

## INTRODUCTION

The Carrizo-Wilcox aquifer is the primary source of ground water for public supply and domestic use within six parishes (Bossier, Caddo, De Soto, Natchitoches, Red River, and Sabine) and a secondary source in parts of three other parishes (Bienville, Claiborne, and Webster) in northwestern Louisiana (fig. 1). The average total withdrawal from the aquifer in these nine parishes was 13.3 million gallons per day in 1990 (Lovelace, 1991, p. 103). Withdrawal from the aquifer is only about 0.01 million gallons per day in Claiborne Parish, and no wells are available in that parish for collecting water-level data.

Additional knowledge about ground-water flow and the effects of withdrawals on the Carrizo-Wilcox aquifer is needed for assessment of ground-water development potential and protection of the resource. To meet this need, the potentiometric surface of the aquifer and water-level changes in that surface are being monitored as part of the U.S. Geological Survey's cooperative program with the Louisiana Department of Transportation and Development.

This report presents data and a map that illustrates the potentiometric surface, during October-December 1991, for the Carrizo-Wilcox aquifer. Hydrographs of water levels in selected wells completed in the aquifer also are presented. Water-level data are on file at the U.S. Geological Survey in Baton Rouge, La.

The map in this report can be used for determining the direction of ground-water flow, hydraulic gradients, and the effects of withdrawals on the ground water. The rate of ground-water movement can be estimated from the gradient when the hydraulic conductivity of the aquifer is known.

## HYDROGEOLOGY

The sediments which comprise the Carrizo-Wilcox aquifer are of Paleocene and Eocene age (fig. 2) (Stuart and others, 1994, p. 9). The Wilcox Group in northwestern Louisiana is composed of an undifferentiated series of interbedded sands and clays, mixed with sandy, lignite layers. The Carrizo Sand, the oldest formation of the Claiborne Group, is a discontinuous, massive sand that lies unconformably over the eroded surface of the Wilcox Group (Page and May, 1964, p. 9-11).

The Carrizo Sand and Wilcox Group are hydraulically connected, and the units are combined into one aquifer (Ryals, 1982, p. 4). In this report, the Carrizo Sand and the Wilcox Group are referred to as the Carrizo-Wilcox aquifer. Locally, within the recharge area, where the Carrizo Sand is absent, the Wilcox Group is overlain by the northern Louisiana terrace deposits or the Red River alluvial deposits. In other areas where the Carrizo Sand is missing, the Wilcox Group is overlain by the Cane River Formation. Near the downdip limit of freshwater in the Carrizo-Wilcox aquifer, the Carrizo Sand is overlain by the Cane River Formation.

The Carrizo-Wilcox aquifer crops out within most of the study area. The aquifer is mostly horizontal within the recharge area, but dips near the edge of the Sabine uplift, with the dip increasing away from the uplift. In Sabine Parish, the dip is to the south; in eastern Bossier Parish, the dip is to the east; and in northern Caddo Parish, the dip is to the north. Recharge occurs from infiltration of rainfall where the Carrizo-Wilcox aquifer crops out and from overlying aquifers where water levels are higher than in the Carrizo-Wilcox aquifer (Page and May, 1964, p. 39; Snider, 1983, p. 5).

The Carrizo-Wilcox aquifer ranges in total thickness from 0 to 2,100 feet. The Carrizo Sand ranges from 0 to 150 feet in thickness. The individual sands within the Wilcox Group range from a few feet to 115 feet in thickness. The Carrizo Sand contains medium- to coarse-grained sand; the Wilcox Group contains very fine- to medium-grained sand (Ryals, 1982, p. 7).

The average hydraulic conductivity is 27 feet per day for the Carrizo Sand and 12 feet per day for the Wilcox Group (Page and May, 1964, p. 38-43). The lower hydraulic conductivities in the Wilcox Group are due to limited areal extent of individual sands and variations in sand thickness, depth, grain size, and sorting. Wells completed in the Wilcox Group usually yield less than 100 gallons per minute, but wells completed in the Carrizo Sand may yield more than 500 gallons per minute (Page and May, 1964, p. 38-43).

