2017 GROUNDWATER DISCHARGE AND USAGE

EDWARDS AQUIFER
AUTHORITY

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2017 Groundwater Discharge and Usage

Groundwater discharges from the Edwards Aquifer either as springflow or as pumping from wells. Comal and San Marcos springs, the largest and second-largest springs in Texas, respectively, are fed by the Edwards Aquifer. This springflow greatly benefits the recreational economies in New Braunfels and San Marcos, and both springs provide habitat for several federally protected threatened and endangered species. Figure 1 shows locations of the major springs in the Edwards Aquifer region. Wells drilled into the Edwards Aquifer throughout the region provide water for many diverse uses, including irrigation, municipal water supplies, industrial applications, and domestic/livestock consumption.

Estimates of total annual groundwater discharge from combined springflow and pumping for the Edwards Aquifer are provided in Table 1 for the period of record (1934–2017). Annual total groundwater discharge estimates range from a low of 388,800 acre-feet in 1955 to a high of 1,130,000 acre-feet in 1992. In 2017, the total groundwater discharged from the Edwards Aquifer from wells and springs is estimated at 872,206 acre-feet: 493,000 acre-feet as springflow and 379,206 acre-feet as pumping from wells.

The portion of discharge as springflow is estimated by measuring streamflow downstream of the springs and converting the streamflow measurements to spring discharge by subtracting any estimated contributions from surface runoff. Total annual spring discharge has varied from a low of 69,800 acre-feet in 1956 to a high of 802,800 acre-feet in 1992. Monthly springflow estimates for 2017 at each of the six major Edwards Aquifer springs are provided in Table 2.

In Figures 2 and 3, flows at Comal and San Marcos springs are shown as mean annual flows compared with the long-term historical mean flow for the available period of record. The 2017 mean annual flow was only slightly lower than the historical mean discharge at San Marcos Springs, while the 2017 mean annual flow at Comal Springs was equal to the historical mean discharge.

Discharge as well pumping can be classified as either reported or unreported discharge. Reported discharge refers to water pumped from the aquifer by a person or entity holding a groundwater withdrawal permit. These users, who are typically larger quantity users, meter their withdrawals and report the totals to the EAA. Unreported discharge refers to use that does not require a groundwater withdrawal permit from the EAA, such as domestic, livestock, or federal facility use. Unreported discharge is estimated based on numbers of wells and statistical estimates of per-well usage. In 2017, unreported discharge for domestic and livestock wells was estimated at 14,011 acre-feet, and non-reporting federal facility discharge was estimated at 5,343 acre-feet, for a total of 19,354 acre-feet of unreported discharge. Reported discharge totaled 359,852 acre-feet. The total of all reported and unreported pumping discharge is 379,206 acre-feet, which is just slightly above the 10-year mean and median annual discharges listed at the end of Table 1.

Table 3 provides a summary of well and spring discharge for 2017 based on type of use and county. The distribution of discharge from springflows and the different types of pumping for 2017 is shown graphically in Figure 4. Total annual discharge from pumping and springflow are compared in Figure 5 for the period of record from 1934–2017. The years when springflow exceeds pumping tend to be wet years when pumping demand is lowered by more frequent

