CHEMICAL ANALYSES OF GROUND-WATER SAMPLES FROM THE RIO GRANDE VALLEY IN THE VICINITY OF ALBUQUERQUE, NEW MEXICO, OCTOBER 1993 THROUGH JANUARY 1994

By D. W. Wilkins, Jamie L. Schlottmann, and Dale M. Ferree

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
foot	0.3048	meter
mile	1.609	kilometer
gallon	3.785	liter

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) by the equation:

$$°F = 9/5\ (°C) + 32°$$

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 the United States and Canada, formerly called Sea Level Datum of 1929.

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ABSTRACT

A study was conducted to investigate general ground-water-quality conditions and contaminant locations in the Rio Grande Valley in the vicinity of Albuquerque, New Mexico. Water samples from 36 observation wells in 12 well nests were analyzed. The well nests are located along three roads near the Rio Grande--two well nests near Paseo del Norte, five well nests near Montaño Road, and five well nests near Rio Bravo Boulevard.

The water samples were collected from October 19, 1993, through January 18, 1994. Water-quality types by major-ion composition were calcium bicarbonate (found in most samples), sodium sulfate, calcium sulfate, and calcium sulfate chloride. Nutrients were detected in all but one sample. Ammonia was detected in 34 samples, nitrite in 4 samples, and nitrate in 17 samples. Orthophosphate was detected in 31 samples. Organic carbon was detected in all samples collected. The trace elements arsenic and barium were detected in all samples and zinc in 31 samples. Fourteen samples contained detectable copper. Cadmium was detected in one sample, chromium in two samples, lead in four samples, and selenium in two samples. Mercury and silver were not detected.

INTRODUCTION

Ground-water contamination in the Rio Grande Valley near Albuquerque has been reported by previous investigations (Hines, 1981; McQuillan, 1982). Determining the location of areas containing contaminated ground water will assist local water managers in locating future water-supply wells.

To investigate general ground-water-quality conditions and contaminant locations in the Rio Grande Valley in the vicinity of Albuquerque, the U.S. Geological Survey, in cooperation with the City of Albuquerque, sampled 36 observation wells in 12 well nests located along three east-west sections (fig. 1). Montaño Road well nests 1-4 and Rio Bravo Boulevard well nests 1-4 were installed in cooperation with the New Mexico Environmental Improvement Division (now the New Mexico Environment Department) and the City of Albuquerque Public Works Department (Anderholm and Bullard, 1987). Paseo del Norte well nest 1, Montaño Road well nest 5, and Rio Bravo Boulevard well nest 5 were installed in cooperation with the City of Albuquerque as part of a project to determine a water budget for the Rio Grande between the levees. Paseo del Norte well nest 2 was installed in cooperation with the City of Albuquerque and the Bureau of Reclamation as part of the water budget study and also for obtaining data for a continuing definition of sediments that compose the local aquifer system. Data obtained from these wells have provided information about water resources of the valley, including ground-water quality as reported in this report. This report was prepared in cooperation with the City of Albuquerque Public Works Department.

Purpose and Scope

This report presents chemical analyses of ground-water samples collected from 36 observation wells in a reach of the Rio Grande Valley in the vicinity of Albuquerque from October 19, 1993, through January 18, 1994. Descriptions of well completions, sample preservation methods, analytical methods, and results of water-quality analyses are included in several tables in this report. Illustrations are included that display spatial variations of major-ion concentrations at shallow (22 to 50 feet), medium (75 to 150 feet), and deep (131 to 600 feet) depths, and depict variations in nutrient and trace-element concentrations with depth along three east-west sections.

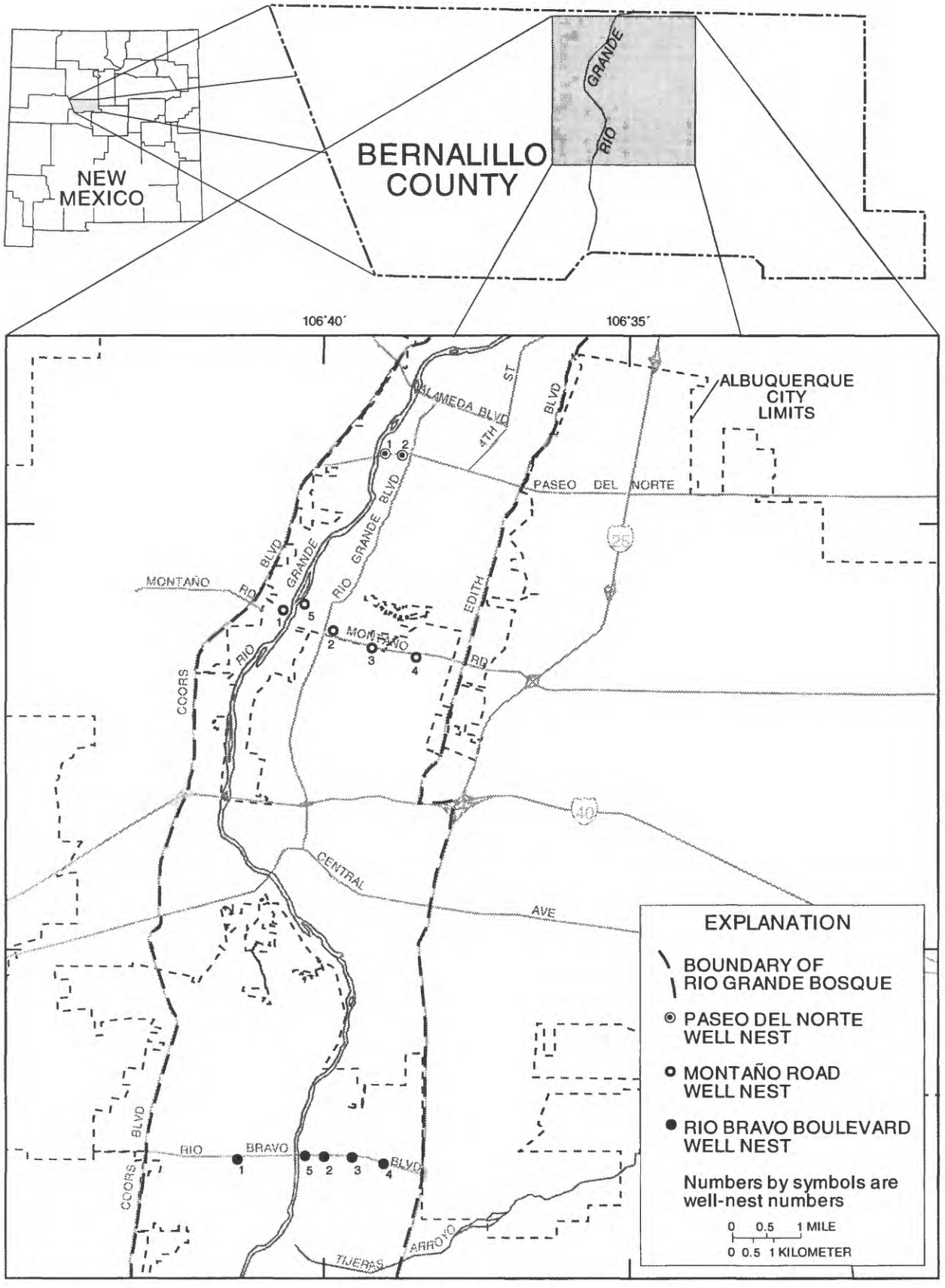


Figure 1.--Location of study area and well nests.

Well-Numbering System

The locations of observation wells located outside of land-grant areas are specified by latitude and longitude to the nearest second and by a local identifier that is based on the public-land survey. The local identifier includes township and range followed by quarter-section subdivisions from largest to smallest. The order of the quarter-section subdivisions is opposite of that used in the public-land survey. A sequence letter is added to make the identifier unique in the U.S. Geological Survey data base. As illustrated in the following diagram, the public-land survey description of the site indicated by the dot is SE 1/4 SE 1/4 NW 1/4 sec. 08, T. 09 N., R. 03 E., which is denoted by the local identifier 09N.03E.08.144. If the observation well is the third well at that location, the sequence letter is C, and the complete identifier is 09N.03E.08.144C. Locations of observation wells that are within land grants, and thus are not included in the public-land survey, are specified by latitude and longitude to the nearest second and the land-grant name is used as the local identifier.

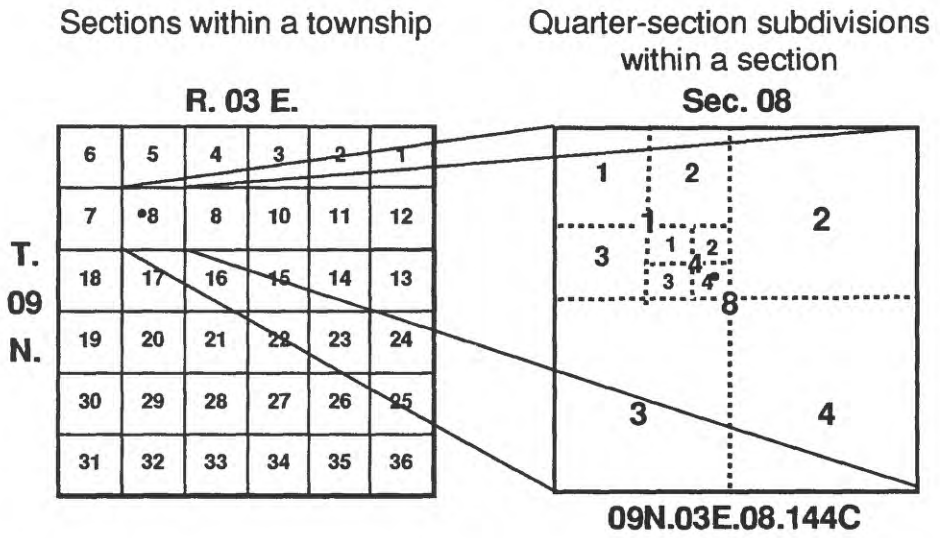


Figure 2.--Well-numbering system for New Mexico.

Description of the Study Area and Wells

The study area is that reach of the Rio Grande Valley that is between Paseo del Norte and Rio Bravo Boulevard and bounded on the west by Coors Boulevard and on the east by Edith Boulevard north of Interstate 40 and by Interstate 25 south of Interstate 40. This area is largely within the city limits of Albuquerque, though portions do include unincorporated areas of Bernalillo County and several small incorporated areas. The study area is located in the Albuquerque Basin, a large, complex deposit of alluvial and volcanic rocks bounded by regional faults of the Rio Grande Rift; a complete description of the basin (hydrology and geology) can be found in Thorn and others (1993). Ground-water recharge is generally from the Rio Grande, which flows through the approximate center of the basin, and from infiltration of precipitation in uplifted areas to the north and east of the basin (Thorn and others, 1993). These ground-water sources originate on and in different sediments and rock types resulting in variation in water quality in the basin/aquifer system (Anderholm, 1988).

Three east-west sections consisting of 12 observation-well nests were installed west of Interstate 25 paralleling three roads: Paseo del Norte, Montaño Road, and Rio Bravo Boulevard (fig. 1). Two well nests lie along Paseo del Norte, five well nests along Montaño Road, and five well nests along Rio Bravo Boulevard. Each nest includes three wells, completed at shallow, medium, and deep depths (table 1). The observation wells are completed in unconsolidated Quaternary alluvial deposits and Pleistocene sediments of the Santa Fe Group composed dominantly of fine- to very coarse grained quartz litharenite sand with interbeds of clayey, silty, or gravelly sand; silty or sandy clay; and sandy gravel. Wells were completed with a 5- to 10-foot screened interval that is isolated from the rest of the borehole by cement grout. Installation details for eight of the well nests along Montaño Road and Rio Bravo Boulevard were described by Anderholm and Bullard (1987). The other four well nests were installed in a similar manner.