Water from the Carrizo-Wilcox aquifer generally is soft with low concentrations of iron, but locally the water can have very high iron concentrations (Ryals, 1982, p. 8). Freshwater (water containing less than 250 milligrams per liter of chloride; U.S. Environmental Protection Agency, 1994, p. 10) occurs throughout most of the study area (fig. 1).

## POTENTIOMETRIC SURFACE

The potentiometric surface of the Carrizo-Wilcox aquifer (fig. 1) was constructed using the altitude of water levels from 74 wells measured October through December 1991. These water-level measurements are listed in table 1. The measurements are reported to tenths or hundredths of a foot, depending on the method of measurement used. The altitude of water levels ranged from 58 feet above sea level in Webster Parish to 300 feet above sea level in Caddo Parish.

Ground-water movement in the Carrizo-Wilcox aquifer generally is toward the Red River Valley, which is a major discharge area. Locally, ground water discharges to streams and lakes. Water levels indicated small cones of depression around some individual public-supply wells, but these cones have a limited effect on the regional water system, and water levels from these wells were not used in drawing the potentiometric surface map. However, large water withdrawals in southeastern Caddo and southwestern Webster Parishes have altered the regional flow pattern toward the center of the cones of depression.

## WATER-LEVEL CHANGES

Hydrographs for wells completed in the Carrizo-Wilcox aquifer show seasonal variations but small net changes (fig. 3). The hydrograph for well Bi-215 shows no trend in water levels during 1979-91. The water level in well DS-445 declined 6 feet during 1977-85, but has since recovered. Hydrographs for wells DS-517, Na-491, and RR-278 show trends of slightly increasing water levels. Water levels in these wells have risen approximately 2.5 feet in the last 10 years. The water level in well Sa-394 (fig. 4) has not changed substantially since 1975. A 7-foot rise during 1968 for well Sa-394 is a result of the filling of the Toledo Bend Reservoir on the Sabine River.

Withdrawals from the Carrizo-Wilcox aquifer have increased from about 4.7 million gallons per day in 1965 to 13.3 million gallons per day in 1990 (fig. 5). The largest water-level changes resulted from the increased withdrawals that have occurred in southeastern Caddo Parish south of Shreveport and southwestern Webster Parish near Doyline.

## SELECTED REFERENCES

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- Newcome, Roy, Jr., Page, L.V., and Sloss, Raymond, 1963, Water resources of Natchitoches Parish, Louisiana: Louisiana Department of Conservation, Louisiana Geological Survey, and Louisiana Department of Public Works Water Resources Bulletin no. 5, 105 p.
- Page, L.V., Newcome, Roy, Jr., and Graeff, G.D., Jr., 1963, Water resources of Sabine Parish, Louisiana: Louisiana Department of Conservation, Louisiana Geological Survey, and Louisiana Department of Public Works Water Resources Bulletin no. 3, 146 p.
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- 1992, Louisiana ground-water map no. 4: Potentiometric surface, 1989, and water-level changes, 1984-89, of the Jasper aquifer system in west-central Louisiana: U.S. Geological Survey Water-Resources Investigations Report 91-4137, 2 sheets.
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- Stuart, C.G., Knochenmus, Darwin, and McGee, B.D., 1994, Guide to Louisiana's ground-water resources: U.S. Geological Survey Water-Resources Investigations Report 94-4085, 55 p.
- U.S. Environmental Protection Agency, 1994, Drinking water regulations and health advisories: U.S. Environmental Protection Agency, Office of Water, May 1994, EPA 822-R-94-001, 11 p.

