

EXPLANATION

Approximate recharge area (adapted from Burchett, Retman, and Boring, 1986)

Bad-water line

NITRITE PLUS NITRATE, AS NITROGEN

Map symbol	Range of representative concentration, in milligrams per liter	Number and type of site in range
▲	0-2	13 stream gages
●	0-2	162 wells
○	0-2	2 springs
●	2-3	53 wells
●	3-4	20 wells
●	4-8.4	1 cave
●	4-8.4	3 wells

2 Number indicates the number of wells at location

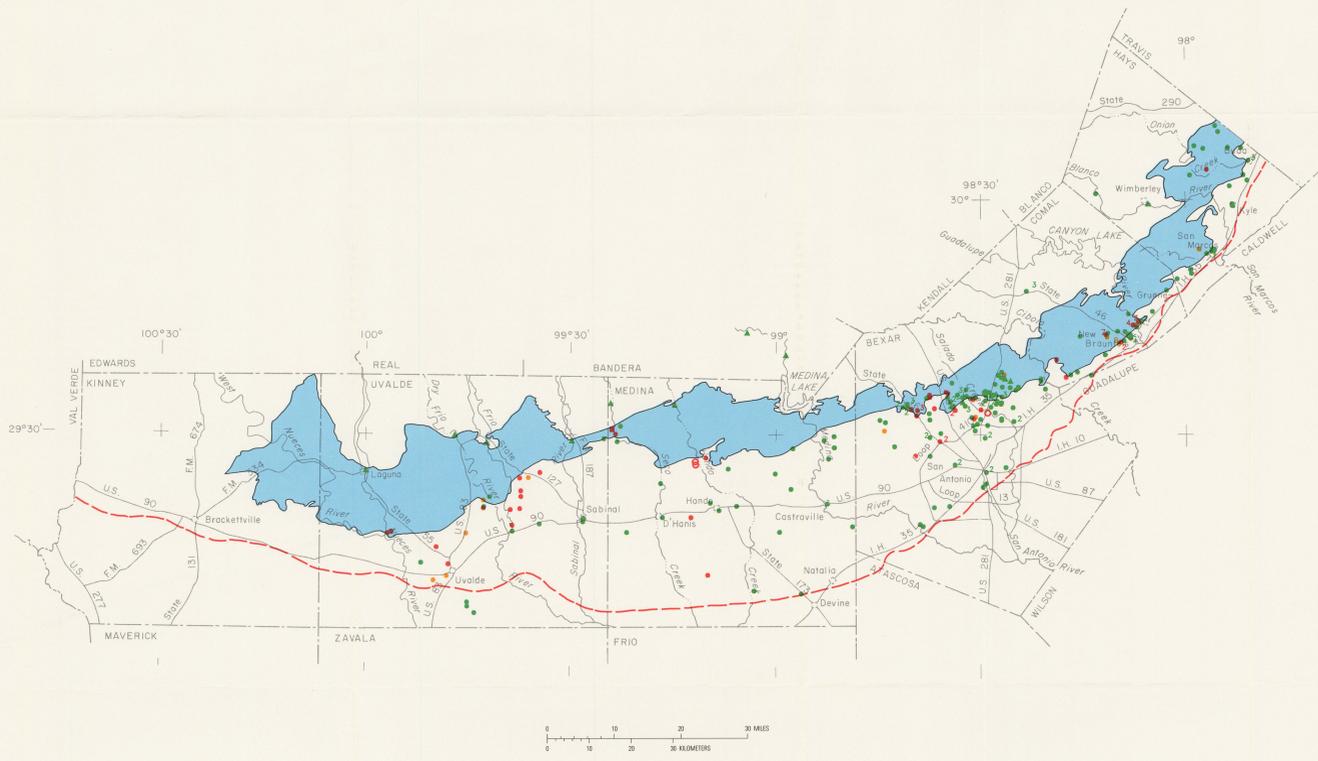


Figure 4. Areal distribution of nitrite plus nitrate concentrations.

NITROGEN AND PHOSPHORUS

Nitrogen and phosphorus are considered primary nutrients, which are chemical elements necessary for plant growth. Although necessary for life, excessive concentrations of nutrients in water can be harmful—large concentrations of ammonia are toxic to fish, excessive nitrate concentrations in drinking water are harmful to infants, and large concentrations of phosphorus may lead to excessive algal blooms.

