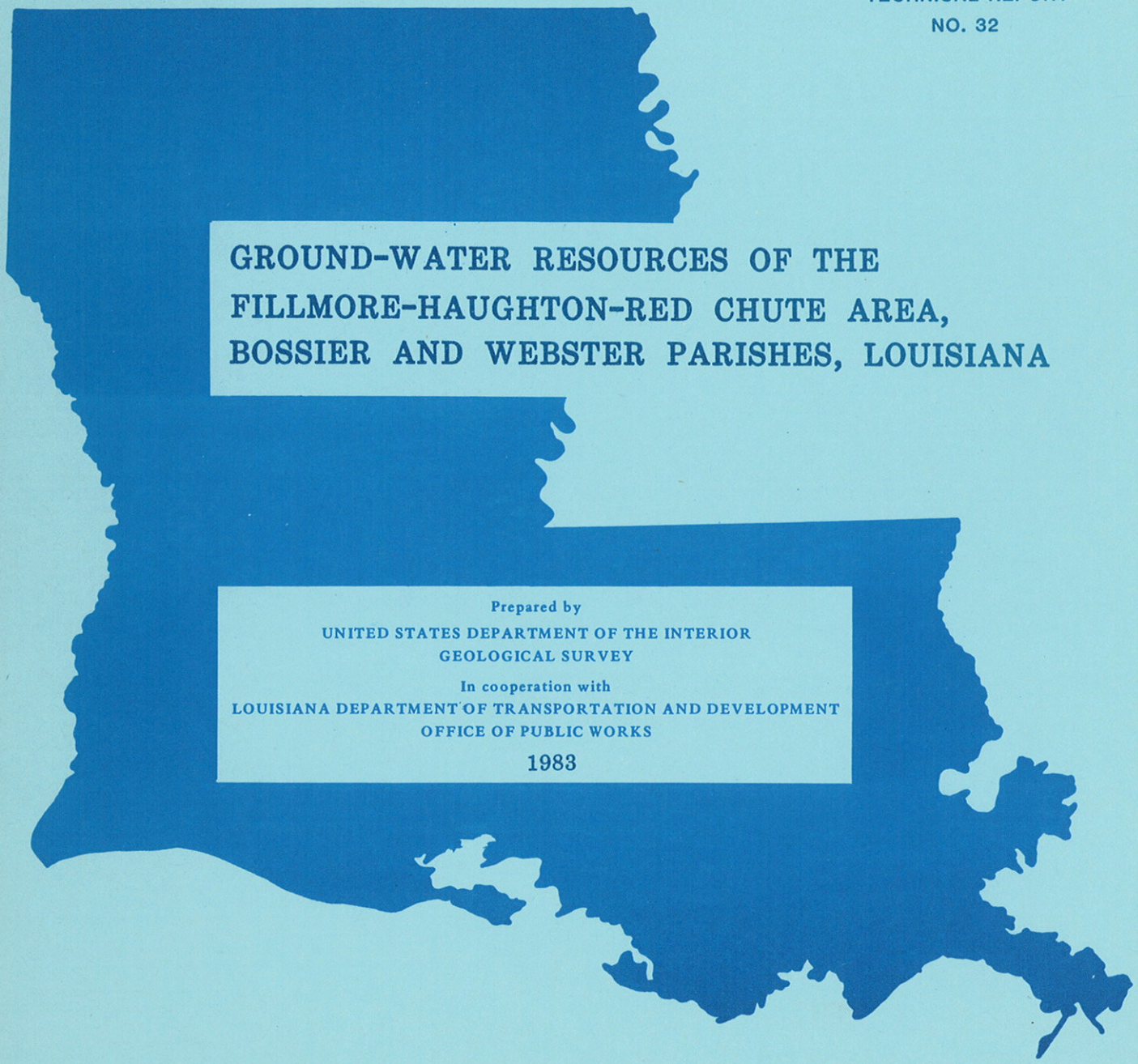
STATE OF LOUISIANA
DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT
OFFICE OF PUBLIC WORKS

WATER RESOURCES
TECHNICAL REPORT
NO. 32

GROUND-WATER RESOURCES OF THE FILLMORE-HAUGHTON-RED CHUTE AREA, BOSSIER AND WEBSTER PARISHES, LOUISIANA



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UNITED STATES DEPARTMENT OF THE INTERIOR
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In cooperation with
LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT
OFFICE OF PUBLIC WORKS

1983

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Water Resources

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By

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U.S. Geological Survey

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CONTENTS

ILLUSTRATIONS

[Plates are at back]

TABLES

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.

Artesian aquifer

An aquifer in which water is confined by an overlying clay or fine-grained bed. Water levels in wells screened in the aquifer rise above the top of the aquifer.

Confining bed

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

Hardness

The U.S. Environmental Protection Agency (1976, p. 75) classifies hardness as follows: Water having a hardness of 0 to 75 mg/L is considered soft, 75-150 mg/L is moderately hard, 150-300 mg/L is hard, and more than 300 mg/L is very hard.

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."

Potentiometric surface

A surface, as related to an aquifer, that everywhere coincides with the water level in tightly cased wells penetrating the aquifer.

Specific capacity

The rate of discharge of water from a well divided by the drawdown of water level within the well expressed as gallons per minute per foot of drawdown for a specified period of pumping, usually 24 hours.

Specific yield

The ratio of the volume of water that will drain by gravity from saturated aquifer material to the total volume of the material.

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 the head.

Theoretical specific capacity

The specific capacity computed using the coefficients of storage and transmissivity. In this report, it is assumed that the well has a 1-foot diameter with a screen set opposite the entire saturated aquifer thickness and that the duration of drawdown is 24 hours.

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. Replaces the term "transmissibility."

Water-table aquifer
: An aquifer in which the water table or upper surface of the zone of saturation is unconfined.

FACTORS FOR CONVERTING INCH-POUND UNITS TO UNITS OF THE INTERNATIONAL SYSTEM (SI)

Multiply	By	To obtain
foot (ft)	0.3048	meter (m)
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)	3.785×10^{-3}	cubic meter per minute (m^3/min)
gallon per minute per foot [(gal/min)/ft]	2.070×10^{-4}	cubic meter per second per meter [$(m^3/s)/m$]
gallon per minute per square mile [$(gal/min)/mi^2$]	2.436×10^{-5}	cubic meter per second per square kilometer [$(m^3/s)/km^2$]
inch (in.)	25.40	millimeter (mm)
micromho (μmho)	1	microsiemens (μs)
mile (mi)	1.609	kilometer (km)
million gallons per day (Mgal/d)	3.785×10^3	cubic meter per day (m^3/d)
square mile (mi^2)	2.590	square kilometer (km^2)

To convert temperature in degree Fahrenheit (°F) to degree Celsius (°C), subtract 32 and divide by 1.8.

GROUND-WATER RESOURCES OF THE FILLMORE-HAUGHTON-RED CHUTE AREA, BOSSIER AND WEBSTER PARISHES, LOUISIANA

By J. L. Snider

ABSTRACT

The Fillmore-Haughton-Red Chute area is suburban to Bossier City and Shreveport. Population influx has resulted in increased water demands on the principal source (Wilcox-Carrizo aquifer) for water supply in the area. The Wilcox-Carrizo generally yields water satisfactory for drinking-water supplies with little or no treatment. Sand beds in the Wilcox-Carrizo are irregular in thickness. Where the beds are thin and fine-grained or silty, wells yield less than 40 gallons per minute. About half of the test holes drilled in the area do not penetrate sand beds capable of yielding at least 40 gallons per minute. Water-level declines in wells are large enough to limit well yields. The Wilcox-Carrizo aquifer may not be capable of yielding adequate water for future needs of the area.

The Sparta aquifer in the northeastern part of the project area is a potential alternate source of water. At a well site 2 1/2 miles north of the project area, the Sparta aquifer contains water that is satisfactory for drinking-water use without treatment. The theoretical specific capacity of a well screened in the Sparta aquifer at this site is 10 gallons per minute per foot of drawdown. About a mile south of this site a test well penetrated a sand 67 feet in thickness in the Sparta, but the water has an iron concentration of 2.0 milligrams per liter.

The terrace aquifer is another alternate source of water in the area. This aquifer could sustain a continuous yield of about 100 gallons per minute per square mile. The water generally has an iron concentration greater than 0.3 milligrams per liter and a hardness greater than 180 milligrams per liter. This aquifer has been developed for public-supply and industrial use in parts of the area.

In the Fillmore-Haughton-Red Chute area, the Red River alluvial aquifer contains water that has a hardness from 330 to 560 milligrams per liter and an iron concentration from 0.02 to 10 milligrams per liter. Specific capacities as high as 25 gallons per minute per foot of drawdown could be obtained in the project area.

INTRODUCTION

Population influx into the Fillmore-Haughton-Red Chute area (fig. 1) is the result of suburban development, mostly along and adjacent to U.S. Highways 79, 80, and Interstate Highway 20 east of Shreveport and Bossier City. Most of the water supplies for this population are from ground water. Before 1968 the towns of Doyline and Haughton and Mimosa Gardens Subdivision (pl. 1) had the only public-supply systems in the report area; the rest of the population obtained water from individual systems or industrial systems. During 1968 the Village Water System began supplying water for the central part of the report area that is adjacent to U.S. Highways 79 and 80. In 1969 the Jenkins Community Water System began supplying water for the area south and east of Doyline, and about 1979 Red Chute Utilities started supplying water to Dogwood Subdivision.

Most public-supply and industrial wells are screened in sands of the Wilcox Group and (or) the Carrizo Sand. Water-system managers are having difficulty finding sand beds capable of supplying additional water and some wells yield only about 40 gal/min. Therefore, water managers have become concerned over the availability of ground water to satisfy future demands.