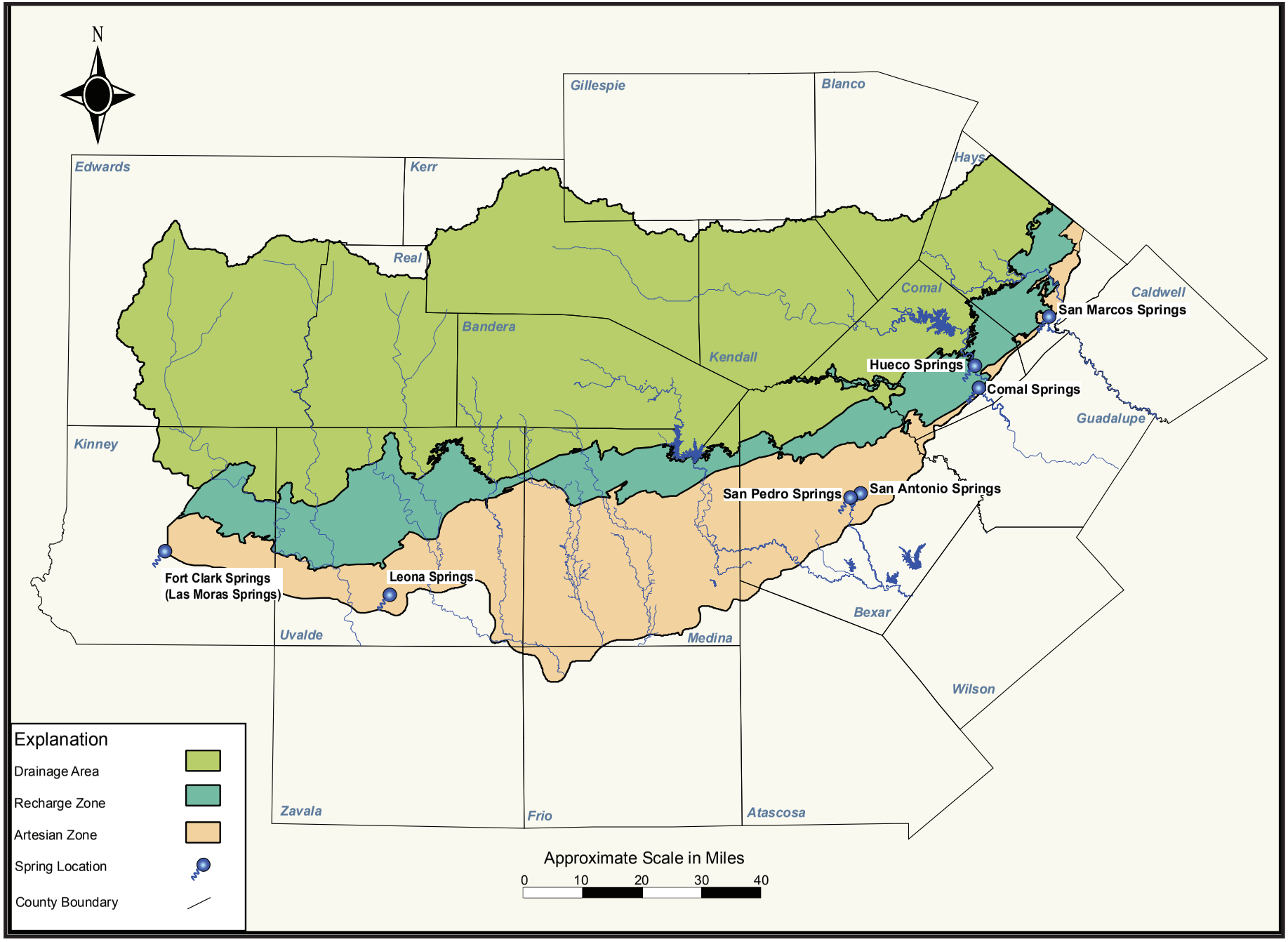

Figure 1. Major Springs in the Southern Segment of the Balcones Fault Zone Edwards Aquifer.

rainfall and higher aquifer levels produce increased springflows. Conversely, during dry years pumping tends to exceed springflow due to increased municipal and agricultural demand and lower aquifer levels. Since 1997, however, the increase in pumping demand during dry years has been limited by the withdrawal permit system and critical period pumping reductions implemented under the Edwards Aquifer Authority Act. Table 4 provides a historical list of total annual discharge by type of use for the period 1955–2017.

Table 1. Annual Estimated Groundwater Discharge Data by County for the Edwards Aquifer, 1934–2017 (measured in thousands of acre-feet).

