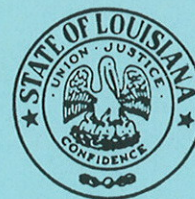
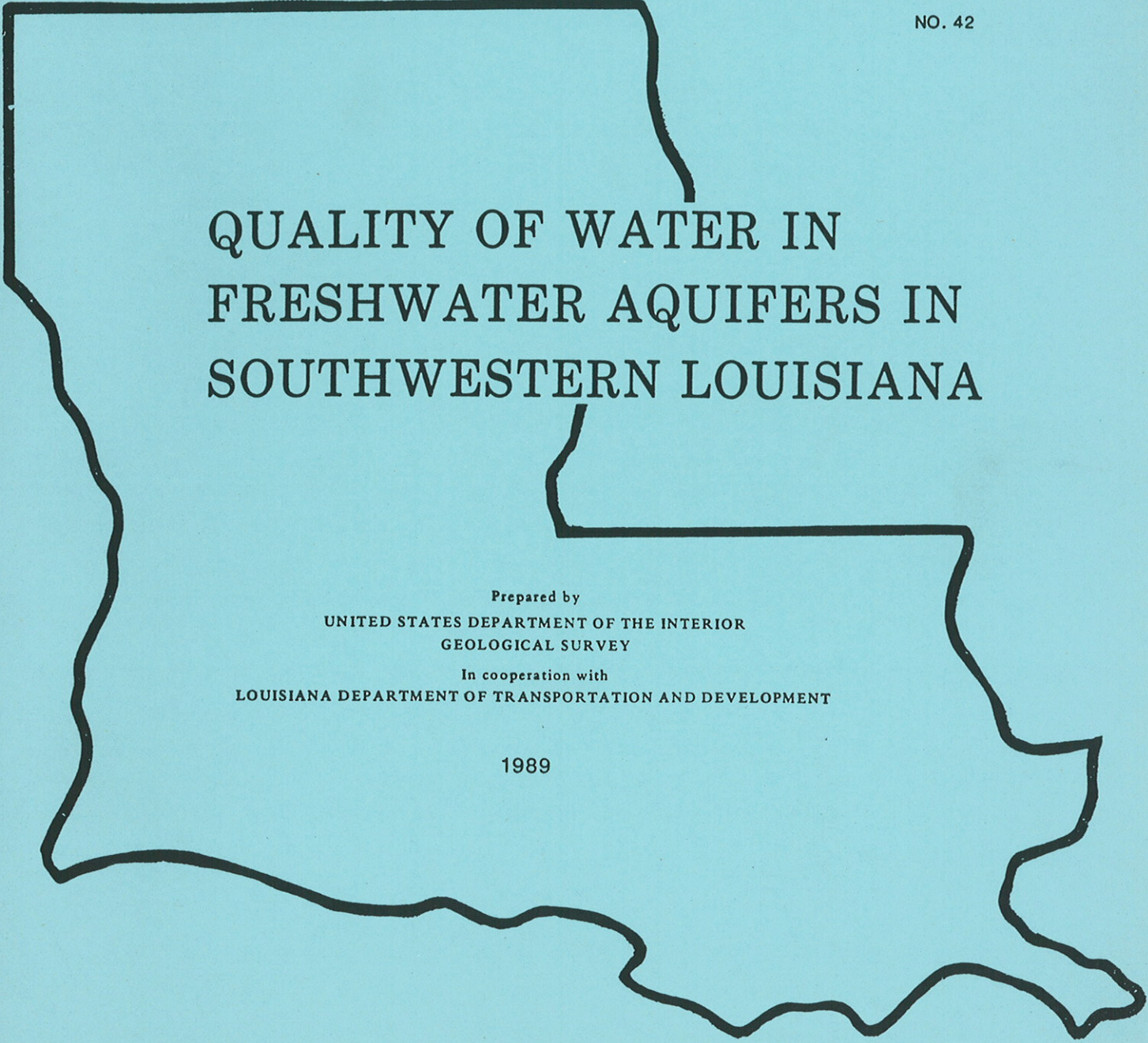




STATE OF LOUISIANA
DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT



WATER RESOURCES
TECHNICAL REPORT
NO. 42



QUALITY OF WATER IN
FRESHWATER AQUIFERS IN
SOUTHWESTERN LOUISIANA

Prepared by
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
In cooperation with
LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

1989

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IN SOUTHWESTERN LOUISIANA

Water Resources

TECHNICAL REPORT NO. 42

By

Dale J. Nyman

U.S. Geological Survey

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CONVERSION FACTORS

For the convenience of readers who prefer to use metric (International System) units rather than the inch-pound units used in this report, values may be converted by using the following factors:

Multiply inch-pound units	By	To obtain metric units
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi ²)	2.59	square kilometer (km ²)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
foot per day (ft/d)	0.3048	meter per day (m/d)
square foot per day (ft ² /d)	0.09290	square meter per day (m ² /d)
gallon per minute (gal/min)	0.06309	liter per second (L/s)
	6.308	cubic meter per second (m ³ /s)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m ³ /s)

QUALITY OF WATER IN FRESHWATER AQUIFERS IN SOUTHWESTERN LOUISIANA

By Dale J. Nyman

ABSTRACT

The quality of freshwater from aquifers in southwestern Louisiana is generally acceptable for most water uses and typically meets the primary standards for drinking water established by the U.S. Environmental Protection Agency. Ground-water quality changes horizontally and sometimes with depth in each aquifer, but the largest differences in water quality are related to geologic age of the aquifer. The younger aquifers (Atchafalaya and Chicot) typically contain the best water for irrigation, but the water generally is less acceptable for domestic purposes. The converse is true of the older aquifers (Evangeline and Jasper). Water quality is dependent upon chemical equilibria and the concentrations of soluble minerals that contribute iron, hardness, and other solution products.

Average concentrations of selected characteristics for the principal aquifers are as follows. The Atchafalaya aquifer is the youngest in geologic age (Holocene and Pleistocene) and median values are: specific conductance, 650 microsiemens per centimeter; hardness, 260 milligrams per liter; and iron, nearly 5.0 milligrams per liter. Median values of specific conductance in units of the Chicot aquifer system (Pleistocene age) range from 400 to 900 microsiemens per centimeter, hardness from 95 to 170 milligrams per liter, and iron from 0.6 to more than 2.0 milligrams per liter. The Evangeline (Pliocene and Miocene age) and Jasper (Miocene age), have median values of specific conductance of about 580 and 380 microsiemens per centimeter, respectively, hardness of about 20 milligrams per liter, and iron generally less than 0.2 milligrams per liter.