Table 1.--Description of sampled observation wells

[Site identifier is a location-based code used to identify sites in the U.S. Geological Survey WATSTORE (Water-Data Storage and Retrieval System) data base; local identifier is based on the public-land survey and land grants (see figure 2); latitude and longitude: deg, degrees; min, minutes; sec, seconds; open interval is in feet below land surface]

Well-nest name	Depth category	Depth of well (feet)	Site identifier	Local identifier	Latitude Deg Min Sec	Longitude Deg Min Sec	Land-surface altitude (feet above sea level)	Open interval (feet)
Paseo del Norte 1	Shallow	25.0	351059106385902	Elena Gallegos Land Grant	35 10 59	106 38 59	4,990.80	10.0–20.0
Paseo del Norte 2	Shallow	45.0	351057106384203	Elena Gallegos Land Grant	35 10 57	106 38 42	4,988.58	30.0–40.0
Paseo del Norte 1	Medium	150.0	351059106385901	Elena Gallegos Land Grant	35 10 59	106 38 59	4,989.53	135.0–145.0
Paseo del Norte 2	Medium	95.0	351057106384202	Elena Gallegos Land Grant	35 10 57	106 38 42	4,988.60	80.0–90.0
Paseo del Norte 1	Deep	600.0	351059106385903	Elena Gallegos Land Grant	35 10 59	106 38 59	4,991.18	545.0–555.0
Paseo del Norte 2	Deep	150.0	351057106384201	Elena Gallegos Land Grant	35 10 57	106 38 42	4,989.07	135.0–145.0
Montaño 1	Shallow	48.4	350854106403703	Elena Gallegos Land Grant	35 08 54	106 40 37	4,975.08	40.0–45.0
Montaño 5	Shallow	25.0	350859106401601	Elena Gallegos Land Grant	35 08 59	106 40 16	4,977.28	10.0–20.0
Montaño 2	Shallow	39.7	350836106395603	Elena Gallegos Land Grant	35 08 36	106 39 56	4,970.07	30.0–35.0
Montaño 3	Shallow	49.8	350827106391303	Elena Gallegos Land Grant	35 08 27	106 39 13	4,972.32	40.0–45.0
Montaño 4	Shallow	50.2	350821106383703	Elena Gallegos Land Grant	35 08 21	106 38 37	4,974.68	40.2–45.2
Montaño 1	Medium	93.4	350854106403702	Elena Gallegos Land Grant	35 08 54	106 40 37	4,975.58	83.4–88.4
Montaño 5	Medium	75.0	350859106401602	Elena Gallegos Land Grant	35 08 59	106 40 16	4,977.31	60.0–70.0
Montaño 2	Medium	99.0	350836106395602	Elena Gallegos Land Grant	35 08 36	106 39 56	4,970.07	90.0–95.0
Montaño 3	Medium	99.0	350827106391302	Elena Gallegos Land Grant	35 08 27	106 39 13	4,972.33	90.0–95.0
Montaño 4	Medium	93.5	350821106383702	Elena Gallegos Land Grant	35 08 21	106 38 37	4,974.00	84.5–89.5
Montaño 1	Deep	152.0	350854106403701	Elena Gallegos Land Grant	35 08 54	106 40 37	4,975.52	140.0–145.0
Montaño 5	Deep	150.0	350859106401603	Elena Gallegos Land Grant	35 08 59	106 40 16	4,977.14	135.0–145.0
Montaño 2	Deep	147.4	350836106395601	Elena Gallegos Land Grant	35 08 36	106 39 56	4,970.17	138.0–143.0
Montaño 3	Deep	149.8	350827106391301	Elena Gallegos Land Grant	35 08 27	106 39 13	4,972.33	140.0–145.0
Montaño 4	Deep	131.5	350821106383701	Elena Gallegos Land Grant	35 08 21	106 38 37	4,975.01	122.5–127.5
Rio Bravo 1	Shallow	38.4	350137106410503	Atrisco Land Grant	35 01 37	106 41 05	4,930.5	28.0–33.0
Rio Bravo 5	Shallow	22.0	350138106401102	09N.03E.07.114A	35 01 38	106 40 11	4,930	7.0–17.0
Rio Bravo 2	Shallow	48.6	350138106395503	09N.03E.07.131C	35 01 38	106 39 55	4,928.91	38.6–43.6
Rio Bravo 3	Shallow	49.3	350138106393203	09N.03E.07.241C	35 01 38	106 39 32	4,927.48	39.3–44.3
Rio Bravo 4	Shallow	49.3	350135106390603	09N.03E.08.144C	35 01 35	106 39 06	4,932.81	39.3–44.3
Rio Bravo 1	Medium	103.8	350137106410502	Atrisco Land Grant	35 01 37	106 41 05	4,930.81	94–99
Rio Bravo 5	Medium	150.0	350138106401101	09N.03E.07.114A	35 01 38	106 40 11	4,930	135.0–145.0
Rio Bravo 2	Medium	91.2	350138106395502	09N.03E.07.131B	35 01 38	106 39 55	4,928.84	81–86
Rio Bravo 3	Medium	101.0	350138106393202	09N.03E.07.241B	35 01 38	106 39 32	4,927.40	91–96
Rio Bravo 4	Medium	124.2	350135106390602	09N.03E.08.144B	35 01 35	106 39 06	4,932.7	114.2–119.2
Rio Bravo 1	Deep	148.5	350137106410501	Atrisco Land Grant	35 01 37	106 41 05	4,930.88	138.5–143.5
Rio Bravo 5	Deep	515.0	350138106401103	09N.03E.07.114B	35 01 38	106 40 11	4,930	500.0–510.0
Rio Bravo 2	Deep	153.5	350138106395501	09N.03E.07.131A	35 01 38	106 39 55	4,928.71	143.5–148.5
Rio Bravo 3	Deep	148.0	350138106393201	09N.03E.07.241A	35 01 38	106 39 32	4,927.14	138–143
Rio Bravo 4	Deep	149.4	350135106390601	09N.03E.08.144A	35 01 35	106 39 06	4,932.65	139.4–144.4

DATA-COLLECTION METHODS

Water samples were collected once from each well for chemical analysis. Methods used for the collection, preparation, and analyses are described below.

Sample-Collection Methods

Prior to sampling, all wells were purged by withdrawing a minimum of three casing volumes of water. Wells were purged using either a submersible, centrifugal, or air-operated bladder pump depending on the depth to water and the capacity of the well to produce water. The submersible pump was used on the Paseo del Norte 1 and 2, Montaño 2, 3, and 4, and Rio Bravo 3 and 4 well nests; the centrifugal pump was used on the Montaño 1 and 5 and Rio Bravo 5 well nests; and the air-lift pump was used on the Rio Bravo 1 and 2 well nests. Temperature and specific conductance were measured during purging at 2- to 15-minute intervals. When temperature and specific-conductance values stabilized, the water was considered to be representative of formation water.

Most water samples were collected using a 1-liter teflon bailer. The bailer was washed with liquinox soap and rinsed three times with deionized water before each well was sampled. Two bailers were used to collect samples from the first sampled well, which was the shallow well in the Rio Bravo 1 well nest. The 1-liter teflon bailer was used to collect samples to be analyzed for volatile organic carbon compounds; a 2–liter polyvinyl chloride bailer was used to collect all other samples. A polyethylene sheet was laid beside the well to prevent dirt and dust contamination of equipment and bottles during sampling. The bailer was lowered into the well, allowed to fill with water, and retrieved. Water from the first retrieval was used to wash and rinse the bailer. Water from the second retrieval was used to rinse sample bottles to be filled with unfiltered water. Water from subsequent retrievals of the bailer from the well was used to fill sample bottles. After direct filled (no rinse) bottles were filled, rinsed bottles for unfiltered samples were filled. Finally, a 2-liter or 1-gallon polyethylene bottle was filled to be used for filtered samples, alkalinity, pH, and specific-conductance measurements. Latex or vinyl gloves were worn for sampling and preserving samples. The gloves were changed after each well was sampled and between use of different sample preservatives.

Two quality-assurance blank samples were prepared after laboratory determinations of volatile organic carbon compounds indicated the presence of toluene in some samples. An equipment blank was prepared on April 1, 1994, by filling the sample vial with organic-carbon-free water that had been passed through the sampling equipment. An ambient blank was prepared on April 4, 1994, by filling a sample vial at the Paseo del Norte 2 well nest with organic-carbon-free water.

Sample-Preparation Methods

Procedures used for preparation and preservation of the ground-water samples are listed in table 2. After samples were collected using the teflon bailer, water for the filtered samples was drawn through silicone tubing in a peristaltic pump, then pumped through a 0.45-micron cartridge filter. About 1 liter of deionized water was pumped through the tube and filter before

filtering the sample water. Vials for volatile organic carbon determination and bottles for total organic carbon determination were not rinsed but were filled directly allowing as little turbulence as possible. The gallon bottles and bottles for unfiltered, unacidified samples were rinsed three times with bailed well water before filling. All bottles for filtered samples were rinsed with filtered well water three times before filling (Timme, 1994). All samples were iced and shipped overnight express to the U.S. Geological Survey National Water Quality Laboratory (NWQL) in Arvada, Colorado.

Table 2.--Field procedures for preparation and preservation of water samples for laboratory analysis

[μ, micron; ml, milliliter; °C, degrees Celsius. From Timme, 1994]

Constituents to be analyzed	Filter type used	Collection bottle type	Preservation method
Major cations and trace elements, dissolved except mercury	0.45-μ cartridge filter	2 250-ml acid-rinsed polyethylene	1 ml nitric acid per 250-ml sample
Major anions, dissolved	0.45-μ cartridge filter	1 500-ml nonacid-rinsed polyethylene	None
Nutrients, dissolved	0.45-μ cartridge filter	1 250-ml amber polyethylene	1 ml 10^{-4} molar mercuric chloride sodium chloride, chilled to 4 °C
Mercury, dissolved	0.45-μ cartridge filter	1 125-ml baked glass	5 ml nitric acid/potassium dichromate ampoule
Laboratory alkalinity, pH, and specific conductance	Unfiltered	2 250-ml nonacid-rinsed polyethylene	None
Volatile organic carbon compounds	Unfiltered	3 40-ml amber glass septa vials	Chilled to 4 °C
Total organic carbon	Unfiltered	1 125-ml baked glass	Chilled to 4 °C

Analytical Methods

All laboratory determinations were done by the NWQL using standard methods described in Fishman and Friedman (1989). Methods used for total organic carbon and inorganic determinations are listed in table 3. The volatile organic compounds listed in table 4 were determined using a method similar to U.S. Environmental Protection Agency method 524.2 (U.S. Environmental Protection Agency, 1988). Volatile organic compounds were purged from the water sample, and the purged compound types and concentrations were determined using a gas chromatograph with a mass spectrometric detector. Water pH, specific conductance, and alkalinity were measured on site and in the laboratory. Alkalinity was measured on site by an incremental titration (Knapton, 1985) using 0.1639-N sulfuric acid on a 50-milliliter aliquot of unfiltered sample. All concentrations, except organic carbon and toluene, are dissolved.