Nitrogen can occur in several chemical forms or "species" in the nitrogen cycle. Nitrogen commonly is oxidized by bacteria in the following order: organic nitrogen, ammonia, nitrite, and nitrate. Nitrite was not always determined and nitrite plus nitrate, which usually is virtually equal to nitrate in oxygenated waters, has been substituted in this report. Relative concentrations of nitrogen species may be used to evaluate the trophic state of waters, and in some instances, relative distances from a pollution source. A summary of the nutrient data for wells, springs, and surface-water sampling sites is given by hydrologic subarea in table 3.

DISTRIBUTION OF NITRITE PLUS NITRATE

The total number of samples analyzed for nitrite plus nitrate was 1,443. There were 981 samples for nitrite plus nitrate collected from 238 wells, 16 from Comal Springs, 14 from San Marcos Springs, 4 from Woodard Cave, and 428 from 13 surface-water sites. About one-third of the wells were sampled only once, and another one-third were sampled twice, and 10 percent were sampled more than 10 times.

Time-nested-average concentrations of nitrite plus nitrate were less than 3 mg/L, the smallest concentration which indicates traces of manmade pollution, at 90 percent of the ground-water sites and at all 13 surface-water sites (fig. 4). Time-nested-average concentrations were larger than 4.0 mg/L in water from two wells near the recharge area in the ranchland of Medina County, in one well near a landfill in north Bexar County, and in Woodard Cave, where bats are known to roost.

Comparing the data among all the hydrologic subareas in table 3, median time-nested-average concentrations of nitrite plus nitrate were largest for the Comal-Hays subarea (2.2 mg/L) and Uvalde subarea (2.1 mg/L), and smallest for the transition subarea (0.9 mg/L) and saline-water subarea (0.1 mg/L) where other species of nitrogen predominate. Median time-nested-average concentrations of nitrite plus nitrate in water from both surface-water subareas were smaller than from freshwater wells. Only one sample exceeded the EPA maximum contaminant level for drinking water of 10 mg/L for nitrite plus nitrate: a concentration of 11 mg/L was detected in water from a well completed in the Edwards aquifer just downstream from the recharge area in the ranchland of Medina County.

DISTRIBUTION OF ORGANIC NITROGEN, AMMONIA, TOTAL NITROGEN, AND PHOSPHORUS BY HYDROLOGIC SUBAREA

There were 1,089 samples analyzed for organic nitrogen—614 from 138 wells, 10 from Comal Springs, 10 from San Marcos Springs, 4 from Woodard Cave, and 451 from 13 surface-water sites. About one-third of the wells were sampled only once, another one-third were sampled twice, and 10 percent were sampled 9 times or more. There were 1,446 samples analyzed for ammonia—943 from 219 wells, 13 from Comal Springs, 13 from San Marcos Springs, 4 from Woodard Cave, and 473 from 13 surface-water sites. About one-third of the wells were sampled once, another one-third were sampled twice, and 10 percent were sampled 9 times or more. There were 1,489 samples analyzed for phosphorus—960 from 244 wells, 15 from Comal Springs, 15 from San Marcos Springs, 4 from Woodard Cave, and 475 from 13 surface-water sites. About one-third of the wells were sampled once, another one-third were sampled twice, and 10 percent were sampled more than 10 times.

Concentrations of organic nitrogen, ammonia, total nitrogen, and phosphorus typically were small in the Edwards aquifer and in the rural surface waters, indicative of generally acceptable quality water, with respect to nutrients. Median time-nested-average concentrations of total organic nitrogen typically were less than 0.7 mg/L for all but two subareas (table 3). The median time-nested-average concentration for the transition subarea was 1.5 mg/L. Water from the only well sampled in the Glen Rose subarea had a concentration of 3.2 mg/L. The two largest concentrations in ground water, 7.1 and 8.5 mg/L, were for samples collected from wells near the "bad-water" line in Uvalde County.