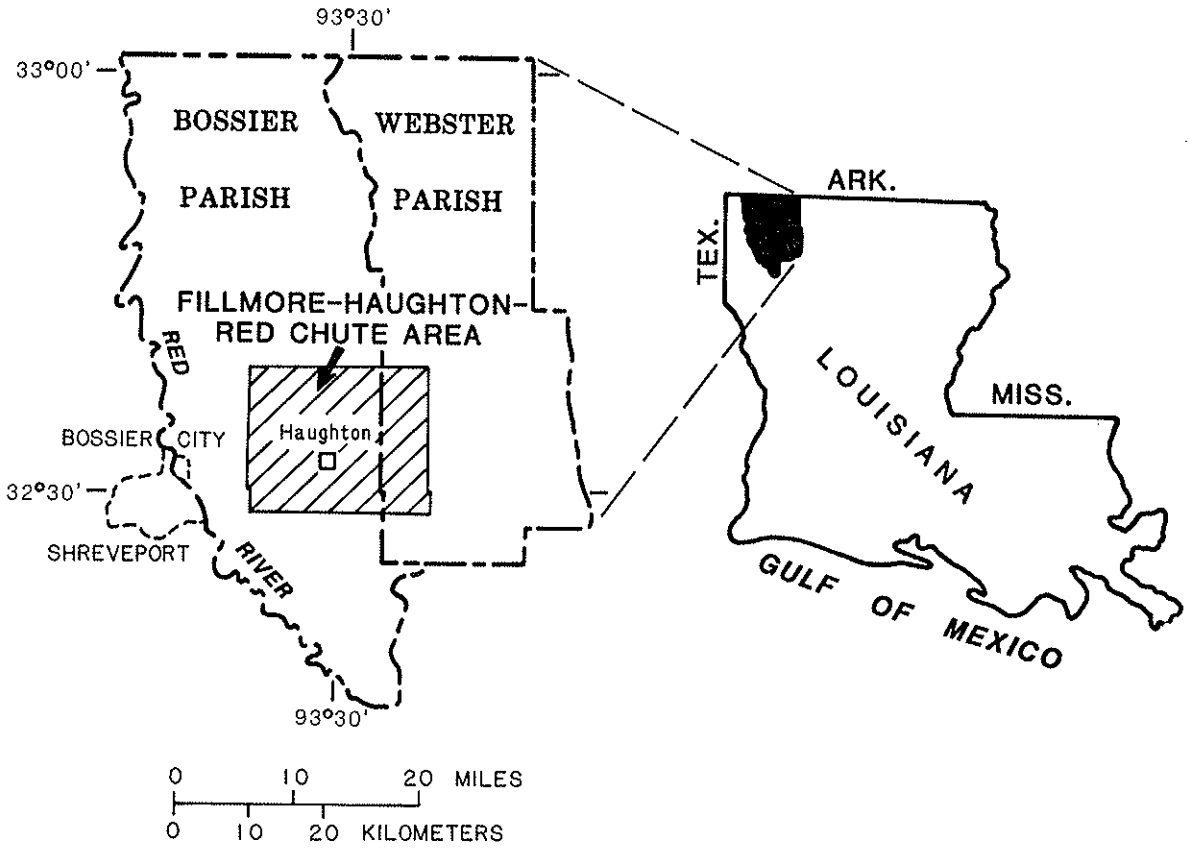

Figure 1.--Location of the Fillmore-Haughton-Red Chute area.

Objective and Scope of Project

The U.S. Geological Survey, in cooperation with the Louisiana Department of Transportation and Development, Office of Public Works, investigated the Fillmore-Haughton-Red Chute area to determine the availability of ground water. Much geologic and hydrologic information was available in this area as a result of test drilling by the Office of Public Works and the U.S. Geological Survey. Supplemental information was collected for this report by drilling shallow test wells in October and November 1973 and July 1974. Information from test holes and wells drilled from 1974 to 1982 was obtained from water users in the area. Most of the information was tabulated and analyzed for this report (tables 1 and 2).

Acknowledgments

The writer wishes to thank the public and industrial water-supply managers, engineering firms, water-well drillers, and well owners who furnished data for this report. Electrical logs of oil-test wells were made available by the Louisiana Department of Natural Resources, Office of Conservation.

GROUND-WATER SOURCES

Fresh ground water in the Fillmore-Haughton-Red Chute area occurs in several geologic formations. These units are--from oldest to youngest--the Wilcox Group, Carrizo Sand, Sparta Sand, terrace deposits, and Red River alluvium.

The Wilcox Group of Paleocene and Eocene age underlies all of the area except for about 2 mi^2 near the north edge (pl. 2). Sands of the Wilcox Group are the only source of fresh ground water in the central part of the area, as shown on plate 2. Beneath the Wilcox is the Midway Group, a Paleocene clay unit that retards the vertical movement of ground water. The Carrizo Sand of Eocene age is discontinuous and overlies the Wilcox locally in the area. As the Carrizo Sand appears to be hydrologically connected to the Wilcox in the project area, the two units are treated as one aquifer, the Wilcox-Carrizo aquifer. Above the Wilcox-Carrizo aquifer is the Cane River Formation of Eocene age, a clayey unit that contains no water-bearing sands in the Fillmore-Haughton-Red Chute area.

In the eastern part of the project area in Webster Parish, the Sparta Sand of Eocene age overlies the Cane River Formation and underlies the terrace deposits (pl. 3). The sands of the Sparta compose the Sparta aquifer.

Partially surrounding the central part of the project area are the terrace deposits. Sand and gravel in the lower part of the terrace deposits compose the terrace aquifer. In the western part of the area alluvium underlies the flood plain of the Red River and its tributaries. Sand and gravel in the lower part of the alluvium comprise the Red River alluvial aquifer.

Wilcox-Carrizo Aquifer

Description

In the Fillmore-Haughton-Red Chute area, the Wilcox-Carrizo aquifer ranges in thickness from 0 to about 520 ft. The thickest occurrence probably is in the eastern part of the area in Webster Parish (pl. 3), although the unit is about 500 ft thick in the vicinity of Haughton. The Wilcox-Carrizo ranges from about 280 to 390 ft in thickness in the vicinity of Red Chute. In the northeastern part of the project area, the Wilcox-Carrizo thins toward the Bellevue Oil and Gas Field and is missing in the northeastern part of the field.

The sand beds of the Wilcox-Carrizo aquifer are separated by silty clay and lignite beds. The sand beds comprise about 20 percent of the unit, range from 0 to about 100 ft in thickness, and average about 30 ft in thickness. The sand in the Wilcox-Carrizo generally is fine or very fine, some sands are silty, and some interfinger with clay or lignite beds. Sand thickness is irregular and may increase or decrease greatly in short horizontal distances (pl. 3). For example: In test hole Bo-301[1/] (T. 19 N., R. 12 W.), a sand 57 ft in thickness was logged; about 300 ft to the northeast in test hole Bo-320, only 10 ft of sand was logged in the same depth interval.

Water-Bearing Characteristics, Well Yields, and Specific Capacities

Based on 23 aquifer tests by the Geological Survey in (22 single-well tests and one two-well test) Bossier, Caddo, and Webster Parishes, the hydraulic conductivity of the Wilcox-Carrizo aquifer ranges from 1 to 29 ft/d and averages 11 ft/d. The coefficient of storage for the two-well test was 1.2×10^{-3}. A sand 30 ft in thickness with a hydraulic conductivity of 11 ft/d would have an estimated transmissivity of 330 ft^2/d. The transmissivity of the Wilcox-Carrizo aquifer is low because of the thin sands, fine grain size, and disseminated clay, silt, and lignite in the sands.

[1/] Prefix Bo indicates a well in Bossier Parish; Wb indicates a well in Webster Parish. The number identifies a well in a parish. See plate 1 for location of wells. Where more than one test well has been developed in the same test hole, the different wells are indicated by a letter suffix. For example, wells Bo-315A and Bo-315B are test wells installed in test hole Bo-315.

Recharge to the Wilcox-Carrizo aquifer is from infiltration of rainfall in areas where the aquifer is exposed and from overlying aquifers in areas where the potentiometric surface in the overlying aquifers is higher than the potentiometric surface of the Wilcox-Carrizo aquifer (Page and May, 1964, p. 39). Most of the water in the Wilcox-Carrizo aquifer is confined under artesian conditions. Water in sand beds at or near land surface in the area is under water-table conditions (unconfined).

Public-supply and industrial wells in the Fillmore-Haughton-Red Chute area that are screened in the Wilcox-Carrizo aquifer yield from 40 to 280 gal/min and average 130 gal/min (table 2). The specific capacities of wells screened in the Wilcox-Carrizo aquifer in the project area range from 0.4 to 4.3 (gal/min)/ft of drawdown and average 1.9 (gal/min)/ft. A well with a specific capacity of 0.4 (gal/min)/ft would have 100 ft of drawdown while pumping 40 gal/min. The same yield would cause 9.3 ft of drawdown if the specific capacity were 4.3 (gal/min)/ft.

Water-Level Decline

Nonpumping water levels in wells screened in the Wilcox-Carrizo aquifer generally range from 50 to 210 ft below land surface. Water levels in wells in the Wilcox-Carrizo aquifer declined during the period 1968-74 because of pumpage, especially in the vicinity of wells pumped most of the time. Water-level trends in wells of the Village Water System for 1968-74 are shown in figure 2. Nonpumping water levels generally declined about 30 ft, 1968-74. The trend of pumping levels in wells owned by the Village Water System parallels the trend of nonpumping levels (fig. 2).

Nonpumping water levels in wells screened in the Wilcox-Carrizo aquifer at the Louisiana Army Ammunition Plant have declined during the periods of World War II and the Korean and Vietnam conflicts. Those were periods of relatively high production and increased pumping at the plant. During interim periods when production at the plant was relatively low, water levels tended to recover in response to reduced pumping at the plant.

Water Quality

The Wilcox-Carrizo aquifer contains freshwater[2/] through its entire thickness in most of the Fillmore-Haughton-Red Chute area. From examination of electrical logs it appears that the Wilcox-Carrizo aquifer contains salty water in the eastern part of the project area in Webster Parish (pl. 2). Water from well Wb-124 (pl. 1) increased in chloride concentration from 91 mg/L in 1946 to 480 mg/L in 1952 (table 3). Well Wb-265, a test well for the Jenkins Community Water System, yielded water with a chloride concentration of 360 mg/L. Water from well Wb-403, also

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2/ In ground-water studies in Louisiana the U.S. Geological Survey defines freshwater as that containing 250 mg/L or less of chloride. Freshwater has also been defined as containing 1,000 mg/L or less of dissolved solids, which is essentially equivalent to water containing 250 mg/L of chloride.