Year	Uvalde[a]	Medina	Bexar[b]	Comal[c]	Hays	Total	Total Wells	Total Springs
1934	12.6	1.3	109.3	229.1	85.6	437.9	101.9	336.0
1935	12.2	1.5	171.8	237.2	96.9	519.6	103.7	415.9
1936	26.6	1.5	215.2	261.7	93.2	598.2	112.7	485.5
1937	28.3	1.5	201.8	252.5	87.1	571.2	120.2	451.0
1938	25.2	1.6	187.6	250.0	93.4	557.8	120.1	437.7
1939	18.2	1.6	122.5	219.4	71.1	432.8	118.9	313.9
1940	16.1	1.6	116.7	203.8	78.4	416.6	120.1	296.5
1941	17.9	1.6	197.4	250.0	134.3	601.2	136.8	464.4
1942	22.5	1.7	203.2	255.1	112.2	594.7	144.6	450.1
1943	19.2	1.7	172.0	249.2	97.2	539.3	149.1	390.2
1944	11.6	1.7	166.3	252.5	135.3	567.4	147.3	420.1
1945	12.4	1.7	199.8	263.1	137.8	614.8	153.3	461.5
1946	6.2	1.7	180.1	261.9	134.0	583.9	155.0	428.9
1947	13.8	2.0	193.3	256.8	127.6	593.5	167.0	426.5
1948	9.2	1.9	159.2	203.0	77.3	450.6	168.7	281.9
1949	13.2	2.0	165.3	209.5	89.8	479.8	179.4	300.4
1950	17.8	2.2	177.3	191.1	78.3	466.7	193.8	272.9
1951	16.9	2.2	186.9	150.5	69.1	425.6	209.7	215.9
1952	22.7	3.1	187.1	133.2	78.8	424.9	215.4	209.5
1953	27.5	4.0	193.7	141.7	101.4	468.3	229.8	238.5
1954	26.6	6.3	208.9	101.0	81.5	424.3	246.2	178.1
1955	28.3	11.1	215.2	70.1	64.1	388.8	261.0	127.8
1956	59.6	17.7	229.6	33.6	50.4	390.9	321.1	69.8
1957	29.0	11.9	189.4	113.2	113.0	456.5	237.3	219.2
1958	23.7	6.6	199.5	231.8	155.9	617.5	219.3	398.2
1959	43.0	8.3	217.5	231.7	118.5	619.0	234.5	384.5
1960	53.7	7.6	215.4	235.2	143.5	655.4	227.1	428.3
1961	56.5	6.4	230.3	249.5	140.8	683.5	228.2	455.3
1962	64.6	8.1	220.0	197.5	98.8	589.0	267.9	321.1
1963	51.4	9.7	217.3	155.7	81.9	516.0	276.4	239.6
1964	49.3	8.6	201.0	141.8	73.3	474.0	260.2	213.8
1965	46.8	10.0	201.1	194.7	126.3	578.9	256.1	322.8
1966	48.5	10.4	198.0	198.9	115.4	571.2	255.9	315.3
1967	81.1	15.2	239.7	139.1	82.3	557.4	341.3	216.1
1968	58.0	9.9	207.1	238.2	146.8	660.0	251.7	408.3
1969	88.5	13.6	216.3	218.2	122.1	658.7	307.5	351.2
1970	100.9	16.5	230.6	229.2	149.9	727.1	329.4	397.7
1971	117.0	32.4	262.8	168.2	99.1	679.5	406.8	272.7
1972	112.6	28.8	247.7	234.3	123.7	747.1	371.3	375.8
1973	96.5	14.9	273.0	289.3	164.3	838.0	310.4	527.6
1974	133.3	28.6	272.1	286.1	141.1	861.2	377.4	483.8
1975	112.0	22.6	259.0	296.0	178.6	868.2	327.8	540.4
1976	136.4	19.4	253.2	279.7	164.7	853.4	349.5	503.9
1977	156.5	19.9	317.5	295.0	172.0	960.9	380.6	580.3
1978	154.3	38.7	269.5	245.7	99.1	807.3	431.8	375.5
1979	130.1	32.9	294.5	300.0	157.0	914.5	391.5	523.0
1980	151.0	39.9	300.3	220.3	107.9	819.4	491.1	328.3
1981	104.2	26.1	280.7	241.8	141.6	794.4	387.1	407.3
1982	129.2	33.4	305.1	213.2	105.5	786.4	453.1	333.3
1983	107.7	29.7	277.6	186.6	118.5	720.1	418.5	301.6
1984	156.9	46.9	309.7	108.9	85.7	708.1	529.8	178.3
1985	156.9	59.2	295.5	200.0	144.9	856.5	522.5	334.0
1986	91.7	41.9	294.0	229.3	160.4	817.3	429.3	388.0
1987	94.9	15.9	326.6	286.2	198.4	922.0	364.1	557.9
1988	156.7	82.2	317.4	236.5	116.9	909.7	540.0	369.7

Table 1. (continued)

Year	Uvalde[a]	Medina	Bexar[b]	Comal[c]	Hays	Total	Total Wells	Total Springs
1989	156.9	70.5	305.6	147.9	85.6	766.5	542.4	224.1
1990	118.1	69.7	276.8	171.3	94.1	730.0	489.4	240.6
1991	76.6	25.6	315.5	221.9	151.0	790.6	436.0	354.6
1992	76.5	9.3	370.5	412.4	261.3	1130.0	327.2	802.8
1993	107.5	17.8	371.0	349.5	151.0	996.7	407.3	589.4
1994	95.5	41.1	297.7	269.8	110.6	814.8	424.6	390.2
1995	90.8	35.2	272.1	235.0	127.8	761.0	399.6	361.3
1996	117.6	66.3	286.8	150.2	84.7	705.6	493.6	212.0
1997	77.0	31.4	260.2	243.3	149.2	761.1	377.1	383.9
1998	113.1	51.3	312.4	271.8	168.8	917.6	453.5	464.1
1999	104.0	49.2	307.1	295.5	143.0	898.8	442.7	456.1
2000	89.1	45.1	283.6	226.1	108.4	752.3	414.8	337.5
2001	68.6	33.9	291.6	327.7	175.4	890.0	367.7	529.6
2002	76.2	40.6	311.9	350.4	202.1	981.2	371.3	609.9
2003	89.4	34.8	331.7	344.7	176.3	976.9	362.1	621.5
2004	91.3	22.5	331.9	341.4	153.1	940.3	317.4	622.9
2005	107.4	37.3	366.1	349.3	175.6	1035.7	388.5	647.1
2006	107.5	64.9	289.5	216.7	87.9	766.5	454.5	312.0
2007	64.6	18.4	330.2	331.7	196.0	940.9	319.9	621.0
2008	102.0	48.8	320.4	266.6	108.0	845.7	428.6	417.1
2009	76.9	47.3	265.2	206.6	87.8	683.7	395.7	287.9
2010	53.1	36.4	298.5	312.1	162.5	862.6	372.6	490.0
2011	79.6	57.4	277.2	187.7	91.0	692.9	427.7	265.2
2012	57.6	44.3	267.5	193.4	124.2	687.0	384.7	302.3
2013	43.6	42.8	251.0	154.9	96.0	588.6	355.8	232.8
2014	41.5	43.1	230.5	114.5	97.9	527.5	332.2	195.4
2015	27.1	27.6	256.3	239.8	178.8	729.7	325.2	404.5
2016	46.9	31.9	262.6	320.7	208.3	870.3	325.3	545.0
2017	63.0	43.6	305.3	294.0	166.8	872.2	379.2	493.0
For period of record 1934–2017:								
Median	66.6	18.9	257.7	234.7	118.5	699.3	328.6	384.2
Mean	71.1	24.0	249.4	228.3	123.3	698.7	316.3	382.6
For last 10 years, 2007–2017:								
Median	55.4	43.4	266.4	223.2	116.1	711.3	375.9	353.4
Mean	59.1	42.3	273.5	214.9	123.0	736.0	372.7	363.3

