screen (feet) | Date sampled | Altitude of water level (feet relative to sea level) | Specific conductance (micro-siemens per centimeter at 25 degrees Celsius) | Chloride concentration (milligrams per liter) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CALCASIEU PARISH -- continued | | | | | | | | | | | |
| Cu-975 | 301941 | 930356 | 11202LC | 20.00 | 237 | 231 | 237 | 11-29-95 | -17.20 | 1,080 | 230 |
| | | | | | | | | 04-30-96 | -17.28 | -- | -- |
| Cu-977 | 301944 | 932204 | 11205LC | 20.00 | 515 | 510 | 515 | 11-22-95 | -34.44 | 473 | 33 |
| Cu-978 | 301409 | 931203 | 11207LC | 15.00 | 645 | 640 | 645 | 11-01-95 | -71.99 | 360 | 39 |
| Cu-979 | 301005 | 931104 | 11205LC | 20.00 | 555 | 550 | 555 | 11-21-95 | -56.40 | 435 | 29 |
| Cu-987 | 301341 | 931748 | 11202LC | 15.00 | 200 | 170 | 200 | 09-27-95 | -- | 409 | 18 |
| Cu-988 | 301059 | 931251 | 11205LC | 14.00 | 523 | 518 | 523 | 11-02-95 | -67.57 | 466 | 35 |
| | | | | | | | | 04-22-96 | -68.96 | -- | -- |
| Cu-989 | 301059 | 931251 | 11205LC | 14.00 | 335 | 330 | 335 | 11-02-95 | -54.47 | 424 | 20 |
| | | | | | | | | 04-22-96 | -53.70 | -- | -- |
| Cu-990 | 301059 | 931251 | 11202LC | 14.00 | 183 | 178 | 183 | 11-02-95 | -46.72 | 430 | 18 |
| | | | | | | | | 04-22-96 | -45.57 | -- | -- |
| Cu-991 | 301436 | 933351 | 11205LC | 20.00 | 315 | 310 | 315 | 12-08-95 | -17.62 | 206 | 17 |
| | | | | | | | | 05-02-96 | -17.81 | -- | -- |
| Cu-994 | 300634 | 934004 | 11207LC | 5.00 | 757 | 752 | 757 | 12-08-95 | -38.00 | 760 | 130 |
| Cu-1003 | 301603 | 931530 | 11205LC | 18.00 | 492 | 410 | 492 | 09-16-96 | -- | 292 | 28 |
| Cu-1015 | 302244 | 933257 | 11205LC | 47.50 | 386 | 296 | 386 | 12-13-95 | -17.41 | -- | -- |
| Cu-1017 | 302719 | 932342 | 112CHCT | 72.50 | 351 | 301 | 351 | 05-01-96 | -0.62 | -- | -- |
| Cu-1018 | 301800 | 931217 | 11205LC | 20.00 | 398 | 318 | 398 | 11-30-95 | -- | 316 | 27 |
| Cu-1020 | 301141 | 931235 | 11205LC | 18.00 | 375 | 367 | 375 | 11-02-95 | -68.02 | -- | -- |
| Cu-1021 | 301435 | 931546 | 11205LC | 12.00 | 487 | 477 | 487 | 10-12-95 | -81.43 | 311 | 24 |
| Cu-1022 | 301444 | 931629 | 11207LC | 11.00 | 618 | 608 | 618 | 09-28-95 | -83.78 | -- | -- |
| Cu-1023 | 301328 | 931647 | 11207LC | 15.00 | 701 | 566 | 701 | 09-07-95 | -- | 1,060 | 220 |
| Cu-1039 | 301150 | 932243 | 11205LC | 11.50 | 484 | 464 | 484 | 09-28-95 | -70.65 | 368 | 23 |
| Cu-1041 | 300702 | 931658 | 11205LC | 9.00 | 560 | 550 | 560 | 11-02-95 | -60.72 | 445 | 31 |