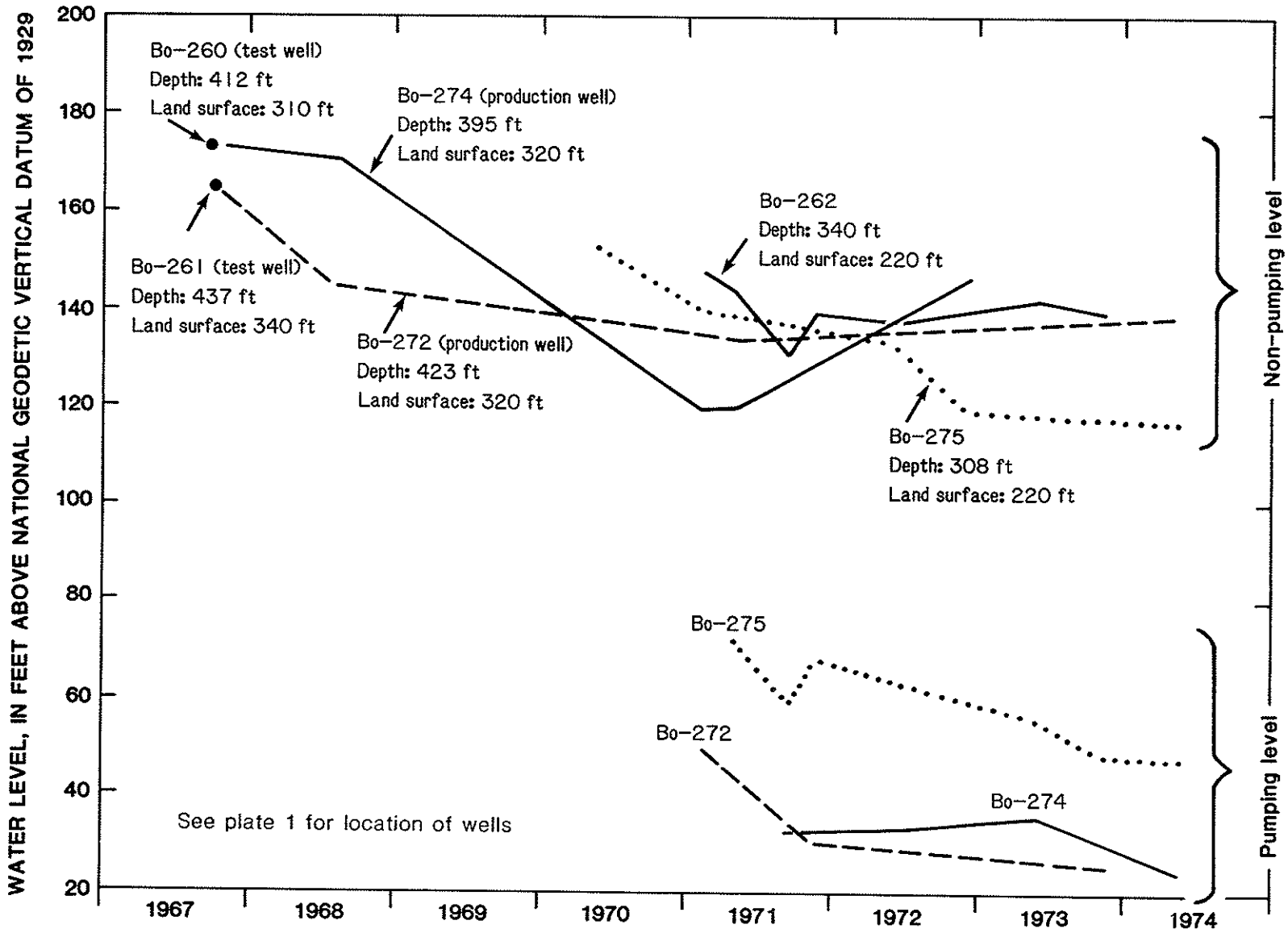

Figure 2.--Hydrographs of wells screened in the Wilcox-Carrizo aquifer, Fillmore-Haughton-Red Chute area.

in the area of high-chloride water, had a chloride concentration of 2,000 mg/L. In the western part of the project area (in the vicinity of test holes or wells Bo-268, Bo-318, and Bo-321) electrical logs indicate that a sand at the base of the Wilcox-Carrizo aquifer contains water with a high concentration of chloride. Water from test well Bo-318B, screened in the basal sand, had a chloride concentration of 400 mg/L.

Water from the Wilcox-Carrizo is generally low in iron (less than 0.3 mg/L). However, test well Bo-260, half a mile north of Fillmore, yielded water with an iron concentration of 1.5 mg/L, and water from two nearby wells (Bo-273 and Bo-274) is treated to remove iron[3/]. Water from test well Wb-265, on the eastern edge of Doyline, had an iron concentration of 1.1 mg/L. Water from the aquifer is soft to moderately hard. Water from some wells has higher concentrations of manganese (table 3) than is recommended by the U.S. Environmental Protection Agency (1976, p. 95).

The pH of water from wells screened in the Wilcox-Carrizo aquifer generally ranges from 7.4 to 8.9 (table 3). This indicates that the water is probably not corrosive. However, test well Bo-316A yielded water with a pH of 5.6, and test well Wb-403 yielded water with a pH of 6.7. Water from these wells would be corrosive and will react with metals in water systems. Some of the wells screened in the Wilcox-Carrizo aquifer yield water that is reported to have a hydrogen sulfide odor at times. Temperature of water from wells screened in the Wilcox-Carrizo aquifer ranges from 69° to 75°F for well depths of about 125-675 ft.

Present and Potential Development

Pumpage by industrial and public-water systems from the Wilcox-Carrizo aquifer in the Fillmore-Haughton-Red Chute area averaged about 1.2 Mgal/d in 1980. About 45 percent of this pumpage is by industries.

The name, pumpage, and population served by public-supply systems using water from the Wilcox-Carrizo aquifer during 1980 are listed below:

Owner	Average daily pumpage (Mgal/d)	Population served
East Highland Mobile Home Park-----	0.020	300
Jenkins Community Water System-----	.050	860
Mimosa Gardens Service Corp--------	.160	1,300
Village Water System----------	.300	4,700
Water Works District No. 2, Bossier Parish (Haughton)----------	.130	1,500
Total----------	0.660	8,660

[3/] In Louisiana, water that contains an iron concentration exceeding 0.3 mg/L and (or) that is hard or very hard generally is treated for public-supply use.

The town of Doyline obtains water from the Louisiana Army Ammunition Plant which has wells screened in the Wilcox-Carrizo aquifer. Average daily water use by Doyline is about 0.1 Mgal/d; about 800 people are served by the system.

Additional water could be developed from the Wilcox-Carrizo by pumping water that has a relatively high chloride concentration from the northwestern part of the area and mixing it with water that has a lower concentration. For example, water from well Bo-318B, screened in a sand at the base of the Wilcox-Carrizo aquifer, has a chloride concentration of 400 mg/L; water from well Bo-265, 2 1/2 mi northeast of well Bo-318B, screened in a sand about 110 ft above the base of the aquifer, has a chloride concentration of 34 mg/L. A mix of equal amounts of water from these two sands would have a chloride concentration of 217 mg/L.

Because of variations in sand thickness, it generally is necessary to drill several test holes to find sands thick enough to utilize for public-supply and industrial wells. Only about 50 percent of the test holes have penetrated sands that can supply at least 40 gal/min.

Additional water supplies probably can be developed from the Wilcox-Carrizo aquifer in parts of the Fillmore-Haughton-Red Chute area. However, in the northeastern part of the area, where the Wilcox Group is thin, there may be less chance of finding sands that can yield 40 gal/min or more. In the northeastern part of the Bellevue Oil and Gas Field, the Wilcox-Carrizo is missing. The Wilcox-Carrizo is not a potential source for public-supply wells near the eastern edge of the area (pl. 2) because the water has a chloride concentration greater than 250 mg/L.

Sparta Aquifer

The Sparta Sand occurs in the eastern and northeastern part of the Fillmore-Haughton-Red Chute area as shown on plate 2. Available data on this aquifer primarily is from wells just to the north of the study area. The formation dips and thickens eastward from 0 ft at its western limit to about 100 ft at the eastern edge of the project area near U.S. Highways 79 and 80. (See pl. 3.) The maximum known thickness of the Sparta Sand in or near the project area is about 200 ft at well Wb-335, 2 1/2 mi north of the project area. The Sparta consists of very fine to fine sands separated by clay and lignite. Sand beds constitute a higher percentage of the Sparta Sand than of the Wilcox Group. Sand beds of the Sparta aquifer constitute about 40 percent of the formation and range from 0 to 70 ft in thickness and average 40 ft.

Sands in the Sparta aquifer are more permeable than those of the Wilcox-Carrizo aquifer. At the site of well Wb-335 (about 2 mi north of project area, sec. 32, T. 20 N., R. 10 W.) the transmissivity of a 40-ft sand in the Sparta is 2,800 ft^2/d and the hydraulic conductivity is 70 ft/d. Assuming a storage coefficient of 0.0001, typical of artesian conditions in the aquifer, a fully developed well 1 ft in diameter screened opposite the entire thickness of a 40-ft sand would have a

theoretical specific capacity of about 10 (gal/min)/ft of drawdown after pumping for 24 hours. If the specific capacity were 10 (gal/min)/ft of drawdown, a yield of 400 gal/min would cause the water level in the well to be drawn down 40 ft after pumping 24 hours. Well Wb-335 site is near the western limit of the Sparta aquifer (Martin and others, 1954, pl. 9). Thus, the location may limit the development of a sustained yield of 400 gal/min at the site.

Recharge to the Sparta aquifer is mostly from the overlying terrace aquifer. Water moves downdip, or easterly, in the Sparta aquifer. Water levels are probably similar to those in wells in the terrace aquifer, in the range of 20-50 ft below land surface.

