Carrizo Aquifer

The Carrizo aquifer, the most productive aquifer in the county, underlies the Queen City-Bigford aquifer and (downdip) Reklaw confining unit (table 1). The Carrizo aquifer is a coarser grained, more massive crossbedded sand than the overlying strata. A narrow band of the Carrizo aquifer crops out in extreme northwestern Webb County, and the aquifer is present in the subsurface throughout the rest of the county (fig. 40). The outcrop covers about 18 mi^2, and the formation dips to the southeast toward the Gulf of Mexico at about 87 ft/mi. The top of the Carrizo aquifer ranges from about 760 ft above NGVD 29 in northwestern Webb County to 7,800 ft below NGVD 29 in southeastern Webb County (fig. 41). The thickness of the Carrizo aquifer varies within a narrow range throughout much of Webb County (fig. 42). The Carrizo aquifer is thinnest in the outcrop area and thickens to the southeast, ranging from less than 1 ft along the western edge of the outcrop to about 1,250 ft in south-central parts of the county. Generally the Carrizo aquifer is composed of a series of stacked, massive crossbedded sandstones and in some places minor amounts of shale and clay. The net sand thickness map of the Carrizo aquifer shows that the thickest sections of sand occur in several places in the central part of the county (fig. 43). The net sand thickness ranges from about 1 ft in the outcrop area in northwestern Webb County to more than 790 ft in central Webb County.

Recharge to the Carrizo aquifer occurs primarily by infiltration of precipitation on the outcrop; minor or substantial amounts of recharge might occur by downward flow from the overlying Queen City-Bigford aquifer in regions where the formations are hydraulically connected (Klemt and others, 1976). Recharge occurring by infiltration of precipitation on the outcrop in the county is estimated to be only about 950 acre-ft/yr assuming that 5 percent of the average annual rainfall of 20.1 in. recharges the aquifer through the outcrop. (However, the Carrizo aquifer receives substantial recharge through its outcrop outside of Webb County.) Although yields for some irrigation wells in the Winter Garden area northeast of Webb County exceed 1,000 gal/min, yields for Carrizo aquifer wells in Webb County generally range from 150 to 200 gal/min. The Carrizo aquifer is confined throughout much of Webb County. The water levels in the two wells measured for this report were about 162 and 209 ft below land surface (fig. 40). Specific capacities for four wells in the Carrizo aquifer in Webb County ranged from 6.0 to 33 ft^2/d, and estimated transmissivities from the specific-capacity data ranged from 115 to 350 ft^2/d (fig. 44, table 2). These transmissivities, although probably less than average for the Carrizo aquifer in the county, are compatible with a previous study that indicated Carrizo aquifer transmissivity is less than about 940 ft^2/d in the county.

Water from the Carrizo aquifer is fresh to slightly saline and commonly is used for commercial and industrial purposes and public supply in Webb County. Generally the freshest water in the Carrizo aquifer is nearest the outcrop (recharge zone), with increasing dissolved solids concentration farther downdip. Lonsdale and Day (1937) noted that wells improperly completed in the Carrizo aquifer often were contaminated with saline water from the Bigford Formation. Six wells completed in the Carrizo aquifer were sampled for this report (fig. 2, nos. 1, 4–6, 17, 19). The dissolved solids concentration in these samples ranged from 826 to 2,220 mg/L (table 6), all greater than the SDWR of 500 mg/L. The water chemistry of the samples was dominated by sodium and chloride, with minor amounts of bicarbonate and sulfate (fig. 45). The sodium percentage for all samples was 99. The chloride concentration in three of the six samples exceeded the SDWR of 250 mg/L, and in those same samples, fluoride concentrations equaled or exceeded the SDWR of 2.0 mg/L. Neither metal nor trace element concentrations exceeded their respective USEPA standards except for boron, which exceeded the lifetime HA of 600 µg/L in all samples.