Median time-nested-average concentrations of total ammonia nitrogen were less than the detection limit of 0.05 mg/L for the urban subarea. The median time-nested-average concentration was 0.06 mg/L for the urban subarea. Largest median time-nested-average ammonia concentrations (0.45 and 0.57 mg/L) were in the two ground-water subareas near and south of the "bad-water" line, where the water is oxygen deficient. The maximum measured total ammonia concentration, 0.79 mg/L, was for water from a saline-water well in Uvalde County.

Median time-nested-average concentrations of total nitrogen generally were less than 3.0 mg/L for all of the hydrologic subareas. Concentrations were smaller for surface-water sites in the rural subarea than for freshwater wells, which suggests that recharge water may be receiving contaminants from development in or near the recharge area or during infiltration through the unsaturated zone. The ground-water sample with the maximum measured concentration of nitrogen, 11.3 mg/L, was taken from a well completed in the Edwards aquifer just downstream from the recharge area in the ranchland of Medina County.

Median time-nested-average concentrations of total phosphorus for ground water in most subareas were approximately equal to the detection limit of 0.01 mg/L, and no sample concentration exceeded 0.22 mg/L. Concentrations of total phosphorus in samples from surface-water sites in the rural subarea generally were similar to concentrations in ground water; however, the maximum concentration of 0.93 mg/L in surface water was much larger than the maximum detected in ground water. Concentrations of total phosphorus in samples from surface-water sites in the urban subarea generally were much larger than for ground-water samples and had a median time-nested-average concentration of 0.21 mg/L.

CONVERSION FACTORS

Some values in this report are given in inch-pound units. Conversion factors for metric (International System) units are listed below:

Multiply inch-pound units	By	To obtain metric units
acre-foot (acre-ft)	0.001233	cubic hectometer
foot (ft)	0.3048	meter
inch per year (in/yr)	25.4	millimeter per year
mile (mi)	1.609	kilometer
square foot per day (ft ² /d)	0.09290	square meter per day
square mile (mi ²)	2.590	square kilometer

Table 3. Results of analyses for total nitrogen species and phosphorus by hydrologic subarea

(mg/L, milligrams per liter; <, less than; =, less than or equal to)

[Detection levels ranged from 0.01 to 0.10 mg/L]

Hydro-logic subarea	Num-ber of sites	Percent of sites	Num-ber of detected concen-trations	Concentration (mg/L as N)	
				Min-imum	Max-imum
Urban	4	91	0.01	3.5	0.36
Rural	9	367	0.07	2.9	2.70
Medina-Bexar	50	154	0.02	11.0	1.50
Uvalde	24	70	0.09	3.8	2.10
North Bexar	85	506	0.1	7.2	1.30
Comal-Hays	55	183	0.76	3.8	2.20
North Hays	16	77	0.1	4.1	2.6
Transition	3	8	0.2	3.8	0.9
Saline water	3	0.1	1	0.1	0.1
Glen Rose	4	9	0.5	1.6	0.93

Table 4. Results of analyses for dissolved metals by hydrologic subarea

(µg/L, micrograms per liter; <, less than; =, less than or equal to)

[Detection levels ranged from 0.01 to 0.07 mg/L]

Hydro-logic subarea	Num-ber of sites	Percent of sites	Num-ber of detected concen-trations	Concentration (µg/L as P)	
				Min-imum	Max-imum
Urban	4	100	98	0.02	0.80
Rural	9	100	37	0.01	0.31
Medina-Bexar	47	81	154	0.01	0.21
Uvalde	22	68	68	0.01	0.10
North Bexar	89	88	500	0.01	0.22
Comal-Hays	58	90	189	0.01	0.13
North Hays	15	100	80	0.01	0.06
Transition	3	67	3	0.01	0.02
Saline water	6	43	8	0.01	0.03
Glen Rose	5	67	9	0.01	0.02

* A time-nested average was computed for each site by successively averaging concentrations by day, month, year, and period of record. Thus for phosphorus, 90 percent of the wells in the Medina-Bexar subarea had time-nested averages of 0.03 mg/L or less.