Appendix. Selected data for wells in southwestern Louisiana, including water-level measurements, specific conductance, and chloride concentrations—Continued

| Well number | Latitude (degrees) | Longitude (degrees) | Aquifer code | Altitude of land surface (feet relative to sea level) | Depth of well (feet) | Depth to top of screen (feet) | Depth to bottom of screen (feet) | Date sampled | Altitude of water level (feet relative to sea level) | Specific conductance (micro-siemens per centimeter at 25 degrees Celsius) | Chloride concentration (milligrams per liter) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CALCASIEU PARISH -- continued | | | | | | | | | | | |
| Cu-1051 | 301401 | 933024 | 11205LC | 20.00 | 410 | 380 | 410 | 12-13-95 | -37.42 | -- | -- |
| Cu-1056 | 301406 | 931552 | 11205LC | 10.00 | 505 | 405 | 505 | 09-06-95 | -- | 543 | 79 |
| Cu-1057 | 301405 | 931552 | 11205LC | 10.00 | 510 | 390 | 510 | 09-06-95 | -94.68 | -- | -- |
| Cu-1060 | 301339 | 931728 | 11202LC | 12.00 | 200 | 180 | 200 | 09-07-95 | -- | 377 | 17 |
| Cu-1064 | 300638 | 931705 | 11205LC | 6.00 | 640 | 568 | 640 | 11-21-95 | -63.85 | 558 | 63 |
| Cu-1066 | 301847 | 934057 | 11202LC | 25.00 | 255 | 235 | 255 | 12-12-95 | -7.29 | -- | -- |
| | | | | | | | | 05-02-96 | -7.92 | -- | -- |
| Cu-1087 | 301419 | 932035 | 11205LC | 15.00 | 580 | 344 | 580 | 09-16-96 | -- | 423 | 58 |
| Cu-1091 | 301347 | 931705 | 11202LC | 10.00 | 222 | 202 | 222 | 09-27-95 | -- | 413 | 17 |
| Cu-1096 | 301607 | 931531 | 11205LC | 17.50 | 480 | 400 | 480 | 09-16-96 | -- | 302 | 30 |
| Cu-1097 | 301133 | 931934 | 11205LC | 15.00 | 545 | 425 | 545 | 09-19-95 | -- | 550 | 76 |
| Cu-1109 | 301356 | 931601 | 11205LC | 10.00 | 500 | -- | -- | 09-06-95 | -104.30 | -- | -- |
| Cu-1128 | 301352 | 931714 | 11202LC | 10.00 | 223 | 193 | 223 | 09-28-95 | -- | 406 | 20 |
| Cu-1149 | 302108 | 931157 | 11207LC | 25.00 | 557 | 461 | 557 | 11-30-95 | -- | 277 | 30 |
| Cu-1158 | 301428 | 931614 | 11205LC | 10.00 | 495 | 395 | 495 | 09-20-95 | -95.71 | -- | -- |
| Cu-1159 | 301025 | 932616 | 11202LC | 11.00 | 280 | 270 | 280 | 05.06-96 | -48.00 | -- | -- |
| Cu-1185 | 302027 | 931805 | 11202LC | 21.73 | -- | -- | -- | 05-01-96 | -9.94 | -- | -- |
| Cu-1236 | 301135 | 932301 | 11205LC | 12.00 | 554 | 451 | 554 | 09-17-96 | -- | 374 | 28 |
| Cu-1239 | 302106 | 931154 | 11207LC | 25.00 | 502 | 389 | 502 | 11-30-95 | -29.08 | -- | -- |
| Cu-1240 | 301130 | 931806 | 11205LC | 8.00 | 548 | 468 | 548 | 10-19-95 | -92.10 | 494 | 50 |
| Cu-1245 | 301200 | 934044 | 11202LC | 11.00 | 136 | 116 | 136 | 12-13-95 | -4.54 | -- | -- |
| | | | | | | | | 05-02-96 | -4.38 | -- | -- |
| Cu-1249 | 301415 | 930045 | 112CHCTL | 20.00 | 500 | 420 | 500 | 12-12-95 | -- | 383 | 21 |
| Cu-1250 | 301456 | 931820 | 11205LC | 15.00 | 343 | 303 | 343 | 09-16-96 | -- | 370 | 42 |

Appendix. Selected data for wells in southwestern Louisiana, including water-level measurements, specific conductance, and chloride concentrations—Continued