INTRODUCTION

Water is one of Louisiana's most significant and plentiful natural resources. Owing to the State's climatic situation, rainfall replaces most of the ground water pumped from the hydrologic system year after year. The unconsolidated rocks beneath the land provides the structure for vast ground-water reservoirs throughout the State. In most of the State, ground water is the principal source of supply. In southwestern Louisiana, the underlying aquifers support the irrigation and industrial activities that provide the economic base for the area. Fresh ground water, therefore, is one of this area's most valuable resources. However, it is not enough to know that water is plentiful, it is also necessary to know the quality, or chemical character, of the water. Chemical character determines the suitability of water for irrigation use, for use in industrial processes, and for drinking and other domestic use.

Plate 1 shows the location of the study area and the location and extent of the outcrop, or recharge, areas of the major aquifers mentioned in this report. The geographic relationship of the recharge areas indicates the general stratigraphic sequence and orientation of the underlying geology. The older sedimentary beds containing the aquifers of southwestern Louisiana have a general east-west strike and dip to the south. The Atchafalaya aquifer is a relatively recent alluvial deposit overlying the sequence of older sediments. (See Glossary for explanation of technical terms.)

Purpose and Scope

The purpose of this report is to summarize and interpret the water-quality data for the principal aquifers available for southwestern Louisiana so that individual water users and water managers can better assess the chemical character of the sources of ground water present.

The report begins with the geohydrologic setting of the aquifer system, followed by a tabulation of analyses representative of each aquifer unit with a listing, for comparison, of EPA (U.S. Environmental Protection Agency) primary and secondary drinking-water standards. Sampling of an additional 20 wells was conducted in 1982. Each of the 20 samples was analyzed for 38 chemical characteristics, mostly inorganic constituents, so that concentrations of common ions, selected trace metals, and toxic ions, could be compared. The remaining sections of the report briefly describe the geohydrology of interconnected aquifer units followed by discussions of the water-quality maps showing distribution of four water-quality characteristics.

More than 10,000 water-quality analyses from about 2,000 wells in southwestern Louisiana were reviewed for this study. All of these data can be retrieved from WATSTORE.¹ A representative analysis was selected for each well and selected chemical characteristics were plotted and the changes mapped. The wells were grouped by aquifer and maps of specific conductance, pH, hardness, and iron were drawn for the Atchafalaya aquifer and units of the Chicot aquifer system in the study area. A computer mapping program, SYMAP,² was used to plot the data and to do preliminary mapping. The water-quality maps in this report were adapted manually from the original SYMAP maps.

The chemical character of water in the Atchafalaya aquifer and units of the Chicot aquifer system were found to be more homogeneous vertically than in the Evangeline and Jasper aquifers; therefore, the water-quality maps for the Atchafalaya aquifer and Chicot aquifer system disregard depth in the aquifer. Because the Evangeline and Jasper aquifers are very thick and sand units are separated by thick clays, the four chemical characteristics have been mapped according to regions of related chemical concentration and depth in each aquifer.

¹ WATSTORE--(National Water Data Storage and Retrieval System)--The system provides nationwide computer access to the basic data collected by the Water Resources Division of the U.S. Geological Survey.

² SYMAP--(Synagraphic Mapping System)--A computer mapping program copyrighted by Harvard University.

The maps indicate the typically observed values; therefore, each map may not show local chemical anomalies (unusual high or low values for a particular chemical characteristic at a particular location). Water users requiring detailed water-quality information at a specific site may use the maps in this report as a general guide to select the aquifer(s) having water quality best suited to their needs and then, for more complete information, refer to the analyses that are nearest to the site for the aquifer selected.

Acknowledgments

The author acknowledges the help of the following students from Louisiana State University: Teresita C. Foley, who ably accomplished the vast amount of computer programming and processing needed for this report, such as the mapping programs and statistical summaries of the principal chemical parameters; and to Paul B. King, who assisted with the data analysis and drafting.

This report is the result of a continuing program of water-resources investigations accomplished in cooperation with the Louisiana Department of Transportation and Development.

GEOHYDROLOGIC SETTING

Hydrologic Units

The freshwater aquifers underlying southwestern Louisiana are a sequence of unconsolidated deltaic and near-shore marine sediments ranging in depth from surficial alluvial deposits (Holocene age) to about 3,000 ft (Miocene age). This sedimentary sequence is divided into four major aquifers and an aquifer system, in order of increasing depth and age: The Atchafalaya aquifer (Holocene and Pleistocene) and Chicot aquifer system (Pleistocene); the Evangeline aquifer (Pliocene and Miocene); and the Jasper aquifer (Miocene). The Atchafalaya aquifer and Chicot aquifer system are primarily of continental origin and contain mostly coarse sand with interbedded layers of gravel; whereas, the older aquifers are of marine origin and contain finer sediments and thicker clays. The relative positions of the aquifers and the names used in this report are given in table 1. The Chicot aquifer system has been subdivided into the "200-foot," "500-foot," and "700-foot" sands of the Lake Charles area (Calcasieu and Cameron Parishes, pl. 1); and the "upper sand" and "lower sand" to the east of Lake Charles. The "200-foot" sand, the "upper sand" and the Atchafalaya aquifer; and the "700-foot" sand and "lower sand," respectively, are hydraulically connected (pl. 3). The "500-foot" sand is an intermediate unit of the Chicot aquifer system in the Lake Charles area and is poorly connected to the Chicot units to the east and southwest.

Water Levels

The altitudes of the water-level surfaces for the Atchafalaya aquifer and the Chicot aquifer system during the spring of 1981 are shown on plate 2. The direction of ground-water flow is perpendicular to the contour lines. The spacing of the contours is a qualitative indication of the velocity of ground-

Table 1.--Stratigraphic sequence of aquifers in southwestern Louisiana

Epoch	Aquifers in the Lake Charles area		Aquifers east of Lake Charles	
Holocene -----	Chicot aquifer system	"200-foot" sand	Chicot aquifer system	Atchafalaya aquifer ----- ? -----
Pleistocene		"500-foot" sand		"Upper sand"
		"700-foot" sand		"Lower sand"
Pliocene	Evangeline aquifer			
Miocene	----- ? -----			
	Jasper aquifer			

water flow, with narrowly spaced contours indicating greater flow velocities, but not necessarily greater volumes of flow, than broadly spaced contours. The direction and rate of movement can determine water-quality changes as water moves from one area into another.

Most of the water pumped from the Chicot aquifer system originates from the recharge area in Beauregard and Allen Parishes; however, there are other sources. According to the results of the analog aquifer model of the Chicot aquifer system, 55 percent of the total water pumped originates from the recharge area, 15 percent originates from the east, less than 5 percent flows from the west and northward from the coastal area, and the remaining approximately 25 percent of recharge is vertical leakage (the water that moves very slowly through clays from aquifers of higher hydraulic head to aquifers of lower head). Ground-water recharge moves toward centers of irrigation pumping in Acadia and Jefferson Davis Parishes, and toward industrial pumping centers in Calcasieu Parish (pl. 2). Similarly, water in the Evangeline and Jasper aquifers originates primarily in the outcrop (recharge) areas, where water levels are the highest in altitude, and from there moves southward downdip toward pumping centers, where water levels are lower. Water-level maps for the Evangeline and Jasper aquifers are available in Whitfield (1975).