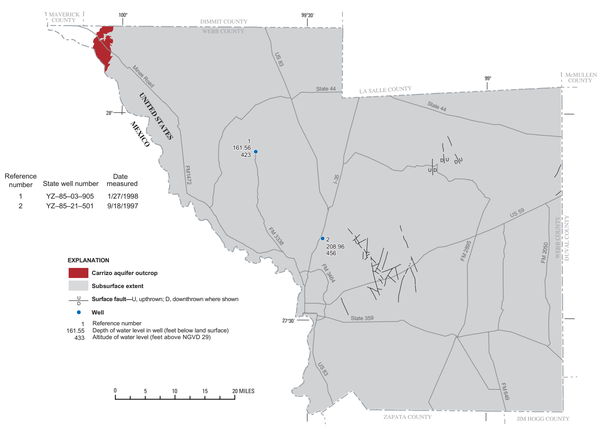


Figure 40. Extent of the Carrizo aquifer outcrop, subsurface extent of the aquifer, and depth of water level in wells, 1997–98.

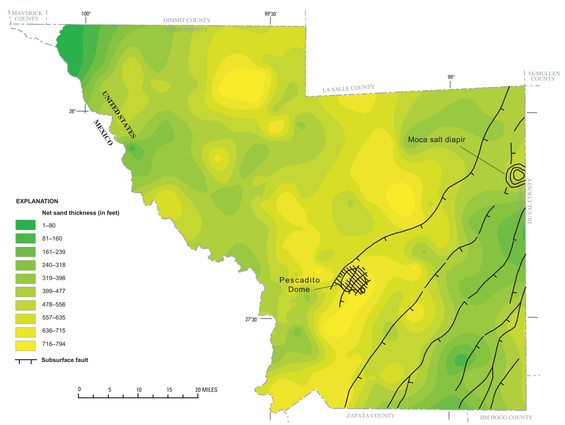


Figure 43. Net sand thickness of the Carrizo aquifer.

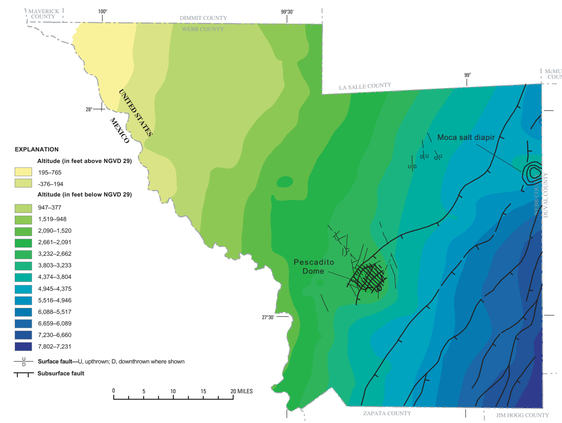


Figure 41. Altitude of the top of the Carrizo aquifer.

Table 6. Water quality of the Carrizo aquifer

[ft, feet; gal/min; gallons per minute; µS/cm, microsiemens per centimeter at 25 °C; °C, degrees Celsius; mg/L, milligrams per liter; NTU, nephelometric turbidity units; --, not available; <, less than; µg/L, micrograms per liter]

Sampled well number (fig. 2)	USGS station number	State well number	Aquifer	Sample date	Depth of well (ft)	Flow rate (gal/min)	Specific conductance (field) (µS/cm)	pH (field) (standard units)	Water temperature (°C)	Dissolved solids, residue at 180 °C (mg/L)	Turbidity (NTU)	Hardness, total (mg/L as $CaCO_3$)
1	280318099400501	YZ–77–59–501	Carrizo	03/18/1998	2,031	15	1,410	8.2	35	826	0.3	4
4	275812099535801	YZ–85–01–301	Carrizo	03/17/1998	1,500	20	1,422	8.5	29	828	.18	3.0
5	275631099372001	YZ–85–04–401	Carrizo	09/04/1997	1,991	--	1,530	8.8	37	1,060	.20	5.0
6	275355099381701	YZ–85–03–905	Carrizo	01/27/1998	1,900	10	2,368	8.5	31	1,460	.17	7.0
17	273903099374501	YZ–85–19–903	Carrizo	09/12/1997	1,918	150	3,740	8.3	38	2,220	1.3	8.0
19	274115099271301	YZ–85–21–501	Carrizo	10/30/1997	3,320	60	4,363	7.9	47	2,080	.10	9.0