Data source: Unpublished USGS and Edwards Aquifer Authority files (2017).
a = As of 2008, no longer includes Kinney County discharge; prior years include 1,900 acre-feet of discharge for Kinney County.
b = Includes reports of Edwards Aquifer irrigators in Atascosa County.
c = Includes reports of Edwards Aquifer industrial and municipal users in Guadalupe County.
Differences in totals may occur as a result of rounding.

Table 2. Estimated Spring Discharge from the Edwards Aquifer, 2017 (measured in acre-feet).

Month	Leona Springs and Leona River Underflow	San Pedro Springs	San Antonio Springs	Comal Springs	Hueco Springs	San Marcos Springs	Total Monthly Discharge from Springs
January	2.120	760	5,460	24,100	5,300	13,900	51,700
February	1,790	730	5,020	23,000	4,800	13,100	48,500
March	1,970	870	5,770	25,500	5,960	14,700	54,800
April	2,160	640	3,420	24,500	5,070	16,200	51,900
May	1,950	390	763	23,400	4,400	16,600	47,500
June	1,910	312	415	20,700	2,990	14,400	40,700
July	1,370	92	0	17,900	2,500	12,500	34,300
August	1,190	108	0	16,600	2,390	11,400	31,700
September	1,260	122	0	16,900	1,970	13,600	33,900
October	1,840	201	0	18,000	1,570	12,500	34,000
November	1,840	152	0	17,600	1,190	11,100	31,800
December	2,060	198	0	17,800	1,430	10,600	32,100
Total	21,500	4,570	20,800	246,000	39,600	161,000	493,000

Data source: USGS unpublished report (2017).
Totals might not equal sum of discharge values as a result of rounding.