Table 3.--Analytical methods used for total organic carbon and inorganic determinations

[Parameter codes are used to designate chemical constituents in the U.S. Geological Survey WATSTORE (Water-Data Storage and Retrieval System) data base and the U.S. Environmental Protection Agency STORET data base. Parameter name, phase, and units: mg/L, milligrams per liter; µg/L, micrograms per liter; total, total recoverable concentration including suspended and colloidal solids; $CaCO_3$, calcium carbonate; SiO_2, silica; SO_4, sulfate; dissolved, concentration in filtered sample. Method number and laboratory codes are used by the National Water Quality Laboratory of the U.S. Geological Survey to specify analytical methods. MRL, minimum reporting level (smallest concentration that may be reliably reported (Fishman and Friedman (1989) and Fishman (1993))]

Parameter code	Parameter name, phase, and units	Method	Method number	Laboratory code	MRL
		WATER PROPERTIES			
90410	Alkalinity, laboratory, unfiltered (mg/L as $CaCO_3$)	Electrometric titration	2030–85	SH1027	1
00403	pH, laboratory (standard units)	Electrometry, glass electrode, automated	2587–85	SH1027	0.1
70300	Solids, residual on evaporation (mg/L)	180 degrees Celsius, gravimetric	1750–85	SH1027	1
90095	Specific conductance, laboratory (microsiemens per centimer at 25 degrees Celsius)	Electrometry, automated	2781–85	SH1027	1
		MAJOR CATIONS			
00915	Calcium, dissolved (mg/L as Ca)	Atomic absorption, direct	1152–85	SH1027	.02
00925	Magnesium, dissolved (mg/L as Mg)	Atomic absorption, direct	1447–85	SH1027	.01
00935	Potassium, dissolved (mg/L as K)	Atomic absorption, direct	1630–85	SH1027	.1
00930	Sodium, dissolved (mg/L as Na)	Atomic absorption, direct	1735–85	SH1027	.1
		MAJOR ANIONS			
00940	Chloride, dissolved (mg/L as Cl)	Ion chromatography	2057–85	SH1027	.1
00950	Fluoride, dissolved (mg/L as F)	Ion selective electrode, automated	2327–85	SH1027	.1
00955	Silica, dissolved (mg/L as SiO_2)	Molybdate blue, automated-segmented flow colorimetry	2700–85	SH1027	.1
00945	Sulfate, dissolved (mg/L as SO_4)	Ion chromatography	2057–85	SH1027	.1
		NUTRIENTS			
00608	Nitrogen, ammonia, dissolved (mg/L as N)	Colorimetry, automated	2522–90	SH1031	.01
00613	Nitrogen, nitrite, dissolved (mg/L as N)	Diazotization, automated-segmented flow colorimetry	2540–90	SH1031	.01
00631	Nitrogen, nitrite plus nitrate, dissolved (mg/L as N)	Cadmium-reduction, automated-segmented flow colorimetry	2545–85	SH1031	.05
00671	Phosphorus, orthophosphate, dissolved (mg/L as P)	Phosphomolybdate, automated-segmented flow colorimetry	2601–90	SH1031	.01
		CARBON			
00680	Organic carbon, total, unfiltered (mg/L as C)	Wet oxidation	3100–83	LC0114	.1
		TRACE ELEMENTS			
01000	Arsenic, dissolved (µg/L as As)	Atomic absorption, hydride generation, automated	2062–85	SH1072	1
01005	Barium, dissolved (µg/L as Ba)	Atomic emission, inductively coupled plasma, direct	1472–87	SH1072	2
01025	Cadmium, dissolved (µg/L as Cd)	Atomic absorption, graphite furnace, automated	1238–89	SH1072	1
1030	Chromium, dissolved (µg/L as Cr)	Atomic absorption, graphite furnace, automated	1235–85	SH1072	1
01040	Copper, dissolved (µg/L as Cu)	Atomic absorption, graphite furnace, automated	2274–89	SH1072	1
01049	Lead, dissolved (µg/L as Pb)	Atomic absorption, graphite furnace, automated	2403–89	SH1072	1
71890	Mercury, dissolved (µg/L as Hg)	Atomic absorption, cold vapor	2462–85	SH1072	.1
01145	Selenium, dissolved (µg/L as Se)	Atomic absorption, hydride generation, automated	2667–85	SH1072	1
01075	Silver, dissolved (µg/L as Ag)	Atomic absorption, graphite furnace, automated	2724–89	SH1072	1
01090	Zinc, dissolved (µg/L as Zn)	Atomic absorption, direct	1900–85	SH1072	3

Table 4.—Volatile organic compounds for which water samples were analyzed

[Parameter codes designate chemical constituents in the U.S. Geological Survey WATSTORE (Water-Data Storage and Retrieval System) data base. MRL, minimum reporting level (smallest concentration that may be reliably reported); µg/L, micrograms per liter]

Parameter code	Compound name	MRL (µg/L)	Parameter code	Compound name	MRL (µg/L)
77275	1,2-Chlorotoluene	0.2	32104	Bromoform	0.2
77277	1,4-Chlorotoluene	0.2	77342	n-Butylbenzene	0.2
34576	2-Chloroethylvinylether	1	77350	sec-Butylbenzene	0.2
77651	1,2-Dibromoethane	0.2	32102	Carbon tetrachloride	0.2
34536	1,2-Dichlorobenzene	3	34301	Chlorobenzene	0.2
34566	1,3-Dichlorobenzene	0.2	32105	Chlorodibromomethane	0.2
34571	1,4-Dichlorobenzene	0.2	34311	Chloroethane	0.2
34496	1,1-Dichloroethane	0.2	32106	Chloroform	0.2
32103	1,2-Dichloroethane	0.2	34418	Chloromethane	0.2
34501	1,1-Dichlorethylene	0.2	82625	Dibromochloropropane	1.0
77093	cis-1,2-Dichloroethene	0.2	30217	Dibromomethane	0.2
34546	trans-1,2-Dichloroethene	0.2	32101	Dichlorobromomethane	0.2
34541	1,2-Dichloropropane	0.2	77128	Dichlorodifluoromethane	0.2
77173	1,3-Dichloropropane	0.2	34371	Ethylbenzene	0.2
77170	2,2-Dichloropropane	0.2	3970	Hexachlorobutadiene	0.2
77168	1,1-Dichloropropene	0.2	77223	Isopropylbenzene	0.2
34704	cis-1,3-Dichloropropene	0.2	77356	p-Isopropyltoluene	0.2
34699	trans-1,3-Dichloropropene	0.2	34413	Methylbromide	0.2
77562	1,1,1,2-Tetrachloroethane	0.2	34423	Methylene chloride	0.2
34516	1,1,2,2-Tetrachloroethane	0.2	78032	Methyltertbutylether	1
77613	1,2,3-Trichlorobenzene	0.2	34696	Naphthalene	0.2
34551	1,2,4-Trichlorobenzene	0.2	77224	n-Propylbenzene	0.2
34506	1,1,1-Trichloroethane	0.2	77128	Styrene	0.2
34511	1,1,2-Trichloroethane	0.2	77353	Tertbutylbenzene	0.2
77443	1,2,3-Trichloropropane	0.2	34475	Tetrachloroethylene	0.2
77222	1,2,4-Trimethylbenzene	0.2	34010	Toluene	0.2
77226	1,3,5-Trimethylbenzene	0.2	77652	Trichlorofluoroethane	0.5
34210	Acrolein	20	39180	Trichloroethylene	0.2
34215	Acrylonitrile	20	34488	Trichlorofluoromethane	0.2
34030	Benzene	0.2	39175	Vinyl chloride	0.2
81555	Bromobenzene	0.2	81551	Xylenes, ortho, meta, and para	0.2
77297	Bromochloromethane	0.2			

RESULTS OF CHEMICAL ANALYSES

Results of water analyses for physical properties, major ions, nutrients, trace elements, and toluene are listed in table 5. Results are not listed for volatile organic compounds other than toluene because only toluene was detected above the minimum reporting levels shown in table 4. Since both the equipment blank and the ambient blank contained toluene, toluene concentrations may not be reliable. Distributions of element concentrations related to depth and distance are given in the following sections.

Major Ions

The chemical character of ground water in the shallow, medium, and deep wells sampled in this investigation is shown by water-quality diagrams in figures 3 through 5. In these diagrams cation concentrations, in milliequivalents per liter (meq/L), are indicated by the horizontal axis extending left from the center axis; anion concentrations, in meq/L, are indicated by the horizontal axis extending to the right; dissolved-solids concentration is indicated by the area of the diagram. Water-quality types can be inferred from the overall shape of the diagram; dominant-ion concentrations will extend farthest from the central axis. Sodium plus potassium, magnesium, calcium, chloride plus fluoride, sulfate, and bicarbonate plus carbonate are shown on the water-quality diagrams. In the following discussions water types that are composed of pairs (such as sodium plus potassium) are described using only the first ion of the above ion pairs.

Water from shallow wells is a calcium bicarbonate type except from Montaño 4, which is a calcium sulfate type, and Rio Bravo 3, which is a sodium calcium bicarbonate type. Water from Montaño 4 has the highest dissolved-solids concentration, 1,280 milligrams per liter (mg/L), of water from any well of any depth.

Several variations of water types are found in water from medium wells. Water from medium wells in the Paseo del Norte and Montaño sections is a calcium bicarbonate type except Montaño 1, which is a calcium sulfate bicarbonate type, and Montaño 3, which is a sodium calcium bicarbonate type. In the Rio Bravo section, water from Rio Bravo 1 is a sodium sulfate type; from Rio Bravo 5 is a sodium bicarbonate type; from Rio Bravo 2 and 3 is a sodium calcium bicarbonate type; and from Rio Bravo 4 is a calcium chloride sulfate type. Water from Montaño 4 and Rio Bravo 4 contains the highest dissolved-solids concentrations of the medium wells, 653 and 654 mg/L, respectively.

Water quality varies in deep wells at the Montaño and Rio Bravo sections. Water from wells at the Paseo del Norte section is a calcium bicarbonate type. At the Montaño section, water from Montaño 1 is a calcium sulfate bicarbonate type; the other wells in the Montaño section have water of a calcium bicarbonate type. At the Rio Bravo section, Rio Bravo 1 and 5 contain water of a sodium sulfate type. Water from Rio Bravo 2 is a sodium bicarbonate type; from Rio Bravo 3 is a calcium sulfate type; and from Rio Bravo 4 is a calcium bicarbonate type. Water from Montaño 3 has a dissolved-solids concentration of 553 mg/L, the highest from the deep wells.

