U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
ENVIRONMENTAL DEPARTMENT,
FORT McDOWELL YAVAPAI NATION

Quality of Water and Estimates of Water Inflow, Northern Boundary Area, Fort McDowell Indian Reservation, Maricopa County, Arizona

Water-Resources Investigations Report 01—4151

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By John P. Hoffmann *and* Christie M. O'Day

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Tucson, Arizona
September 2001

U.S. DEPARTMENT OF THE INTERIOR
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CONTENTS

FIGURES

TABLES

CONVERSION FACTORS

Multiply	By	To obtain
Length		
inch (in)	2.54	centimeter
inch (in)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
Area		
acre	4,047	square meter
square foot (ft^2)	0.09290	square meter
square mile (mi^2)	2.590	square kilometer
Volume		
gallon (gal)	0.003785	cubic meter
million gallons (Mgal)	3,785	cubic meter
acre-foot (acre-ft)	1,233	cubic meter
Flow rate		
acre-foot per day (acre-ft/d)	0.01427	cubic meter per second
acre-foot per year (acre-ft/yr)	1,233	cubic meter per year
foot per day (ft/d)	0.3048	meter per day
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
cubic foot per second per square mile [$(ft^3/s)/mi^2$]	0.01093	cubic meter per second per square kilometer
cubic foot per day (ft^3/d)	0.02832	cubic meter per day
gallon per day (gal/d)	0.003785	cubic meter per day
Hydraulic conductivity		
foot per day (ft/d)	0.3048	meter per day
Hydraulic gradient		
foot per mile (ft/mi)	0.1894	meter per kilometer

Temperature in degrees Celsius (°C) may be converted to degrees Farenheit (°F) as follows:

$$°F = (1.8°C)+32$$

ABBREVIATED WATER-QUALITY UNITS

Chemical concentration and water temperature are given only in metric units. Chemical concentration in water is given in milligrams per liter (mg/L) or micrograms per liter (µg/L). Milligrams per liter is a unit expressing the solute mass (milligrams) per unit volume (liter) of water. One thousand micrograms per liter is equivalent to 1 milligram per liter. For concentrations less than 7,000 milligrams per liter, the numerical value is about the same as for concentrations in parts per million. Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25°C). Chemical concentration in sediment is given in grams per kilogram (g/kg), micrograms per gram (µg/kg). Grams per kilogram is equal to parts per thousand (ppt). Milligrams per kilogram and micrograms per gram are equal to parts per million (ppm). Micrograms per kilogram are equal to parts per billion (ppb).

VERTICAL DATUM

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

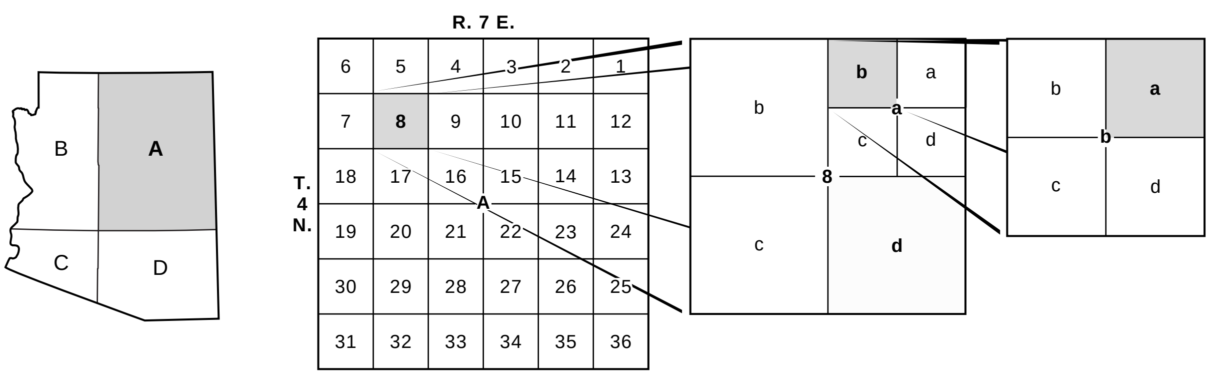
Altitude: As used in this report, refers to distance above or below sea level or to local datum as indicated.

Transmissivity: The standard unit for transmissivity is cubic foot per day per square foot times foot of aquifer thickness $[(ft^3/d)/ft^2]ft$. In this report, the mathematically reduced form, foot squared per day (ft^2/d), is used for convenience.

Water year: The 12-month period, October 1 through September 30. The water year is designated by the calendar year in which it ends and includes 9 of the 12 months. Thus, the year ending September 30, 2001, is called the “2001 water year.”

ARIZONA WELL-NUMBERING SYSTEM

WELL (A–04–07)08aba



Quadrant A, Township 4 North, Range 7 East, section 8, quarter section a, quarter section b, quarter section a

The well numbers used by the U.S. Geological Survey in Arizona are in accordance with the Bureau of Land Management's system of land subdivision. The land survey in Arizona is based on the Gila and Salt River meridian and base line, which divide the State into four quadrants and are designated by capital letters A, B, C, and D in a counterclockwise direction beginning in the northeast quarter. The first digit of a well number indicates the township, the second the range, and the third the section in which the well is situated. The lowercase letters a, b, c, and d after the section number indicate the well location within the section. The first letter denotes a particular 160-acre tract, the second the 40-acre tract and the third the 10-acre tract. These letters also are assigned in a counterclockwise direction beginning in the northeast quarter. If the location is known within the 10-acre tract, three lowercase letters are shown in the well number. Where more than one well is within a 10-acre tract, consecutive numbers beginning with 1 are added as suffixes. In the example shown, well number (A–04–07)08aba designates the well as being in the NE1/4,NW1/4, NE1/4, section 8, Township 4 North, and Range 7 East.

Quality of Water and Estimates of Water Inflow, Northern Boundary Area, Fort McDowell Indian Reservation, Maricopa County, Arizona

By John P. Hoffmann *and* Christie M. O'Day

Abstract

Increased agricultural and recreational activities and recent growth of population centers within the Verde River basin have led to concerns about the quality and quantity of water flowing onto the Fort McDowell Indian Reservation. The purpose of this study was to determine the quality and quantity of water in the Verde River and in the shallow stream-channel deposits in the vicinity of the northern boundary of the reservation.

The quality of surface water entering the reservation at the northern boundary and of ground water in the shallow stream-channel deposits beneath the flood plain is suitable for most purposes. Concentrations of dissolved solids and major ions did not exceed water-quality standards. Dissolved oxygen and pH generally were in acceptable ranges for all designated uses. Total coliform counts and nutrient concentrations also did not exceed water-quality standards. Six organic compounds were detected; however, concentrations of these compounds were below U.S. Environmental Protection Agency Maximum Contaminant Levels. The presence of these organic compounds indicates that the water has been affected by anthropogenic activities. Concentrations of all trace metals were below the applicable State of Arizona Water Quality Standards for Surface Water and U.S. Environmental Protection Agency Maximum Contaminant Levels. Arsenic concentrations were below the Maximum Contaminant Level of 50 micrograms per liter at the time of collection and analysis; however, in January 2001, the U.S. Environmental Protection Agency set a new Maximum Contaminant Level of 10 micrograms per liter. All arsenic concentrations in surface water were 10 micrograms per liter or greater. Arsenic concentration in ground water ranged from 6 to 9 micrograms per liter. The source of arsenic is probably oxidized arsenic compounds that are typically found in basin-fill sediments in southern Arizona.