Sampled well number (fig. 2)	Calcium, dissolved, (mg/L as Ca)	Magnesium, dissolved, (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sodium-adsorption ratio	Sodium percentage	Potassium, dissolved (mg/L as K)	Alkalinity (field, total) (mg/L as $CaCO_3$)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved, (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)
1	0.84	0.31	324	77	99	1.3	342	417	159	122	0.91
4	.73	.17	319	87	99	1.1	213	260	183	160	.80
5	1.3	.37	400	78	99	1.4	540	653	95	190	1.2
6	1.8	.51	544	92	99	1.8	692	844	85	319	2.0
17	2.0	.52	870	140	99	2.5	1,092	1,329	1.0	630	2.8
19	2.5	.50	790	120	99	3.4	1,090	1,329	.4	540	2.6

Sampled well number (fig. 2)	Silica, dissolved (mg/L as Si)	Nitrogen, nitrite, dissolved (mg/L as N)	Nitrogen, nitrite + nitrate, dissolved (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as NH^3)	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, ammonia + organic, dissolved (mg/L as N)	Nitrogen, organic, dissolved (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Phosphate, ortho, dissolved (mg/L as PO_4)	Aluminum, dissolved (µg/L as Al)
1	20	<0.01	<0.05	0.39	0.30	0.36	0.06	0.13	0.17	0.52	6.9
4	15	<.01	<.05	.37	.29	.39	.1	.05	.08	.24	6.6
5	17	<.01	<.05	.61	.47	.50	.06	.05	.08	.23	9.0
6	17	<.01	<.05	.79	.61	.69	.08	.06	.12	.38	6.4
17	18	<.01	<.05	.90	.70	.60	--	.07	.10	.31	16
19	22	<.01	<.05	1.2	.91	.80	--	.05	.06	.19	10

Sampled well number (fig. 2)	Antimony, dissolved (µg/L as Sb)	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Beryllium, dissolved (µg/L as Be)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)	Copper, dissolved (µg/L as Cu)	Iron, dissolved (µg/L as Fe)	Lead, dissolved (µg/L as Pb)
1	<1	<1	49	<1	710	<1	1.8	<1	<1	265	<1
4	<1	<1	35	<1	722	<1	<1.0	<1	<1	84	<1
5	<1	<1	98	<1	976	<1	3.8	<1	<1	42	<1
6	<2	<1	115	<2	1,124	<2	4.6	<2	<2	106	<2
17	<2	<1	99	<2	1,530	<2	9.5	<2	<2	180	<2
19	<2	<1	544	<2	1,430	<2	13	<2	<2	73	<2

Sampled well number (fig. 2)	Lithium, dissolved (µg/L as Li)	Manganese, dissolved (µg/L as Mn)	Mercury, dissolved (µg/L as Hg)	Molybdenum, dissolved (µg/L as Mo)	Nickel, dissolved (µg/L as Ni)	Selenium, dissolved (µg/L as Se)	Silver, dissolved (µg/L as Ag)	Strontium, dissolved (µg/L as Sr)	Uranium, dissolved (µg/L as U)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)
1	35	6.0	<0.1	3.6	<1	<1	<1	87	<1	<10	3.0
4	34	15	<.1	2.8	<1	<1	--	90	<1	<10	1.2
5	41	9.7	<.1	3.0	<1	<1	--	126	<1	<6	<1
6	62	8.9	<.1	3.4	<2	<1	<2	161	<2	<30	<2
17	100	6.5	<.1	<2	<2	<1	<2	291	<2	<18	3.1
19	136	3.1	<.1	<2	<2	<1	<2	293	<2	<18	<2