## CONVERSION FACTORS AND VERTICAL DATUM

| Multiply                | By       | To obtain              |
|-------------------------|----------|------------------------|
| foot                    | 0.3048   | meter                  |
| foot per day            | 0.3048   | meter per day          |
| gallons per minute      | 0.000063 | cubic meter per second |
| million gallons per day | 3.785    | cubic meter per day    |

*Sea level:* In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

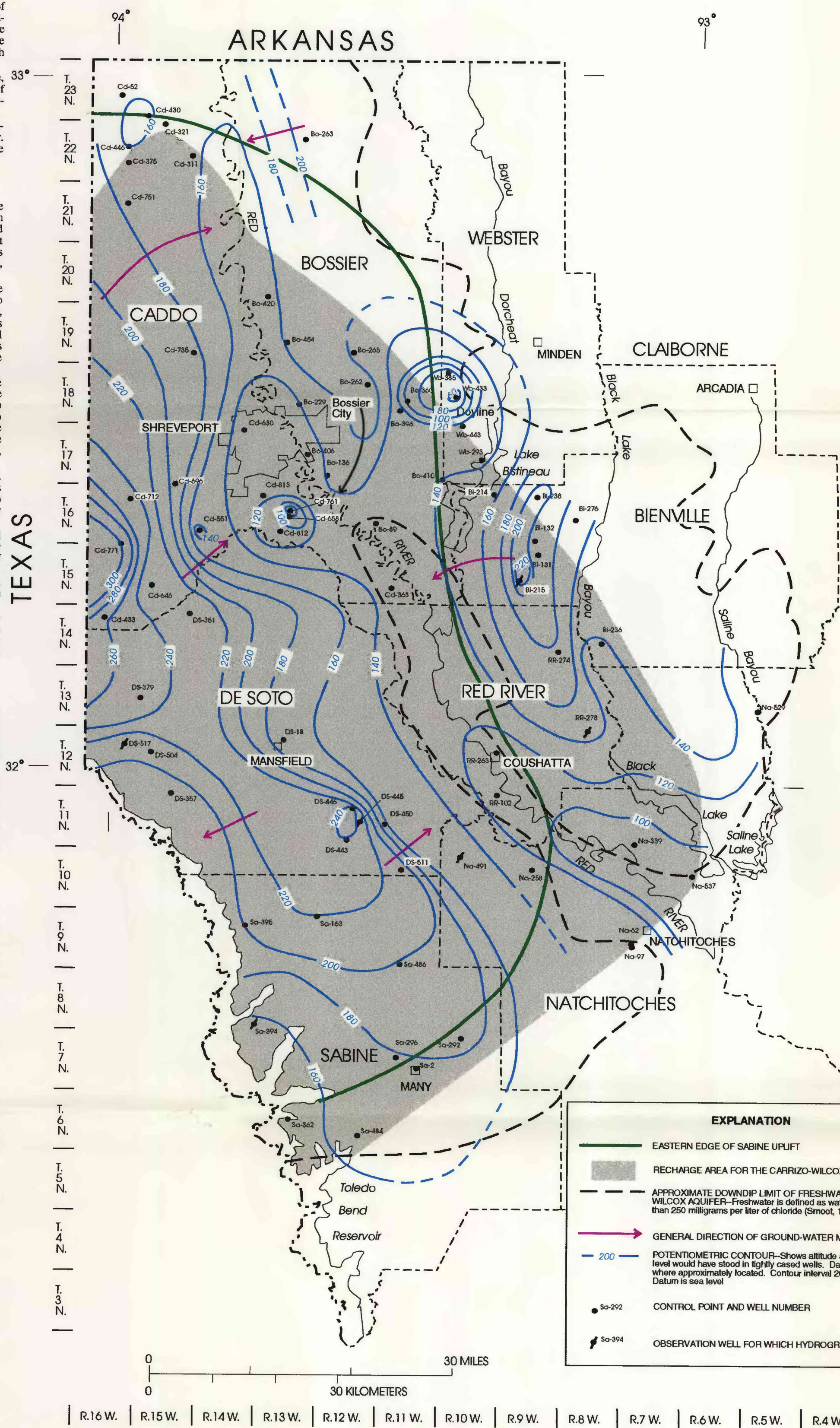


Figure 1. Potentiometric surface of the Carrizo-Wilcox aquifer, October through December 1991.