Surface-water flow onto the reservation was determined from recorded discharge at the Verde River below Bartlett Dam and Verde River near Scottsdale streamflow-gaging stations from 1962–99. Average annual flow onto the reservation is about 13 cubic feet per second less than average annual discharge at the Verde River below Bartlett Dam and 17.5 cubic feet per second more than the average annual discharge at the Verde River near Scottsdale for years in which rainfall is less than 20 inches. Average daily flow onto the reservation also is about 13 cubic feet per second less than discharge at the Verde River below Bartlett Dam and 18.7 cubic feet per second more than discharge at the Verde River near Scottsdale for May through November. Flow onto the reservation for December through April is less predictable because of a large variation between discharges at the Verde River below Bartlett Dam and the Verde River near Scottsdale.

Correlation between the nine instantaneous discharge measurements made between January 1998 and August 1999 at the northern boundary and recorded discharge at the two streamflow-gaging stations is high; correlation coefficients were greater than 0.99. Instantaneous inflows onto the reservation can be related to discharges at the Verde River below Bartlett Dam and the Verde River near Scottsdale using the equations:

instantaneous inflow = 0.861(instantaneous discharge at the Verde River below Bartlett Dam) + 20 cubic feet per second, and,

instantaneous inflow = 0.893(instantaneous discharge at the Verde River near Scottsdale) + 36 cubic feet per second

for discharges that range from 102 to 704 cubic feet per second at the northern boundary.

The direction of ground-water flow is approximately parallel to the flow of the Verde River. Ground water has a minor component of flow into the river when the river stage is lower than about 5 feet above the local datum. There is a minor component of flow into the stream-channel deposits when the river stage is higher than about 5 feet above the local datum. Ground-water inflow to the reservation in the Verde River stream-channel deposits is about 1.1 cubic feet per second and is minor compared to the average annual streamflow of 675 cubic feet per second at the Verde River below Bartlett Dam on the basis of 111 years of record.

INTRODUCTION

The Verde River, which flows north to south, has supplied water for mining, agricultural, and ranching water needs within the lower Verde Valley for the past century. The Fort McDowell Indian Reservation, in the southern part of the lower Verde Valley, also has relied on this resource for agricultural, recreational, and domestic water supplies. The river supports many types of aquatic life and maintains dense riparian vegetation on the adjacent flood plain that serves as habitat for many types of wildlife. Demand for river water has increased for both agricultural and domestic purposes in recent years. Water for agricultural use is diverted directly from the river and also is withdrawn from wells that are connected hydraulically to the river. The Verde River enters the reservation at its northern boundary and bisects the entire length of the reservation (**fig. 1**).

Increased agricultural and recreational activities and recent growth of population centers within the Verde River basin have led to concerns about the quality and quantity of water flowing onto the reservation. To address these concerns, the U.S. Geological Survey (USGS), in cooperation with the Fort McDowell Yavapai Nation, completed a study to determine the quality and quantity of surface water and ground water flowing onto the reservation at its northern boundary.

Purpose and Scope

This report presents (1) water-quality data for water flowing onto the Fort McDowell Indian reservation at its northern boundary, (2) estimates of surface-water inflow made on the basis of streamflow statistics and discharge-measurement data, and (3) estimates of ground-water inflow made on the basis of water-level gradients and stream-channel geometry. Samples of streamflow and shallow ground water entering the reservation were collected periodically between January 1998 and August 1999 and were analyzed for a variety of constituents including selected trace metals, pesticides, and volatile organic compounds (VOCs). Historic (1962 to 1999) streamflow data at streamflow-gaging stations 09510000 (Verde River below Bartlett Dam) and 09511300 (Verde River near Scottsdale; fig. 1) were used to evaluate long-term estimates of flow onto the reservation. Discharge measurements were made near the northern boundary and were compared to measurements at gaging stations upstream (Verde River below Bartlett Dam) and downstream (Verde River near Scottsdale) from the reservation. Ground-water inflow was estimated on the basis of water-level gradients and an estimated cross sectional area of the stream-channel deposits. Water-level gradients were determined using a rectangular array of nine shallow drive-point wells installed near the boundary. The cross sectional area of the stream-channel deposits was estimated using the results of surface geophysical surveys at the northern boundary.