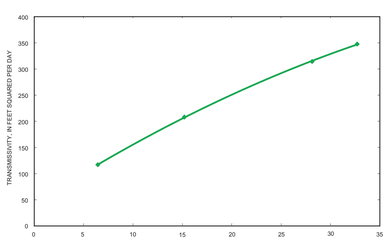
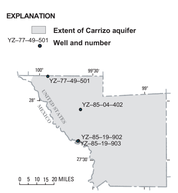


Figure 44. Specific capacity and estimated transmissivity of the Carrizo aquifer.



SUMMARY

Webb County, Texas, is a region confronted by increasing stresses on natural resources. Increased water demand associated with development and population growth have increased the need for the City of Laredo and Webb County to evaluate water sources other than the Rio Grande to meet future demand. The USGS conducted a study in cooperation with the City of Laredo during 1996–98 to assess the ground-water resources of Webb County. A hydrogeologic study was conducted to review and analyze available information on the hydrogeologic units (aquifers and confining units) in Webb County, to locate available wells in the region with water-level and water-quality information from the aquifers, and to analyze the hydraulic properties of the aquifers.

The geologic units that compose the aquifers and confining units in Webb County can be characterized as a series of northeast-southwest trending interbedded sand and shale sequences that were deposited in fluvial-deltaic and nearshore marine depositional environments, separated by regional transgressive marine shales. These Tertiary- and Quaternary-age units crop out in northeast-southwest trending belts oriented approximately parallel to the present shoreline of the Gulf of Mexico. The units gradually thicken to the southeast toward the Gulf of Mexico along a dip trend.

The major aquifers are the Gulf Coast aquifer in southeastern Webb County, the Laredo aquifer in central Webb County, and the Carrizo aquifer throughout much of Webb County. Minor aquifers are the Jackson and Yegua aquifers in eastern Webb County and the Queen City-Bigford aquifer in central Webb County. The Gulf Coast aquifer crops out in southeastern Webb County in a band that trends northeast-southwest. Most of the Gulf Coast aquifer in the county ranges in thickness from less than 1 ft along the western edge of the outcrop to about 1,300 ft in the subsurface in the eastern part of the county. The greatest thickness of sand in the Gulf Coast aquifer (about 375 to about 450 ft) is along the eastern county line. The depth to water in the aquifer obtained from measurements in inventoried wells ranged from about 64 to 123 ft below land surface. Specific capacity for wells open to and completed in the Gulf Coast aquifer ranged from 12 to 180 ft^2/d. Transmissivities estimated from specific capacities ranged from 180 to 1,090 ft^2/d. The Gulf Coast aquifer generally yields small (less than 15 gal/min) amounts of water in the shallow outcrop and yields greater quantities (30 to 150 gal/min) of water from deeper zones. The water withdrawn from the Gulf Coast aquifer in Webb County is fresh to slightly saline. The water also contains several trace elements; the concentrations of three exceeded Federal water-quality standards in one sample each—arsenic and uranium greater than respective USEPA maximum contaminant levels (MCLs); strontium greater than the USEPA health advisory (HA). The concentration of boron in all four samples, as in all samples from all aquifers, also exceeded the USEPA HA.