| Well number | Latitude (degrees) | Longitude (degrees) | Aquifer code | Altitude of land surface (feet relative to sea level) | Depth of well (feet) | Depth to top of screen (feet) | Depth to bottom of screen (feet) | Date sampled | Altitude of water level (feet relative to sea level) | Specific conductance (micro-siemens per centimeter at 25 degrees Celsius) | Chloride concentration (milligrams per liter) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CALCASIEU PARISH -- continued | | | | | | | | | | | |
| Cu-1260 | 301409 | 931711 | 11202LC | 10.00 | 252 | 212 | 252 | 10-19-95 | -46.18 | -- | -- |
| | | | | | | | | 04-30-96 | -46.19 | -- | -- |
| Cu-1267 | 301852 | 933939 | 11205LC | 30.00 | 405 | -- | -- | 12-12-95 | -- | 261 | 15 |
| Cu-1269 | 301414 | 930045 | 112CHCTL | 22.00 | 503 | 423 | 503 | 12-12-95 | -41.84 | -- | -- |
| Cu-1272 | 301439 | 931504 | 11205LC | 13.00 | 511 | 440 | 511 | 09-16-96 | -- | 356 | 42 |
| Cu-1295 | 301159 | 930943 | 11202LC | 14.00 | 180 | 160 | 180 | 05-01-96 | -43.57 | -- | -- |
| Cu-1302 | 302357 | 932742 | 11202LC | 45.00 | 180 | 160 | 180 | 05-01-96 | +3.96 | -- | -- |
| Cu-1317 | 301427 | 931646 | 11205LC | 7.00 | 460 | 430 | 460 | 09-27-95 | -- | 410 | 37 |
| Cu-1320 | 301112 | 930046 | 112CHCTU | 24.00 | 345 | 265 | 345 | 05-13-96 | -62.20 | -- | -- |
| Cu-1326 | 300930 | 933810 | 11202LC | 17.00 | 280 | 260 | 280 | 05-06-96 | -27.18 | -- | -- |
| Cu-1364 | 301441 | 931525 | 11205LC | 15.00 | 552 | 450 | 552 | 09-16-96 | -- | 380 | 49 |
| Cu-1365 | 301326 | 931707 | 11202LC | 14.92 | 203 | 180 | 200 | 09-07-95 | -- | 418 | 17 |
| Cu-1372 | 301151 | 931941 | 11205LC | 12.00 | 567 | 463 | 565 | 09-27-95 | -- | 447 | 50 |
| Cu-1375 | 301424 | 931250 | 11205LC | 16.00 | 500 | 394 | 495 | 09-17-96 | -- | 392 | 38 |
| Cu-1384 | 301344 | 931705 | 11202LC | 10.00 | 200 | -- | -- | 09-27-95 | -- | 411 | 17 |
| Cu-1388 | 301852 | 933939 | 11207LC | 30.00 | 585 | 550 | 580 | 12-12-95 | -14.50 | 315 | 18 |
| Cu-5250Z | 302403 | 930846 | 11202LC | 20.00 | 140 | 128 | 138 | 03-28-95 | -- | 418 | 33 |
| Cu-5279Z | 301326 | 930646 | 11202LC | 20.00 | 105 | 100 | 105 | 03-28-95 | -- | 1,180 | 130 |
| Cu-5350Z | 300636 | 925815 | 112CHCTU | 20.00 | 219 | -- | -- | 03-28-95 | -- | 739 | 65 |
| Cu-5412Z | 301426 | 933107 | 11202LC | 21.00 | 165 | 160 | 165 | 03-29-95 | -- | 316 | 23 |
| Cu-5429Z | 301838 | 930346 | 11202LC | 20.00 | 180 | 175 | 180 | 03-28-95 | -- | 636 | 96 |
| Cu-5811Z | 300331 | 930216 | 11202LC | 10.00 | 350 | 340 | 350 | 07-26-94 | -- | 944 | 170 |
| Cu-6103Z | 300717 | 932547 | 11202LC | 20.00 | 285 | 279 | 285 | 03-29-95 | -- | 388 | 14 |
| Cu-6106Z | 300527 | 933217 | 11202LC | 10.00 | 159 | 154 | 159 | 03-29-95 | -- | 761 | 39 |
| Cu-6161Z | 301658 | 930946 | 11202LC | 15.00 | 165 | 160 | 165 | 03-28-95 | -- | 408 | 19 |

Appendix. Selected data for wells in southwestern Louisiana, including water-level measurements, specific conductance, and chloride concentrations—Continued