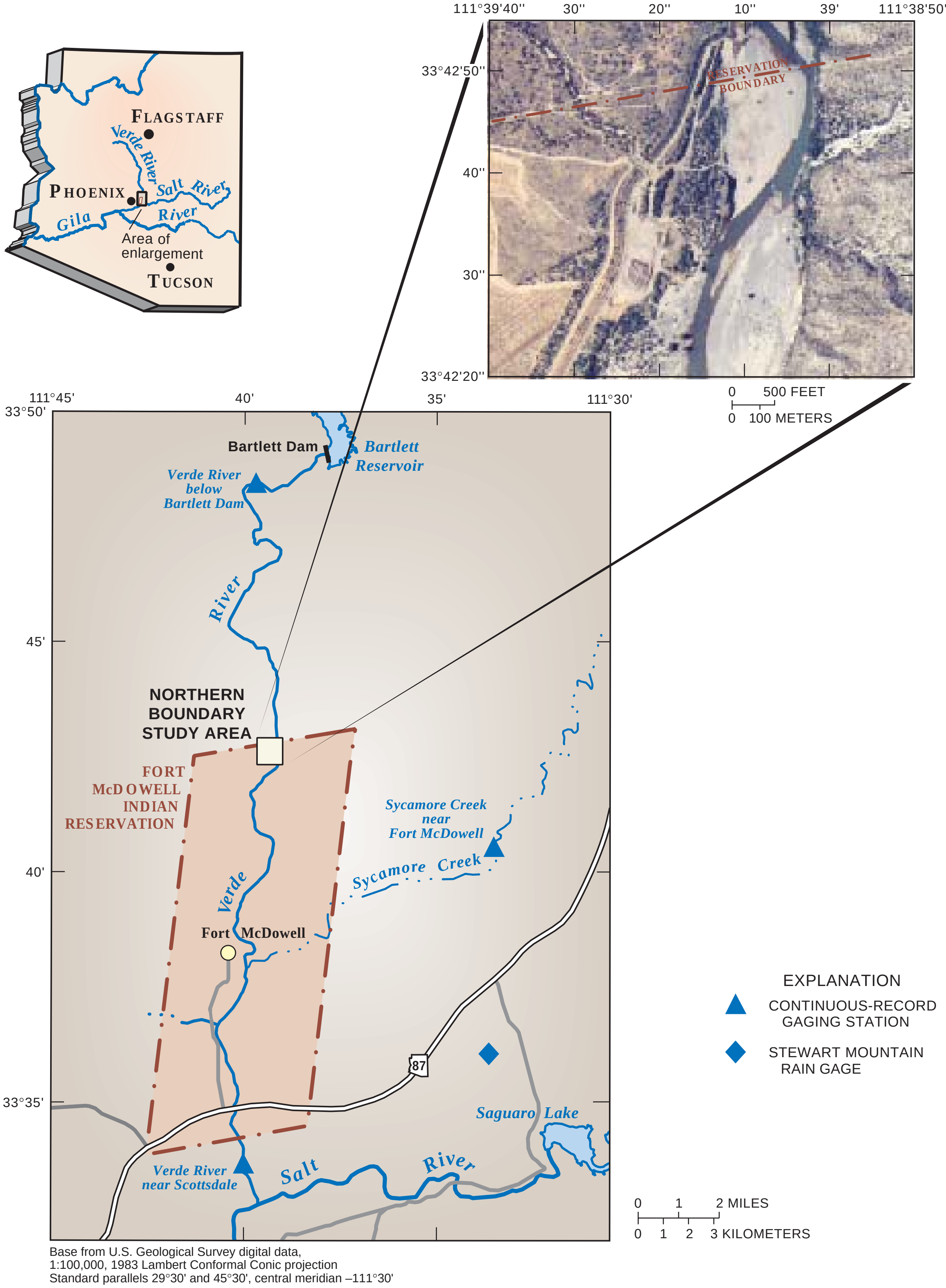


Figure 1. Northern boundary study area, Fort McDowell Indian Reservation, Arizona.

Previous Investigations

McDonald and Padgett (1945) described the geology and ground-water resources of the Verde River Valley below Bartlett Dam to determine the adequacy of ground water from the alluvium beneath and adjacent the Verde River for municipal supply to the City of Phoenix. Wilson and others (1957) mapped the geology of the basin. The water resources of Sycamore Creek, a tributary of the Verde River on the east side of the Fort McDowell Indian Reservation, were studied by Thomsen and Dennis (1963), Schumann (1967), and Thomsen and Schumann (1968). Maps showing ground-water conditions in the area have been published by Ross (1977), Reeter and Remick (1986), and Hammett and Herther (1995). Stream discharge and water quality of the Verde River have been reported in annual USGS Water Resources Data reports. Stream discharge has been reported for USGS gaging station Verde River below Bartlett Dam since 1888 and for USGS gaging station Verde River near Scottsdale since 1961. Stream discharge also has been reported for USGS gaging station 09510200 (Sycamore Creek near Fort McDowell) since 1906. Water quality data for the Verde River below Bartlett Dam are available for the periods 1950–92 and 1999.

GEOGRAPHIC AND HYDROLOGIC SETTING

The Fort McDowell Indian Reservation is 23 miles northeast of Phoenix in the lower Verde River Valley (**fig. 1**). The valley is a broad alluvial basin within the Basin and Range physiographic province (Fenneman, 1931). Basins within this province are bounded by steep, fault-block mountains. The reservation lies on an alluvial plain that is almost completely surrounded by mountains composed primarily of granitic, metamorphic, and volcanic rocks (Reeter and Remick, 1986).

The principle hydrologic feature of the valley is the Verde River. The river begins in the mountains of west-central Arizona and flows south to join the Salt River immediately south of the reservation. Discharge of the Verde River in the lower Verde Valley is controlled by discharge at Bartlett Dam. Discharge in water years 1998 and 1999 averaged 682 and 327 ft^3/s, respectively, at the Verde River below Bartlett Dam about 9 mi upstream from the northern boundary of the reservation. Discharge averaged 681 and 303 ft^3/s at the Verde River near Scottsdale, about 12.5 mi downstream from the northern boundary of the reservation during the same period (Tadayon and others, 1998, 1999).

Ground-water development in the lower Verde River Valley has not been extensive and little is known about the hydrology of the area. Ground water occurs in the Verde River stream-channel deposits and underlying and adjacent basin-fill sediments. The stream-channel deposits at the northern boundary of the reservation have a lateral extent (width) of about 1,000 ft; the lateral extent is defined by the extent of the flood plain. Water-supply wells for the reservation and the City of Phoenix are completed in these deposits along the west bank of the river. Depth to ground water in the water-supply wells near the river is about 20 ft (Reeter and Remick, 1986).

The basin fill consists of unconsolidated to consolidated sediments of Quaternary and late Tertiary age that are as much as several hundred feet thick (Wilson and others, 1957). The Quaternary basin-fill sediments consist of sand and gravel interbedded with clay and silt (Wilson and others, 1957). The interbedded clay and silt units comprise layers that are inches to several hundreds of feet thick. Conglomerate of late Tertiary age underlies the unconsolidated Quaternary deposits at various depths. The unconsolidated basin fill and conglomerate generally are thinner near the McDowell and Mazatzal Mountains at the perimeter of the basin (fig. 1) and thicken to several hundreds of feet near the Verde River at the center of the basin. The thickness of interbedded clay and silt layers also tends to increase toward the center of the basin. The basin-fill deposits unconformably overlie crystalline bedrock of Precambrian age.

METHODS OF INVESTIGATION

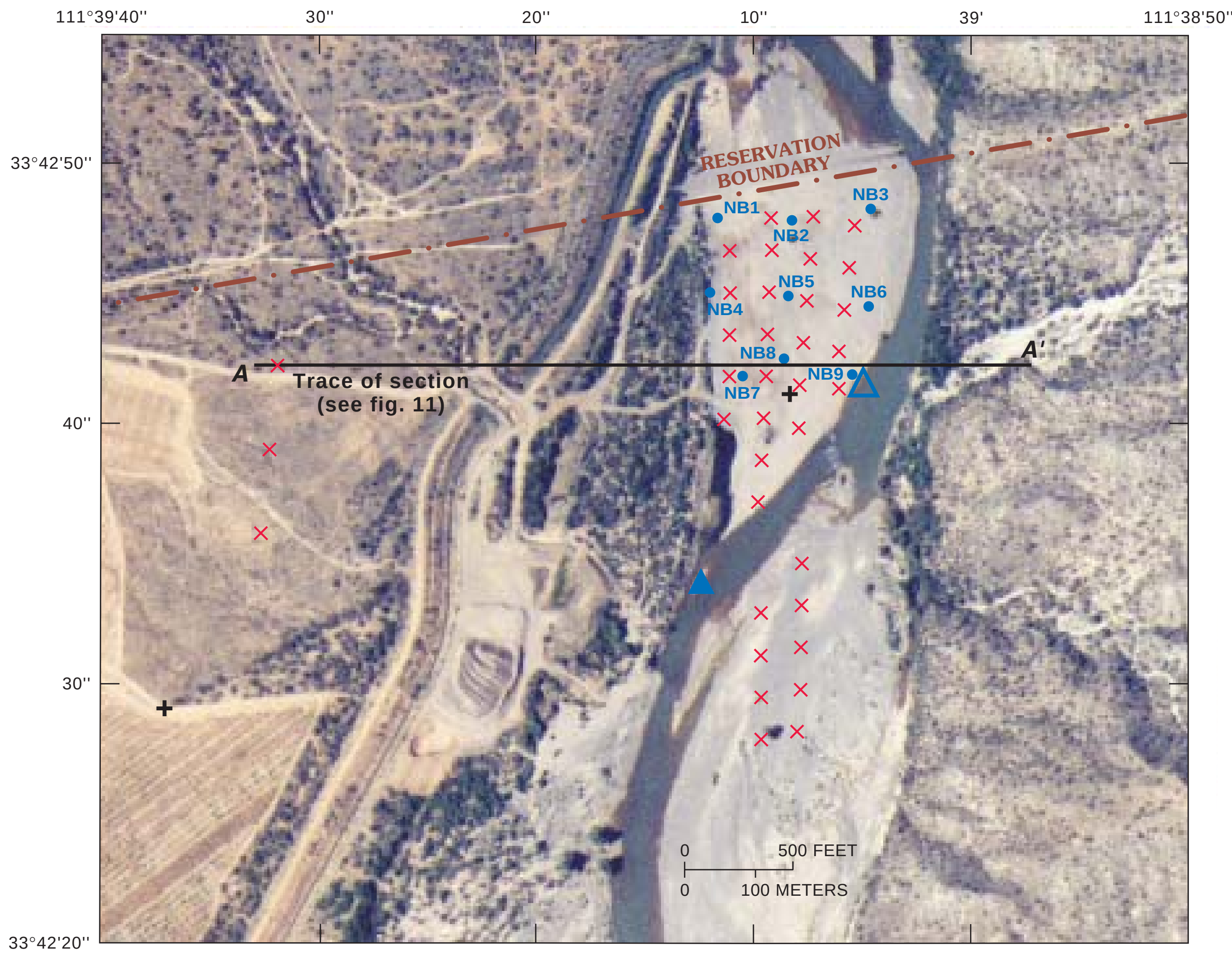
Because little hydrologic information on the northern boundary area was available, an investigative program was designed to develop information on surface- and ground-water quality, subsurface lithology, and relations among flows at the northern boundary and at nearby USGS gaging stations. This program included water and suspended-sediment sampling and analyses, streamflow measurements, surface geophysical surveys, and water-level monitoring.