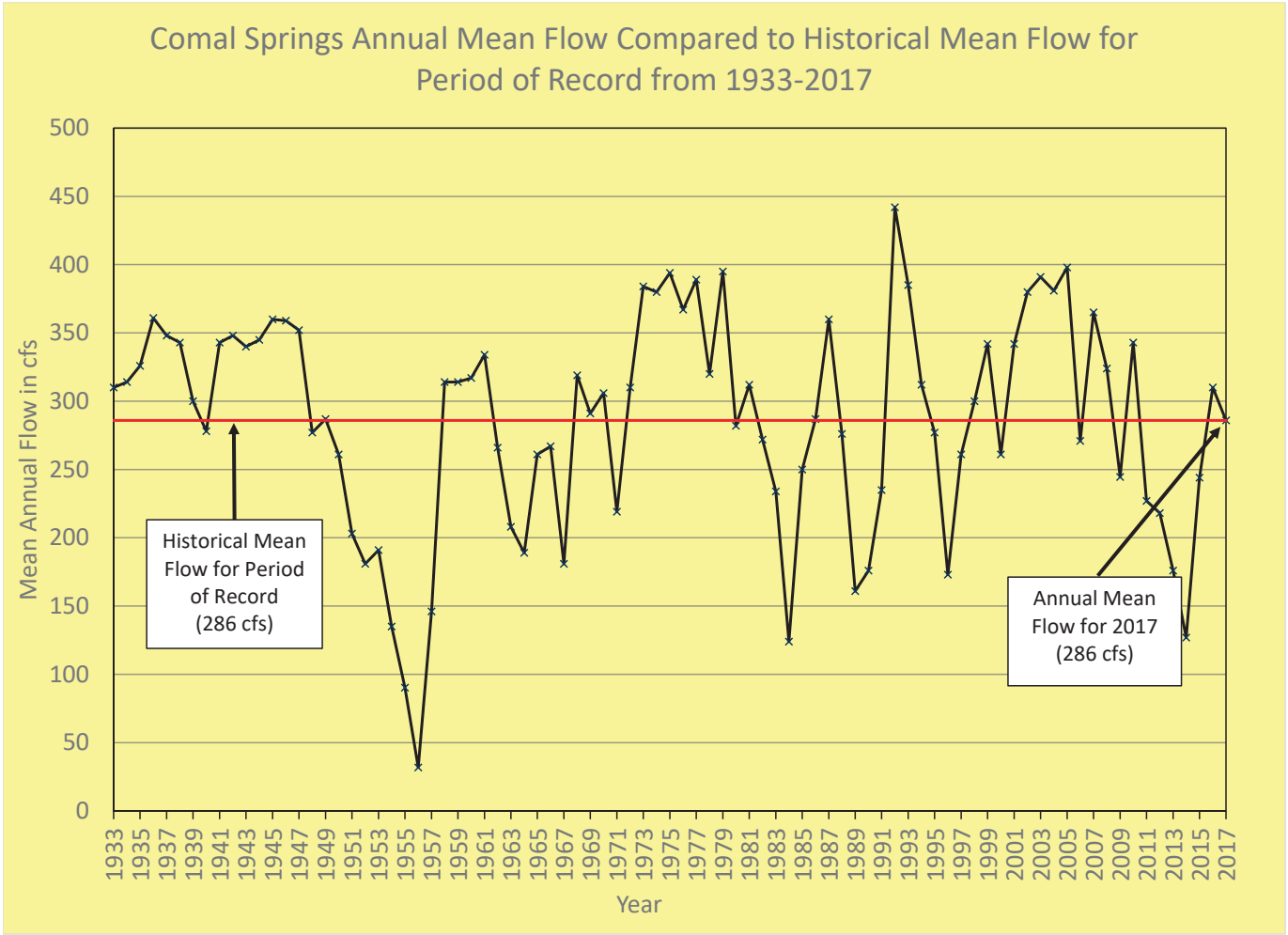

Figure 2. Mean Annual Discharge at Comal Springs

Table 3. Comprehensive Discharge Summary for Calendar Year 2017 (in acre-feet)

	Reported Use (permitted wells)			Unreported Use				
County	Irrigation	Municipal	Industrial	Domestic or Livestock*	Non-Reporting Facilities*	Total Well Discharge	Spring Discharge	Total Wells and Springs
Atascosa	1,454	0	0	0	0	1,454	0	1,454
Bexar	4,951	244,528	14,948	8,919	5,089	278,435	25,370	303,805
Comal	42	4,991	2,816	410	0	8,259	285,600	293,859
Guadalupe	0	6	184	0	0	190	0	190
Hays	117	3,247	1,307	880	254	5,805	161,000	166,805
Medina	32,021	6,983	3,413	1,159	0	43,576	0	43,576
Uvalde	35,534	3,182	128	2,643	0	41,487	21,500	62,987
Totals	74,119	262,937	22,795	14,011	5,343	379,206	493,000	872,206

* Federal facilities and domestic and livestock wells do not report annual use (non-reporting); quantities estimated.
Differences in totals may occur because of rounding.