The Laredo aquifer crops out in the middle of Webb County in a north-south trend. The Laredo aquifer in Webb County ranges in thickness from about 1 ft along the western edge of the outcrop to about 1,510 ft in the central part of the county. The thickest sections of the aquifer are along a north-south trend beneath the eastern edge of the outcrop. Generally, the sandiest parts of the aquifer are at the base of the aquifer. The thickest sections of net sand in the Laredo aquifer are in the central and eastern parts of the county. The depth to water in the Laredo aquifer ranged from about 12 to 252 ft below land surface. Ground-water flow through the Laredo aquifer is partly dependent on the interconnection between the interbedded sand units within the aquifer. Specific capacities computed from 20 tests in the Laredo aquifer were highly variable, ranging from 4.0 to 711 ft^2/d, and estimated transmissivities ranged from 85 to 2,735 ft^2/d. Wells completed in the Laredo aquifer yield small to large (5 to 170 gal/min) amounts of fresh to moderately saline water. Water samples from the Laredo aquifer generally show the presence of some metals and trace elements. Of 24 samples, iron concentrations in five, manganese concentrations in three, and zinc concentrations in one exceeded the respective SDWRs. Strontium concentrations in one-half the samples and boron concentrations in all the samples exceeded the respective USEPA HAs.

The Carrizo aquifer is the most productive aquifer in Webb County. A narrow band of the Carrizo aquifer crops out in the extreme northwestern part of the county, and the aquifer is present in the subsurface throughout the rest of the county. The Carrizo aquifer is thinnest in the outcrop area and thickens to the southeast, ranging from less than 1 ft along the western edge of the outcrop to about 1,250 ft in south-central parts of the county. The thickest sections of sand occur in several places in the central part of the county. The net sand thickness ranges from about 1 ft in the outcrop area in northwestern Webb County to more than 790 ft in central Webb County. The water levels in the two wells measured for this report were about 162 and 209 ft below land surface. Specific capacities for four wells in the Carrizo aquifer in Webb County ranged from 6.0 to 33 ft^2/d, and estimated transmissivities from the specific-capacity data, although probably less than average for the Carrizo aquifer in the county, ranged from 115 to 350 ft^2/d. Carrizo aquifer well yields in the county generally range from 150 to 200 gal/min. Water from the Carrizo aquifer is fresh to slightly saline and generally fresher near the outcrop. Neither metal nor trace element concentrations (except for boron) exceeded their respective USEPA standards.

The minor aquifers in Webb County—Jackson, Yegua, Queen City-Bigford—generally yield less water than the major aquifers because they contain proportionally less sand and more shale and clay. The Yegua aquifer generally is the most saline of the aquifers in Webb County.

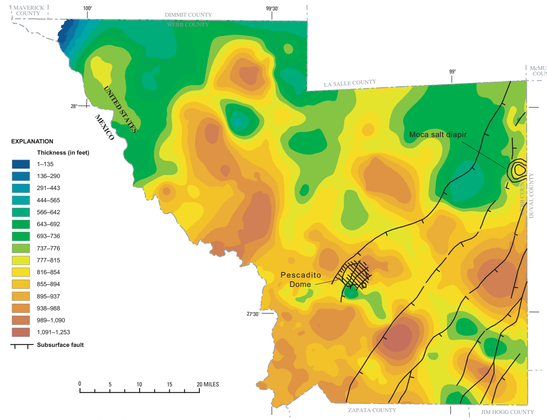


Figure 42. Thickness of the Carrizo aquifer.

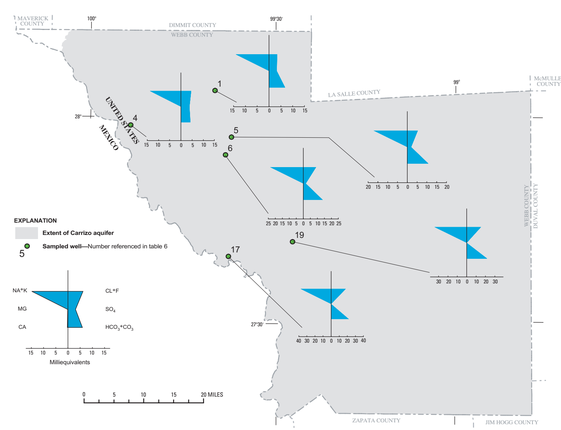


Figure 45. Chemical characteristics of water from the Carrizo aquifer.

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