| System     | Series                         | Stratigraphic unit  | Aquifer or confining unit   |
|------------|--------------------------------|---|---|
| Quaternary | Pleistocene                    | Red River alluvial deposits<br>Mississippi River alluvial deposits<br>Northern Louisiana terrace deposits<br>Unnamed Pleistocene deposits | Red River alluvial aquifer or surficial confining unit<br>Mississippi River alluvial aquifer or surficial confining unit<br>Unnamed terrace aquifer or surficial confining unit |
| Tertiary   | Pliocene                       | Blooms Creek Member   | Pliocene-Miocene aquifers are absent in this area   |
|            |                                | Cator Creek Member  |   |
|            |                                | Williamson Creek Member   |   |
|            |                                | Dough Hills Member  |   |
|            |                                | Lena Member   |   |
|            | 7                              | Catahoula Formation   |   |
|            | Oligocene                      | Vicksburg Group, undifferentiated   | Vicksburg-Jackson confining unit  |
|            |                                | Jackson Group, undifferentiated   |   |
| Eocene     | Claiborne Group                | Cockfield Formation   | Cockfield aquifer or surficial confining unit   |
|            |                                | Cook Mountain Formation   | Cook Mountain aquifer or confining unit   |
|            |                                | Sparta Sand   | Sparta aquifer or surficial confining unit  |
|            |                                | Cane River Formation  | Cane River aquifer or confining unit  |
|            | 7                              | Carrizo Sand  | Carrizo-Wilcox aquifer or surficial confining unit  |
| Paleocene  | Wilcox Group, undifferentiated |   |   |
|            |                                | Midway Group, undifferentiated  | Midway confining unit   |

(From Stuart and others, 1994)

Figure 2. Hydrogeologic column of aquifers in northern Louisiana.