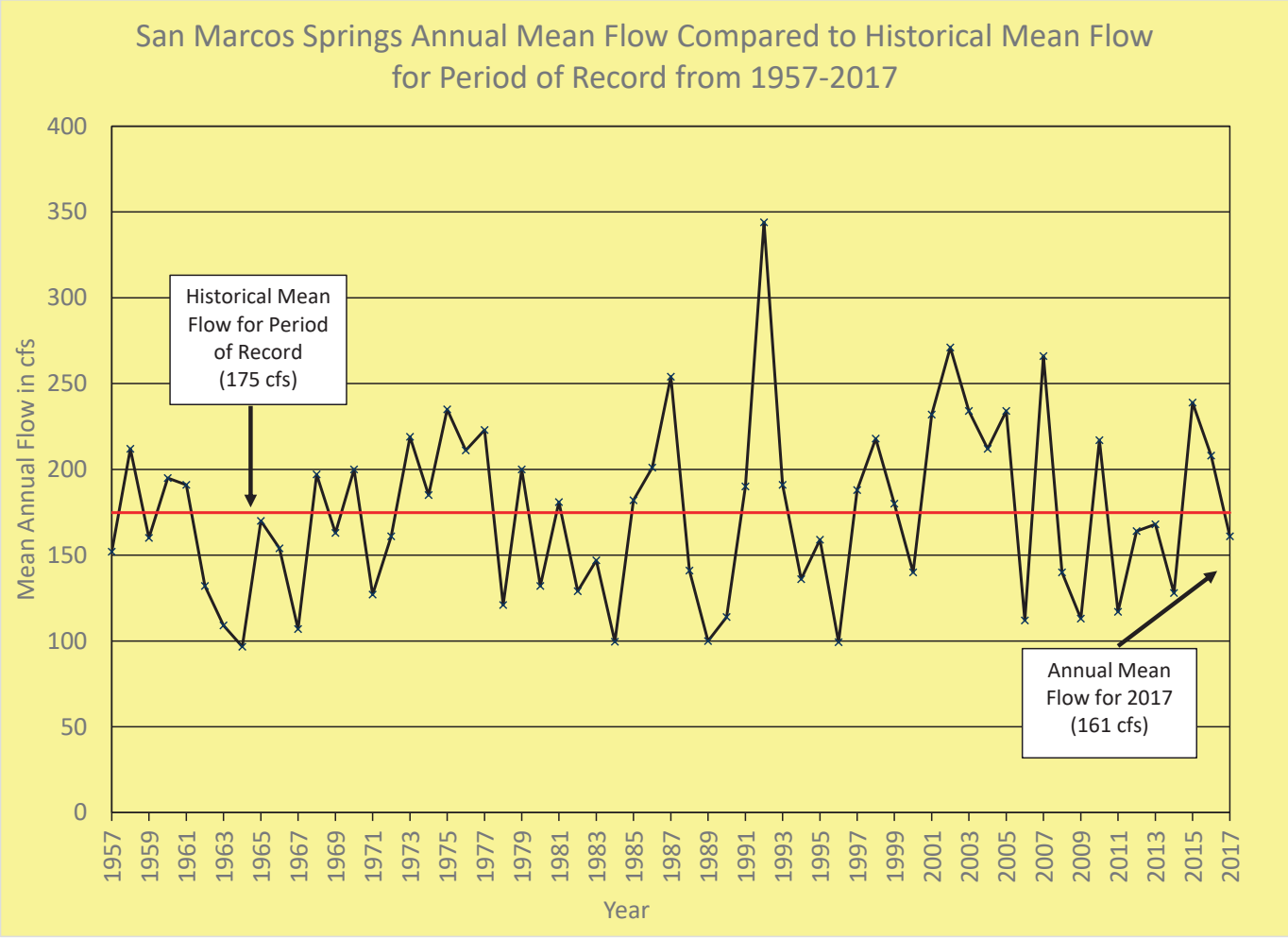

Figure 3. Mean Annual Discharge at San Marcos Springs

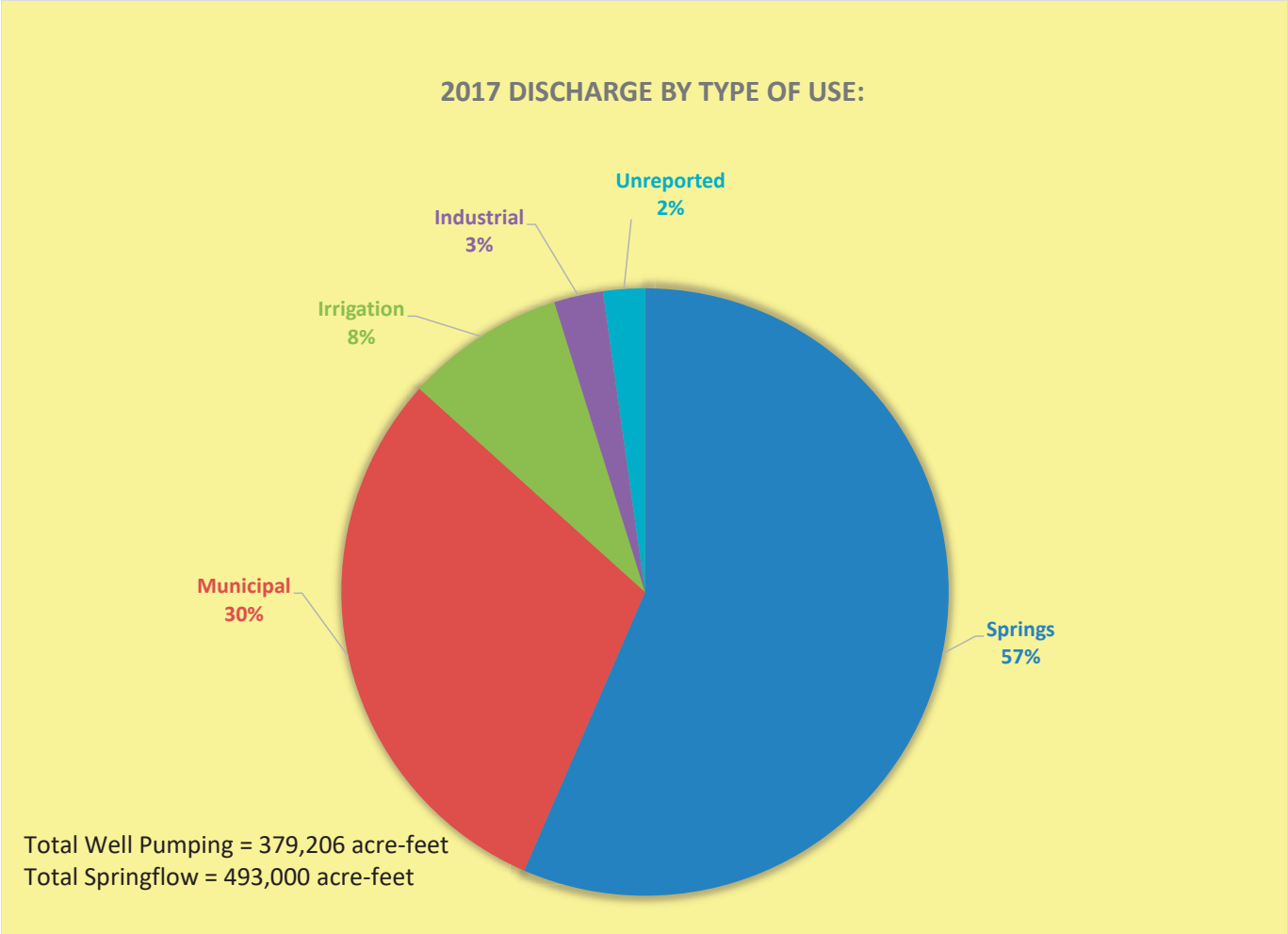

Figure 4. 2017 Discharge by Type of Use