Water-Sample Collection and Analysis

Surface-water samples were collected about 1,000 ft downstream from the northern boundary of the reservation (**fig. 2**) six times between January 1998 and August 1999 and analyzed for major ions, selected metals, nutrients, and selected organic compounds. In this report, the term “metals” is used to denote metals and metalloids. These samples were collected using National Water-Quality Assessment (NAWQA) program protocols (Shelton, 1994) and the equal-width-increment (EWI) method (Edwards and Glysson, 1988). A DH-81 sampler ring was used with either a plastic or a teflon 1-L bottle attached to a shrink-wrapped wand. Once collected, the surface-water samples were composited using a churn splitter or, for organics analyses, a teflon cone splitter. Suspended-sediment samples were collected in separate bottles using the EWI method. Samples for major-ion, metal, and nutrient analyses were filtered using 0.45-micrometer membrane filters. Samples for cation and metal analyses were preserved with nitric acid. Plastic amber bottles were used to collect the filtered nutrient samples. Samples for volatile organic compound (VOC) analyses were collected in glass amber vials with air excluded and were preserved with ultra-pure hydrochloric acid. Samples for pesticide analyses were filtered through a 0.7-micrometer baked, glass-fiber filter and collected in baked, amber glass bottles. All tubing in contact with the sample was teflon with stainless steel fittings. Dissolved-oxygen concentration and temperature were measured at the same points in the cross sections at which the samples were collected. Specific conductance and pH were measured using aliquots of the composited samples. All surface-water samples were chilled after collection and sent within 24 hours to the USGS National Water-Quality Laboratory in Denver, Colorado, for analyses.

In January 1998, nine drive-point wells were installed in a three-by-three array in the flood plain on the west bank of the Verde River (fig. 2). Depth to the water table is commonly less than 3 feet below land surface allowing for shallow drive-point well installations. Each drive-point well has a diameter of 2 in. and consists of a 2-ft galvanized or stainless-steel slotted screen at the bottom of a 3.5-ft section of galvanized pipe. Ground water was sampled five times from drive-point well NB5 (fig. 2) from August 1998 to August 1999. Ground-water sampling protocols used are those defined for the NAWQA program (Koterba and others, 1995). The ground-water samples were collected after at least three casing volumes of water were removed from the well using either a submersible pump or a peristaltic pump. Pumping was held constant at 0.5 to 1 gallon per minute. All sampling and filter equipment was rinsed thoroughly with water from the well before sample collection. Specific conductance, temperature, pH, turbidity, and dissolved-oxygen concentration were monitored in a flow-through chamber at 5-minute intervals. Water samples were collected when the field-determined properties and constituents had stabilized within the percentage deviation allowed over a 25-minute period (Koterba and others 1995, table 19). Bicarbonate and carbonate concentrations were determined in the field by incremental titration of filtered samples with dilute sulfuric acid. The samples were filtered and preserved using the same protocols as described for the surface-water samples. All ground-water samples were chilled as needed after collection and sent to the USGS National Water-Quality Laboratory in Colorado within 24 hours.

Results of the surface-water and ground-water sample analyses were compared to the Primary and Secondary-Drinking Water Regulations, Health Advisories, and the contaminant candidate list of the U.S. Environmental Protection Agency (USEPA) for a general assessment of water quality (USEPA, 1996). Primary Drinking-Water Regulations include Maximum Contaminant Levels (MCLs) that are enforceable standards with accompanying treatment techniques if concentrations of certain constituents exceed action levels. Secondary Drinking-Water Regulations include Secondary Maximum Contaminant Levels (SMCLs) that are nonenforceable guidelines based on the aesthetic properties of drinking water. Health Advisories provide acceptably safe levels of exposures to contaminants in drinking water on the basis of documented health risks. Contaminant candidates are constituents that are being evaluated for possible future regulation by the USEPA. Data from surface-water samples also were compared to State of Arizona water-quality standards that are based on designated uses (Arizona Department of Environmental Quality, 1996). For example, below Bartlett Dam, the Verde River is designated for full body contact, domestic water source, fish consumption, aquatic and wildlife, agricultural irrigation, and agricultural livestock watering. Each designated use has a specific standard for each constituent.



(Aerial photograph by Kenney Aerial Mapping Company, 1995)

EXPLANATION

- ELECTROMAGNETIC (EM) SOUNDING
- RESISTIVITY (VES) SOUNDING
- NB7 DRIVE-POINT WELL AND DESIGNATION
- STAFF GAGE
- STREAMFLOW-GAGING STATION AND WATER-QUALITY SAMPLING SITE

Figure 2. Locations of study sites, northern boundary area, Fort McDowell Indian Reservation, Arizona.

Inflow Estimates and Discharge Measurements

Streamflow in the Verde River is monitored continuously at the streamflow-gaging stations Verde River below Bartlett Dam and Verde River near Scottsdale, which are about 9 mi upstream and 12.5 mi downstream from the northern boundary of the reservation, respectively (fig. 1). Streamflow in Sycamore Creek, which flows into the Verde River 5.25 mi downstream from the northern boundary, also is continuously monitored at the gaging station Sycamore Creek near Fort McDowell. Comparisons of the average annual discharge and average daily discharge among the three gaging stations for a common period of record (1962–99) were made to determine similarities and differences and to provide long-term estimates of streamflow onto the reservation.