The chemical quality of water from test well Wb-318, at the site of well Wb-335, meets the U.S. Environmental Protection Agency drinking-water standards for public supply. The pH is 6.1 and the temperature 67°F. Water from test hole Wb-327, 1 mi southwest of well Wb-318, has an iron concentration of 2.0 mg/L and a manganese concentration of 0.09 mg/L. Except for iron and manganese (Environmental Protection Agency, 1976, p. 78, 95), water from well Wb-327 meets the criteria for drinking water for public supply. The pH is 6.8 and the temperature is 68°F.

The Sparta aquifer is a potential source of water in the northeastern part of the area. Well Wb-335 supplies water for the Pleasant Valley Water System, which is north of the project area. Test well Wb-327 was drilled to test the Sparta aquifer for the Village Water System. At the site of well Wb-327, a 67-ft sand occurs between depths of 173 ft and 240 ft. Water from this well (table 3) would require treatment for iron removal for public-supply use.

Terrace Aquifer

Description

The terrace deposits consist of a lower layer of sand and gravel (the terrace aquifer) and an upper layer of clay and silt (pl. 3). Either the sand and gravel or the clay-silt layer may be missing locally. For example, the sand and gravel is missing at the site of test hole Wb-324 at Goodwill (pl. 3). Except where the terrace deposits pinch out against the underlying beds at the edge of the central part of the project area (pl. 2), they range from 40 to 145 ft in thickness and average about 80 ft.

The terrace aquifer ranges from 0 to about 100 ft in thickness and averages about 40 ft. Normally, the grain size of the terrace aquifer increases with depth from very fine or fine sand to coarse or very coarse sand mixed with gravel at the base. The sand in the terrace aquifer generally is coarser than the sand in the Wilcox-Carrizo or Sparta aquifers. At test hole Bo-326, 2 1/2 mi east of Haughton, however, the terrace aquifer consists of very fine-grained sand. At test hole Bo-268 and near the sites of the Village Water System's wells Bo-340 and Bo-341 (sec. 12, T. 19 N., R. 11 W., pl. 1), the sand interval includes clay beds.

Most of the sand and gravel in the terrace aquifer is saturated. The thickness of saturated material in the aquifer ranges from 0 to 97 ft and averages about 40 ft.

Water-Bearing Characteristics

The terrace aquifer is more permeable than the Wilcox-Carrizo or Sparta aquifers. Aquifer tests in and near the project area indicate that the aquifer has an average hydraulic conductivity of 120 ft/d. Under average conditions, the transmissivity for a sand 40 ft in thickness would be 4,800 ft^2/d. The storage coefficient determined at one site was 0.0002, which is typical of artesian aquifers.

Although water in the terrace aquifer is under artesian conditions in most of the project area, locally (as at well Bo-330, sec. 1, T. 17 N., R. 11 W.) water in the aquifer is under water-table conditions. In some artesian wells the water level is only a few feet above the top of the aquifer, and a water-level decline of 10 ft or less would change the aquifer conditions near the well from artesian to water table. Where the terrace aquifer is under water-table conditions the storage coefficient probably ranges from about 0.05 to about 0.20.

The sustained yield of the terrace aquifer depends on infiltration of rainfall. In parts of the project area, sand and silt occur between the saturated sand and land surface, and recharge to the saturated sand is rapid. In other parts of the area, clay and silty clay overlie the saturated sand, and recharge is retarded. On the average, perhaps as much as 3 in. of water per year infiltrates to the aquifer. This amount of infiltration would sustain a continuous yield of about 100 $(gal/min)/mi^2$. Higher yields can be pumped by wells for short periods of time.

The average specific capacity of wells screened in the terrace aquifer in the project area is greater than that of wells screened in the Wilcox-Carrizo aquifer. Specific capacities of seven public-supply and industrial wells range from 2.6 to 16.6 (gal/min)/ft and average 6.6 (gal/min)/ft. (See table 2.) Yields measured during the specific capacity tests ranged from 41 to 330 gal/min and averaged 135 gal/min. The specific capacity tests were of short duration; pumping times ranged from 2 1/2 to 6 hours.

Water levels in wells screened in the terrace aquifer and located in areas of little or no pumping range from 14 to 50 ft below land surface and most levels are less than 28 ft below land surface. The range of annual water-level fluctuations in wells away from pumping areas is from 1/2 to 4 ft. These fluctuations are seasonal and are principally the result of differences in recharge from local rainfall and resulting differences in annual natural discharge. In well Bo-336, located about 800 ft from public-supply well Bo-341, annual water-level fluctuations are as much as 9 ft.

Water Quality

The hardness and the iron concentration of water from wells screened in the terrace aquifer in the project area are shown on plate 2 and water-quality data are listed in table 3. Iron concentrations in water from the terrace aquifer ranges from 0.02 to 4.4 mg/L and the manganese concentration from 0.00 to 0.35 mg/L. The hardness ranges from 49 to 380 mg/L. In most of the project area, the terrace aquifer contains water with iron concentrations of more than 0.3 mg/L and hardness of more than 180 mg/L. Some wells in the eastern part of the project area (pl. 2) yield water that has iron concentrations less than 0.3 mg/L and hardness less than 180 mg/L. Near the site of wells Bo-340 and Bo-341, the Village Water System public-supply wells, iron concentrations range from about 0.02 to 0.4 mg/L, and the hardness from about 80 to 160 mg/L.

The pH of water from the terrace aquifer ranges from 5.4 to 8.2. Water with a pH as low as 5.4 is corrosive and could react with metals in water systems. The dissolved-solids concentration ranges from 127 to 595 mg/L (table 3). The temperature of water from one well was 69°F.

Present and Potential Development

Pumpage from the terrace aquifer by industries and public supplies in the Fillmore-Haughton-Red Chute area averaged about 0.49 Mgal/d in 1980. Average industrial pumpage is 0.23 Mgal/d at the Bellevue Oilfield and 0.07 Mgal/d at the Calumet Refining Company's plant near Princeton.

The terrace aquifer is the source of water for the Red Chute Utilities system which serves Dogwood Subdivision. The average daily pumpage is 0.14 Mgal/d for a population of 1,400. The Village Water System pumps about 0.05 Mgal/d from the terrace aquifer.

The terrace aquifer has the potential for further development as a source of water for larger supplies in the area. Saturated sand thicknesses shown on plate 2 are great enough so that additional water supplies might be developed north of Red Chute and in the eastern part of the project area. In parts of the area, it would be necessary to remove or reduce the iron and hardness concentraton to meet drinking-water requirements. Care must be taken to avoid contamination of the aquifer by disposed waste. The terrace aquifer is very susceptible to contamination from septic-tank effluent and from waste disposed upon the land surface.

Red River Alluvial Aquifer

In and near the Fillmore-Haughton-Red Chute area, alluvium of the Red River (pl. 2) generally ranges from 60 to 75 ft in thickness and averages about 65 ft. The alluvium consists of an upper clay-silt unit and a lower sand unit which is the Red River alluvial aquifer. The sand in the aquifer grades from fine at the top to coarse at the base. Locally, the lower part of the aquifer contains gravel. The aquifer ranges from 30 to 55 ft in thickness and averages 45 ft.

The Red River alluvial aquifer is the most permeable aquifer in the area. From aquifer tests of the alluvial aquifer in Bossier and Caddo Parishes, near the project area, the hydraulic conductivity ranges from 150 to 220 ft/d and averages 190 ft/d. The aquifer in the project area probably has similar hydraulic characteristics. Thus, in the project area where the average aquifer thickness is 45 ft, an average hydraulic conductivity of 190 would give an average transmissivity of 8,600 ft^2/d. The storage coefficient is typical of artesian aquifers and ranges from 0.0002 to 0.0009 and averages 0.0005 (Page and May, 1964, p. 54 and 89). Specific capacities of irrigation wells screened in the alluvium in Bossier Parish, outside of the project area, range from 14 to 25 (gal/min)/ft. Similar specific capacities probably could be obtained in the project area.

Water in the Red River alluvial aquifer is under both artesian and water-table conditions in the project area. At well Bo-183 the water level is probably above the top of the aquifer all year. At wells Bo-155 and Bo-283 the water level fluctuates above and below the top of the aquifer. If pumpage should cause the water level in a well to decline from above to below the aquifer top, aquifer conditions would change from artesian to water table in the vicinity of the pumped well. If the aquifer were under water-table conditions, the storage coefficient would probably range from about 0.05 to about 0.20.

Water levels in the alluvial aquifer in the area generally range from 5 to 20 ft below land surface. The water levels fluctuate in response to changes in stage of the Red River and its tributaries. The annual fluctuation of water levels in the alluvial aquifer in Bossier and Caddo Parishes ranges from 5 to 17 ft (Page and May, 1964, p. 57).

The alluvial aquifer is recharged from infiltration of rainfall, occasionally from streams when the stream stage is higher than the potentiometric surface of the alluvial aquifer in the vicinity of the stream, and from the underlying Wilcox-Carrizo aquifer in areas where the potentiometric surface of the Wilcox-Carrizo aquifer is higher than that of the alluvial aquifer (Page and May, 1964, p. 55).

The hardness of water from wells screened in the Red River alluvial aquifer in the project area ranges from 330 to 560 mg/L and averages 415 mg/L. The iron concentration ranges from 0.02 to 10 mg/L and averages 5.5 mg/L. The manganese concentration of water from two wells is 0.66 mg/L and 1.2 mg/L. The temperature of water from alluvial wells ranges from 66° to 69°F.

The alluvial aquifer is primarily a source of water for domestic wells in the western part of the area. The aquifer is a potential source of water for public supplies, but treatment would be required to make the water satisfactory for public-supply use.

SUMMARY AND CONCLUSIONS

There are four ground-water sources in and near the Fillmore-Haughton-Red Chute area--the Wilcox-Carrizo aquifer, Sparta aquifer, terrace aquifer, and Red River alluvial aquifer. Average sand thicknesses and the hydraulic conductivities of these sources are summarized below.