Table 5.--Physical properties of and concentrations of major ions, nutrients, trace elements, and toluene in water samples from observation wells in the Rio Grande Valley in the vicinity of Albuquerque, New Mexico

[Geologic unit: ALVM, alluvium; AVMB, alluvium and bolson deposits; SNTF, Santa Fe Group; °C, degrees Celsius; e, estimated; mg/L, milligrams per liter; all concentrations, except for organic carbon and toluene, are dissolved (sample was filtered through a 0.45-micron membrane filter at the time of collection); field, analyzed on site; µS/cm, microsiemens per centimeter at 25 °C; it, incremental titration; $CaCO_3$, calcium carbonate; N, nitrogen; $NO_2 + NO_3$, nitrite plus nitrate; µg/L, micrograms per liter; <, less than]

Well-nest name, number, and depth category	Geo-logic unit	Depth of well (feet)	Date	Physical properties				Organic carbon, total (mg/L)
				pH, field (standard units)	Solids, residue at 180 °C (mg/L)	Specific conductance, field (µS/cm)	Water temperature, field (°C)	
Paseo del Norte 1-shallow	AVMB	25.0	01/04/94	8.0	240	386	8.5	2.0
Paseo del Norte 2-shallow	AVMB	45.0	01/04/94	7.7	339	516	14.5	2.6
Paseo del Norte 1-medium	AVMB	150.0	01/05/94	8.0	284	430	12.5	1.2
Paseo del Norte 2-medium	AVMB	95.0	01/04/94	8.0	300	470	14.0	2.2
Paseo del Norte 1-deep	AVMB	600.0	01/05/94	8.0	240	323	15.5	1.0
Paseo del Norte 2-deep	AVMB	150.0	01/07/94	8.1	237	350	14.5	1.4
Montaño 1-shallow	SNTF	48.4	11/18/93	8.0	406	650	14.5	8.7
Montaño 5-shallow	AVMB	25.0	01/03/94	7.9	229	382	7.0	1.7
Montaño 2-shallow	SNTF	39.7	11/23/93	7.7	470	705	17.0	2.3
Montaño 3-shallow	SNTF	49.8	11/30/93	7.4	596	855	15.5	5.9
Montaño 4-shallow	ALVM	50.2	01/10/94	7.3	1,280	1,620	17.5	2.9
Montaño 1-medium	SNTF	93.4	11/18/93	8.0	386	545	14.5	1.7
Montaño 5-medium	AVMB	75.0	01/03/94	8.0	252	398	11.5	1.9
Montaño 2-medium	SNTF	99.0	11/23/93	8.0	421	650	16.0	1.9
Montaño 3-medium	SNTF	99.0	11/30/93	7.6	581	845	15.5	3.5
Montaño 4-medium	SNTF	93.5	01/18/94	7.6	653	950	17.0	7.0
Montaño 1-deep	SNTF	152.0	11/18/93	8.0	420	615	16.0	1.9
Montaño 5-deep	AVMB	150.0	01/03/94	8.0	312	447	13.0	1.3
Montaño 2-deep	SNTF	147.4	11/23/93	8.0	342	520	16.0	1.8
Montaño 3-deep	SNTF	149.8	11/30/93	7.6	553	790	15.5	4.4
Montaño 4-deep	SNTF	131.5	11/29/93	8.1	261	355	16.5	22
Rio Bravo 1-shallow	SNTF	38.4	10/19/93	7.9	296	455	17.0	3.2
Rio Bravo 5-shallow	AVMB	22.0	11/10/93	8.1	318	370	18.5	2.4
Rio Bravo 2-shallow	SNTF	48.6	10/21/93	7.9	448	650	16.0	2.6
Rio Bravo 3-shallow	SNTF	49.3	11/08/93	8.2	446	e640	18.0	3.9
Rio Bravo 4-shallow	SNTF	49.3	11/09/93	7.7	330	e460	17.5	9.4
Rio Bravo 1-medium	SNTF	103.8	10/19/93	8.3	331	690	19.0	4.5
Rio Bravo 5-medium	AVMB	150.0	11/10/93	8.4	327	445	15.5	1.4
Rio Bravo 2-medium	SNTF	91.2	10/21/93	8.0	423	560	18.0	1.4
Rio Bravo 3-medium	SNTF	101.0	11/08/93	8.2	280	370	18.5	1.5
Rio Bravo 4-medium	SNTF	124.2	11/09/93	7.7	654	940	18.5	2.4
Rio Bravo 1-deep	SNTF	148.5	10/20/93	8.5	450	620	18.0	9.7
Rio Bravo 5-deep	AVMB	515.0	11/10/93	9.0	381	625	21.5	no data
Rio Bravo 2-deep	SNTF	153.5	10/21/93	7.9	235	440	18.0	5.4
Rio Bravo 3-deep	SNTF	148.0	11/08/93	7.9	224	400	18.5	6.0
Rio Bravo 4-deep	SNTF	149.4	11/09/93	7.2	264	350	19.5	4.2

Table 5.--Physical properties of and concentrations of major ions, nutrients, trace elements, and toluene in water samples from observation wells in the Rio Grande Valley in the vicinity of Albuquerque, New Mexico--Continued

Well-nest name and depth category	Major cations				Major anions							Nutrient
	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Bicarbonate it, field (mg/L)	Carbonate it, field (mg/L)	Alkalinity total it, field (mg/L as $CaCO_3$)	Chloride (mg/L)	Sulfate (mg/L)	Fluoride (mg/L)	Silica (mg/L)	Nitrogen, ammonia (mg/L as N)
Paseo del Norte 1-shallow	46	7.3	22	2.9	151	0	124	8.2	58	0.3	17	0.03
Paseo del Norte 2-shallow	60	7.6	37	4.2	220	0	180	14	76	0.6	34	0.10
Paseo del Norte 1-medium	55	9.1	18	4.7	155	0	127	12	73	0.2	38	0.01
Paseo del Norte 2-medium	62	8.0	21	3.2	164	0	134	12	81	0.2	29	0.05
Paseo del Norte 1-deep	37	6.9	16	6.4	146	0	120	7.2	33	0.3	65	0.01
Paseo del Norte 2-deep	40	6.5	19	3.8	127	0	104	12	53	0.3	36	0.03
Montaño 1-shallow	71	12	32	9.0	227	0	186	20	120	0.3	40	0.71
Montaño 5-shallow	42	7.3	22	2.5	149	0	122	8.1	56	0.3	16	0.01
Montaño 2-shallow	85	13	41	6.8	298	0	244	17	110	0.5	38	0.11
Montaño 3-shallow	120	18	40	6.9	376	0	308	11	75	0.3	42	0.19
Montaño 4-shallow	210	41	92	11	478	0	392	25	540	0.3	47	0.12
Montaño 1-medium	58	11	28	8.2	144	0	118	28	110	0.4	57	0.02
Montaño 5-medium	45	6.3	26	3.8	156	0	128	8.7	58	0.4	23	0.03
Montaño 2-medium	62	16	27	11	217	0	178	21	100	0.2	59	0.09
Montaño 3-medium	70	20	80	11	400	0	328	9.3	130	0.2	66	0.08
Montaño 4-medium	110	23	57	10	415	0	340	13	180	0.2	46	0.39
Montaño 1-deep	75	13	26	7.4	161	0	132	33	130	0.2	61	0.05
Montaño 5-deep	44	9.8	29	7.5	168	0	138	12	69	0.4	60	0.02
Montaño 2-deep	51	13	21	8.7	176	0	144	19	70	0.3	65	0.03
Montaño 3-deep	90	27	31	12	371	0	304	13	120	0.1	64	0.11
Montaño 4-deep	34	7.8	18	7.7	126	0	103	14	50	0.3	60	0.02
Rio Bravo 1-shallow	59	7.5	25	6.6	189	0	155	8.9	62	0.4	29	0.12
Rio Bravo 5-shallow	45	7.0	19	3.5	151	0	124	11	66	0.7	69	0.04
Rio Bravo 2-shallow	68	14	52	9.1	255	0	209	18	100	0.7	60	0.04
Rio Bravo 3-shallow	51	13	60	11	225	0	184	19	110	0.7	66	0.03
Rio Bravo 4-shallow	56	6.8	31	17	178	0	146	16	66	0.2	12	0.09
Rio Bravo 1-medium	12	1.8	120	3.6	114	2	98	22	150	1.5	37	0.03
Rio Bravo 5-medium	16	3.8	74	6.0	154	6	136	10	69	0.8	71	<0.01
Rio Bravo 2-medium	46	11	49	10	160	0	131	35	100	0.4	81	0.03
Rio Bravo 3-medium	30	6.4	28	8.8	142	0	116	27	34	0.5	82	0.33
Rio Bravo 4-medium	110	21	28	10	127	0	104	120	160	0.3	65	0.02
Rio Bravo 1-deep	11	1.3	140	3.1	112	4	98	28	180	1.5	32	0.03
Rio Bravo 5-deep	7.5	0.35	120	1.7	70	7	69	51	140	1.8	20	<0.01
Rio Bravo 2-deep	17	3.4	28	8.0	95	0	78	13	45	0.6	49	0.20
Rio Bravo 3-deep	35	2.9	21	12	77	0	63	17	70	0.1	17	0.05
Rio Bravo 4-deep	36	7.0	17	6.9	139	0	114	21	31	0.5	66	0.58

Table 5.--Physical properties of and concentrations of major ions, nutrients, trace elements, and toluene in water samples from observation wells in the Rio Grande Valley in the vicinity of Albuquerque, New Mexico--Concluded

Well-nest name and depth category	Nutrients			Trace elements										
	Nitrogen, nitrite (mg/L as N)	Nitrogen, NO_2+NO_3 (mg/L as N)	Phos-phorus, ortho (mg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Copper (µg/L)	Lead (µg/L)	Mercury (µg/L)	Selenium (µg/L)	Silver (µg/L)	Zinc (µg/L)	Toluene, total (µg/L)
Paseo del Norte 1-shallow	<0.01	0.10	0.03	3	98	<1	<1	4	<1	<0.1	<1	<1	5	<0.2
Paseo del Norte 2-shallow	<0.01	<0.05	0.03	6	66	<1	<1	<1	<1	<0.1	<1	<1	4	<0.2
Paseo del Norte 1-medium	<0.01	<0.05	0.01	2	81	<1	<1	<1	<1	<0.1	<1	<1	<3	<0.2
Paseo del Norte 2-medium	<0.01	<0.05	0.03	3	67	<1	<1	<1	<1	<0.1	<1	<1	9	<0.2
Paseo del Norte 1-deep	<0.01	<0.05	<0.01	4	51	<1	<1	<1	<1	<0.1	<1	<1	17	0.2
Paseo del Norte 2-deep	<0.01	<0.05	0.49	3	76	<1	<1	<1	<1	<0.1	<1	<1	<3	<0.2
Montaño 1-shallow	0.01	<0.05	0.09	4	260	<1	<1	<1	<1	<0.1	<1	<1	5	<0.2
Montaño 5-shallow	<0.01	0.13	0.03	2	64	<1	<1	1	<1	<0.1	<1	<1	<3	<0.2
Montaño 2-shallow	<0.01	0.08	0.02	4	62	<1	<1	<1	<1	<0.1	<1	<1	23	0.2
Montaño 3-shallow	<0.01	<0.05	0.02	3	46	<1	<1	<1	<1	<0.1	<1	<1	9	0.8
Montaño 4-shallow	<0.01	<0.05	<0.01	5	48	<1	<1	<1	<1	<0.1	<1	<1	180	0.2
Montaño 1-medium	<0.01	0.17	0.02	4	68	<1	<1	<1	<1	<0.1	<1	<1	6	<0.2
Montaño 5-medium	<0.01	<0.05	0.02	4	86	<1	<1	<1	<1	<0.1	<1	<1	<3	<0.2
Montaño 2-medium	0.03	0.07	<0.01	3	130	<1	<1	1	<1	<0.1	<1	<1	51	0.5
Montaño 3-medium	<0.01	<0.05	0.02	4	62	<1	<1	<1	<1	<0.1	<1	<1	36	0.8
Montaño 4-medium	0.05	0.09	0.07	2	64	<1	<1	1	<1	<0.1	<1	<1	<3	<0.2
Montaño 1-deep	<0.01	<0.05	0.02	4	78	<1	<1	<1	<1	<0.1	<1	<1	9	<0.2
Montaño 5-deep	<0.01	<0.05	<0.01	4	70	<1	<1	<1	<1	<0.1	<1	<1	5	<0.2
Montaño 2-deep	<0.01	0.09	0.04	5	74	<1	<1	1	1	<0.1	<1	<1	95	<0.2
Montaño 3-deep	<0.01	<0.05	0.02	4	160	<1	<1	<1	<1	<0.1	<1	<1	28	<0.2
Montaño 4-deep	<0.01	<0.05	0.01	5	110	<1	<1	2	<1	<0.1	<1	<1	47	1.3
Rio Bravo 1-shallow	<0.01	<0.05	0.10	7	100	<1	<1	<1	<1	<0.1	<1	<1	3	<0.2
Rio Bravo 5-shallow	<0.01	<0.05	0.06	4	72	<1	<1	<1	<1	<0.1	<1	<1	11	<0.2
Rio Bravo 2-shallow	<0.01	<0.05	0.01	9	38	<1	<1	4	<1	<0.1	<1	<1	23	<0.2
Rio Bravo 3-shallow	<0.01	0.36	0.03	9	52	<1	<1	3	<1	<0.1	<1	<1	37	1.7
Rio Bravo 4-shallow	<0.01	5.30	0.91	10	53	<1	<1	6	<1	<0.1	<1	<1	33	1.9
Rio Bravo 1-medium	<0.01	0.91	0.02	39	18	<1	9	3	<1	<0.1	1	<1	11	<0.2
Rio Bravo 5-medium	<0.01	<0.05	<0.01	22	37	<1	<1	<1	<1	<0.1	<1	<1	10	<0.2
Rio Bravo 2-medium	<0.01	0.33	0.01	14	82	<1	<1	4	1	<0.1	<1	<1	22	<0.2
Rio Bravo 3-medium	<0.01	0.26	0.03	15	69	<1	<1	<1	<1	<0.1	<1	<1	3	2.1
Rio Bravo 4-medium	<0.01	5.30	0.02	4	92	<1	<1	<1	<1	<0.1	<1	<1	34	1.4
Rio Bravo 1-deep	<0.01	1.10	0.02	32	31	<1	10	3	<1	<0.1	2	<1	27	<0.2
Rio Bravo 5-deep	<0.01	<0.05	0.03	25	22	<1	<1	<1	<1	<0.1	<1	<1	18	<0.2
Rio Bravo 2-deep	0.01	0.23	0.17	10	40	<1	<1	11	10	<0.1	<1	<1	45	<0.2
Rio Bravo 3-deep	<0.01	0.49	0.53	8	53	1	<1	16	2	<0.1	<1	<1	62	4.7
Rio Bravo 4-deep	<0.01	0.14	0.05	6	85	<1	<1	<1	<1	<0.1	<1	<1	16	0.7