Ground-Water Withdrawals

About 100 years of pumping have modified the water-level gradients that existed in the aquifers in southwestern Louisiana before 1900. During 1980, the total ground-water withdrawals averaged more than 1,000 Mgal/d from the

13-parish area of southwestern Louisiana (Walter, 1982). An average of 990 Mgal/d was pumped from units of the Chicot aquifer system and the Atchafalaya aquifer, 15 Mgal/d from the Evangeline aquifer, and 25 Mgal/d from the Jasper aquifer. The largest withdrawals were used for rice irrigation and much lesser amounts were used for industrial and public supplies and other categories (pl. 4). Irrigation pumping primarily is from the "upper sand" of the Chicot aquifer system in Jefferson Davis, Acadia, and Vermilion Parishes. Most of the industrial pumping is from the Lake Charles "500-foot" and "700-foot" sands of the Chicot aquifer system in Calcasieu Parish.

GENERAL QUALITY OF WATER

Although the quality of ground water in southwestern Louisiana may change abruptly from one location to another, and may change with depth in the same aquifer, regional water-quality changes are usually within predictable limits. These differences in water quality reflect the mineralogy and chemical equilibria of the aquifer and the velocity at which water moves through the aquifer.

Precipitation, as it passes through the atmosphere, absorbs carbon dioxide, oxygen, nitrogen, and man-made emissions that cause the rain to be acidic. The acidic rain soaks into the soil and reacts with soluble soil minerals. Excess soil water moves downward to the water table and recharges the aquifer in the outcrop area. Local shallow water-table aquifers may be the least desirable sources of drinking water due to their nearness to possible sources of pollutants at the earth's surface.

In southwestern Louisiana, as water moves through the aquifers, the quality continues to change because the acidic water reacts with aquifer minerals. At some distance downdip, the water changes from an acid, low-solute, aggressive (corrosive) water to a slightly alkaline, calcium-bicarbonate type that may have high concentrations of hardness and iron. Further downdip in the aquifer the calcium-bicarbonate water is changed to a sodium-bicarbonate water as clay minerals exchange sodium ions for calcium in the aquifer's intercalated clays, or in the confining clays above and below the aquifer. Sodium-bicarbonate waters are often desired for domestic purposes because they have low hardness concentrations and, typically, relatively low iron concentrations. As the freshwater-saltwater interface is approached (the downdip limit of freshwater), the sodium-bicarbonate water becomes a sodium-chloride type with increased salinity. Sodium-type waters generally are less desirable for irrigation purposes and may be of concern for human health.

In southwestern Louisiana, low-solute, high-quality water generally is found in parts of the aquifer that have high permeability, and less desirable water may be found in the less permeable parts. Aquifers constituted of young sediments generally contain a greater abundance of soluble minerals and tend to produce water having high concentrations of objectionable constituents as compared to older aquifers. These differences in water quality are important when selecting sources of water for drinking or other uses.

Drinking-Water Criteria

The primary consideration in the use of a water source for domestic supply is its effect on human health. The achievement of safe drinking water is one goal of the EPA. To accomplish this goal the EPA has established primary and secondary standards for drinking water (U.S. Environmental Protection Agency, 1976a, 1979). U.S. Environmental Protection Agency primary standards for chemical constituents represent acceptable ingestion levels over an average human lifetime (70 years). Drinking water containing constituents in concentrations that exceed primary standards may be a health hazard, the hazard being proportional to the length of time the water is ingested and how much each standard is exceeded. Secondary drinking water standards are based principally on aesthetics (taste, smell, and appearance), which ordinarily do not represent health hazards.

About 25 chemical elements are essential to life (Keller, 1978, p. 334) and all of these are found in varying concentrations in water. Eleven of the elements comprise 99.99 percent of the human body--listed according to decreasing abundance in the body they are hydrogen, oxygen, carbon, nitrogen, calcium, phosphorus, chlorine, potassium, sulphur, sodium, and magnesium (Keller, 1978). Evidence exists that an additional 14 elements are needed in human nutrition in trace amounts--fluorine, silicon, vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc, selenium, molybdenum, tin, and iodine (Hopps, 1975). Concentrations of most of these elements needed for life were determined in the water analyses from selected wells in the report area (table 2, in pocket at back). The analyses in table 2 indicate that representative water from all aquifers in southwestern Louisiana generally meets EPA standards for the 38 chemical constituents and properties listed, which include some hazardous compounds.

Summary of Principal Chemical Characteristics

Four chemical characteristics were selected for summary in this report: specific conductance, pH, hardness, and iron. These characteristics were selected because they are the most frequently requested by water users. Specific conductance is a measure of the ability of a water to conduct an electrical current and is expressed as microsiemens per centimeter at 25°C ($\mu\text{S}/\text{cm}$). Specific conductance is related to the type and concentration of ions in solution and can be used to estimate the dissolved-solids concentration in freshwater. Generally, dissolved solids can be approximated by multiplying the value for specific conductance by 0.65. Units of pH indicate the degree of acidity or alkalinity. In natural waters a pH below 7.0 units (neutral) usually indicates that the water is corrosive. Hardness is important to some water users because the calcium and magnesium, which contribute most to hardness, aids plant nutrition and soil tilth, which is helpful to the irrigator. However, hardness is a nuisance to the housewife, because of the increased consumption of soap and detergent, and to industrial users because of the formation of scale inside hot-water pipes. Iron also contributes to hardness and can stain fixtures and laundry even in relatively low concentrations. The treatment of high concentrations of iron can be a large expense.

The median values for the principal chemical characteristics of aquifers in southwestern Louisiana are listed in table 3. A representative analysis for each of nearly 2,000 wells, including analyses for freshwater and saline water, was grouped by major aquifers or water-bearing units of an aquifer and then each group was statistically analyzed. The table provides the quantitative basis for determination of the typical chemical character of water from each aquifer or water-bearing unit and for understanding the water-quality changes that may occur between interconnected aquifers or water-bearing unit of an aquifer as water moves from one unit into another.

Table 3 shows that the shallowest and youngest aquifers (Atchafalaya aquifer and Chicot aquifer system) generally contain water of the poorest quality for domestic purposes. On the other hand, the oldest and deepest aquifers (Evangeline and Jasper) generally contain water of good quality for most purposes. Similarly, the lower units of the Chicot aquifer system ("700-foot" sand of the Lake Charles area and "lower sand") may contain water of slightly better quality than the upper units; however, in some areas water from the "lower sand" may contain sodium concentrations that exceed 100 mg/L.³ (Refer to table 2.) Sodium concentrations also may increase when wells are screened near the freshwater-saltwater interface because pumping may induce the flow of nearby saline water toward the well.