Aquifer	Average saturated sand thickness (ft)	Average hydraulic conductivity (ft/d)
Alluvial----------	45	190
Terrace----------	40	120
Sparta----------	40	70
Wilcox-Carrizo--------	30	11

The Wilcox-Carrizo aquifer is the principal source now being used by the public-supply systems in the project area. Water from the Wilcox-Carrizo is soft to moderately hard, and generally the iron concentration is less than 0.3 mg/L. In the eastern part of the project area in Webster Parish and locally in Bossier Parish, the chloride concentration of water in the Wilcox-Carrizo is greater than 250 mg/L. Yields of public-supply wells screened in the aquifer range from 40 to 280 gal/min, and specific capacities range from 0.4 to 4.3 (gal/min)/ft. Because of irregular sand thicknesses, only about half of the test holes have penetrated sands capable of providing at least 40 gal/min for a public-supply well. Thus, other sources may be needed to supply future water requirements of the area.

The Sparta aquifer in the northeastern part of the project area is a potential alternate source of water for supplies in the area. A well screened in the Sparta aquifer, 2 1/2 mi north of the project area, yields water that is used for public supply without treatment. A test well drilled about a mile south of the public-supply well penetrated a 67-ft sand, but the water has an iron concentration of 2.0 mg/L.

The terrace aquifer is the source of water for a few public-supply wells in the area and is a potential source for more wells. Sand in the terrace aquifer is coarser and more permeable than sand in the Wilcox-Carrizo and Sparta aquifers. The sustained yield from the aquifer is estimated to be about 100 (gal/min)/mi^2 based on an estimated average infiltration rate of 3 in./yr. The concentration of iron and the hardness of water in the terrace aquifer varies areally. Generally the water would require treatment to be satisfactory for drinking-water use. However, water at some well sites in Webster Parish has an iron concentration less than 0.3 mg/L and hardness less than 180 mg/L and possibly could be used for drinking water without treatment other than disinfection.

Water in the alluvial aquifer has a higher hardness and iron concentration than water in the other aquifers in the project area. Hardness of the water ranges from 330 to 560 mg/L and iron concentrations range from 0.02 to 10 mg/L. Treatment would be required to render water from the alluvial aquifer satisfactory for drinking-water use.

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BASIC DATA

Tables 1-3

Table 1.--Summary of data for selected test holes and wells in and near the Filmore-Haughton-Red Chute area

[Data available: D, driller's or geologist's log; E, electrical log; MA, mechanical analysis of sand samples; S, sand samples. Location of wells shown on plate 1. Status of test well: D, well destroyed; H, domestic well; O, observation well; N, no test well installed. Remarks: C or P, chemical analysis in table 3; C, complete analysis; P, partial analysis]

USGS well No.	Location			Test hole depth (ft)	Well depth (ft)	Water level		Depth of sand interval (ft)	Aquifer	Data available				Status	Remarks
	Sec.	T. (N.)	R. (W.)			Depth, in feet below land surface	Year measured			D	E	MA	S		
Bossier Parish															
Bo-155	17	18	12	66	65	6.0	1973	11- 65	Alluvial	X	-	-	X	D	P; water-level measurements available, 1956-60 and 1963-74.
Bo-260	8	18	11	418	412	137.05	1967	320-395	Wilcox-Carrizo	X	X	X	X	D	C.
Bo-261	18	18	11	511	437	174.96	1967	415-435	---do---	X	X	X	X	D	C; sand (Wilcox-Carrizo) 464-511 ft (sand base below base of log).
Bo-265	34	19	12	457	258	102.25	1974	208-267	---do---	X	X	X	X	O	C; sand (Wilcox-Carrizo) 348-382 ft, contains brackish water.
Bo-267	34	19	12	403	---	------	----	-------	--------	X	X	X	X	N	Sands (Wilcox-Carrizo) 224-260 ft and 328-349 ft.
Bo-268	4	18	12	408	---	------	----	-------	--------	X	X	-	X	N	Sand (Wilcox-Carrizo) 386-400 ft, contains brackish water.
Bo-269	9	18	12	427	---	------	----	-------	--------	X	X	-	X	N	Sands (terrace) 62-122 ft.
Bo-281	9	17	12	101	52	11.05	1974	14- 94	Alluvial	X	-	X	-	O	P; clay 60-63 ft.
Bo-282	5	17	12	91	52	6.35	1974	16- 65	---do---	X	-	-	-	O	P.
Bo-283	29	18	12	76	42	2.45	1974	6- 58	---do---	X	-	X	-	O	C.
Bo-301	34	19	12	352	---	------	----	-------	--------	X	X	X	X	N	Sand (Wilcox-Carrizo) 238-305 ft.
Bo-303	11	18	12	464	---	------	----	-------	--------	X	-	-	X	N	
Bo-315A	22	18	11	497	241	63.99	1973	225-261	Wilcox-Carrizo	X	X	X	X	D	C; well completed open hole, 226-241 ft.
Bo-315B	22	18	11	497	471	110.15	1973	434-471	---do---	X	X	-	-	D	C; well completed open hole, 432-471 ft.
Bo-316A	27	18	11	623	126	46.64	1973	104-135	---do---	X	X	X	X	D	C.
Bo-316B	27	18	11	623	589	134.09	1973	528-596	---do---	X	X	X	X	D	C.
Bo-318A	5	18	12	408	137	50.00	1973	123-144	---do---	X	X	-	-	H	C; sand (terrace) 13-109 ft.
Bo-318B	5	18	12	408	378	81.02	1973	347-397	---do---	X	X	X	X	D	C; sand 347-397 ft, contains brackish water.
Bo-319	4	18	12	407	---	------	----	-------	--------	X	-	-	X	N	Sand (terrace) 40-96 ft.
Bo-320	34	19	12	360	---	------	----	-------	--------	-	X	-	-	N	
Bo-321	5	18	12	362	---	------	----	-------	--------	-	X	-	X	N	Sand (terrace) from above 20 to 93 ft. Sand (Wilcox-Carrizo) 298-325 ft, contains brackish water.
Bo-322	10	18	11	75	66	13.75	1973	17- 74	Terrace	X	-	-	-	O	C.

Bo-323	11	18	11	122	75	28.88	1973	25- 84	Terrace	X	-	-	-	D	C.
Bo-324	12	18	11	146	139	21.85	1973	48-145	---do---	X	-	-	-	O	C.
Bo-325	23	18	11	60	53	17.13	1973	40- 53	---do---	X	-	-	-	D	C.
Bo-326	23	18	11	62	---	------	----	-------	--------	X	-	-	-	N	
Bo-327	24	18	11	95	77	28.35	1973	12- 93	Terrace	X	-	-	-	D	C; clay 38-50 ft.
Bo-328	2	17	11	104	96	15.07	1973	0-103	---do---	X	-	-	-	D	C.
Bo-329	1	17	11	75	---	------	----	-------	--------	X	-	-	-	N	
Bo-330	1	17	11	97	93	46.05	1973	12- 95	Terrace	X	-	-	-	D	C; clay 60-70 ft.
Bo-331	9	19	11	82	---	------	----	-------	--------	X	-	-	-	N	
Bo-332	16	17	11	86	---	------	----	-------	--------	X	-	-	-	N	
Bo-335	12	19	11	92	89	28.52	1974	30- 91	Terrace	X	-	-	-	O	C.
Bo-336	13	19	11	86	84	26.78	1974	30- 85	---do---	X	-	-	-	O	C.
Bo-337	14	19	11	125	95	26.34	1974	35-105	---do---	X	-	-	-	O	C; clay 50-55 ft, 65-70 ft.
Bo-358	9	18	12	380	---	------	----	-------	--------	X	-	-	X	N	
Bo-359	16	18	12	401	---	------	----	-------	--------	X	X	X	X	N	
Bo-375	17	18	12	55	52	13.40	1978	20- 54	Alluvial	X	-	-	-	O	P.
									Webster Parish						
Wb-265	27	18	10	451	201	20.30	1968	163-205	Wilcox-Carrizo	X	X	X	X	D	C.
Wb-270	26	18	10	350	226	23.88	1968	204-238	---do---	X	X	X	X	D	C.
Wb-301	4	18	10	601	---	------	----	-------	--------	X	X	-	X	N	Sand (terrace) 63-85 ft; sand (Sparta) 99-114 ft.
Wb-302	34	19	10	594	---	------	----	-------	--------	X	X	-	X	N	Sand (terrace) 12-60 ft; sand (Sparta) 60-153 ft.
Wb-318	32	20	10	405	188	36.32	1972	169-209	Sparta	X	X	X	X	D	C; sand (Sparta) 103-131 ft and 135-157 ft; not shown on pl. 1.
Wb-323	6	18	10	84	75	31.67	1973	45- 82	Terrace	X	-	-	-	D	C.
Wb-324	6	18	10	68	---	------	----	-------	--------	X	-	-	-	N	No sand in the terrace deposits.
Wb-327	5	19	10	282	221	28.46	1974	173-240	Sparta	X	X	X	X	D	C; sand (terrace) 58-104 ft; not shown on pl. 1.
Wb-330	20	19	10	82	76	31.68	1974	25- 80	Terrace	X	-	-	-	O	C.
Wb-403	3	18	10	747	740	57.44	1980	659-743	Wilcox-Carrizo	X	X	X	-	O	C; sand (terrace) 0-72 ft; sand (Sparta) 72-136 ft.