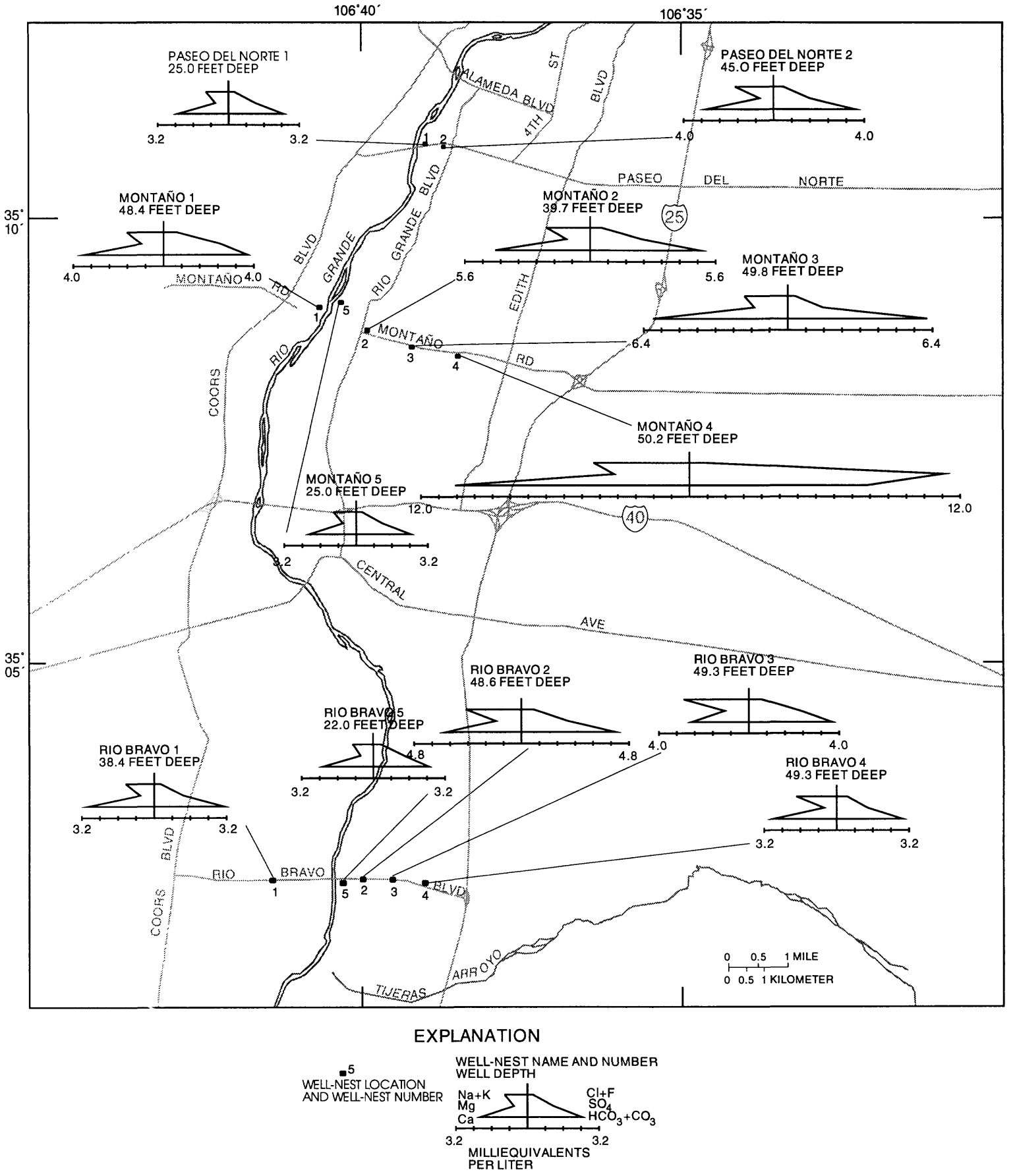


Figure 3.--Distribution of dissolved major-ion concentrations in shallow wells.

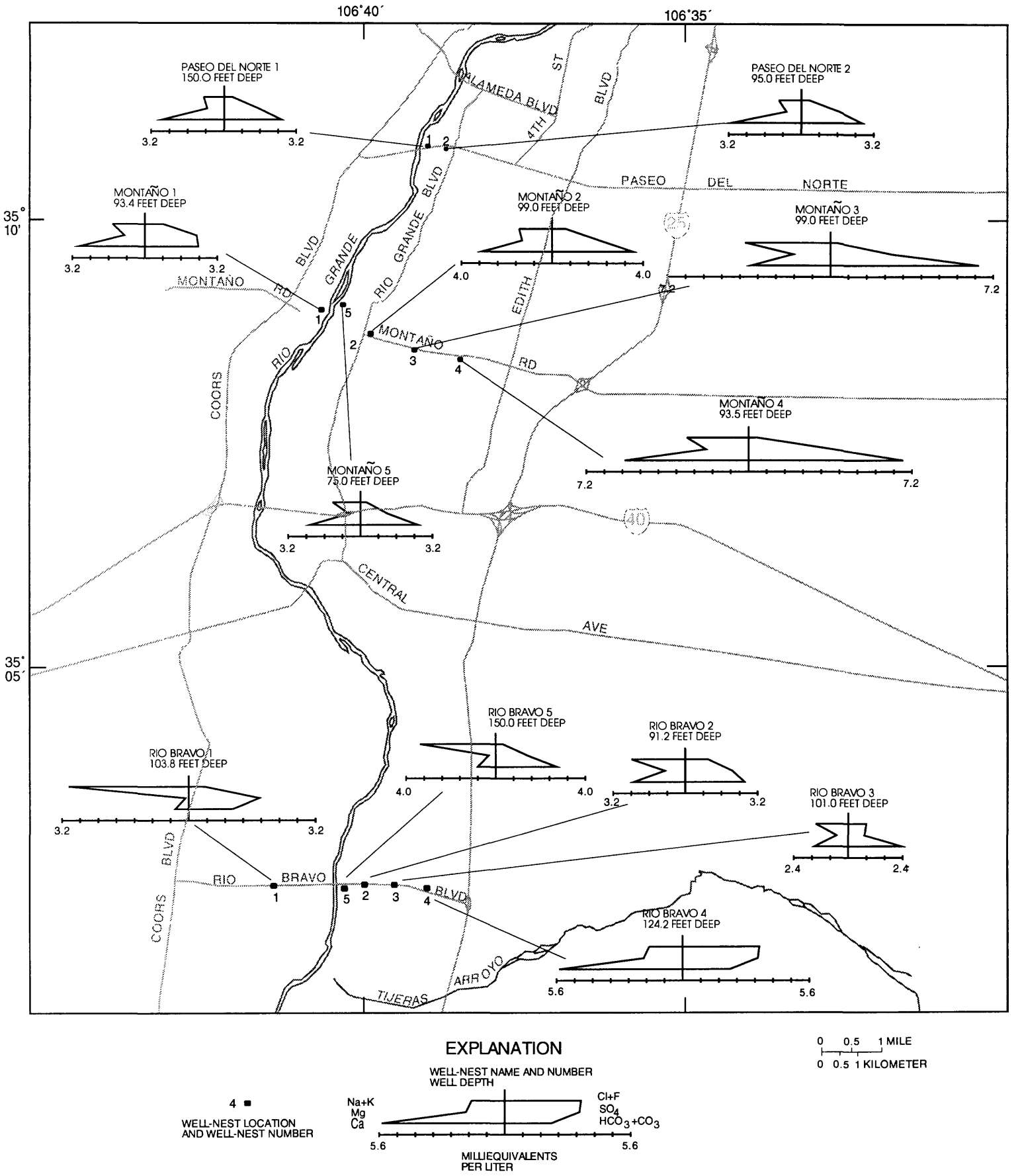


Figure 4.--Distribution of dissolved major-ion concentrations in medium wells.