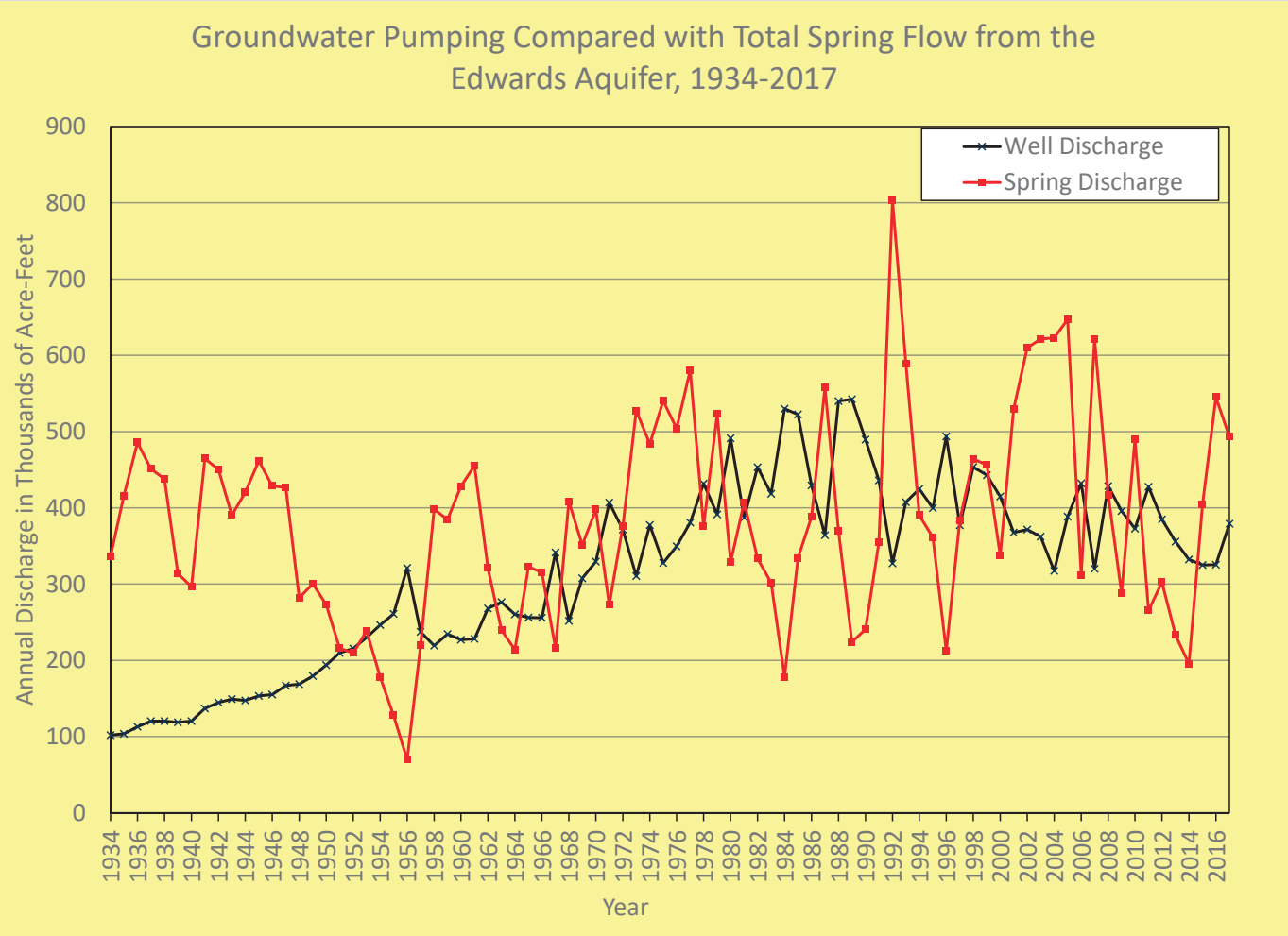

Figure 5. Groundwater Pumping Compared with Springflow

Table 4. Annual Estimated Edwards Aquifer Groundwater Discharge by Use, 1955–2017 (measured in thousands of acre-feet).