| Well number | Latitude (degrees) | Longitude (degrees) | Aquifer code | Altitude of land surface (feet relative to sea level) | Depth of well (feet) | Depth to top of screen (feet) | Depth to bottom of screen (feet) | Date sampled | Altitude of water level (feet relative to sea level) | Specific conductance (micro-siemens per centimeter at 25 degrees Celsius) | Chloride concentration (milligrams per liter) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | CALCASIEU PARISH -- continued | | | | | | | |
| Cu-6235Z | 300912 | 933904 | 11202LC | 12.00 | 170 | 160 | 170 | 03-29-95 | -- | 419 | 20 |
| Cu-6552Z | 300544 | 930830 | 11202LC | 8.00 | 180 | -- | 180 | 03-28-95 | -- | 578 | 34 |
| Cu-6680Z | 301632 | 930919 | 11202LC | 11.00 | 170 | 160 | 170 | 05-08-96 | -27.68 | -- | -- |
| Cu-6694Z | 301415 | 931719 | 11202LC | 15.00 | 155 | 150 | 155 | 03-27-95 | -- | 434 | 18 |
| Cu-6767Z | 301332 | 932327 | 11202LC | 15.00 | 350 | 340 | 350 | 03-29-95 | -- | 324 | 24 |
| Cu-6799Z | 300243 | 930622 | 11202LC | 12.00 | 300 | 295 | 300 | 03-28-95 | -- | 619 | 42 |
| Cu-7054Z | 301306 | 930636 | 11202LC | 20.00 | 295 | 285 | 295 | 07-27-94 | -- | 692 | 33 |
| Cu-7082Z | 301816 | 932805 | 11202LC | 13.00 | 260 | 240 | 260 | 05-06-96 | -- | -- | -- |
| Cu-7341Z | 301020 | 930552 | 11202LC | 20.00 | 225 | 40 | 225 | 03-28-95 | -- | 362 | 15 |
| Cu-7542Z | 301108 | 930546 | 11202LC | 21.00 | 210 | 200 | 210 | 07-26-95 | -- | 837 | 70 |
| Cu-7678Z | 300755 | 933103 | 11202LC | 8.00 | 315 | 310 | 315 | 03-29-95 | -- | 407 | 15 |
| Cu-7738Z | 301413 | 932010 | 11202LC | 19.00 | 201 | 186 | 201 | 05-06-96 | -27.05 | -- | -- |
| Cu-7782Z | 301920 | 930415 | 11202LC | 10.00 | 165 | 160 | 165 | 07-27-94 | -- | 912 | 160 |
| Cu-7948Z | 301340 | 933826 | 11202LC | 22.00 | 250 | 240 | 250 | 03-29-95 | -- | 293 | 20 |
| Cu-7952Z | 301924 | 934035 | 11202LC | 25.00 | 205 | 200 | 205 | 03-29-95 | -- | 300 | 12 |
| Cu-7955Z | 301306 | 932639 | 11202LC | 15.00 | 350 | 340 | 350 | 03-27-95 | -- | 349 | 19 |
| Cu-7967Z | 301707 | 932232 | 11202LC | 19.00 | 220 | 210 | 220 | 03-27-95 | -- | 290 | 22 |
| Cu-7979Z | 300949 | 931035 | 11202LC | 21.00 | 205 | 200 | 205 | 03-28-95 | -- | 595 | 51 |
| Cu-8507Z | 300749 | 931458 | 11202LC | 10.00 | 230 | 225 | 230 | 03-28-95 | -- | 586 | 28 |
| Cu-8638Z | 300943 | 933819 | 11202LC | 12.00 | 185 | 180 | 185 | 03-29-95 | -- | 403 | 15 |
| Cu-10278Z | 301509 | 930052 | 112CHCTU | 25.00 | -- | -- | -- | 11-01-95 | -- | 1,130 | 230 |
| | | | | CAMERON PARISH | | | | | | | |
| Cn-80L | 295846 | 923811 | 112CHCTU | 4.73 | 481 | 475 | 481 | 08-28-96 | -24.99 | 1,320 | 280 |
| Cn-80U | 295846 | 923811 | 112CHCTU | 4.73 | 453 | 443 | 453 | 02-08-93 | -- | 1,260 | 260 |

Appendix. Selected data for wells in southwestern Louisiana, including water-level measurements, specific conductance, and chloride concentrations—Continued