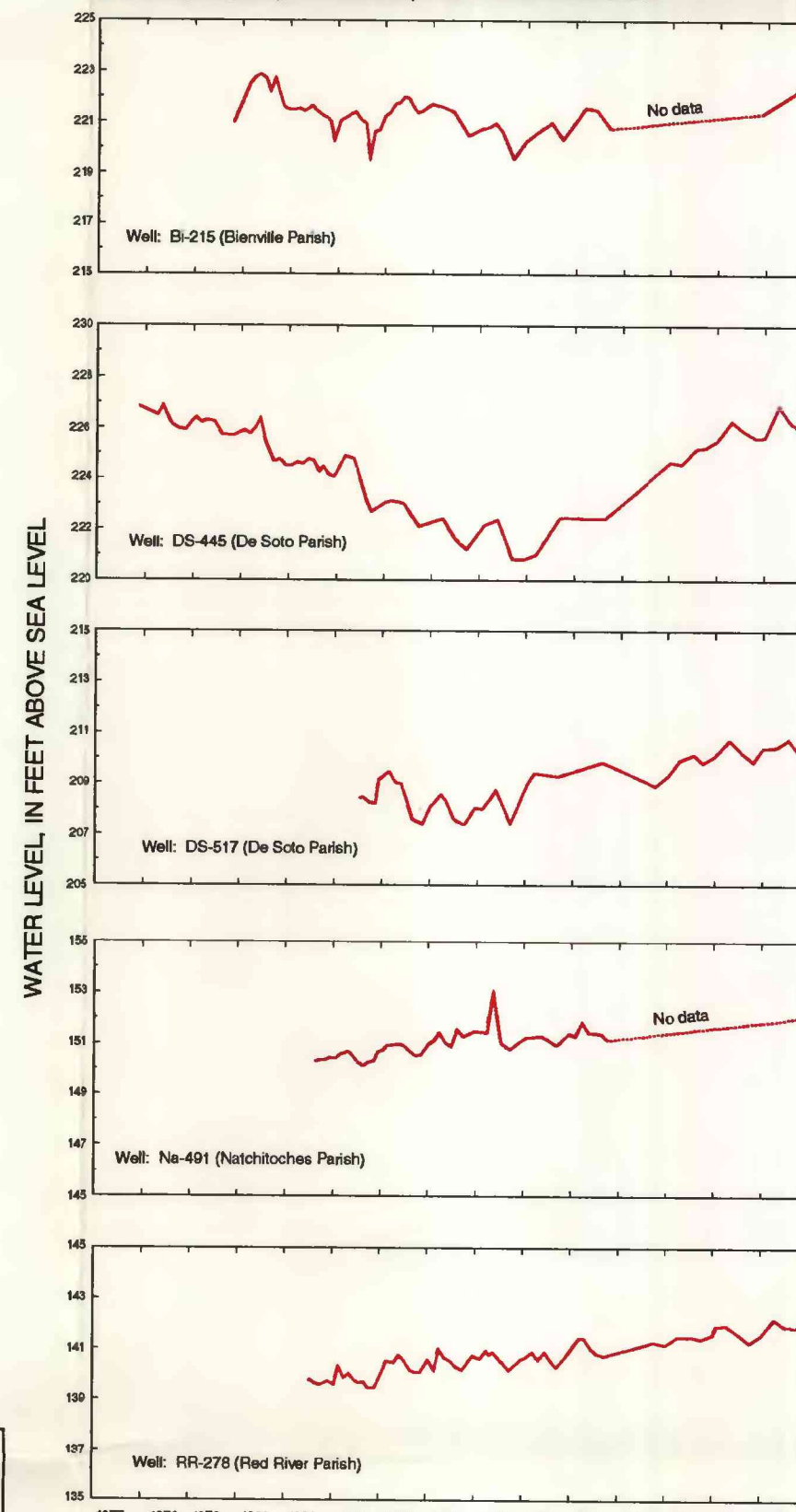


Figure 3. Water levels in selected wells in northwestern Louisiana.

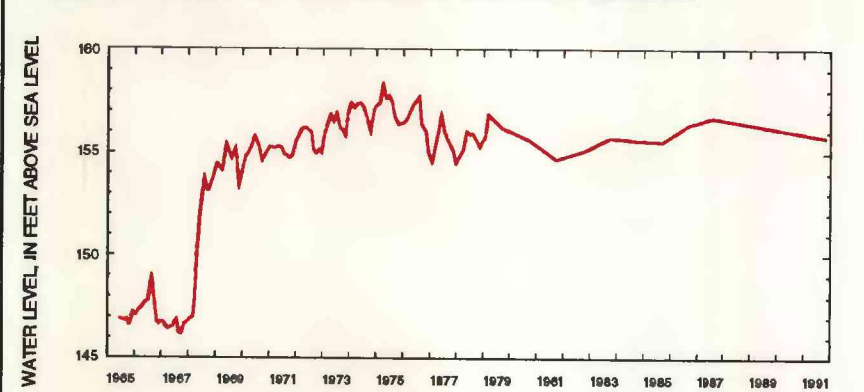


Figure 4. Water level in well Sa-394 in Sabine Parish, Louisiana.

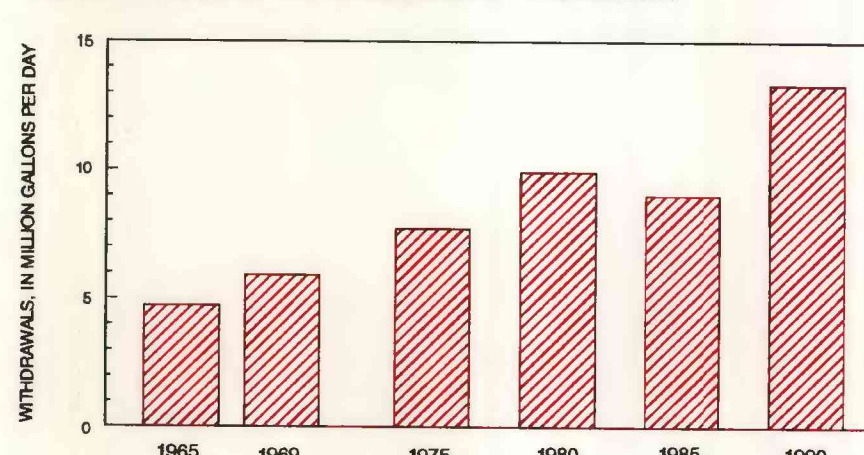


Figure 5. Withdrawals from the Carrizo-Wilcox aquifer in northwestern Louisiana, 1965-90.