Inflow onto the reservation can be estimated using discharge at the Verde River below Bartlett Dam and at the Verde River near Scottsdale because these stations are on either side of the northern boundary, and minimal gains or losses to the river occur between the stations. Losses of water from the river can occur as a result of pumping of shallow wells completed in the stream-channel deposits and from diversions and evapotranspiration. Gains in streamflow are from overland flow and from tributaries within the middle and lower Verde River basin. The largest tributary in the basin is Sycamore Creek. Rainfall data from a rain gage near the study area (Stewart Mountain; fig. 1) were used to compare annual discharge variations to annual rainfall variations.

Discharge was measured nine times between January 1998 and August 1999 at the surface-water quality sampling site using the conventional current-meter method (Rantz and others, 1982). These discharge measurements were adjusted for diversions immediately upstream from the measurement site (fig. 1). The adjusted measurements were compared with measurements from the Verde River below Bartlett Dam and the Verde River near Scottsdale stations (fig. 1) to derive an empirical relation between instantaneous inflow at the northern boundary and discharge at each of the stations.

Surficial Geophysical Surveys

The electrical properties of sands and gravels differ from those of silts, clays, and crystalline rocks. Crystalline rocks and dry alluvium in the arid Southwest have high electrical resistivities, commonly higher than 100 ohm•m. Resistivity values for saturated silts and clay typically range from 20 to 50 ohm•m; those of saturated sand and gravel are about 100 ohm•m. Therefore, electrical methods are used to detect changes in resistivity that are used to infer sediment type with depth.

In this investigation, surface electromagnetic-induction (EM) and vertical-electrical soundings (VES) were used to obtain information about subsurface lithology and to determine the cross-sectional area of the stream-channel deposits. EM techniques measure the ability of Earth materials to conduct the flow of an electric current (electrical conductivity, the inverse of resistivity). The EM method is based on an induced magnetic field and measurement of the consequent electrical response of the subsurface materials. This investigation used two portable electronic magnetic-induction tools—an EM31 and EM34-3—manufactured by GEONICS LIMITED. The tools include two coils; one coil transmits a primary magnetic field that induces current flow in the subsurface and creates a secondary magnetic field; the second coil measures the primary and secondary magnetic fields. Depth of investigation for these tools is related to the orientation of dipole and coil spacing (table 1). The EM31 has a depth of investigation of about 10 to 20 ft; the EM34-3 has a depth of investigation that ranges from 25 to 200 ft (McNeill, 1980). The coil spacing for the EM31 is fixed at 12.1 ft; coil spacings of 32.8, 65.6, and 131.2 ft can be selected with the EM34-3 instrument to allow for different depths of investigation. The coils can be placed in two orientations—horizontal (vertical dipole) and vertical (horizontal dipole)—at each spacing for a total of eight measurements from the two instruments. Soundings were made at 33 sites within the Verde River flood plain and at 3 sites on the terraced recent alluvium adjacent to the flood plain (fig. 2) using multiple coil orientations and spacings for the soundings (table 1); the larger coil spacings and vertical dipoles provide information from greater depths. Data from the soundings were inversely modeled for subsurface electrical layers using commercially available EMIX 34 PLUS software (Interpex Limited, 1994).

Table 1. Depths of investigation for EM31 and EM34-3 at various coil spacings and orientations

	Depth of investigation (feet)	
Coil spacing (feet)	Horizontal dipole	Vertical dipole
12.1	9.8	19.7
32.8	24.6	49.2
65.6	49.2	98.4
131.2	98.4	196.9

The VES uses a direct-current electrical field that flows between two electrodes inserted into the ground. The resulting potential field is measured using two other electrodes that are inserted in the ground colinear with the current electrodes. Resistivity is calculated using Ohm’s law and a geometric factor that is based on electrode spacing. To conduct a vertical sounding, the spacing between electrodes is increased so that the resistivity of deeper materials can be measured. A VES results in several measurements of resistivity at successively greater electrode spacings. Two VESs were done for this study (fig. 2) using spacings between distant electrodes that ranged from 2,625 to 3,937 ft. These spacings provided a depth of investigation of about 500 to 700 ft.

Water-Level Monitoring

Water levels were monitored periodically at all drive-point wells installed for this study to determine the directions of ground-water flow. Water levels also were compared to the stage of the Verde River at a nearby staff gage (fig. 2) to determine the hydraulic relation between ground water and surface water. Data are stored in the U.S. Geological Survey's Ground-Water Site Inventory (GWSI) System database.

WATER QUALITY

The quality of the Verde River water entering the reservation at the northern boundary and of ground water in the shallow stream-channel deposits beneath the flood plain on the west bank of the river generally is good, and the water is suitable for most purposes. Five organic compounds were detected in the surface-water samples; however, concentrations of these compounds were below the MCLs. The presence of these organic compounds indicate that the water quality has been affected by anthropogenic activities. A table of all constituents and measured concentrations are included in the Basic Data section at the back of the report.

Surface Water

Six surface-water samples were collected between January 1998 and August 1999. Dissolved-oxygen concentrations were near 100 percent saturation in most of the samples and varied seasonally, ranging from 9.1 to 11.3 mg/L in the winter and spring and from 5.8 to 7.9 mg/L in the summer (table 2). The concentration in only one sample (5.8 mg/L) was less than the minimum State of Arizona Water Quality Standard for "Aquatic and Wildlife warm water" (6.0 mg/L). Algae was observed along the banks and on submerged cobbles during most visits. E. coli and fecal coliform bacteria, indicators of the presence of animal waste products, were detected in August 1998 at 6 and 77 colonies per 100 mL of water, respectively (**table 4** in the section entitled "Basic Data" at the back of the report). These concentrations are above the Federal drinking-water standards but below the State of Arizona Water Quality Standards for surface water (table 2). Fecal streptococci, also an indicator of the presence of animal-waste products, was detected at concentrations that ranged from 11 to 80 colonies per 100 mL of water. Field values of pH varied from 8.3 to 8.6; one value (8.6) exceeded the SMCL of 8.5.