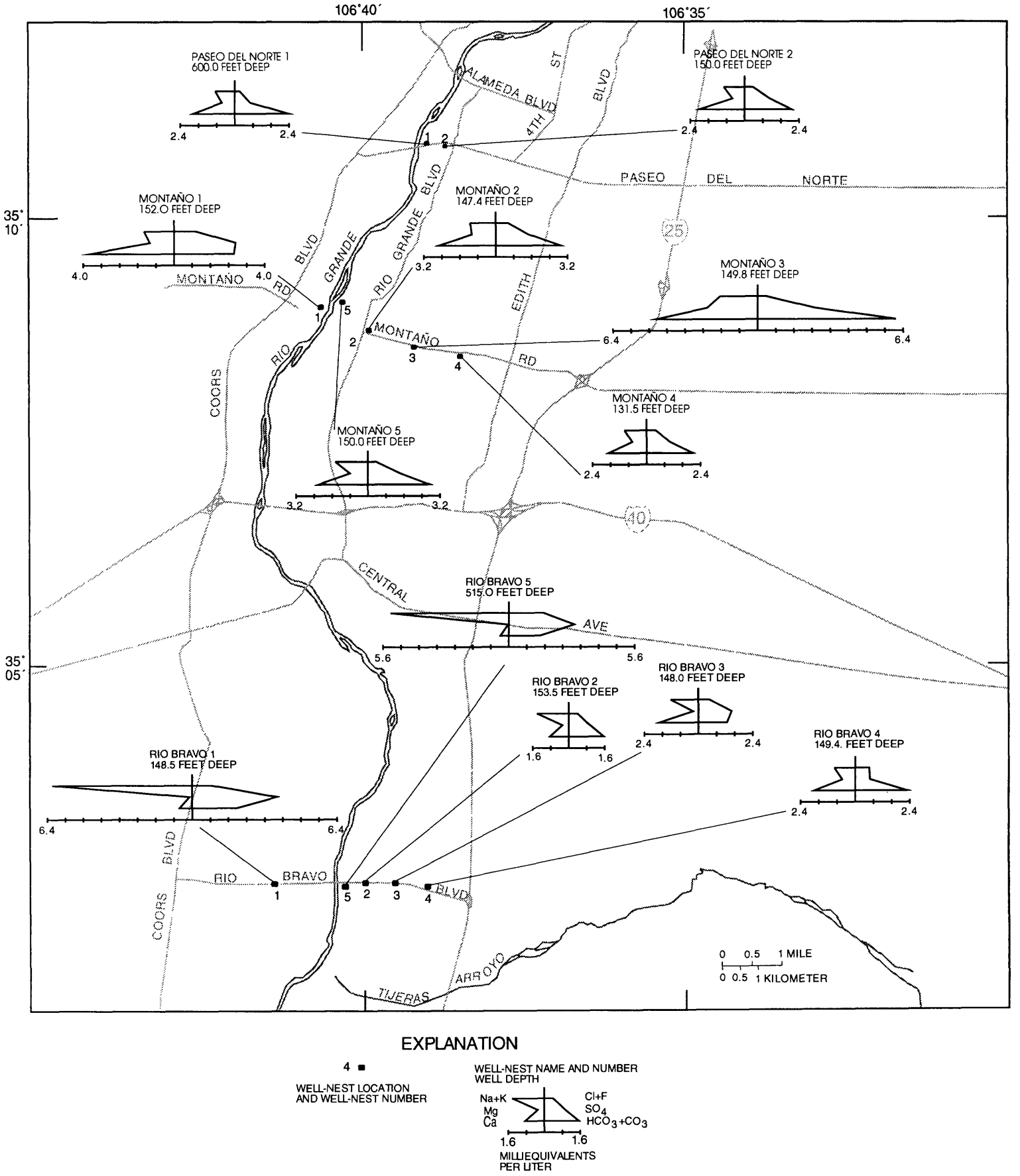


Figure 5.--Distribution of dissolved major-ion concentrations in deep wells.

Nutrients

Distribution of nutrient concentrations at various depths along each of the three sections is shown in figures 6, 7, and 8. Ammonia, nitrite, nitrite plus nitrate, or orthophosphate concentrations were measured in water from each of the 36 wells.

Ammonia as nitrogen was detected in water from 34 wells. At the Paseo del Norte section ammonia was detected in all water samples. Measured ammonia concentrations ranged from 0.01 mg/L in the Paseo del Norte 1 medium and deep wells to 0.10 mg/L in the Paseo del Norte 2 shallow well. Nitrite was not detected in water from any Paseo del Norte wells. Nitrite plus nitrate as nitrogen was detected in only the Paseo del Norte 1 shallow well at a concentration of 0.10 mg/L. Orthophosphate as phosphorus was detected in all but one of the Paseo del Norte wells--the Paseo del Norte 1 deep well. Measured concentrations of orthophosphate in the remaining wells ranged from 0.01 mg/L in the Paseo del Norte 1 medium well to 0.49 mg/L in the Paseo del Norte 2 deep well.

At the Montaño section ammonia as nitrogen was detected in all water samples. Measured ammonia concentrations ranged from 0.01 mg/L in water from the Montaño 5 shallow well to 0.71 mg/L in water from the Montaño 1 shallow well. Nitrite as nitrogen was detected in the Montaño 1 shallow, Montaño 2 medium, and Montaño 4 medium wells. Nitrite concentrations ranged from 0.01 mg/L in the Montaño 1 shallow well to 0.05 mg/L in the Montaño 4 medium well. Nitrite plus nitrate was detected in water from the Montaño 1 medium; Montaño 5 shallow; Montaño 2 shallow, medium, and deep; and Montaño 4 medium wells. Concentrations ranged from 0.07 mg/L in the Montaño 2 medium well to 0.17 in the Montaño 1 medium well. Orthophosphate as phosphorus was detected in water from all but three of the Montaño wells--the Montaño 5 deep, Montaño 2 medium, and Montaño 4 shallow wells. Measured orthophosphate concentrations ranged from 0.01 mg/L in the Montaño 4 deep well to 0.09 mg/L in the Montaño 1 shallow well.

At the Rio Bravo section ammonia as nitrogen was detected in water from all but two wells--the Rio Bravo 5 medium and deep wells. Measured ammonia concentrations in the remaining wells ranged from 0.02 mg/L in the Rio Bravo 4 medium well to 0.58 mg/L in the Rio Bravo 4 deep well. Nitrite as nitrogen was detected only in water from the Rio Bravo 2 deep well at a concentration 0.01 mg/L. Nitrite plus nitrate was not detected in water from the Rio Bravo 1 shallow; Rio Bravo 5 shallow, medium, and deep; and Rio Bravo 2 shallow wells. Nitrite plus nitrate concentrations in water from the other wells ranged from 0.14 mg/L in the Rio Bravo 4 deep well to 5.30 mg/L in the Rio Bravo 4 shallow and medium wells. Orthophosphate as phosphorus was not detected in water from the Rio Bravo 5 medium well. Measured orthophosphate concentrations in water from the remaining wells ranged from 0.01 mg/L in the Rio Bravo 2 shallow and medium wells to 0.91 mg/L in the Rio Bravo 4 shallow well.

Selected Trace Elements

Distribution of selected trace-element concentrations at various depths along each of the three sections is shown in figures 9, 10, and 11. All water samples were analyzed for arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, silver, and zinc. Mercury and silver were not detected in any water samples and therefore are not shown on the graphs in figures 9 through 11. The greatest barium and zinc concentrations in general were detected in water from wells in the Montaño section, and the greatest arsenic, chromium, copper, lead, and selenium concentrations were in water from wells in the Rio Bravo section.

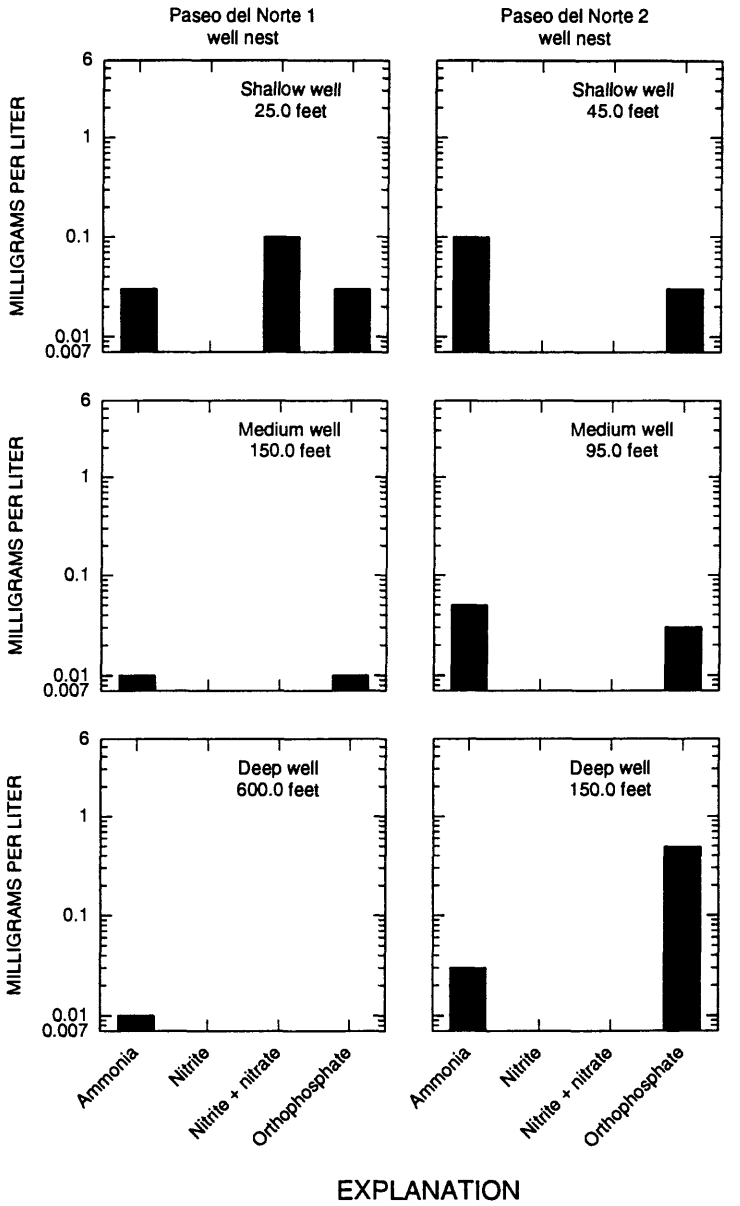


Figure 6.--Dissolved-nutrient concentrations in water from wells in the Paseo del Norte section.

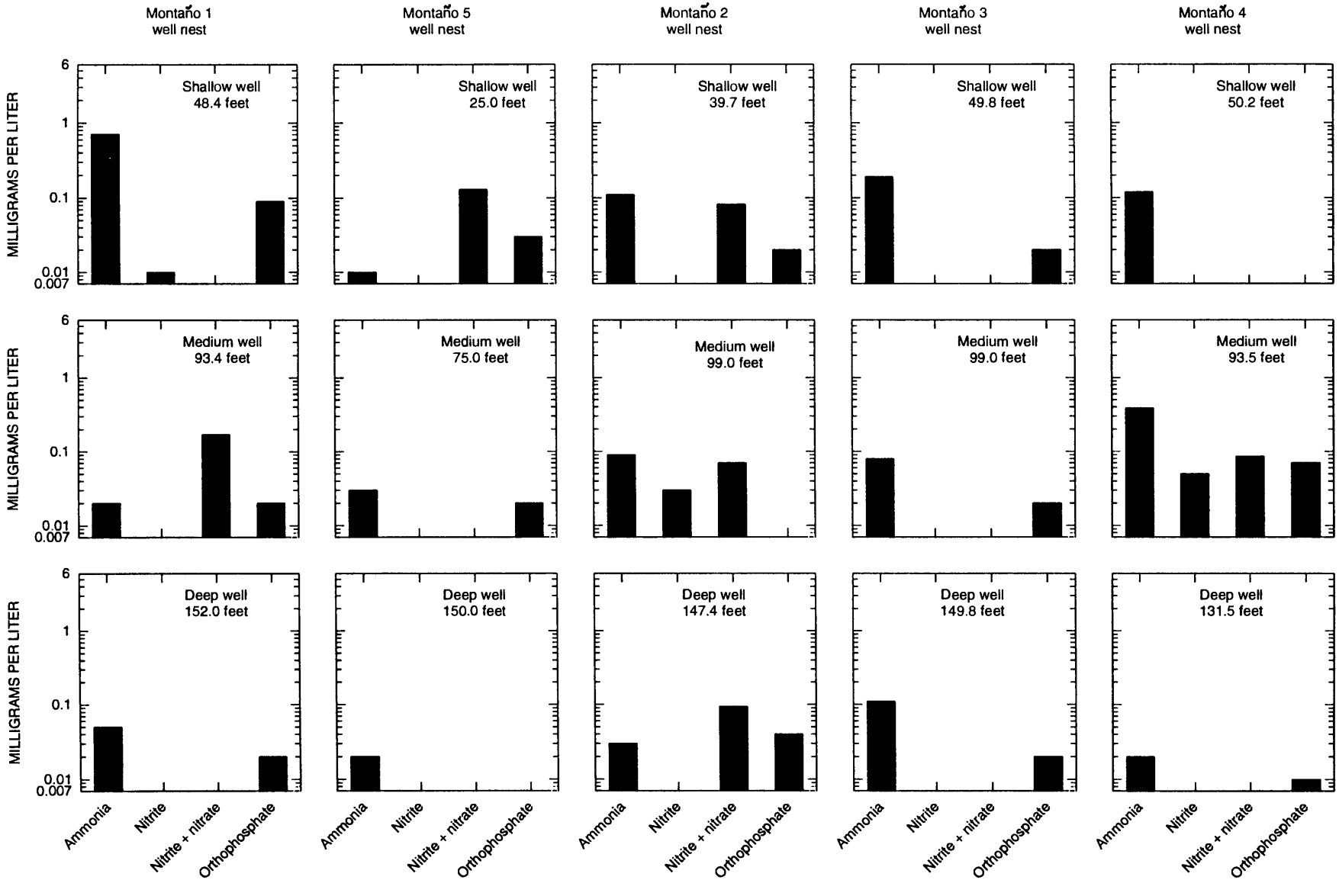


Figure 7.--Dissolved-nutrient concentrations in water from wells in the Montaño section.