Year	Irrigation	Municipal	Domestic/ Stock	Industrial/ Commercial	Springs
1955	85.2	120.5	30.1	25.1	127.8
1956	127.2	138.3	28.9	22.4	69.8
1957	68.8	116.1	29.8	22.6	219.2
1958	47.2	113.7	33.4	25.1	398.2
1959	60.0	118.9	31.5	24.2	384.5
1960	54.9	121.1	29.1	23.3	428.3
1961	52.1	124.5	29.6	22.2	455.3
1962	72.7	143.7	28.8	22.8	321.1
1963	75.4	151.8	27.8	21.8	239.6
1964	72.6	140.2	26.3	21.7	213.8
1965	68.0	138.8	27.0	22.3	322.8
1966	68.2	141.8	23.3	22.6	315.3
1967	119.4	171.0	25.1	25.8	216.1
1968	59.3	146.9	25.5	20.0	408.3
1969	95.2	162.0	29.2	21.1	351.2
1970	110.1	167.5	29.3	22.5	397.7
1971	159.4	196.2	28.6	22.6	272.7
1972	128.8	190.5	30.8	21.1	375.8
1973	82.2	177.1	32.3	18.8	527.6
1974	140.4	174.6	33.5	15.1	483.3
1975	96.4	182.5	33.6	15.3	540.4
1976	118.2	182.1	34.6	14.7	503.9
1977	124.2	205.3	38.1	13.0	580.3
1978	165.8	214.2	40.3	11.5	375.5
1979	126.8	208.9	40.7	15.2	523.0
1980	177.9	256.2	43.3	13.7	328.3
1981	101.8	231.8	40.9	12.6	407.3
1982	130.0	268.6	39.5	15.0	333.3
1983	115.9	249.2	38.8	14.7	301.5
1984	191.2	287.2	36.2	15.2	178.3
1985	203.1	263.7	39.2	16.5	334.0
1986	104.2	266.3	42.0	16.8	388.0
1987	40.9	260.9	43.5	18.7	557.9
1988	193.1	286.2	41.9	18.8	369.7
1989	196.2	285.2	38.2	22.9	224.1
1990	172.9	254.9	37.9	23.7	240.6
1991	88.5	240.5	39.5	67.5	354.6
1992	27.1	236.5	34.8	29.0	802.8
1993	69.3	252.0	49.9	36.1	589.4
1994	104.5	247.0	33.9	39.3	390.2
1995	95.6	255.0	11.6*	37.3	361.3
1996	181.3	261.3	12.3*	38.8	212.0

Table 4. (continued)

Year	Irrigation	Municipal	Domestic/ Stock	Industrial/ Commercial	Springs
1997	77.4[a/b]	253.0	12.3	34.4	383.9
1998	131.9[a]	266.5	13.4	41.7[b]	464.1
1999	113.6	273.3	13.4	42.4	456.1
2000	106.3	261.3	13.4	33.8	337.5
2001	79.0	245.9	13.4	29.4	529.4
2002	97.1	228.4	13.6	32.3	609.9
2003	79.6	237.2	13.7	31.7	621.5
2004	55.4	220.3	13.8	28.1	622.9
2005	85.3	255.1	13.8	34.3	647.1
2006	149.1	259.1	13.8	34.5	312.0
2007	42.5	236.0	13.8	27.6	620.6
2008	112.7	273.6	13.5**	28.8	417.1
2009	108.9	247.5	13.6**	25.7	288.0
2010	72.7	259.9	13.6**	26.4	490.0
2011	124.9	265.5	13.6**	23.6	265.2
2012	90.6	257.9	13.7**	22.6	302.3
2013	76.3	239.5	13.7**	26.3	232.8
2014	75.3	220.1	13.9**	22.8	195.4
2015	42.2	247.2	13.9**	21.9	404.5
2016	54.7	232.6	14.0**	24.0	545.0
2017	74.1	268.3	14.0**	22.8	493.0
For period of record 1955–2017:					
Median	95.6	236.5	13.6**	22.8	383.9
Mean	101.9	215.9	13.5**	24.8	391.5
For period of record 2007–2017 (last ten years):					
Median	75.8	252.7	13.7	23.8	353.4
Mean	83.2	251.2	13.7	24.5	363.3

Data source: USGS unpublished report and Edwards Aquifer Authority files (2017).
a = Includes estimates from Atascosa County discharge by Edwards Aquifer users.
b = Includes estimates from Guadalupe County discharge by Edwards Aquifer users.
* = In 1995 USGS revised the method of calculating domestic/livestock pumpage, which significantly decreased the estimates for 1995 and 1996.
** = Revision based on number of new wells permitted annually and discontinuation of Kinney County estimates in total. Differences in totals may occur as a result of rounding.