Table 3. Results of analyses for total nitrogen species and phosphorus by hydrologic subarea

(mg/L, milligrams per liter; <, less than; =, less than or equal to)

[Detection levels ranged from 0.01 to 0.10 mg/L]

Hydro-logic subarea	Num-ber of sites	Percent of sites	Num-ber of detected concen-trations	Concentration (mg/L as P)	
				Min-imum	Max-imum
Urban	4	100	98	0.02	0.80
Rural	9	100	37	0.01	0.31
Medina-Bexar	47	81	154	0.01	0.21
Uvalde	22	68	68	0.01	0.10
North Bexar	89	88	500	0.01	0.22
Comal-Hays	58	90	189	0.01	0.13
North Hays	15	100	80	0.01	0.06
Transition	3	67	3	0.01	0.02
Saline water	6	43	8	0.01	0.03
Glen Rose	5	67	9	0.01	0.02

Table 3. Results of analyses for total nitrogen species and phosphorus by hydrologic subarea

(mg/L, milligrams per liter; <, less than; =, less than or equal to)

[Detection levels ranged from 0.01 to 0.07 mg/L]

Hydro-logic subarea	Num-ber of sites	Percent of sites	Num-ber of detected concen-trations	Concentration (µg/L as B)	
				Min-imum	Max-imum
Urban	4	100	63	0.1	1.2
Rural	9	100	17	0.1	0.6
Medina-Bexar	38	53	135	0.1	0.2
Uvalde	15	53	56	0.1	0.2
North Bexar	78	86	309	0.1	0.4
Comal-Hays	24	67	112	0.1	0.2
North Hays	7	57	17	0.1	0.2
Transition	3	33	7	0.1	0.2
Saline water	2	0	2	0.1	0.1
Glen Rose	5	80	6	0.1	0.2

Table 3. Results of analyses for total nitrogen species and phosphorus by hydrologic subarea

(mg/L, milligrams per liter; <, less than; =, less than or equal to)

[Detection levels ranged from 1 to 20 µg/L]

Hydro-logic subarea	Num-ber of sites	Percent of sites	Num-ber of detected concen-trations	Concentration (µg/L as B)	
				Min-imum	Max-imum
Urban	4	100	63	2	60
Rural	9	100	65	20	69
Medina-Bexar	2	100	2	50	80
North Bexar	25	96	33	1	500
Comal-Hays	7	86	8	1	100

Table 3. Results of analyses for total nitrogen species and phosphorus by hydrologic subarea

(mg/L, milligrams per liter; <, less than; =, less than or equal to)

[Detection levels ranged from 1 to 20 µg/L]

Hydro-logic subarea	Num-ber of sites	Percent of sites	Num-ber of detected concen-trations	Concentration (µg/L as Cd)	
				Min-imum	Max-imum
Urban	4	75	63	0.1	0.1
Rural	9	89	173	0.1	0.1
Medina-Bexar	35	20	122	0.1	0.1
Uvalde	15	9	25	0.1	0.1
North Bexar	58	10	242	0.1	0.1
Comal-Hays	20	40	106	0.1	0.1
North Hays	7	14	17	0.1	0.1
Transition	3	33	7	0.1	0.1
Saline water	3	100	3	0.1	0.1
Glen Rose	5	0	6	0.1	0.1

Table 3. Results of analyses for total nitrogen species and phosphorus by hydrologic subarea

(mg/L, milligrams per liter; <, less than; =, less than or equal to)

[Detection levels ranged from 1 to 30 µg/L]

Hydro-logic subarea	Num-ber of sites	Percent of sites	Num-ber of detected concen-trations	Concentration (µg/L as Cu)	
				Min-imum	Max-imum
Urban	4	100	63	0.2	25
Rural	9	100	175	0.1	2
Medina-Bexar	37	65	134	0.1	2
Uvalde	15	73	52	0.1	2
North Bexar	69	52	286	0.1	1.5
Comal-Hays	20	75	108	0.1	0.9
North Hays	7	100	17	0.1	0.6
Transition	3	67	7	0.1	0.2
Saline water	2	0	2	0.1	0.2
Glen Rose	5	6	6	0.1	0.2

Table 3. Results of analyses for total nitrogen species and phosphorus by hydrologic subarea

(mg/L, milligrams per liter; <, less than; =, less than or equal to)

[Detection levels ranged from 0.1 to 0.9 µg/L]