WATER QUALITY OF THE ATCHAFALAYA AQUIFER

Aquifer Description

The Atchafalaya aquifer underlies the Atchafalaya River basin (pl. 1) and was named by Jones, and others (1956, p. 293), for alluvial sands and gravels of the Atchafalaya River incised into the Chicot aquifer system (pl. 2) during the melting of the last ice age. The Atchafalaya aquifer is hydraulically connected to the "upper sand" of the Chicot aquifer system and has similar aquifer characteristics and well yields. A structure contour map on the base of the Atchafalaya aquifer was not drawn because it is difficult to determine where one aquifer stops and the other begins. According to Jones, and others (1956, p. 237), wells generally less than 300 ft in depth are screened in the Atchafalaya aquifer.

Chemical Character of the Water

The base of freshwater in the Atchafalaya aquifer is generally at the base of the aquifer or more appropriate in the closely associated "upper sand" at the Chicot aquifer system. For the purpose of depicting water quality the Atchafalaya is combined with the "upper sand" because of the similarity of the two and the difficulty to distinguish between them on a hydrogeologic bases. Water in the aquifer is typically poorly suited for domestic purposes. In St. Martin and eastern St. Landry Parishes, iron generally exceeds 5,000 µg/L (5.0

³ According to the National Academy of Sciences (1977, p. 402-403), the ingestion of sodium above what is needed by the body (about 2,000 mg/d) can contribute to high blood pressure and hypertension in genetically susceptible people.

Table 3.--Range and median values of selected chemical characteristics in water from aquifers in southwestern Louisiana

[Results in microsiemens per centimeter, (µS/cm), milligrams per liter (mg/L), and micrograms per liter (µg/L)]

Aquifer and aquifer system	Conductance (µS/cm)			Dissolved solids (mg/L)			pH			Hardness (mg/L)			Iron, dissolved (µg/L)		
	Range	Median	Number of samples	Range	Median	Number of samples	Range	Median	Number of samples	Range	Median	Number of samples	Range	Median	Number of samples
Jasper ¹	28-136,000	382	104	28-122,000	271	102	5.7- 8.9	7.7	112	1-9,800	22	190	0-21,000	140	102
Evangeline---	47-130,500	578	240	38-118,000	392	245	4.9- 8.9	7.8	247	0-9,000	19	308	0-24,000	190	250
Chicot "Lower sand"-----	311- 6,390	882	78	214- 3,810	536	67	6.1- 8.7	7.6	71	8- 480	94	76	70-15,000	630	71
"700-foot" sand-----	263- 32,500	568	67	203- 22,800	360	42	6.3-10.9	7.6	57	28-2,500	110	67	100- 8,100	1,200	42
"500-foot" sand-----	265- 5,020	421	165	195- 2,570	280	98	6.0-10.5	7.4	127	39- 270	110	127	70-11,000	1,300	107
"200-foot" sand-----	274- 1,280	400 ²	9	201- 711	268	7	6.8- 8.0	7.4	7	76- 160	130 ²	7	120- 4,000	2,100	4
"Upper sand"-----	114- 9,930	668	531	99- 6,290	475	189	5.6 8.7	7.5	281	28-2,000	170	451	13-20,000	1,400	299
Undiffer-entiated---	35- 2,520	437	259	32- 1,870	279	132	5.3- 9.4	7.4	173	1- 650	99	235	0-35,000	1,600	178
Atchafalaya--	103- 5,170	648	47	236- 708	405	28	5.4- 8.6	7.4	40	31- 520	260	55	400-12,000	4,800	42

¹ Nearly all samples from the upper part of the Jasper aquifer (Williamson Creek Member of the Fleming Formation).
² Questionable value because of small sample size.

mg/L) and locally may exceed 10,000 µg/L (10.0 mg/L) (pl. 5). Hardness concentrations in these parishes often exceeds 250 mg/L (pl. 6). Ranges of specific conductance and pH are similar to values in the "upper sand" of the Chicot aquifer system (pls. 7 and 8).

WATER QUALITY OF THE CHICOT AQUIFER SYSTEM

"Upper Sand" and Related Units

The Chicot aquifer system, from the outcrop area, where it is undifferentiated, to the northern limit of the "upper sand"; the "upper sand"; the Lake Charles "200-foot" sand and the Atchafalaya aquifer are interconnected and form a continuous hydrologic unit. The "200-foot" sand is the least important and very little water-quality information is available; therefore, this unit is not discussed in the remainder of the report. The outcrop area collects much of the water that recharges the units of the Chicot aquifer system and provides the pressure (hydraulic head) that pushes the water down gradient to the "upper sand," which is intensively pumped for rice irrigation, and the other units. The Atchafalaya aquifer and Atchafalaya River are hydraulically connected and the aquifer is interconnected with and contributes recharge to the "upper sand" unit (pl. 3).

Aquifer Description

The units of the Chicot aquifer system are generally characterized by thick beds of coarse sand with layers of gravel. The coarseness of the sands, together with an annual average rainfall of nearly 60 in., create a hydrologic system with high permeability, plentiful recharge, and high sustained yields to wells.

The "upper sand" generally is more than 400 ft thick. Structure contours on the base of the "upper sand" are shown on plate 9. The coarse sands and gravels of the "upper sand" have hydraulic conductivities ranging from 200 to 240 ft/d and average 205 ft/d. Transmissivities range from 25,000 to 135,000 ft²/d and average 87,000 ft²/d. The storage coefficient averages 0.0015. Many irrigation and industrial wells have yields exceeding 2,000 gal/min.

Chemical Character of the Water

The "upper sand" and interconnected units of the Chicot aquifer system contain freshwater to the base of the aquifer system in the northern three-fourths of the study area. In approximately the southern one-fourth of the area, saltwater in the basal part of the aquifer underlies freshwater. The altitude of the freshwater-saltwater interface (base of freshwater) is mapped on plate 10. It ranges from less than 400 ft below land surface beneath the Atchafalaya River basin to more than 700 ft below Vermilion Bay and western Marsh Island. The configuration of the base of freshwater is a very irregular surface, principally because saltwater from the "lower sand" is moving vertically through interconnections into the base of the "upper sand." Thousands of years may have been required to create the saltwater ridges beneath

the Atchafalaya River basin, lower Vermilion River basin, and the Cameron-Vermilion and Jefferson Davis-Acadia Parish lines. Saltwater movement was very slow because the hydraulic head was only slightly higher in the "lower sand" than in the "upper sand." Now saltwater ridges are growing at a faster rate than in the past because water levels are declining in the "upper sand" as a result of ground-water withdrawals for rice irrigation. Although encroachment of saltwater in most coastal areas is not detectable, water-level declines due to pumping for irrigation probably are causing some northward movement of saltwater (Nyman, 1984).