| Well number | Latitude (degrees) | Longitude (degrees) | Aquifer code | Altitude of land surface (feet relative to sea level) | Depth of well (feet) | Depth to top of screen (feet) | Depth to bottom of screen (feet) | Date sampled | Altitude of water level (feet relative to sea level) | Specific conductance (micro-siemens per centimeter at 25 degrees Celsius) | Chloride concentration (milligrams per liter) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CAMERON PARISH -- continued | | | | | | | | | | | |
| Cn-81L | 300125 | 923825 | 112CHCTU | 4.45 | 478 | 468 | 478 | 08-23-83 | -25.95 | 1,760 | 400 |
| | | | | | | | | 08-28-96 | -28.09 | -- | -- |
| Cn-81U | 300125 | 923825 | 112CHCTU | 4.45 | 448 | 438 | 448 | 07-01-86 | -- | 1,530 | 350 |
| Cn-84 | 294747 | 931850 | 112CHCTU | 11.07 | 244 | 192 | 244 | 06-13-96 | -- | 1,740 | 320 |
| Cn-86L | 300120 | 933208 | 11205LC | 3.66 | 641 | 631 | 641 | 09-26-96 | -36.03 | 1,930 | 460 |
| Cn-86U | 300120 | 933208 | 11205LC | 3.66 | 535 | 525 | 535 | 09-26-96 | -- | 1,070 | 210 |
| Cn-87 | 295324 | 932406 | 11205LC | 8.46 | 804 | 798 | 804 | 08-27-96 | -40.12 | 5,580 | 1,600 |
| Cn-88L | 300055 | 930930 | 11205LC | 8.86 | 804 | 794 | 804 | 09-19-95 | -41.24 | 2,370 | 590 |
| | | | | | | | | 08-28-96 | -44.58 | 2,360 | 610 |
| Cn-88U | 300055 | 930930 | 11205LC | 8.86 | 666 | 656 | 666 | 08-28-96 | -44.33 | 1,210 | 250 |
| Cn-90 | 295611 | 930448 | 11202LC | 3.19 | 396 | 386 | 396 | 09-21-95 | -26.49 | 987 | 170 |
| | | | | | | | | 04-17-96 | -25.97 | 983 | 170 |
| Cn-92 | 300104 | 930156 | 11202LC | 5.50 | 443 | 438 | 443 | 09-12-95 | -32.12 | 1,610 | 340 |
| | | | | | | | | 04-17-96 | -32.35 | 1,640 | 360 |
| Cn-93 | 294709 | 931743 | 112CHCTU | 3.76 | 360 | 355 | 360 | 08-27-96 | -21.52 | 1,220 | 220 |
| Cn-94 | 294543 | 933914 | 11207LC | 6.82 | 1,118 | 1,112 | 1,118 | 08-27-96 | -30.84 | 32,600 | 12,000 |
| Cn-107 | 294827 | 930955 | 112CHCTU | 4.00 | 320 | 280 | 320 | 06-14-96 | -- | 917 | 120 |
| Cn-118 | 294615 | 930042 | 112CHCTU | 5.00 | 638 | 628 | 638 | 08-28-96 | -17.37 | 3,030 | 820 |
| Cn-119 | 294709 | 931743 | 11205LC | 4.00 | 910 | 900 | 910 | 08-27-96 | -17.26 | 3,350 | 910 |
| Cn-120 | 295721 | 931157 | 11205LC | 3.00 | 764 | 754 | 764 | 08-27-96 | -35.39 | 1,070 | 200 |
| Cn-121 | 300040 | 931618 | 11205LC | 3.00 | 691 | 681 | 691 | 04-23-96 | -42.88 | -- | -- |
| | | | | | | | | 08-27-96 | -45.96 | 1,110 | 220 |
| Cn-134 | 295839 | 932035 | 11205LC | 5.00 | 710 | 690 | 710 | 08-27-96 | -39.10 | 1,430 | 300 |
| Cn-139 | 294825 | 931128 | 112CHCTU | 5.00 | 390 | 339 | 390 | 06-14-96 | -- | 1,280 | 230 |
| Cn-140 | 294545 | 933559 | 11202LC | 5.00 | 548 | 467 | 548 | 06-13-96 | -- | 7,610 | 2,300 |

Appendix. Selected data for wells in southwestern Louisiana, including water-level measurements, specific conductance, and chloride concentrations—Continued