Table 2.--Description of selected industrial and public-supply wells in and near the Fillmore-Haughton-Red Chute area

[Data available: D, driller's or geologist's log; E, electrical log; MA, mechanical analysis of sand samples; PT, pumping test; S, sand samples. Location of wells shown on plate 1. Remarks: C or P, chemical analysis in table 3; C, complete analysis; P, partial analysis; GP, screen is gravel packed]

Well No.		Location					Casing diameter (in.)	Screen			Specific-capacity data					Data available	Remarks
USGS	Owner	Sec.	T., N.	R., W.	Year drilled	Aquifer		Diameter (in.)	Depth interval (ft)	Opening (in.)	Water level below land surface (ft) (nonpumping)	Yield (gal/min)	Time pumped (h)	Specific capacity [(gal/min)/ft]	Year		
Allied Chemical Corp.																	
Bo-255	1	29	18	11	1961	Wilcox-Carrizo	10	6	196-208	-----	78	140	4	1.7	1961	D, E	GP.
							6	6	214-232	-----							
								6	240-246	-----							
								6	262-278	-----							
								6	286-292	-----							
								6	312-324	-----							
ARKLA Gas Co.																	
Bo-207	3	7	17	11	1952	Wilcox-Carrizo	16	6	160-200	-----	-------	110	---	-----	1952	D	GP.
							8			-----	43	---	---	-----	1957		
Calumet Refining Co.																	
Bo-233	1	33	19	11	1953	Terrace	18	12	53- 80	-----	80	41	---	4.1	1956	D	GP; 12 in. casing 80-130 ft.
							12										
Cities Service Oil Co., Bellevue Oil Field																	
Bo-355	--	11	19	11	1976	Terrace	7	---	52- 72	-----	30.15	110	3	4.4	1976	D	
East Highland Mobile Home Park																	
Bo-266	--	16	18	12	1968	Wilcox-Carrizo	4	2	364-384	0.020	86	50	4	1.2	1968		GP.
							2										
Getty Oil Co., Bellevue Oil Field																	
Bo-350	8	10	19	11	1976	Terrace	---	6	66- 81	-----	39	70	3	-----	1976	D	
Bo-351	9	10	19	11	1976	---do---	7	6	63- 78	-----	36	75	3	-----	1976	D	
Bo-352	10	15	19	11	1976	---do---	4	4	68- 78	-----	36	50	3	-----	1976	D	
Bo-353	11	15	19	11	1976	---do---	6	6	71- 81	-----	33	100	---	-----	1976	D	
Bo-354	--	15	19	11	1976	---do---	4	4	69- 79	-----	31	80	---	-----	1976	D	
Town of Haughton																	
Bo-133	1	21	18	11	1955	Wilcox-Carrizo	---	---	----472	-----	67	100	2	0.56	1955	D	C.
Bo-264	2	20	18	11	----	---do---	8	---	----470	-----	-------	---	---	-----	----		
Bo-360	1R	21	18	11	1977	---do---	6		434-499	-----	100	110	2½	.86	1977	D, E	P.
							3										
Bo-398	--	22	18	11	1974	---do---	7	2½	435-465	0.018	-------	---	---	-----	----		GP.
							2½										
Hillcrest Trailer Court																	
Bo-333	1	9	18	12	1973	Wilcox-Carrizo	7	2½	337-365	0.018	49.48	105	3	0.78	1973	E	GP.
							2½										
Jenkins Community Water System																	
Wb-316	1	26	18	10	1968	Wilcox-Carrizo	4	2	215-225	0.020	26	---	---	-----	1968	D, E	GP.
							2										
Wb-317	2	26	18	10	1970	---do---	5	2	215-225	.020	26	48	24	1.5	1970	D	GP.
							2										
Louisiana Army Ammunition Plant																	
Bo-137	18	13	18	11	1953	Wilcox-Carrizo	12	8	330-410	0.014	113	---	---	-----	1953	D, E	C, GP; sand (Wilcox) 154-258 ft.
											84	270			1960		
Wb-100	13	17	18	10	1942	---do---	10	8	367-390	-----	137	---	---	-----	1952	D, E	C, GP.
								8	498-522	-----	-------	150	24	3.0	----		
								8	584-631	-----							

Table 2.--Description of selected industrial and public-supply wells in and near the Fillmore-Haughton-Red Chute area--Continued

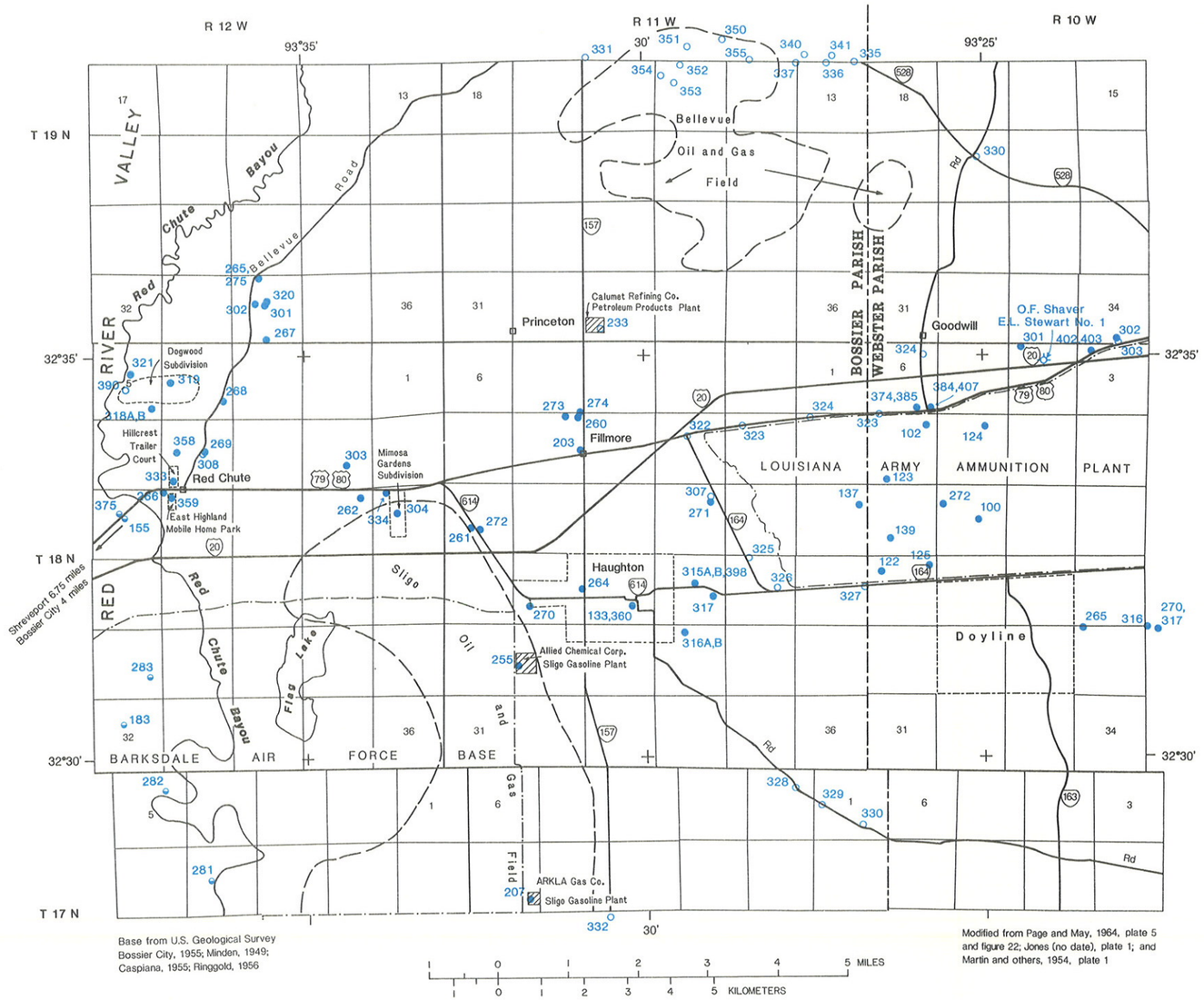
Well No.		Location						Screen			Specific-capacity data						
USGS	Owner	Sec.	T., N.	R., W.	Year drilled	Aquifer	Casing diameter (in.)	Diameter (in.)	Depth interval (ft)	Opening (in.)	Water level below land surface (ft) (nonpumping)	Yield (gal/min)	Time pumped (h)	Specific capacity [(gal/min)/ft]	Year	Data available	Remarks
Louisiana Army Ammunition Plant--Continued																	
Wb-102	6	7	18	10	1941	Wilcox-Carrizo	10	8	410-450	-----	162	190	4	1.8	1956	D, E	C, GP.
							8	8	560-585	-----	112	240	---	-----	1960		
								8	625-674	-----							
Wb-122	14	19	18	10	1942	---do---	10	8	333-406	-----	-----	195	24	4.3	----	D, E	C, GP; sand (Wilcox) 146-212 ft.
								8	466-480	-----	120	---	---	-----	1952		
											-----	160	---	3.2	----	D, E	
											69	209			1960		
Wb-123	16	7	18	10	1942	---do---	15	---	530-645	-----	155	---	---	-----	1952	D, E	C, GP; sand (Wilcox) 180-267 ft.
											-----	130	---	2.6	1956		
											-----	180	---	-----	1960		
Wb-124	7	8	18	10	1941	---do---	10	8	480-493	-----	-----	100	24	.74	----	D, E	C, GP.
							8	8	605-695	-----	150	---	---	-----	1952		
Wb-125	12	19	18	10	1942	---do---	10	8	371-480	-----	-----	275	24	3.9	----	D, E	C, GP.
											160	---	---	-----	1952		
											69	155	---	-----	1960		
Wb-139	20	18	18	10	1954	---do---	12	8	345-355	0.015	200.41	260	18	4.3	1956	D, E	C, GP.
							8	8	355-415	.018							
Wb-272	4A	17	18	10	1968	---do---	12	8	384-457	.030	------	250	---	-----	1968	D	GP, E (Wb-137, 77 ft north).
							8	8	577-612	.025							
Mimosa Gardens Service Corp.																	
Bo-304	2	13	18	12	1972	Wilcox-Carrizo	4	2	228-248	0.014	58.50	50	5	2.7	1972	D, MA, PT, S	C, GP.
							2	2	263-273	.014							
Bo-334	1	13	18	12	1961	---do---	10	---	-------	-----	72	110	7	1.7	1968		
							6										
Olinkraft Inc., Haughton Wood Yard																	
Bo-317	1	22	18	11	1973	Wilcox-Carrizo	7	6	130-150	0.018	35.3	150	4	3.7	1973	D, E, MA, PT, S	GP.
								3	150-171	.018							
Pleasant Valley Water System																	
Wb-335	1	32	20	10	1973	Sparta	6	2	170-190	0.018	35.80	90	3	4.1	1973	D, PT	GP, well not shown on pl. 1.
Red Chute Utilities																	
Bo-390	--	5	18	12	1978	Terrace	8	8	70- 90	-----	14	330	2½	16.6	1978	D	
Village Water System																	
Bo-262	2	14	18	12	1969	Wilcox-Carrizo	6	3	305-315	-----	73	60	9	0.35	1969	D, E	GP.
							3	3	325-340	-----	-----	56	---	-----	1972		
Bo-272	1	18	18	11	1968	---do---	7	2½	408-423	0.020	175	104	25	.59	1968	D	GP.
							2½				-----	54	---	-----	1972		
											181.76	---	---	-----	1974		
Bo-273	3	8	18	11	1968	---do---	7	2½	340-383	.020	159	---	---	-----	1968	D	GP.
							2½				-----	38	---	-----	1972		
Bo-274	4	8	18	11	1968	---do---	7	2½	340-395	.020	150	---	---	-----	1968	D	GP.
							2½				-----	66	---	-----	1972		
Bo-275	5	34	19	12	1970	---do---	6	3	228-258	.018	68	94	20	1.2	1970	D	GP.
							3	2	298-308	.018	-----	96	---	-----	1972		
							2				103.65	---	---	-----	1974		
Bo-340	6	12	19	11	1974	Terrace	6	6	73- 91	.018	28	160	4	9.3	1974	D, PT	
Bo-341	7	12	19	11	1974	---do---	6	6	75- 87	.018	28	144	4	5.2	1974	D, PT	
Wb-374	10	6	18	10	1978	---do---	4	4	65- 75	.016	26	62	3	2.6	1978	D	
Wb-384	8	6	18	10	1978	Wilcox-Carrizo	8	4	400-451	.020	148	162	7½	1.1	1978	D, E	C, GP.
							4½										
Wb-385	9	6	18	10	1978	---do---	8	4	351-398	-----	65	153	3	.85	1978	D, E	
							4										
Wb-407	11	6	18	10	1982	Terrace	6	4	68- 78	-----	25	98	6	4.2	1982	D, PT	