Values for individual chemical characteristics are mapped on plates 5-8. Vertical changes in water quality are generally small where the entire aquifer contains freshwater. Notable increases in specific conductance occur near the freshwater-saltwater interface and near local areas where saltwater occupies the base of the aquifer (pl. 7).

Water of the best quality for domestic purposes (low hardness and low iron) occurs in the "upper sand" in eastern Cameron Parish. (See the analysis for well Cn-159, table 2, and pls. 5 and 6.) In southeastern Allen, northern Jefferson Davis, and southern Evangeline Parishes water in the "upper sand" is not well suited for domestic purposes. In these areas iron typically exceeds 5,000 µg/L (5.0 mg/L) and locally may exceed 10,000 µg/L (10.0 mg/L) (pl. 5). Concentrations of hardness and iron in the "upper sand" are very similar to concentrations in the overlying Atchafalaya aquifer in St. Landry and St. Martin Parishes.

Concentrations of all chemical characteristics are lowest in the primary recharge area and increase to the east and downdip to the south. For example, the concentration of iron is generally less than 100 µg/L (0.1 mg/L) in northern Beauregard and western Allen Parishes; however, as low-solute, acidic water (low pH, pl. 8) moves from the recharge area southeastward beyond the Calcasieu River, the iron increases greatly in concentration (pl. 5).

Special Situations

Iowa saltwater anomaly.--A layer of slightly saline water lies at the base of the "upper sand" near the town of Iowa in eastern Calcasieu Parish (pl. 10). Chloride concentrations range from 100 to 550 mg/L and specific conductance values range from 400 to 1,500 µS/cm. The salinity problems primarily affect high-capacity wells used for irrigation and industry (Nyman, 1984).

Lower Vermilion River saltwater anomaly.--A body of saltwater underlies the lower Vermilion River basin in Vermilion Parish. Locally the "upper sand" contains only saltwater because of the upward movement of saltwater from the "lower sand." This saltwater anomaly, originally described by Harder and others (1967), is expanding and currently increasing in chloride concentration an average of 30 (mg/L)/yr (Nyman, 1984).

Grand Coteau low dissolved-solids anomaly.--A 5-mi² area around the village of Grand Coteau, in southern St. Landry Parish, receives varying amounts of direct recharge from rainfall. (Location of anomaly is shown in (pl. 10.)) The top 150 ft of the "upper sand" contains water of a quality

similar to that in the primary recharge area in Beauregard and Allen Parishes. The water above a depth of 150 ft at Grand Coteau generally has a specific conductance of less than 200 $\mu\text{S}/\text{cm}$, a pH of less than 6.5, a hardness concentration of less than 70 mg/L, and an iron concentration of less than 100 $\mu\text{g}/\text{L}$ (0.1 mg/L).

Lake Charles "500-foot" Sand

The Lake Charles "500-foot" sand is the most intensively pumped aquifer in the Lake Charles area. The unit was named for a bed of sand and gravel, typically about 150 ft in thickness, underlying the Lake Charles industrial area at a depth of 400 to 550 ft. The sand is distinct in Calcasieu and Cameron Parishes but merges with the "700-foot" sand near the boundary between Calcasieu and Beauregard Parishes and becomes part of the massive Chicot aquifer system (pl. 11). The sand thins to the east and west and is locally absent along the Calcasieu-Jefferson Davis Parish line and near the Texas-Louisiana border south of Orange, Texas. The aquifer dips to the south at the rate of 18 to 40 ft/mi (Harder, 1960, p. 31). Structure contours on the base of the "500-foot" sand are shown on plate 11.

Aquifer Description

The "500-foot" sand is a medium to coarse gray sand, that grades to very coarse sand often containing gravel near the base of the aquifer. The average hydraulic conductivity is 160 ft/d, the transmissivity averages 27,000 ft^2/d , and the average storage coefficient is 0.0005 (Harder, 1960, p. 32). Yields to industrial wells typically range from 600 to 2,000 gal/min.

Chemical Character of the Water

The base of freshwater in the Lake Charles "500-foot" sand is the base of the aquifer in most of Calcasieu Parish; however, south of the Calcasieu-Cameron Parish line there is a rapid transition in water quality so that the aquifer contains only brackish water less than 8 mi south of the parish line (pl. 12). The relatively narrow zone occupied by the freshwater-saltwater interface is caused by the Hackberry and Black Bayou salt domes. The northward movement of saltwater is restricted because the aquifer thins above the salt domes. There has been no indication of saltwater encroachment in the "500-foot" sand from the coastal area (Nyman, 1984).

The values of specific conductance, pH, hardness, and iron are shown on plates 13-16. Vertical differences in water quality are generally small, except near the freshwater-saltwater interface and near local layers of saltwater at the base of the "500-foot" sand. The concentration of hardness generally ranges from 50 to 150 mg/L in Calcasieu Parish (pl. 15). Iron decreases in concentration beneath the city of Lake Charles and southward--from less than 500 $\mu\text{g}/\text{L}$ (0.5 mg/L) beneath and south of the city, in contrast to 1,000 to 5,000 $\mu\text{g}/\text{L}$ (1.0 to 5.0 mg/L) in most of Calcasieu Parish (pl. 16).

Special Situation--Lake Charles Industrial Area

Underlying the Lake Charles industrial area is a layer of saltwater ranging in chloride concentration from 50 to 450 mg/L, which corresponds to a specific conductance of 500 to 1,800 $\mu\text{S}/\text{cm}$ (pl. 12). Chloride concentrations in the "500-foot" sand are generally less than 50 mg/L. Salinity in this area increases as pumpage increases. A detailed discussion of this saltwater problem is included in Nyman, 1984.

"Lower Sand" and Related Units

The "lower sand" and Lake Charles "700-foot" sand constitute approximately the lower half of the Chicot aquifer system in the southern part of the 13-parish area. Near Lake Charles the unit occurs between 700 and 900 ft below land surface; at Lafayette between 600 and 1,000 ft. Structure contours on the base of the aquifer system are shown on plate 17. The "lower sand" dips to the south 10 to 50 ft/mi and contains a sequence of tan to gray sands that grade in size from fine near the top to coarse at the base of individual sand beds.

Aquifer Description

The lower part of the Chicot aquifer system is very permeable and has hydraulic characteristics approaching the "upper sand." To the east near the city of Lafayette hydraulic conductivities of the "lower sand" range from 180 to 300 ft/d and transmissivities range from 11,000 to 33,000 ft²/d. At Lake Charles, hydraulic conductivities of the "700-foot" sand range from 140 to 180 ft/d, transmissivities from 20,000 to 25,000 ft²/d, and storage coefficients typically range from 0.0003 to 0.0006 (Harder, 1960, p. 17 and 35). Wells yield 1,000 to 2,000 gal/min in the Lake Charles area and 500 gal/min at the town of Broussard near Lafayette.