| Well number | Latitude (degrees) | Longitude (degrees) | Aquifer code | Altitude of land surface (feet relative to sea level) | Depth of well (feet) | Depth to top of screen (feet) | Depth to bottom of screen (feet) | Date sampled | Altitude of water level (feet relative to sea level) | Specific conductance (micro-siemens per centimeter at 25 degrees Celsius) | Chloride concentration (milligrams per liter) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CAMERON PARISH -- continued | | | | | | | | | | | |
| Cn-141 | 295937 | 932320 | 11202LC | 7.50 | 537 | 395 | 466 | 06-13-96 | -- | 1,820 | 420 |
| Cn-152 | 300213 | 932010 | 11205LC | 4.00 | 750 | 710 | 750 | 06-13-96 | -- | 456 | 25 |
| Cn-157 | 294535 | 933826 | 11202LC | 5.00 | 432 | 372 | 432 | 06-13-96 | -- | 6,500 | 1,900 |
| Cn-162 | 294806 | 932057 | 11205LC | 5.00 | 915 | 875 | 915 | 06-13-96 | -- | 4,920 | 1,400 |
| Cn-170 | 294859 | 930756 | 112CHCTU | 5.00 | 325 | 275 | 325 | 06-14-96 | -- | 946 | 130 |
| Cn-171 | 294549 | 930054 | 112CHCTU | 5.00 | 387 | 336 | 382 | 08-28-96 | -- | 1,010 | 150 |
| Cn-175 | 300022 | 931450 | 11205LC | 5.00 | 710 | 649 | 710 | 06-14-96 | -- | 1,020 | 180 |
| Cn-180 | 294854 | 925559 | 112CHCTU | 5.00 | 362 | 320 | 362 | 06-14-96 | -- | 890 | 120 |
| Cn-181 | 295018 | 925903 | 112CHCTU | 5.00 | 362 | 320 | 362 | 06-14-96 | -- | 981 | 140 |
| Cn-182 | 295114 | 930320 | 112CHCTU | 3.00 | 362 | 320 | 362 | 06-14-96 | -- | 880 | 120 |
| Cn-185 | 294712 | 932054 | 11202LC | 5.00 | 290 | 240 | 290 | 06-13-96 | -- | 1,570 | 280 |
| Cn-190 | 300111 | 930748 | 11202LC | 14.00 | 354 | 293 | 354 | 06-14-96 | -- | 799 | 110 |
| Cn-5553Z | 300031 | 923824 | 112CHCTU | 6.00 | 230 | 220 | 230 | 05-09-95 | -- | 743 | 100 |
| IBERIA PARISH | | | | | | | | | | | |
| I-93 | 300035 | 914433 | 112CHCTU | 18.53 | 585 | 580 | 585 | 03-29-96 | +0.64 | 795 | 67 |
| I-134 | 295422 | 915335 | 112CHCTU | 20.00 | 633 | 537 | 633 | 06-05-96 | -- | 535 | 32 |
| I-157 | 300337 | 913633 | 112CHCTU | 5.00 | 406 | 385 | 406 | 06-05-96 | -- | 2,080 | 420 |
| I-159 | 300454 | 914427 | 112CHCTU | 15.00 | 400 | 360 | 400 | 06-05-96 | -- | 1,030 | 81 |
| I-168 | 295303 | 915417 | 112CHCTU | 7.61 | 600 | -- | -- | 06-05-96 | -- | 772 | 94 |
| I-181 | 295427 | 914017 | 112CHCTU | 14.00 | 387 | 325 | 387 | 06-05-96 | -- | 1,190 | 150 |
| I-182 | 295701 | 915822 | 112CHCTU | 5.00 | 340 | 320 | 340 | 06-06-96 | -- | 490 | 11 |
| I-221 | 295559 | 915853 | 112CHCTU | 5.00 | 380 | 350 | 380 | 06-06-96 | -- | 505 | 13 |
| I-258 | 295424 | 914116 | 112CHCTU | 13.00 | 400 | 390 | 400 | 06-05-96 | -- | 852 | 19 |

Appendix. Selected data for wells in southwestern Louisiana, including water-level measurements, specific conductance, and chloride concentrations—Continued