Table 2. Concentrations of selected constituents in samples from the Verde River at the northern boundary of the Fort McDowell Indian Reservation, Arizona. Six samples were collected from January 1998 to August 1999

[Values are in milligrams per liter unless otherwise noted; MCL, Maximum Contaminant Level; SMCL, Secondary Maximum Contaminant Level; A&Ww, Aquatic and Wildlife warm water; DWS, Domestic Water Source; FC, Fish Consumption; FBC, Full Body Contact; AgI, Agricultural Irrigation; AgL, Agricultural Livestock Watering; na, not applicable; >, greater than; <, less than]

Constituent or chemical characteristic	Range	U.S. Environmental Protection Agency		State of Arizona Water Quality Standards[2]					
		MCL[1]	SMCL[1]	A&Ww	DWS	FC	FBC	AgI	AgL
Dissolved oxygen	5.8–11.3	na	na	>6.0	na	na	na	na	na
pH (standard units)	8.3–8.6	na	6.5–8.5	6.5–9.0	5.0–9.0	na	6.5–9.0	4.5–9.0	6.5–9.0
Manganese	0.003–0.012	na	0.05	na	4.9	na	19.6	19.6	10.0
Chloride	7–24	na	250	na	na	na	na	na	na
Sulfate	14–61	na	250	na	na	na	na	na	na
Fluoride	0.24–0.39	4.0	2.0	na	4.0	na	8.4	na	na
Nitrate	<0.05	10	na	3[3]	na	na	na	na	na
Phosphorous	0.03–0.011	na	na	1[3]	na	na	na	na	na
Arsenic (µg/L)	10–13	0.05[4]	na	0.19	0.05	1.45	0.05	2.0	0.2

[1]U.S. Environmental Protection Agency (1996).
[2]Arizona Department of Environmental Quality (1996).
[3] State of Arizona water quality standard for the Verde River; standards for designated uses are not specified, Arizona Department of Environmental Quality (1996).
[4]U.S. Environmental Protection Agency set a new MCL of 0.01 milligrams per liter on January 22, 2001 (U.S. Environmental Protection Agency, accessed July 3, 2001).

Dissolved-solids concentrations and specific-conductance values ranged from 176 to 350 mg/L and from 313 to 613 µS/cm, respectively.

Major Ions and Nutrients

Concentrations of regulated major ions in surface-water samples were varied but generally low: most concentrations were well below all standards (table 2). The surface water is a calcium magnesium bicarbonate type on the basis of the relative proportions of the major ions (fig. 3).

Nutrient concentrations were very low. Nitrate concentrations did not exceed the detection limit of 0.05 mg/L, and phosphorus concentrations ranged from 0.03 to 0.011 mg/L.

Organic Compounds

Six VOCs were detected in surface-water samples; however, concentrations of these VOCs were low. Chloroform (0.007–0.009 µg/L), chloroethane (0.045 µg/L), methylchloride (0.098 µg/L), and 1,4-dichlorobenzene (0.022–0.073 µg/L) are chlorinated hydrocarbons that can be formed by the reaction of chlorine with naturally occurring organic matter. The other VOCs detected were toluene (0.009 µg/L), a petroleum product, and methyl tert-butyl ether (0.182 µg/L), a petroleum additive. The concentrations of these compounds were well below the minimum applicable State of Arizona Water Quality Standards for Surface Water and the USEPA MCLs (100 µg/L for total trihalomethanes, 5 µg/L for benzene compounds, and 180 µg/L for toluene compounds). Surface-water samples were analyzed for 87 pesticide compounds. Only one pesticide byproduct, carbondisulfide, was detected (0.008 µg/L). Concentrations of all organic compounds were below laboratory calibration standards; therefore, the concentrations are considered to be estimates. The presence of these organic compounds, however, indicates that the water has been affected by anthropogenic activities.

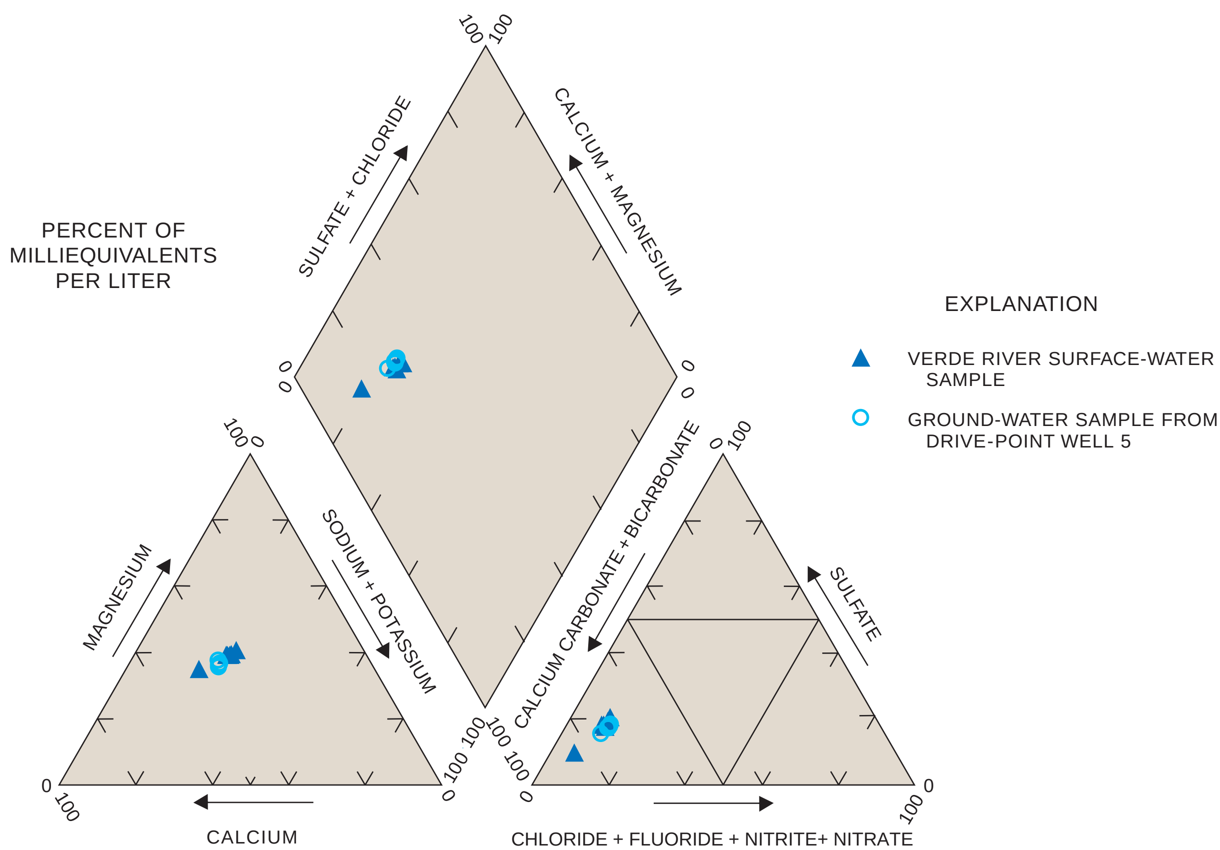


Figure 3. Relative concentrations of major ions in surface-water and ground-water samples, northern boundary area, Fort McDowell Indian Reservation, Arizona.

Metals

Concentrations of all trace metals analyzed were below the minimum applicable State of Arizona Water Quality Standards for Surface Water and USEPA MCLs. Arsenic concentrations ranged from 10 to 13 µg/L (**table 2**). Although these arsenic concentrations were below the MCL in effect at the time of collection and analysis, on January 22, 2001, the USEPA set a new MCL of 10 µg/L (U.S. Environmental Protection Agency, accessed July 3, 2001). The source of arsenic in the samples is likely to be oxidized arsenic compounds that typically are found in basin-fill sediments in southern Arizona (Robertson, 1991).