Chemical Character of the Water

The altitude of the freshwater-saltwater interface in the "lower sand" is deepest in southern Lafayette Parish (pl. 18), about 1,000 ft below sea level. This deep freshwater is similar in quality to water from the Evangeline aquifer and is likely the result of local interconnection between the two aquifers. The freshwater-saltwater transition zone ranges from 15 mi wide in the "700-foot" sand in Calcasieu Parish to as little as 3 mi in the eastern part (St. Martin Parish) of the study area. Because the transition zone underlies the cone of depression for the "700-foot" sand in the Lake Charles area, ground water in that area is increasing in salinity, reflecting varying rates of saltwater encroachment in the "700-foot" sand (Nyman, 1984).

The basal unit of the Chicot aquifer system may contain water that has slightly less iron and hardness than the higher aquifer units, but generally the quality of water in the "500-foot" and "700-foot" sands of the Lake Charles area are very similar; water in the "upper sand" and "lower sand" units are also similar in quality. Related ranges of individual chemical characteristics are grouped on plates 19-22. As in other units of the Chicot aquifer system, there is little vertical change in water quality, except where freshwater is underlain by saltwater.

Special Situation--Soft Water in the Bayou Teche Area

The basal part of the "lower sand" in western St. Martin and eastern Lafayette Parishes is very soft, a hardness generally less than about 50 mg/L, and comparatively low in iron concentration, less than 500 µg/L (0.5 mg/L) (pls. 21 and 22). (See pl. 18 for location of Bayou Teche area.) The water in this zone typically also contains 180 to 560 mg/L of sodium. Locally, there is an interconnection with the Evangeline aquifer, the probable source of the soft water. This water is the result of Evangeline water moving into the "lower sand" during prehistoric time. The Evangeline aquifer in this area is now salty.

Special Situation--Maxie Soft-Water Area

Underlying the Maxie community, in central Acadia Parish, water from the "lower sand" has a hardness of 15 mg/L at observation well Ac-335U (pl. 21). (See pl. 18 for location of Maxie area.) The areal extent of the soft water is unknown. The origin of the water is probably similar to that in the Bayou Teche soft-water area discussed above. As in the Bayou Teche area, the water contains a high concentration of sodium (288 mg/L). (See footnote 3, p. 20a, concerning sodium.)

WATER QUALITY OF THE EVANGELINE AQUIFER

Aquifer Description

The Evangeline aquifer consists of a sequence of relatively thin sands and thick clays and is about 600 ft in thickness in the DeRidder area (Beauregard Parish). The aquifer thins toward the outcrop area in the north and thickens southward (downdip). The dip of the aquifer ranges from 20 to 40 ft/mi in the upper part and 60 to 80 ft/mi in the lower part (Whitfield, 1975, p. 14). Generalized structure contours on the base of the Evangeline aquifer are shown on plate 23. The top of the Evangeline and the base of the Chicot are essentially the same surface. (See pl. 17, which shows structure contours on the base of the Chicot aquifer system.)

Most sands of the Evangeline aquifer range from fine to coarse, have hydraulic conductivities ranging from 30 to 100 ft/d, and transmissivities ranging from less than 1,000 to 12,000 ft²/d (Whitfield, 1975, p. 10 and 20). In Rapides Parish, Rogers (1981, p. 22) found that the hydraulic conductivity ranged from 49 to 100 ft/d and the transmissivity from 1,340 to 6,280 ft²/d. Wells having diameters larger than 6 in. yield as much as 1,000 gal/min.

Chemical Character of the Water

The base of freshwater in the Evangeline aquifer ranges from 0 to 2,200 ft below sea level (pl. 24). A saltwater high, which trends north-south through Avoyelles and St. Landry Parishes and continues southward, divides freshwater in the Evangeline aquifer into two separate bodies. The entire aquifer generally contains only freshwater 10 to 15 mi north of the southern limit of freshwater. The Easton salt dome locally eliminates freshwater in west-central Evangeline Parish.

Related values of conductance, pH, hardness, and iron are grouped by regions and subregions on plate 25. Region I is the outcrop of the Evangeline aquifer (Blounts Creek Member of the Fleming Formation); regions II, III, and IV approximately parallel the outcrop area to the west and the limit of freshwater to the east. Region V trends north-south beneath the Atchafalaya River. The changes in the four chemical characteristics related to depth intervals in each region are given in table 4.

Regions II and III, and subregions V-a and V-c typically contain the most desirable water for domestic purposes. Hardness is not a significant problem in most of the Evangeline aquifer, especially when the Chicot aquifer is considered as an alternative. In region II, concentrations of hardness are greatest toward the outcrop area and generally decrease southward. Iron is generally less than 200 µg/L (0.2 mg/L) in region II and subregions V-a and V-c.

Water of poorest quality is located near the limit of freshwater, in region IV, and in subregion V-b. Subregion V-b contains water having hardness ranging from 100 to 500 mg/L and iron ranging from 400 to 1,000 µg/L (0.4 to 1.0 mg/L).

Region I is characterized by water having specific conductance values of less than 150 µS/cm and pH of 5.0-7.0 units. Although corrosive, this water is low in hardness and iron and therefore is generally of good quality for domestic use.

Table 4.-Distribution of selected chemical characteristics in water from the Evangeline aquifer

Region	Depth (feet below land surface)	Conductance (µS/cm)	pH	Hardness (mg/L)	Iron (µg/L)
I	100- 400	50- 150	5.0-7.0	10- 50	20- 300
IIa	250- 800	150- 400	6.5-8.0	5-100	20- 500
b	400-1,000	150- 350	7.0-8.5	5- 25	50- 400
IIIa	500-1,800	500-1,000	7.0-8.5	5- 35	150-1,000
b	500-1,000	500-1,500	8.0-8.5	5- 35	30- 300
c	300- 800	350- 800	7.5-8.5	5- 15	100-1,000
IVa	600- 700	300-1,500	8.0-8.5	10- 70	250-5,800
b	600- 800	1,700-1,850	7.5-8.5	10- 20	150- 350
c	200- 700	1,000-2,000	7.0-8.5	5- 60	50- 350
d	200- 700	1,000-2,000	7.0-8.5	5- 60	50- 350
Va	1,100-1,900	400-1,100	8.0-8.5	0- 20	50- 250
b	800-1,400	400-1,000	8.0-8.5	100-500	400-1,000
c	350- 500	400-7,000	7.5-8.5	30	20- 500

Water from the Evangeline aquifer may have high concentrations of fluoride and color. According to Whitfield (1975, p. 22), fluoride concentrations exceed 1.6 mg/L in local areas of northeastern and southern Allen Parish and in most of the eastern two-thirds of Evangeline Parish. The highest fluoride concentration (5.5 mg/L) was found south of Ville Platte in Evangeline Parish. This concentration of fluoride is considerably greater than the EPA primary standard (table 2). Also, locally the water may have an amber color because of dissolved or suspended organic material. Concentrations of color range from 0 to 150 platinum cobalt units and typically are greater than 10. The color of water is not considered hazardous to plant or animal health, but may detract aesthetically from water quality.