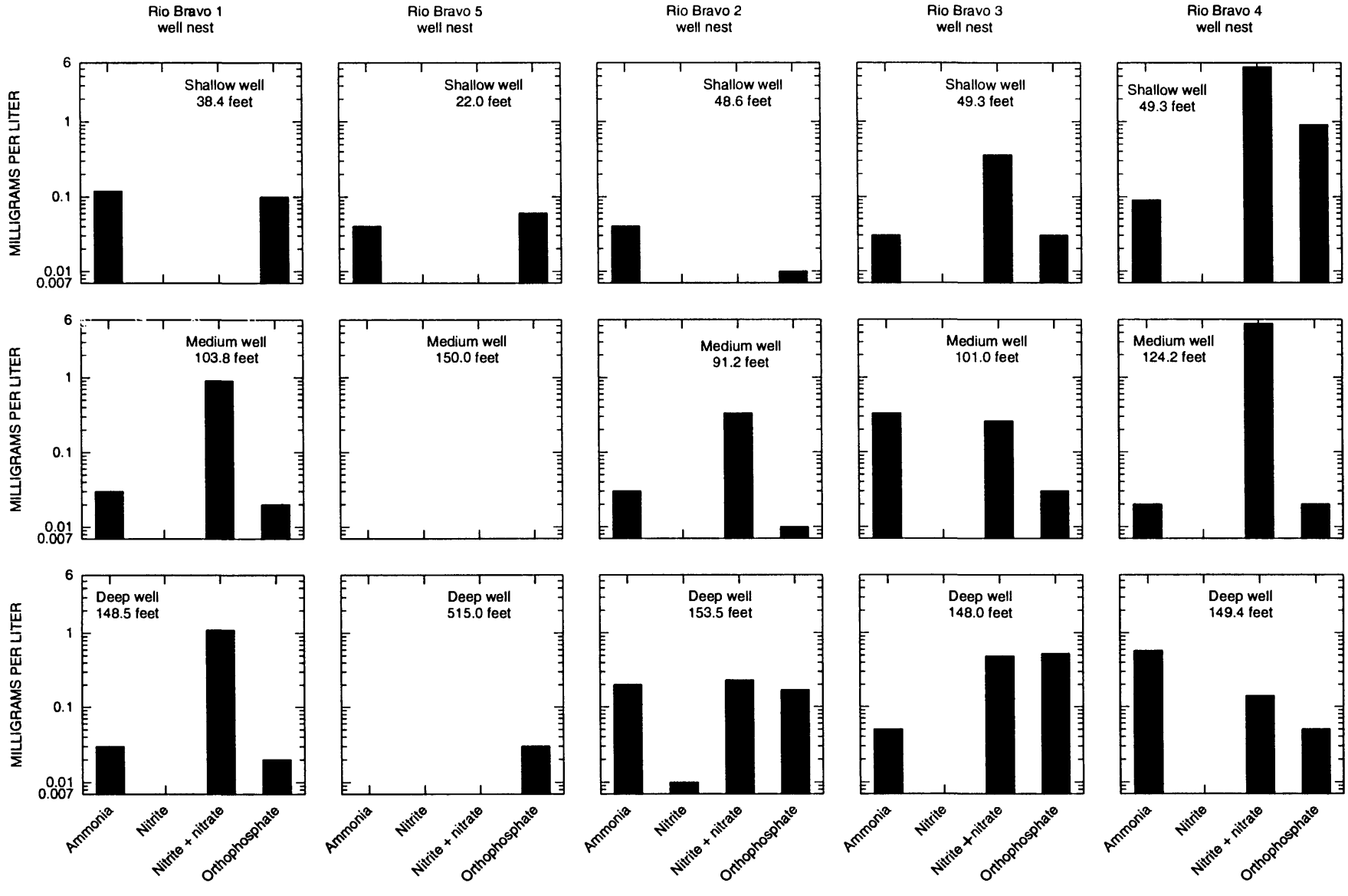


Figure 8.--Dissolved-nutrient concentrations in water from wells in the Rio Bravo section.

Arsenic was detected in water samples from all wells in the Paseo del Norte section. Concentrations ranged from 2 micrograms per liter (µg/L) in the Paseo del Norte 1 medium well to 6 µg/L in the Paseo del Norte 2 shallow well. Barium was detected in water from all Paseo del Norte wells. Concentrations ranged from 51 µg/L in the Paseo del Norte 1 deep well to 98 µg/L in the Paseo del Norte 1 shallow well. Cadmium and chromium were not detected in water from any Paseo del Norte wells. Copper was detected in water from the Paseo del Norte 1 shallow well at a concentration of 4 µg/L. Lead and selenium were not detected in water from any Paseo del Norte wells. Zinc was detected in all Paseo del Norte wells except the Paseo del Norte 1 medium and Paseo del Norte 2 deep wells. Concentrations of zinc in water from the other wells ranged from 4 µg/L in the Paseo del Norte 2 shallow well to 17 µg/L in the Paseo del Norte 1 deep well.

Arsenic was detected in water from all wells in the Montaño section. Concentrations ranged from 2 µg/L in water from the Montaño 5 shallow and Montaño 4 medium wells to 5 µg/L in water from the Montaño 2 deep and Montaño 4 shallow and deep wells. Barium was detected in water from all Montaño wells. Concentrations ranged from 46 µg/L in water from the Montaño 3 shallow well to 260 µg/L in the Montaño 1 shallow well. Water from the Montaño 2 medium, Montaño 3 deep, and Montaño 4 deep wells also contained a barium concentration greater than 100 µg/L. Cadmium and chromium were not detected in water from any Montaño wells. Copper was detected in water from the Montaño 5 shallow, Montaño 2 medium and deep, and Montaño 4 medium and deep wells. Concentrations ranged from 1 to 2 µg/L; the concentration of 2 µg/L was detected at the Montaño 4 deep well. Lead was detected only in water from the Montaño 2 deep well at a concentration of 1 µg/L. Selenium was not detected in water from any Montaño wells. Zinc was detected in water from all Montaño wells except the Montaño 5 shallow and medium and Montaño 4 medium wells. Concentrations of zinc in water from the other wells ranged from 5 µg/L in the Montaño 1 shallow and Montaño 5 deep wells to 180 µg/L in the Montaño 4 shallow well.

Arsenic was detected in water from all wells in the Rio Bravo section. Concentrations ranged from 4 µg/L in water from the Rio Bravo 5 shallow and Rio Bravo 4 medium wells to 39 µg/L in the Rio Bravo 1 medium well. Arsenic concentrations of 10 µg/L or greater were detected in water from the Rio Bravo 1 medium and deep, Rio Bravo 5 medium and deep, Rio Bravo 2 medium and deep, Rio Bravo 3 medium, and Rio Bravo 4 shallow wells. Barium was detected in water from all Rio Bravo wells. Concentrations ranged from 18 µg/L in the Rio Bravo 1 medium well to 100 µg/L in the Rio Bravo 1 shallow well. Cadmium was detected only in water from the Rio Bravo 3 deep well at a concentration of 1 µg/L. Chromium was detected in water from the Rio Bravo 1 medium and deep wells at concentrations of 9 and 10 µg/L, respectively. Copper was detected in water from the Rio Bravo 1 medium and deep; Rio Bravo 2 shallow, medium, and deep; Rio Bravo 3 shallow and deep; and Rio Bravo 4 shallow wells. Concentrations ranged from 3 µg/L in the Rio Bravo 1 medium and deep and Rio Bravo 3 shallow wells to 16 µg/L in the Rio Bravo 3 deep well. Lead was detected in water from the Rio Bravo 2 medium and deep and Rio Bravo 3 deep wells. Concentrations ranged from 1 µg/L in water from the Rio Bravo 2 medium well to 10 µg/L in the Rio Bravo 2 deep well. Selenium was detected in water from the Rio Bravo 1 medium and deep wells at concentrations of 1 and 2 µg/L, respectively. Zinc was detected in water from all wells in the Rio Bravo section. Concentrations ranged from 3 µg/L in the Rio Bravo 1 shallow and Rio Bravo 3 medium wells to 62 µg/L in the Rio Bravo 3 deep well.