| Well number | Latitude (degrees) | Longitude (degrees) | Aquifer code | Altitude of land surface (feet relative to sea level) | Depth of well (feet) | Depth to top of screen (feet) | Depth to bottom of screen (feet) | Date sampled | Altitude of water level (feet relative to sea level) | Specific conductance (micro-siemens per centimeter at 25 degrees Celsius) | Chloride concentration (milligrams per liter) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| JEFFERSON DAVIS PARISH | | | | | | | | | | | |
| JD- 485A | 301300 | 925845 | 112CHCTU | 21.36 | 290 | 270 | 290 | 10-23-95 | -36.94 | -- | -- |
| | | | | | | | | 05-13-96 | -60.70 | -- | -- |
| JD-491 | 300508 | 924035 | 112CHCTU | 10.00 | 377 | 326 | 377 | 04-25-96 | -- | 710 | 100 |
| JD-5816Z | 300733 | 925131 | 112CHCTU | 5.00 | 150 | 145 | 150 | 02-28-95 | -- | 451 | 230 |
| JD-6047Z | 301442 | 925823 | 112CHCTU | 29.00 | 200 | 190 | 200 | 02-28-95 | -- | 1,080 | 250 |
| JD-6175Z | 301341 | 925503 | 112CHCTU | 17.00 | 165 | 160 | 165 | 02-28-95 | -- | 503 | 64 |
| JD-6207Z | 301258 | 925744 | 112CHCTU | 20.00 | 235 | 230 | 235 | 02-28-95 | -- | 1,040 | 230 |
| LAFAYETTE PARISH | | | | | | | | | | | |
| Lf-524 | 300605 | 915935 | 112CHCTU | 25.00 | 174 | 141 | 174 | 04-25-96 | -- | 187 | 7.4 |
| Lf-621 | 300620 | 915629 | 112CHCTU | 25.00 | 402 | 382 | 402 | 06-05-96 | -- | 405 | 8.5 |
| ST. MARTIN PARISH | | | | | | | | | | | |
| SMn-33 | 302034 | 914314 | 112CHCTU | 10.00 | -- | -- | -- | 06-05-96 | -- | 510 | 21 |
| SMn-48 | 302023 | 915028 | 112CHCTL | 25.00 | 577 | 527 | 577 | 05-21-96 | -- | 731 | 11 |
| SMn-108 | 301304 | 914240 | 112CHCTL | 11.34 | 505 | 500 | 505 | 03-29-96 | -- | 2,000 | 380 |
| SMn-109 | 301304 | 914240 | 112CHCTU | 11.34 | 375 | 370 | 375 | 03-29-96 | +6.45 | 1,130 | 120 |
| SMn-116 | 302023 | 915030 | 112CHCTL | 25.00 | 694 | 684 | 694 | 05-21-96 | -- | 749 | 11 |
| SMn-135B | 301512 | 915030 | 112CHCTL | 15.00 | 658 | 648 | 658 | 08-30-96 | +1.11 | 749 | 29 |
| SMn-150 | 302023 | 915030 | 112CHCTL | 25.00 | 575 | 524 | 575 | 05-21-96 | -- | 803 | 19 |
| SMn-163 | 301236 | 914258 | 112CHCTU | 15.00 | 330 | 300 | 330 | 05-21-96 | -- | 1,050 | 90 |
| SMn-177 | 301236 | 914258 | 112CHCTU | 15.00 | 333 | 302 | 333 | 05-21-96 | -- | 930 | 54 |
| SMn-187 | 301840 | 914755 | 112CHCTL | 14.00 | 542 | 502 | 542 | 05-21-96 | -- | 949 | 54 |
| ST. MARY PARISH | | | | | | | | | | | |
| SM-53 | 295017 | 913238 | 112CHCTU | 15.00 | 367 | 296 | 307 | 06-06-96 | -- | 1,280 | 170 |
| SM-57U | 294749 | 914023 | 112CHCTU | 8.72 | 638 | 628 | 638 | 08-29-96 | +0.54 | 1,140 | 190 |
| SM-58 | 295314 | 913121 | 112ACFL | 10.37 | 194 | 188 | 194 | 08-29-96 | +3.77 | 528 | 3.2 |

Appendix. Selected data for wells in southwestern Louisiana, including water-level measurements, specific conductance, and chloride concentrations—Continued