Suspended Sediment

Suspended sediment is not regulated but commonly is measured to estimate sediment loads carried in streams. Previous studies have shown that materials having large surface areas, such as suspended sediments, are the main sites for sorption of trace inorganic constituents (Horowitz and Elrick, 1987). Suspended-sediment concentrations in this study ranged from 9 to 21 mg/L, (**table 4** in the section entitled “Basic Data” at the back of the report). Daily suspended sediment load is estimated to range from 1.9 to 18 tons per day on the basis of sediment concentrations and flow rates of the Verde River. Suspended sediments were not analyzed for sorbed chemical constituents.

Ground Water

Five samples were collected from August 1998 to August 1999. There was no apparent seasonal variation of physical or chemical characteristics measured in the field. Dissolved-oxygen concentrations ranged from 0.7 to 2.1 mg/L (10 to 25 percent saturation; table 3). Bacteria counts for E. coli, total fecal coliform, and fecal streptococci were less than 1 colony per 100 mL of water. Values of pH varied from 7.2 to 7.4. Dissolved-solids concentrations were higher than those in the surface water and ranged from 328 to 372 mg/L but were below the USEPA SMCL of 500 mg/L. Specific conductance ranged from 566 to 654 µS/cm.

Major Ions and Nutrients

Overall, concentrations of major ions in ground water were similar to concentrations in surface water (**fig. 3**, tables 2–5). Concentrations of some constituents, however, such as chloride and sulfate, were slightly higher than concentrations of these ions in surface water but were still below the USEPA SMCLs. The ground water is a calcium magnesium bicarbonate type on the basis of the relative proportions of the major ions (fig. 3).

Table 3. Concentrations of selected constituents in ground-water samples from the stream-channel deposits beneath the Verde River flood plain, northern boundary area, Fort McDowell Indian Reservation, Arizona

[Values are in milligrams per liter unless noted otherwise; na, not applicable; <, less than]

Constituent or chemical characteristic	Concentration (range)	U.S. Environmental Protection Agency: Maximum Contaminant Level	U.S. Environmental Protection Agency: Secondary Maximum Contaminant Level
Dissolved oxygen	0.7–2.1	na	na
pH (standard units)	7.2–7.4	na	6.5–8.5
Manganese	<0.003–0.108	na	0.05
Iron	<0.010–0.19	na	0.3
Fluoride	0.39–0.46	4.0	2.0
Arsenic (µg/L)	6–9	0.05[1]	na
Chloride	19–25	na	250
Sulfate	43–58	na	250
Dissolved solids	328–372	na	500

[1]U.S. Environmental Protection Agency set a new MCL of 10 micrograms per liter on January 22, 2001 (U.S. Environmental Protection Agency, accessed July 3, 2001).

Nutrient concentrations in the ground-water samples also were slightly higher than concentrations in the surface-water samples. The highest nitrogen concentration measured was only 0.55 mg/L in August 1999. Phosphorus concentrations ranged from 0.005 to 0.014 mg/L.

Organic Compounds

Only one VOC (1,4-dichlorobenzene) was detected in ground-water samples (**table 5**, in the section entitled “Basic Data” at the back of the report). 1,4-dichlorobenzene is a chlorinated hydrocarbon that can be formed by the reaction of chlorine with naturally occurring organic matter. The concentration of this compound was estimated at 0.066 μg/L, which is well below the USEPA MCL (100 μg/L) and below laboratory calibration standards. None of the 87 pesticide compounds and byproducts for which the samples were analyzed were detected.

Metals

Metal concentrations in ground-water samples were similar to those in surface-water samples. Concentrations of some constituents, however, such as arsenic, barium, and boron, were slightly lower in the ground-water samples. With the exception of iron and manganese, all metal concentrations were below the applicable USEPA MCLs or SMCLs (**table 3**). The highest levels of iron and manganese were detected in the samples collected in June and August 1999. This could be a result of a change in collection method and (or) because of oxidation of the metal pipe used in the drive-point well. In June 1999, the submersible pump could not be used for sample collection because the water level had dropped below a constriction in the drive-point well. In both June and August, therefore, samples from drive-point well NB5 were collected using a peristaltic pump and 1/4-inch silicone tubing.

Arsenic concentrations varied from 6 to 9 μg/L (table 3). Although these concentrations were below the MCL at the time of collection and analysis, they are near the new USEPA MCL of 10 μg/L (U.S. Environmental Protection Agency, accessed July 3, 2001). The source of arsenic likely is oxidized compounds that are typically found in basin-fill sediments (Robertson, 1991).

SURFACE-WATER INFLOW

Average Annual Inflow Estimates

Between 1962 and 1999, average annual discharge at the Verde River below Bartlett Dam streamflow-gaging station averaged 667 ft^3/s and ranged from 169 to 2,545 ft^3/s (**fig. 4**a). At the Verde River near Scottsdale station, discharge averaged 651 ft^3/s and ranged from 152 to 2,522 ft^3/s over the same period. Although the difference between average annual discharge at these stations is 16 ft^3/s, annual discharge at the Verde River below Bartlett Dam typically is about 30 ft^3/s greater (fig. 4b). The greater annual discharge at the Verde River below Bartlett Dam results from removal of water from surface-water diversions, pumpage from shallow wells, evapotranspiration, and (or) movement of water into underlying aquifers between the gaging stations. Assuming the loss of flow between the stations is linear over the 21.5 river miles, the average loss is about 1.4 ft^3/s per river mile. For some years, however, the annual average discharge at the Verde River near Scottsdale has been as much as 91 ft^3/s higher than at Bartlett Dam (fig. 4b). Higher annual discharge at the Verde River near Scottsdale occurred during years of high precipitation (fig. 4c) in which overland runoff occurred and water was contributed by tributaries, such as Sycamore Creek, between these gages. For years in which rainfall is less than about 20 in. at the Stewart Mountain rain gage, average annual flow onto the reservation at the northern boundary is estimated to be about 13 ft^3/s less than at the Verde River below Bartlett Dam or about 17.5 ft^3/s more than at the Verde River near Scottsdale. This estimate is made under the assumption that the removal of water between the Verde River below Bartlett Dam and the Verde River near Scottsdale is a constant 1.4 ft^3/s per river mile. During years in which rainfall is more than 20 in., the average annual flow onto the reservation is more difficult to estimate because of uncertainties related to inputs from overland flow and tributaries.