WATER QUALITY OF THE JASPER AQUIFER

Aquifer Description

The Jasper aquifer comprises three geologic units in order of increasing age: the Williamson Creek Member (sand), the Dough Hills Member (clay), and the Carnahan Bayou Member (sand); all are members of the Fleming Formation (Whitfield, 1975, p. 6). The Jasper is about 2,500 ft in thickness near DeRidder and dips to the south at 60 to 100 ft/mi. It is overlain by 300 to 500 ft of clay and sand, the Burkeville confining bed (Castor Creek Member of the Fleming Formation).

Only the upper part of the Jasper is discussed in this report because it provides most of the water to wells screened in the Jasper in southwestern Louisiana. The sand in the upper part of the Jasper aquifer typically ranges from fine to medium; but may range from very fine to very coarse (Rogers and Calandro, 1965, p. 26). The outcrop and structure contours on the base of the Williamson Creek Member (upper Jasper) are shown on plate 26.

The hydraulic conductivity of sand in the upper part of the Jasper aquifer ranges from 40 to 100 ft/d and averages about 50 ft/d. Transmissivity typically ranges from 1,000 to 20,000 ft²/d if several sands are screened by one well (Whitfield, 1975, p. 31). In Rapides Parish sands in the upper part of the Jasper have a hydraulic conductivity ranging from 20 to 120 ft/d and transmissivity ranging from 670 to 10,000 ft²/d (Rogers, 1981, p. 22). Yields to wells 4 to 18 in. in diameter in the DeRidder area range from 40 to 800 gal/min.

Chemical Character of the Water

The altitude of the freshwater-saltwater interface ranges from 1,000 to 2,500 ft below sea level and rises in the aquifer to the south and east (pl. 27). The largest volume of freshwater underlies southeastern Vernon Parish.

Chemical characteristics for the upper part of the Jasper aquifer are grouped according to regions and subregions on plate 28. Ranges of values for specific conductance, pH, hardness, and iron are summarized for each region in table 5. Region I is the outcrop of the upper part of the Jasper aquifer, the Williamson Creek Member of the Fleming Formation, and successive regions (II,

Table 5.--Distribution of selected chemical characteristics in water from the Jasper aquifer

[Depth in feet below land surface]

Region	Specific conductance		pH		Hardness		Iron	
	Range µS/cm	Depth	Units	Depth	Range (mg/L)	Depth	Range (µg/L)	Depth
Ia	25- 200	100- 350	6.6-6.8	150- 200	5- 50	100- 500	600-800	100- 350
b	25- 200	100- 350	5.7-6.0	100- 350	5- 50	100- 500	50-400	100- 500
c	25- 200	100- 350	6.8-7.6	100- 200	5- 50	100- 500	50-400	100- 500
d	250- 350	200- 300	6.5-8.5	100- 300	5- 50	100- 500	50-400	100- 500
e	50- 500	150- 500	6.0-7.7	150- 500	5- 50	100- 500	50-400	100- 500
IIa	200- 300	200- 500	7.1-7.8	200- 500	75-150	200- 500	40-250	400- 500
b	200- 450	400- 900	6.3-7.9	400- 900	25-150	150- 900	50-900	400- 900
c	250- 500	450-1,000	6.7-8.7	450- 100	5- 20	450-1,000	25-300	450-1,000
d	550	350- 500	7.7-8.6	350- 500	5- 30	350- 500	50-600	350- 500
e	650-1,150	400- 550	7.9-8.9	400- 550	5- 10	400- 550	50-900	400- 550
IIIa	250- 350	750-1,850	7.4-8.5	750-1,850	100-150	750-1,850	100-300	750-1,850
b	350- 450	800-1,100	7.8-8.7	800-2,000	50	800-1,000	10-150	800-2,000
	250- 350	1,100-1,400	7.8-8.7	800-2,000	5- 25	1,000-2,000	10-150	800-2,000
	350- 450	1,400-1,700	7.8-8.7	800-2,000	5- 25	1,000-2,000	10-150	800-2,000
	300-1,000	1,700-2,000	7.8-8.7	800-2,000	5- 25	1,000-2,000	10-150	800-2,000
IV	400-1,500	1,500-2,400	7.8-8.7	1,500-2,400	0- 15	1,500-2,400	150-300	1,500-2,400

III, and IV) are water-quality zones in downdip bands parallel to the outcrop. The southern limit of region IV is the southern limit of freshwater. The following are examples showing how plate 28 and table 5 can be used.

Example A.--Wells screened between 100 and 350 ft below land surface in subregion I-b (north-central Vernon Parish, pl. 28) would be expected to have specific conductance values ranging from 25 to 200 µS/cm, pH values ranging from 5.7 to 6.0, and concentrations of hardness and iron ranging from 5 to 50 mg/L and from 50 to 400 µg/L (0.05 to 0.4 mg/L), respectively (table 5).

Example B.--Wells screened about 1,500 ft deep in subregion III-b probably would have specific conductance values ranging from 350 to 450 µS/cm, pH values ranging from 7.8 to 8.7, and hardness and iron concentrations ranging from 5 to 25 mg/L and 10 to 150 µg/L (0.01 to 0.15 mg/L), respectively (table 5).

Water from the Jasper aquifer generally is very satisfactory for drinking and domestic purposes because iron concentrations are typically less than 500 µg/L (0.5 mg/L) and hardness less than 50 mg/L. The water of highest quality for domestic purposes is found in subregions II-c, II-d, and region III. Wells deeper than 450 ft in subregion II-c and 800 ft in region III

yield soft water having iron concentrations less than 300 µg/L (0.3 mg/L). In the DeRidder area (pl. 28, subregion III-b), extensive test drilling has shown that very high-quality water occurs between depths of 1,000 and 2,800 ft.

Subregions I-a and I-b have water of relatively poor quality. Water from wells in subregions I-a and I-b generally have iron concentrations exceeding 600 µg/L (0.6 mg/L), which may be caused in part by corrosive water (specific conductance 200 µS/cm, pH 5.7-6.8) acting on iron well casings. Wells east of Rapides Parish yield saltwater and wells near the southern limit of freshwater may develop salinity problems.

In general, specific conductance and pH have the lowest values in the outcrop area (subregions I-a, I-b, and I-c) and the values increase southward as the aquifer becomes confined. Iron and hardness are relatively high in the outcrop area and decrease downdip in the aquifer, until the limit of freshwater is approached. Specific conductance values greater than about 1,800 µS/cm indicate brackish water.