| Well number | Latitude (degrees) | Longitude (degrees) | Aquifer code | Altitude of land surface (feet relative to sea level) | Depth of well (feet) | Depth to top of screen (feet) | Depth to bottom of screen (feet) | Date sampled | Altitude of water level (feet relative to sea level) | Specific conductance (micro-siemens per centimeter at 25 degrees Celsius) | Chloride concentration (milligrams per liter) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ST. MARY PARISH -- continued | | | | | | | | | | | |
| SM-65 | 295017 | 913238 | 112CHCTU | 15.00 | 391 | 310 | 391 | 06-06-96 | -- | 1,280 | 170 |
| SM-69 | 294424 | 914939 | 112CHCTU | 2.00 | 300 | 294 | 300 | 06-05-96 | -- | 810 | 26 |
| VERMILION PARISH | | | | | | | | | | | |
| Ve-629L | 294825 | 922020 | 112CHCTU | 1.79 | 487 | 477 | 487 | 08-28-96 | -5.49 | 1,220 | 220 |
| Ve-630L | 295031 | 922032 | 112CHCTU | 4.75 | 528 | 518 | 528 | 08-28-96 | -6.69 | 2,230 | 530 |
| Ve-630U | 295031 | 922032 | 112CHCTU | 4.75 | 498 | 488 | 498 | 09-14-95 | -- | 1,070 | 140 |
| Ve-637L | 295345 | 921007 | 112CHCTU | 4.06 | 243 | 233 | 243 | 08-29-96 | -7.83 | 2,690 | 690 |
| Ve-637U | 295345 | 921007 | 112CHCTU | 4.06 | 198 | 188 | 198 | 08-29-96 | -7.40 | 1,190 | 200 |
| Ve-639 | 293845 | 922649 | 112CHCTU | 5.84 | 608 | 603 | 608 | 04-17-96 | -3.23 | 1,540 | 310 |
| Ve-640 | 295531 | 920812 | 112CHCTS | 6.76 | 64 | 61 | 64 | 08-29-96 | -8.75 | 536 | 40 |
| Ve-641 | 295429 | 920639 | 112CHCTS | 7.68 | 81 | 77 | 81 | 08-29-96 | -7.23 | 492 | 24 |
| Ve-646 | 295204 | 920912 | 112CHCTS | 8.26 | 65 | 62 | 65 | 08-29-96 | -6.57 | 2,180 | 540 |
| Ve-647 | 295058 | 920914 | 112CHCTS | 5.56 | 76 | 73 | 76 | 08-29-96 | -4.61 | 2,750 | 730 |
| Ve-649 | 295516 | 920825 | 112CHCTU | 9.74 | 350 | 344 | 350 | 08-29-96 | -8.40 | 2,240 | 580 |
| Ve-650 | 295341 | 920554 | 112CHCTS | 7.58 | 205 | 200 | 205 | 08-29-96 | -6.78 | 482 | 8.9 |
| Ve-651 | 295657 | 915925 | 112CHCTU | 10.00 | 379 | 328 | 378 | 06-06-96 | -- | 646 | 53 |
| Ve-658 | 293214 | 921809 | 112CHCTU | 8.60 | 645 | -- | -- | 06-07-96 | -- | 1,330 | 210 |
| Ve-696 | 294907 | 920804 | 112CHCTU | 7.00 | 535 | 473 | 535 | 06-06-96 | -- | 689 | 53 |
| Ve-770 | 294638 | 921034 | 112CHCTU | 3.00 | 574 | 554 | 574 | 06-06-96 | -- | 849 | 95 |
| Ve-829 | 295252 | 921637 | 112CHCTU | 6.00 | 300 | 218 | 300 | 06-07-96 | -- | 834 | 68 |
| Ve-878 | 293237 | 921831 | 112CHCTU | 5.00 | 716 | 665 | 716 | 06-07-96 | -- | 3,090 | 760 |
| Ve-975 | 293928 | 923030 | 112CHCTU | 5.00 | 500 | -- | -- | 08-28-96 | -- | 1,510 | 280 |
| Ve-1141 | 293926 | 923118 | 112CHCTU | 5.00 | 500 | -- | -- | 06-07-96 | -- | 1,530 | 270 |
| Ve-5370Z | 293855 | 922309 | 112CHCTU | 3.00 | 570 | 565 | 570 | 06-07-96 | -- | 1,000 | 110 |
| Ve-5868Z | 294938 | 921131 | 112CHCTU | 5.00 | 465 | 455 | 465 | 06-07-96 | -- | 627 | 27 |

Appendix. Selected data for wells in southwestern Louisiana, including water-level measurements, specific conductance, and chloride concentrations—Continued

| Well number | Latitude (degrees) | Longitude (degrees) | Aquifer code | Altitude of land surface (feet relative to sea level) | Depth of well (feet) | Depth to top of screen (feet) | Depth to bottom of screen (feet) | Date sampled | Altitude of water level (feet relative to sea level) | Specific conductance (micro-siemens per centimeter at 25 degrees Celsius) | Chloride concentration (milligrams per liter) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VERMILION PARISH — continued | | | | | | | | | | | |
| Ve-5778Z | 295027 | 921059 | 112CHCTU | 5.00 | 390 | 380 | 390 | 06-06-95 | -- | 615 | 23 |
| Ve-6678Z | 293741 | 922219 | 112CHCTU | 5.00 | 530 | 520 | 530 | 06-06-95 | -- | 1,040 | 130 |
| Ve-7020Z | 293925 | 923025 | 112CHCTU | 5.00 | 490 | 480 | 490 | 06-06-95 | -- | 1,550 | 290 |
| Ve-7021Z | 293851 | 922724 | 112CHCTU | 5.00 | 540 | 530 | 540 | 06-06-95 | -- | 1,070 | 150 |
| Ve-8296Z | 300333 | 923555 | 112CHCTU | 9.00 | 165 | 160 | 165 | 06-06-95 | -- | 894 | 110 |