Index map

Table 1. Water-level data used to construct potentiometric-surface map of the Carrizo-Wilcox aquifer in northwestern Louisiana, October through December 1991

| Well number                | Well depth (in feet) | Water level (in feet below land surface) | Water level (in feet above sea level) | Date  |
|----------------------------|----------------------|--|---------------------------------------|-------|
| <b>Bienville Parish</b>    |                      |  |                                       |       |
| Bi-131                     | 311                  | 86.65                                    | 188                                   | 11-22 |
| Bi-132                     | 435                  | 72.90                                    | 185                                   | 11-22 |
| Bi-214                     | 159                  | 17.95                                    | 159                                   | 11-22 |
| Bi-215                     | 244                  | 47.49                                    | 223                                   | 11-22 |
| Bi-236                     | 410                  | 64.15                                    | 136                                   | 12- 4 |
| Bi-238                     | 167                  | 59.05                                    | 206                                   | 11-22 |
| Bi-276                     | 336                  | 99.40                                    | 171                                   | 12- 4 |
| <b>Bossier Parish</b>      |                      |  |                                       |       |
| Bo-89                      | 160                  | 13.37                                    | 137                                   | 11-13 |
| Bo-136                     | 180                  | 14.45                                    | 141                                   | 11-12 |
| Bo-229                     | 343                  | 24.07                                    | 140                                   | 12- 3 |
| Bo-262                     | 340                  | 48.92                                    | 171                                   | 11-12 |
| Bo-263                     | 710                  | 156.1                                    | 204                                   | 11-14 |
| Bo-265                     | 258                  | 74.22                                    | 146                                   | 11-12 |
| Bo-360                     | 499                  | 135.4                                    | 95                                    | 11-15 |
| Bo-396                     | 360                  | 129.2                                    | 136                                   | 11-14 |
| Bo-406                     | 168                  | 37.48                                    | 123                                   | 11-15 |
| Bo-410                     | 250                  | 40.05                                    | 140                                   | 11-15 |
| Bo-420                     | 255                  | 40.30                                    | 150                                   | 11-13 |
| Bo-454                     | 220                  | 8.99                                     | 161                                   | 11-14 |
| <b>Caddo Parish</b>        |                      |  |                                       |       |
| Cd-52                      | 660                  | 61.0                                     | 164                                   | 11-14 |
| Cd-311                     | 260                  | 96.30                                    | 164                                   | 12- 3 |
| Cd-321                     | 300                  | 88.0                                     | 172                                   | 11-13 |
| Cd-363                     | 250                  | 13.00                                    | 132                                   | 12-17 |
| Cd-375                     | 275                  | 73.40                                    | 177                                   | 11-18 |
| Cd-430                     | 574                  | 62.10                                    | 158                                   | 11-14 |
| Cd-433                     | 300                  | 61.05                                    | 264                                   | 12- 2 |
| Cd-446                     | 216                  | 49.67                                    | 160                                   | 11-18 |
| Cd-551                     | 270                  | 68.41                                    | 132                                   | 11-19 |
| Cd-630                     | 240                  | 73.57                                    | 126                                   | 11-20 |
| Cd-646                     | 320                  | 56.10                                    | 234                                   | 11-19 |
| Cd-658                     | 192                  | 110.12                                   | 87                                    | 12- 2 |
| Cd-696                     | 170                  | 14.7                                     | 195                                   | 11-19 |
| Cd-712                     | 200                  | 22.98                                    | 247                                   | 12- 3 |
| Cd-735                     | 250                  | 75.00                                    | 185                                   | 11-18 |
| Cd-751                     | 216                  | 33.79                                    | 176                                   | 11-18 |
| Cd-761                     | 215                  | 135.82                                   | 64                                    | 11-21 |
| Cd-771                     | 211                  | .30                                      | 300                                   | 12- 3 |