Hydro-logic subarea	Num-ber of sites	Percent of sites	Num-ber of detected concen-trations	Concentration (µg/L as Hg)	
				Min-imum	Max-imum
Urban	4	100	63	0.1	0.3
Rural	9	70	173	0.1	0.6
Medina-Bexar	37	65	134	0.1	0.3
Uvalde	15	73	52	0.1	0.3
North Bexar	69	52	286	0.1	1.5
Comal-Hays	20	75	108	0.1	0.9
North Hays	7	100	17	0.1	0.6
Transition	3	67	7	0.1	0.2
Saline water	2	0	2	0.1	0.2
Glen Rose	5	6	6	0.1	0.2

Table 3. Results of analyses for total nitrogen species and phosphorus by hydrologic subarea

(mg/L, milligrams per liter; <, less than; =, less than or equal to)

[Detection levels ranged from 1 to 10 µg/L]

Hydro-logic subarea	Num-ber of sites	Percent of sites	Num-ber of detected concen-trations	Concentration (µg/L as Pb)	
				Min-imum	Max-imum
Urban	4	100	63	0.1	1.2
Rural	9	100	17	0.1	0.6
Medina-Bexar	38	53	135	0.1	0.2
Uvalde	15	53	56	0.1	0.2
North Bexar	78	86	309	0.1	0.4
Comal-Hays	24	67	112	0.1	0.2
North Hays	7	57	17	0.1	0.2
Transition	3	33	7	0.1	0.2
Saline water	2	0	2	0.1	0.1
Glen Rose	5	80	6	0.1	0.2

Table 3. Results of analyses for total nitrogen species and phosphorus by hydrologic subarea

(mg/L, milligrams per liter; <, less than; =, less than or equal to)

[Detection levels ranged from 1 to 10 µg/L]

Hydro-logic subarea	Num-ber of sites	Percent of sites	Num-ber of detected concen-trations	Concentration (µg/L as Mn)	
				Min-imum	Max-imum
Urban	4	100	63	2	60
Rural	9	100	65	20	69
Medina-Bexar	43	16	135	0.1	0.3
Uvalde	21	43	64	0.1	0.2
North Bexar	71	32	272	0.1	0.2
Comal-Hays	25	20	122	0.1	0.2
North Hays	7	57	17	0.1	0.2
Transition	3	33	7	0.1	0.2
Saline water	6	100	6	0.1	0.3
Glen Rose	5	40	6	0.1	0.2

Table 3. Results of analyses for total nitrogen species and phosphorus by hydrologic subarea

(mg/L, milligrams per liter; <, less than; =, less than or equal to)

[Detection levels ranged from 0.1 to 0.9 µg/L]

Hydro-logic subarea	Num-ber of sites	Percent of sites	Num-ber of detected concen-trations	Concentration (µg/L as Se)	
				Min-imum	Max-imum
Urban	4	100	63	0.1	0.3
Rural	9	70	173	0.1	0.6
Medina-Bexar	37	65	134	0.1	0.3
Uvalde	15	73	52	0.1	0.3
North Bexar	69	52	286	0.1	1.5
Comal-Hays	20	75	108	0.1	0.9
North Hays	7	100	17	0.1	0.6
Transition	3	67	7	0.1	0.2
Saline water	2	0	2	0.1	0.2
Glen Rose	5	6	6	0.1	0.2

Table 3. Results of analyses for total nitrogen species and phosphorus by hydrologic subarea

(mg/L, milligrams per liter; <, less than; =, less than or equal to)

[Detection levels ranged from 1 to 10 µg/L]

Hydro-logic subarea	Num-ber of sites	Percent of sites	Num-ber of detected concen-trations	Concentration (µg/L as Zn)	
				Min-imum	Max-imum
Urban	4	100	63	0.2	25
Rural	9	100	175	0.1	2
Medina-Bexar	37	65	134	0.1	2
Uvalde	15	73	52	0.1	2
North Bexar	69	52	286	0.1	1.5
Comal-Hays	20	75	108	0.1	0.9
North Hays	7	100	17	0.1	0.6
Transition	3	67	7	0.1	0.2
Saline water	2	0	2	0.1	0.2
Glen Rose	5	6	6	0.1	0.2