SUMMARY AND CONCLUSIONS

1. Analyses of water from representative wells in each aquifer indicate that the freshwater in southwestern Louisiana generally meets U.S. Environmental Protection drinking-water standards. Water from all of the aquifers probably contains varying concentrations of nearly all of the inorganic elements needed in human nutrition.

2. In general, values of specific conductance, pH, hardness, and iron correlate with the age of the aquifers. Water from the younger Atchafalaya aquifer and Chicot aquifer system is not well suited for domestic uses because the water is generally hard, high in iron concentration, and may be corrosive. The older Evangeline and Jasper aquifers generally have lower concentrations of hardness and iron and have less corrosive water.

3. Water in the primary recharge area of the Chicot aquifer system, in Beauregard and Allen Parishes, typically is a low-solute, acidic, corrosive-type water. Water in the recharge area has the lowest values for specific conductance, pH, hardness, and iron, but these values increase greatly and the water becomes less suitable for domestic uses as the water moves downdip.

4. The Atchafalaya aquifer is the youngest in geologic age (Holocene and Pleistocene). The median value for specific conductance is 650 µS/cm, hardness is 260 mg/L, and iron is nearly 5,000 µg/L (5.0 mg/L).

5. The Chicot aquifer system is of Pleistocene age and the ranges of median values are: specific conductance, 400 to 900 µS/cm; hardness 95 to 170 mg/L, and iron 600 to 2,000 µg/L (0.6 to 2.0 mg/L).

6. The Evangeline aquifer is of Pliocene and Miocene age and contains freshwater in all of Beauregard, Allen, and Evangeline Parishes, and parts of adjacent parishes. Approximate median values of key chemical characteristics are specific conductance, 580 µS/cm; hardness, 20 mg/L; and iron, 200 µg/L (0.2 mg/L).

7. The Jasper aquifer is of Miocene age; the upper part of the aquifer contains freshwater in most of Beauregard and northwestern Allen Parishes, and northward to the outcrop area in Vernon and Rapides Parishes. Approximate median values for key chemical characteristics are specific conductance, 380 $\mu\text{S}/\text{cm}$; hardness, 20 mg/L ; and iron, 150 $\mu\text{g}/\text{L}$ (0.15 mg/L).

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GLOSSARY

Aquifer.--A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

Base of freshwater.--Top of the transition zone between freshwater and brackish water.

Brackish water.--Slightly salty, term applied to water that has a salt content intermediate between freshwater and seawater.

Chemical characteristics.--The chemical content and the physical properties of water.

Cone of depression.--The depression, roughly conical in shape, produced in a potentiometric surface by pumping (or artesian flow).

Confining bed.--A body of relatively impermeable material stratigraphically adjacent to one or more aquifers that serves to confine water in the aquifer so that the water level rises above the base of the confining bed.

Dip.--The angle at which a stratum or any planar feature is inclined from the horizontal.

Freshwater.--Water in accordance with U.S. Environmental Protection Agency primary and secondary water-quality standards (table 2).

Freshwater-saltwater interface.--The boundary surface between two fluids of different density; the boundary surface is the zone between freshwater and brackish water in this report.

Head.--The height above a datum plane of a column of water. In a ground-water system it is composed of elevation head and pressure head.

Hydraulic conductivity.--The volume of water at the existing kinematic viscosity that will move through a unit area of an isotropic porous medium in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow. Replaces the term "field coefficient of permeability." The hydraulic conductivity multiplied by 7.48 is equal to the coefficient of permeability. For conversion of hydraulic conductivity in feet per day to meters per day, multiply by 0.3048.

Hydraulic (water-level) gradient.--The difference in head per unit distance measured perpendicularly to lines connecting points of equal head (water-level contour). The hydraulic gradient, hydraulic conductivity (permeability), and porosity determine the velocity, or rate of ground-water movement.

Milligrams per liter (mg/L).--For the purpose of converting to the metric system, the unit "milligrams per liter" replaces the unit "parts per million," formerly used by the U.S. Geological Survey. The two units are equivalent at dissolved-solids concentrations less than about 7,000 mg/L.

Potentiometric (water-level) surface.--The surface which represents the static head with reference to a specified datum, such as sea level. As related to an aquifer, it is defined by the levels to which water will rise in tightly cased wells. The water table is a particular potentiometric surface.

Recharge.--The process by which water is absorbed and added to the zone of saturation, either directly into a formation or indirectly by way of another formation.

Recharge area.--A part of an aquifer that receives water (recharge). The recharge area is generally where an aquifer is exposed at the earth's surface (outcrop area) and receives water from rainfall or surface streams; or the recharge area may be in the subsurface where there are interconnections with aquifers of higher head.

Saline water.--Water with a dissolved solids content between 1,000 and 35,000 mg/L.

Saltwater encroachment (or intrusion).--Displacement of fresh ground water by the advance of saltwater due to its greater density. This generally occurs in coastal areas but may occur anywhere that freshwater and saltwater are in hydraulic continuity. Encroachment occurs when the total head of saltwater exceeds that of adjacent freshwater (Bates and Jackson, 1980, p. 553).

Specific conductance.--A measure of the ability of a water to conduct an electric current and is expressed as microsiemens per centimeter at 25°C. Specific conductance is related to the type and concentration of ions in solution and can be used for approximating the dissolved-solids content in the water by multiplying specific conductance times the factor 0.65.

Storage coefficient.--The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head. In a confined water body the water derived from storage with decline in head comes from expansion of the water and compression of the aquifer; similarly, water added to storage with a rise in head is accommodated partly by compression of the water and partly by expansion of the aquifer. In an unconfined water body, the amount of water derived from or added to the aquifer by these processes generally is negligible compared to that involved in gravity drainage or filling of pores; hence, in an unconfined water body the storage coefficient is virtually equal to the specific yield.

Strike.--The bearing of the outcrop of an inclined bed or structure on a level surface.

Transmissivity.--The rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of the aquifer under a unit hydraulic gradient. It is equal to an integration of the hydraulic conductivities across the saturated part of the aquifer perpendicular to the flow paths. (Formerly termed "transmissibility," defined as the rate of flow of water, at the prevailing water temperature, in gallons per day, through a vertical strip of the aquifer 1-foot wide extending the full saturated height of the aquifer under a unit hydraulic gradient.) The transmissivity multiplied by 7.48 is equal to the coefficient of transmissibility. For conversion of transmissivity in feet squared per day to meters squared per day, multiply by 0.093.

Water table.--That surface in an unconfined water body at which the pressure is atmospheric (water level below the top of the aquifer). It is defined by the levels at which water stands in wells that penetrate the water body just far enough to hold standing water.