| Cd-812                     | 200                  | 83.15                                    | 107                                   | 12- 2 |
| Cd-813                     | 225                  | 87.88                                    | 122                                   | 12- 2 |
| <b>De Soto Parish</b>      |                      |  |                                       |       |
| DS-18                      | 245                  | 157.12                                   | 173                                   | 12-17 |
| DS-351                     | 400                  | 78.82                                    | 231                                   | 12-17 |
| DS-357                     | 358                  | 113.95                                   | 188                                   | 12-17 |
| DS-379                     | 317                  | 71.5                                     | 254                                   | 12-16 |
| DS-443                     | 304                  | 43.56                                    | 236                                   | 11- 7 |
| DS-445                     | 140                  | 79.03                                    | 226                                   | 10- 3 |
| DS-446                     | 220                  | 91.69                                    | 248                                   | 11- 7 |
| DS-450                     | 262                  | 127.94                                   | 162                                   | 12- 3 |
| DS-504                     | 260                  | 68.52                                    | 211                                   | 12- 5 |
| DS-511                     | 350                  | 119.89                                   | 210                                   | 11- 6 |
| DS-517                     | 131                  | 14.76                                    | 210                                   | 10- 3 |
| <b>Natchitoches Parish</b> |                      |  |                                       |       |
| Na-62                      | 186                  | 52.74                                    | 127                                   | 12-18 |
| Na-97                      | 184                  | 35.40                                    | 125                                   | 12-18 |
| Na-258                     | 272                  | flowing                                  | *130                                  | 12-18 |
| Na-339                     | 140                  | 43.08                                    | 87                                    | 12-11 |
| Na-491                     | 493                  | 97.50                                    | 152                                   | 11- 6 |
| Na-529                     | 540                  | flowing                                  | *124                                  | 12-12 |
| Na-537                     | 115                  | 79.65                                    | 90                                    | 11- 6 |
| <b>Red River Parish</b>    |                      |  |                                       |       |
| RR-102                     | 208                  | 14.15                                    | 116                                   | 12-16 |
| RR-263                     | 181                  | 33.29                                    | 110                                   | 12-11 |
| RR-274                     | 206                  | 59.10                                    | 176                                   | 12- 3 |
| RR-278                     | 348                  | 18.02                                    | 142                                   | 12- 3 |
| <b>Sabine Parish</b>       |                      |  |                                       |       |
| Sa-2                       | 450                  | 118.00                                   | 167                                   | 12-11 |
| Sa-163                     | 200                  | 86.40                                    | 219                                   | 11- 6 |
| Sa-292                     | 382                  | 171.64                                   | 190                                   | 12-11 |
| Sa-296                     | 335                  | 61.60                                    | 178                                   | 12-11 |
| Sa-362                     | 245                  | 49.38                                    | 151                                   | 11- 7 |
| Sa-394                     | 278                  | 109.23                                   | 156                                   | 12-11 |
| Sa-395                     | 293                  | 8.53                                     | 201                                   | 12-12 |
| Sa-484                     | 475                  | 25.29                                    | 175                                   | 12-11 |
| Sa-486                     | 350                  | 161.10                                   | 199                                   | 12-11 |
| <b>Webster Parish</b>      |                      |  |                                       |       |
| Wb-293                     | 205                  | 23.00                                    | 137                                   | 11-15 |
| Wb-385                     | 398                  | 144.55                                   | 79                                    | 11-14 |
| Wb-433                     | 340                  | 157.25                                   | 58                                    | 11-21 |
| Wb-443                     | 280                  | 56.02                                    | 134                                   | 11-21 |

\*Water level greater than or equal to value shown.

## LOUISIANA GROUND-WATER MAP NO. 8: POTENTIOMETRIC SURFACE, 1991, OF THE CARRIZO-WILCOX AQUIFER IN NORTHWESTERN LOUISIANA

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