Table 3.--Chemical analyses of water from selected wells

Well No.	Location Sec.	T.	R.	Depth of well (ft)	Date of sample	Specific conductance (µmhos)	pH (units)	Temperature (°C)	Color (platinum-cobalt units)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)
Red River Alluvial Aquifer												
Bo-155	17	18N	12W	65	57- 5-30	----	---	----	-	390	-----	----
Bo-183	32	18N	12W	61	60-12-27	1070	7.0	----	10	530	120	53
Bo-281	9	17N	12W	52	74- 7-16	747	7.1	19.5	--	430	-----	----
Bo-282	5	17N	12W	52	74- 6-14	779	6.8	19.0	--	360	-----	----
Bo-283	29	18N	12W	42	72-11- 3	1230	---	----	5	560	140	50
Bo-375	17	18N	12W	52	78- 6-15	651	6.9	20.5	--	330	-----	----
Terrace Aquifer												
Bo-307	15	18N	11W	80	72- 8- 8	166	6.6	----	5	49	12	4.6
Bo-308	9	18N	12W	110	72- 8- 8	690	7.2	----	0	350	88	32
Bo-322	10	18N	11W	66	73-10-17	340	5.4	----	10	120	25	14
Bo-323	11	18N	11W	75	73-11-12	1070	8.2	----	0	380	87	40
Bo-324	12	18N	11W	139	73-11-28	172	7.1	----	5	66	15	6.9
Bo-325	23	18N	11W	53	73-11-14	244	8.0	----	5	110	29	9.1
Bo-327	24	18N	11W	77	73-11-12	584	7.7	----	0	250	62	23
Bo-328	2	17N	11W	96	73-11-16	384	6.7	----	0	130	34	11
Bo-330	1	17N	11W	93	73-11-15	363	8.1	----	5	120	30	12
Bo-335	12	19N	11W	89	74- 7- 9	556	7.9	----	0	160	46	11
Bo-336	13	19N	11W	84	74- 7-10	611	7.6	----	0	130	24	17
Bo-337	14	19N	11W	95	74- 7-10	496	7.8	----	0	89	18	11
Wb-303	34	19N	10W	63	71- 2-15	335	7.2	----	5	110	29	8.6
Wb-323	6	18N	10W	75	73-11-14	280	---	----	5	49	11	5.2
Wb-330	20	19N	10W	76	74- 7- 9	360	6.4	----	10	82	18	9.0
Sparta Aquifer												
Wb-318	32	20N	10W	188	72-12-11	124	6.1	19.5	--	30	6.6	3.3
Wb-327	5	19N	10W	221	74- 5-23	388	6.8	20.0	0	82	22	6.6
Wilcox-Carrizo Aquifer												
Bo-133	21	18N	11W	472	68- 7-22	1080	7.7	----	5	10	3.0	0.6
Bo-137	13	18N	11W	410	53- 6-13	632	7.4	----	0	82	21	7.0
Bo-203	8	18N	11W	323	67- 6- 9	462	7.6	----	5	96	24	8.8
Bo-260	8	18N	11W	412	67- 9-22	305	8.0	23.0	20	85	22	7.3
Bo-261	18	18N	11W	437	67- 9-30	522	8.0	23.5	10	10	2.4	1.0
Bo-265	34	19N	12W	258	70- 1-10	638	---	----	0	26	8.2	1.3
Bo-302	34	19N	12W	310	71-10-21	621	8.2	21.0	0	49	12	4.6
Bo-304	13	18N	12W	273	73- 2-15	373	6.9	----	0	110	29	8.2
Bo-315A	22	18N	11W	241	73- 3-30	392	8.5	22.0	0	35	7.4	4.0
Bo-315B	22	18N	11W	471	73- 3-27	498	8.4	22.0	0	25	5.6	2.7
Bo-316A	27	18N	11W	126	73- 4-18	78	5.6	20.5	0	16	3.1	2.0
Bo-316B	27	18N	11W	589	73- 4-12	666	8.9	24.0	7	5	1.9	.1
Bo-318A	5	18N	12W	137	73- 8-31	301	7.7	----	0	70	16	7.3
Bo-318B	5	18N	12W	378	73- 8-31	1940	7.6	----	15	12	4.8	.1
Bo-360	21	18N	11W	499	77- 6-00	----	8.7	----	--	17	-----	----
Wb-100	17	18N	10W	631	56- 7-25	1440	8.2	----	10	12	3.4	.9
Wb-102	7	18N	10W	674	56- 7-25	1130	8.1	24.0	0	14	4.2	.8
Wb-122	19	18N	10W	480	55- 8-00	652	7.6	----	5	44	12	3.3
Wb-124	8	18N	10W	695	52- 8- 4	1940	7.8	----	5	64	15	6.3
Wb-125	19	18N	10W	480	56- 7-25	1270	8.1	----	5	18	5.0	1.3
Wb-139	18	18N	10W	415	56- 7-25	661	8.0	----	0	99	26	8.4
Wb-265	27	18N	10W	201	68- 4-15	1790	8.1	21.0	10	50	14	3.6
Wb-270	26	18N	10W	226	68- 7-12	1060	7.6	21.0	40	17	4.8	1.2
Wb-384[1]	6	18N	10W	451	78- 3-16	675	8.2	----	--	19	5.6	1.2
Wb-403	3	18N	10W	740	80- 3-15	6500	6.7	----	5	120	33	10

[1] Analysis by Pope Testing Laboratories, Inc., Dallas, Texas.

Sodium, dissolved (mg/L as Na)	Potassium, dissolved (mg/L as K)	Alkalinity, field (mg/L as $CaCO_3$)	Bicarbonate (mg/L as HCO_3)	Carbonate (mg/L as CO_3)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)
					Red River Alluvial Aquifer--Continued						
------	----	---	---	-	-----	47	---	--	----	-----	----
32	0.9	410	500	0	59	90	0.6	18	627	20	----
------	----	--	---	-	77	27	---	--	----	2500	----
------	----	---	---	-	38	34	---	--	----	6900	----
92	2.6	466	568	0	120	100	.4	19	814	10000	660
------	----	---	---	-	21	12	---	--	----	7700	1200
					Terrace Aquifer--Continued						
14	1.2	---	74	0	4.0	10	0.2	45	127	4000	140
14	1.5	---	380	0	3.8	47	.2	22	396	50	30
21	3.3	---	130	0	21	30	.2	51	230	4400	350
77	2.8	315	384	0	9.8	160	.2	29	595	2000	340
9.0	1.4	---	98	0	4.3	4.6	.1	33	122	-----	----
9.0	.8	---	146	0	1.8	8.2	.4	29	159	50	200
31	2.6	279	340	0	.6	32	.2	27	345	290	150
31	2.3	153	186	0	5.2	32	.2	27	235	710	350
31	1.6	166	202	0	5.2	20	.2	29	229	260	200
56	2.4	242	295	0	.8	36	.4	18	316	360	40
81	3.1	249	304	0	2.4	46	.3	18	342	200	130
70	2.4	201	245	0	1.8	34	.3	20	278	140	70
23	.9	---	99	0	3.8	53	.1	42	209	60	0
35	1.3	37	45	0	5.6	60	.1	53	194	1100	60
36	2.2	37	45	0	5.2	82	.1	50	225	20	160
					Sparta Aquifer--Continued						
12	2.0	25	30	0	14	15	0.0	44	112	144	----
50	1.5	148	180	0	1.0	33	.2	30	235	2000	85
					Wilcox-Carrizo Aquifer--Continued						
240	0.5	286	349	0	3.4	170	0.2	10	605	270	----
------	----	248	302	0	9.1	45	.4	30	375	10	----
70	2.5	201	245	0	26	11	.2	17	281	180	----
35	1.3	120	146	0	5.6	22	.3	52	218	1500	----
110	2.6	167	203	0	11	57	.2	18	304	110	----
140	3.6	276	333	2	15	34	.2	12	382	40	80
130	1.0	---	319	0	15	35	.2	14	371	100	50
41	2.0	146	178	0	15	26	.2	46	255	650	200
80	2.4	158	193	0	16	22	.2	14	241	110	10
110	1.6	197	240	0	35	22	.2	17	313	430	10
7.6	.6	9	11	0	7.8	12	.0	24	62	680	20
160	6.5	251	298	4	11	61	.3	13	406	50	5
45	2.4	157	191	0	5.2	7.8	.5	22	200	280	80
420	4.8	340	415	0	2.6	400	.4	12	1050	290	110
------	----	---	---	-	-----	40	---	--	----	150	----
------	----	415	506	0	.6	210	.7	14	804	-----	----
------	----	371	452	0	.4	140	.4	14	642	-----	----
------	----	237	289	0	20	58	.2	24	397	-----	----
------	----	191	233	0	1.6	480	.1	13	1020	0	----
------	----	397	484	0	.6	180	.7	19	733	40	----
------	----	260	317	0	13	51	.3	32	402	-----	----
370	10	---	412	0	.0	360	.9	12	975	1100	----
240	1.7	---	412	0	4.4	130	.7	10	595	340	----
165	----	328	381	0	.0	35	.1	--	596	90	10
1300	8.8	359	438	0	7.0	2000	.4	15	3590	90	80