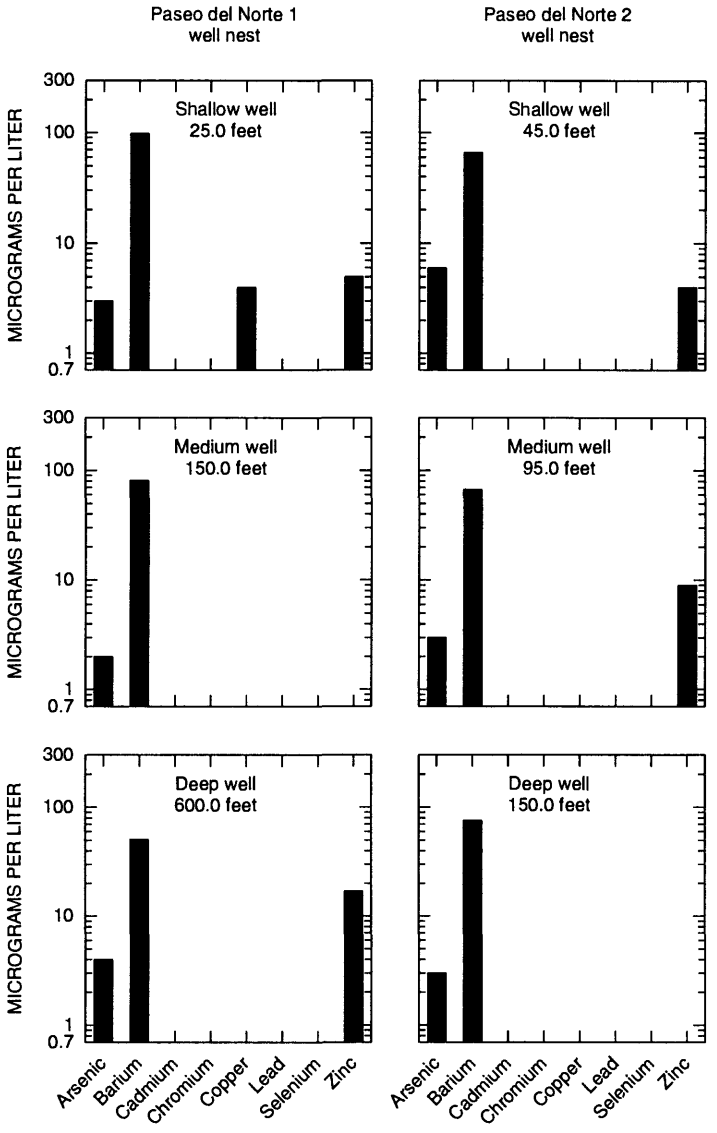
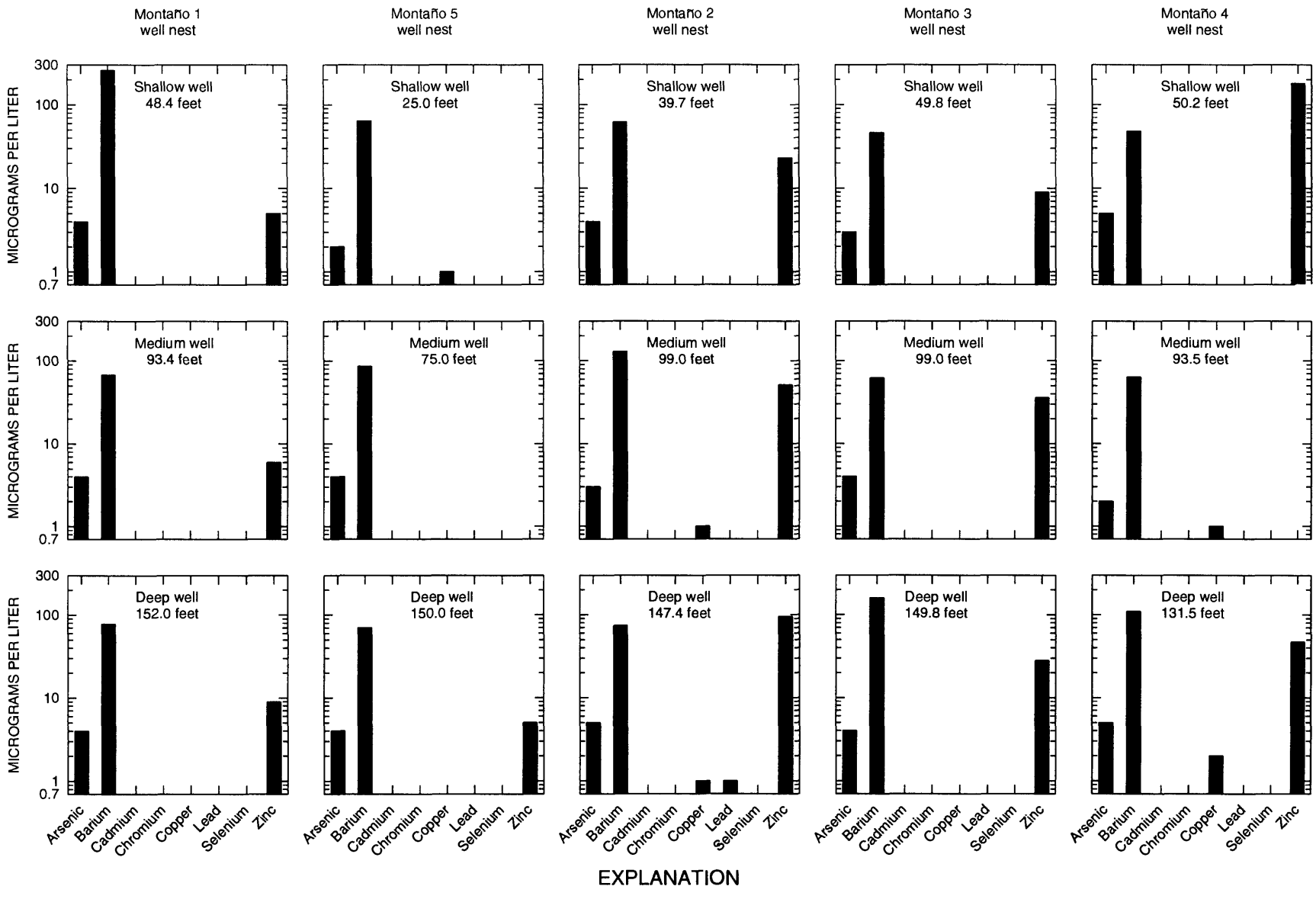
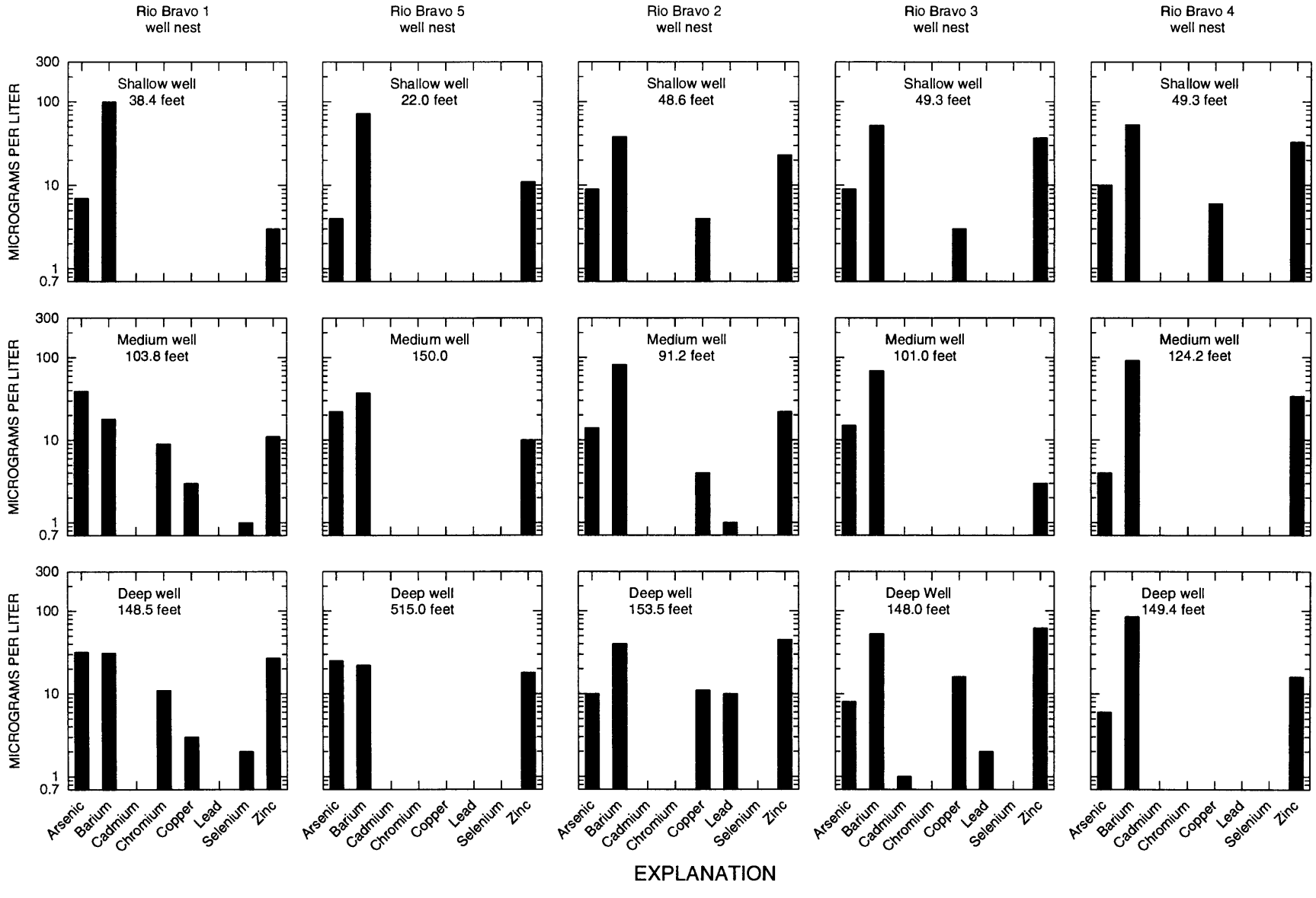


Figure 9.--Dissolved trace-element concentrations in water from wells in the Paseo del Norte section.



No bar indicates analysis results were less than 1 microgram per liter minimum reporting level for cadmium, chromium, copper, lead, and selenium and 3 micrograms per liter minimum reporting level for zinc

Figure 10.--Dissolved trace-element concentrations in water from wells in the Montaño section.



No bar indicates analysis results were less than 1 microgram per liter minimum reporting level for cadmium, chromium, copper, lead, and selenium

Figure 11.--Dissolved trace-element concentrations in water from wells in the Rio Bravo section.

SUMMARY

Water samples from 36 observation wells in the Rio Grande Valley in the vicinity of Albuquerque, New Mexico, were collected as part of a program to investigate general ground-water-quality conditions and to determine contaminant locations in the Albuquerque area. The wells are located in three sections comprising 12 well nests. Each nest includes three wells, completed at shallow (22 to 50 feet), medium (75 to 150 feet), and deep (131 to 600 feet) depths. The observation wells are completed in unconsolidated alluvial deposits and Pleistocene sediments of the Santa Fe Group. The water samples were collected from October 19, 1993; through January 18, 1994.

Laboratory determinations included dissolved solids, major ions, nutrients, total organic carbon, trace elements (arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, silver, and zinc), and volatile organic compounds. Toluene was the only volatile organic compound detected; however, sample results may not be reliable since toluene was also detected in quality assurance blanks.

All water from wells in the Paseo del Norte section is a calcium bicarbonate type. Ammonia was detected in water from all wells, nitrite in no wells, nitrite plus nitrate in one well, orthophosphate in all but one well, arsenic and barium in all wells, cadmium and chromium in no wells, copper in one well, lead and selenium in no wells, and zinc in four of six wells.

All water in the Montaño section wells is a calcium bicarbonate type except in the Montaño 1 medium and deep wells, which have a calcium sulfate bicarbonate water; the Montaño 3 medium well, which has a sodium calcium bicarbonate water; and the Montaño 4 shallow well, which has a calcium sulfate water and contains the largest dissolved-solids concentration of any well of any depth, 1,280 mg/L. Ammonia was detected in all water samples, nitrite in 2 wells, nitrite plus nitrate in 5 wells, orthophosphate in all but 1 well, arsenic and barium in all wells, cadmium and chromium in no wells, copper in 5 wells, lead in 1 well, selenium in no wells, and zinc in 12 of the 15 wells.

All Rio Bravo shallow wells have a calcium bicarbonate water except Rio Bravo 3, which has a sodium bicarbonate water. Rio Bravo medium wells have sodium sulfate, sodium bicarbonate, calcium sodium bicarbonate, and calcium chloride sulfate waters. Ammonia was detected in all but 2 wells, nitrite in 1 well, nitrite plus nitrate in 10 wells, orthophosphates in all but 1 well, arsenic and barium in all wells, cadmium in 1 well, chromium in 2 wells, copper in 8 wells, lead in 3 wells, selenium in 2 wells, and zinc in all wells.

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