EXPLANATION

- Well in the Red River alluvial aquifer
- Well or test hole in the terrace aquifer
- Well or test hole in the Wilcox-Carrizo aquifer
- Oil or gas well (or test well)

317 Parish well number

(Wells Wb-318, -327, and -335 in the Sparta aquifer are north of the mapped area, and are not shown on this plate)

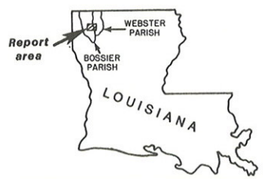


PLATE 1. MAP SHOWING LOCATION OF WELLS IN THE FILLMORE–HAUGHTON–RED CHUTE AREA, BOSSIER AND WEBSTER PARISHES, LOUISIANA.

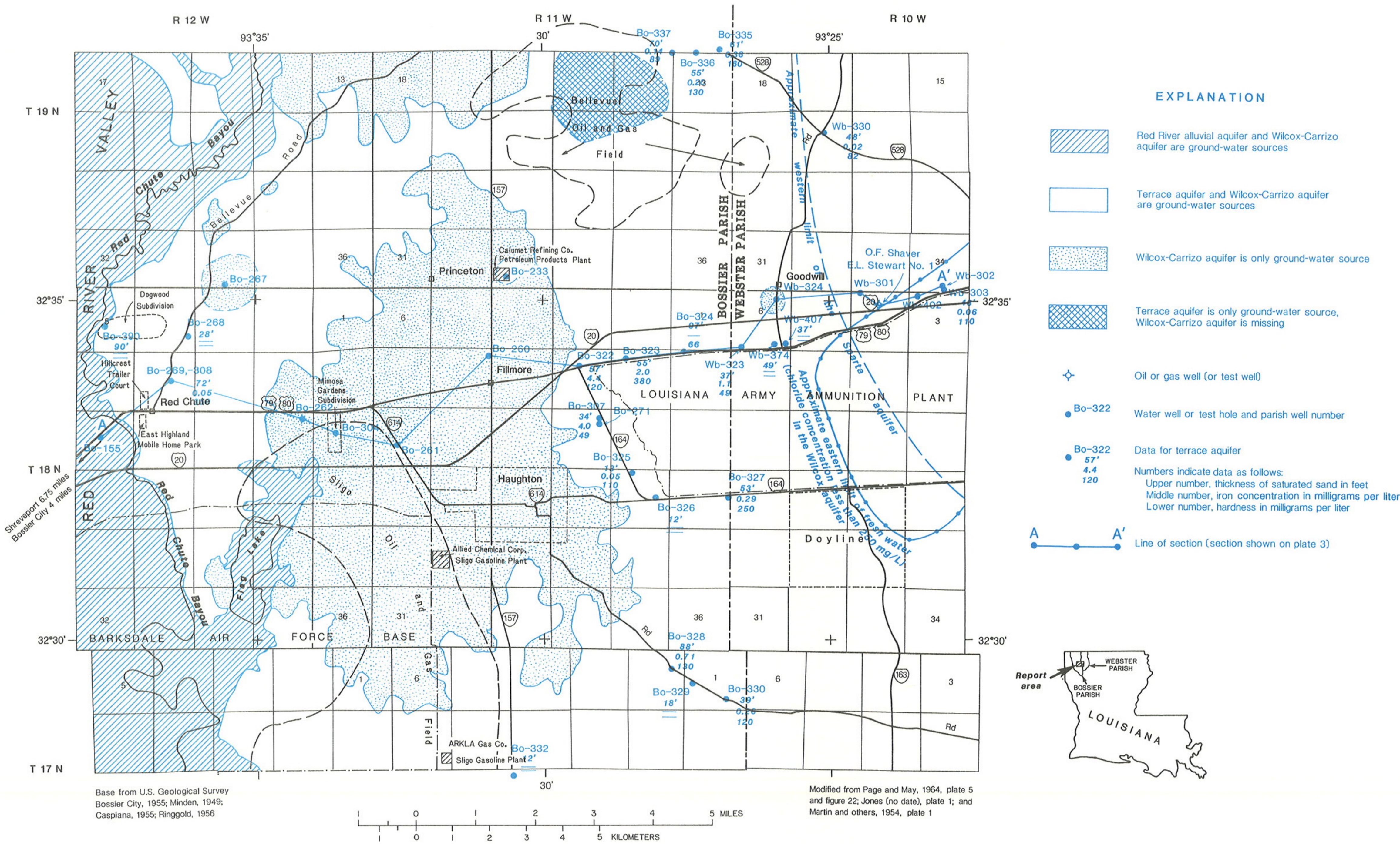


PLATE 2. MAP SHOWING GROUND-WATER SOURCES IN THE FILLMORE-HAUGHTON-RED CHUTE AREA, BOSSIER AND WEBSTER PARISHES, LOUISIANA.

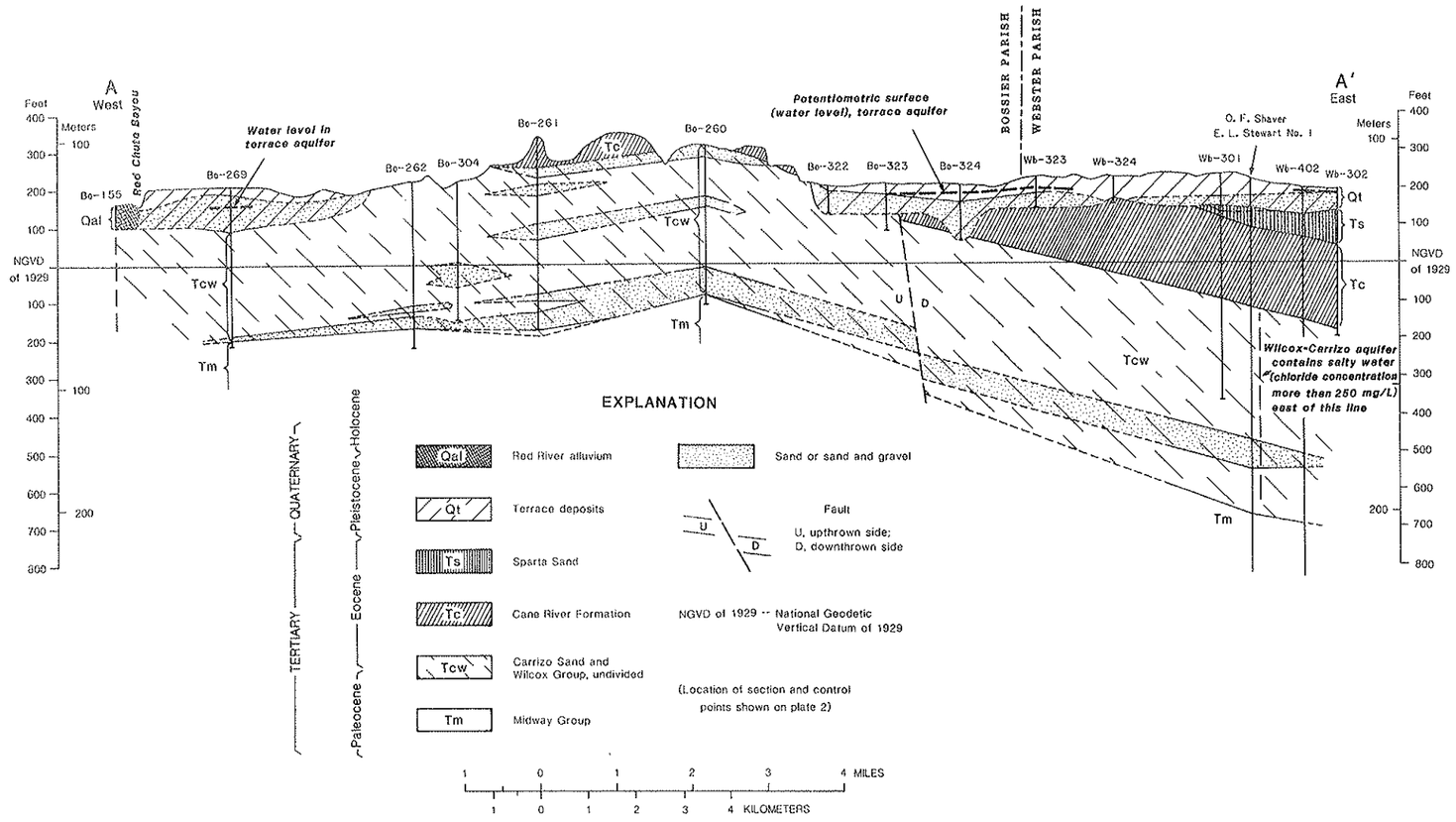


PLATE 3. EAST–WEST GEOHYDROLOGIC SECTION, FILLMORE–HAUGHTON–RED CHUTE AREA, BOSSIER AND WEBSTER PARISHES, LOUISIANA.