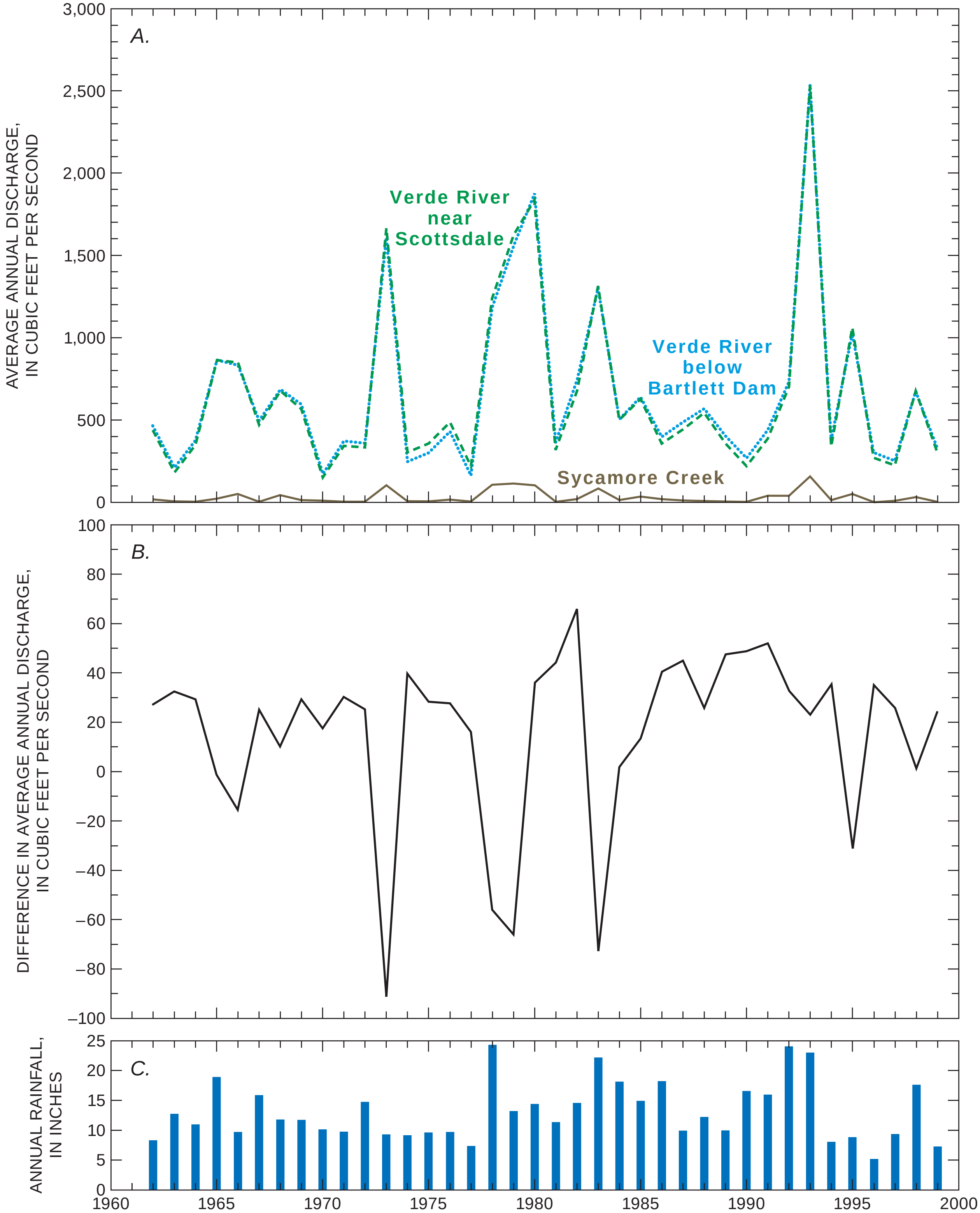


Figure 4. Average annual discharge and annual precipitation, northern boundary area, Fort McDowell Indian Reservation, Arizona. *A*, Average annual discharge at the Verde River below Bartlett Dam, the Verde River near Scottsdale, and Sycamore Creek near Fort McDowell, 1962–99. *B*, Difference in average annual discharge between the Verde River below Bartlett Dam and the Verde River near Scottsdale, 1962–99. *C*, Annual rainfall at Stewart Mountain rain gage, 1962–99.

Average Daily Inflow Estimates

Average daily discharge data from 1962 through 1999 show that discharges at the Verde River below Bartlett Dam and the Verde River near Scottsdale typically vary from December through April and are more stable from May through November (**fig. 5**a). The large and often short-lived winter and spring discharges bias the calculated average value; therefore, the median of the average daily discharge is shown on figure 5b for comparison. The effect of the large, short-lived discharges become less apparent in the plot of the median value. The differences in the average daily discharge and the median of the average daily discharge between the two gages are shown in figures 5c and 5d, respectively. These differences are most variable and greatest from December through April (fig. 5c) and can be either positive (greater discharge at the Verde River below Bartlett Dam) or negative (greater discharge at the Verde River near Scottsdale). This large variation in discharge from December through April makes it difficult to predict inflow onto the reservation for this period on the basis of flow at these stations. Differences in the average daily discharges between the two stations are most consistent from May through November. The differences generally are positive, average about 32 ft^3/s (a loss of 1.5 ft^3/s per river mile), and typically are less than 75 ft^3/s (a loss of 3.5 ft^3/s per river mile). During the months of May through November, therefore, the average daily discharge onto the reservation, assuming a loss of water at a rate of 1.5 ft^3/s per river mile, is estimated to be about 13.5 ft^3/s less than that at the Verde River below Bartlett Dam or 18.7 ft^3/s more than that at the Verde River near Scottsdale.

Instantaneous Inflow Estimates

Nine discharge measurements were made on the Verde River at the northern boundary between January 1998 and August 1999; discharge ranged from 78 to 677 ft^3/s. The relation of measured discharge at the northern boundary to discharge at the Verde River below Bartlett Dam, the Verde River near Scottsdale, and Sycamore Creek near Fort McDowell is shown in **figure 6**. Inflow onto the reservation was calculated by adding the discharge value for the northern boundary to the discharge value for a diversion canal upstream from the discharge measurement site. This diversion typically removes about 25 ft^3/s from the river for the irrigation needs of the Fort McDowell Indian Community. Total inflow onto the reservation ranged from 102 to 704 ft^3/s at the time the nine discharge measurements were made (fig. 6).

The amount of flow in the Verde River below Bartlett Dam is controlled primarily by releases at Bartlett Dam. Timing of variations in discharge at the Verde River below Bartlett Dam and the Verde River near Scottsdale stations was used to estimate travel times between these gages. For flows of about 800 ft^3/s, travel times were about 7.5 hours; for flows less than 200 ft^3/s, travel times increased to 13 hours. Discharge was measured at the northern boundary of the reservation at mile 9 of the 21.5-mi reach that separates the two gages. Slope of the stream channel between the Verde River below Bartlett Dam and the northern boundary is 10 ft/mi. Slope of the stream channel between the northern boundary and the Verde River near Scottsdale is 12.5 ft/mi. Travel time from the Verde River below Bartlett Dam station to the northern boundary is therefore estimated to be about half the travel time from the Bartlett Dam station to the Verde River near Scottsdale station. Discharges at the Verde River below Bartlett Dam and the Verde River near Scottsdale were adjusted for travel times before being compared with inflow at the northern boundary.

Inflow at the northern boundary has a strong correlation to the discharge at the Verde River below Bartlett Dam and to the discharge at the Verde River near Scottsdale. For example, inflows at the northern boundary that range from 102 to 704 ft^3/s (**fig. 7**a) correlate with time-corresponding discharges at the Verde River below Bartlett Dam; the correlation coefficient (R^2) was 0.991. Instantaneous inflows at the northern boundary can be estimated using the equation:

instantaneous inflow = 0.861(instantaneous discharge at the Verde River below Bartlett Dam) + 20 ft^3/s.

The correlation between flow at the northern boundary and flow at the Verde River below Bartlett increases when flows of less than 523 ft^3/s at the northern boundary are considered (fig. 7a).

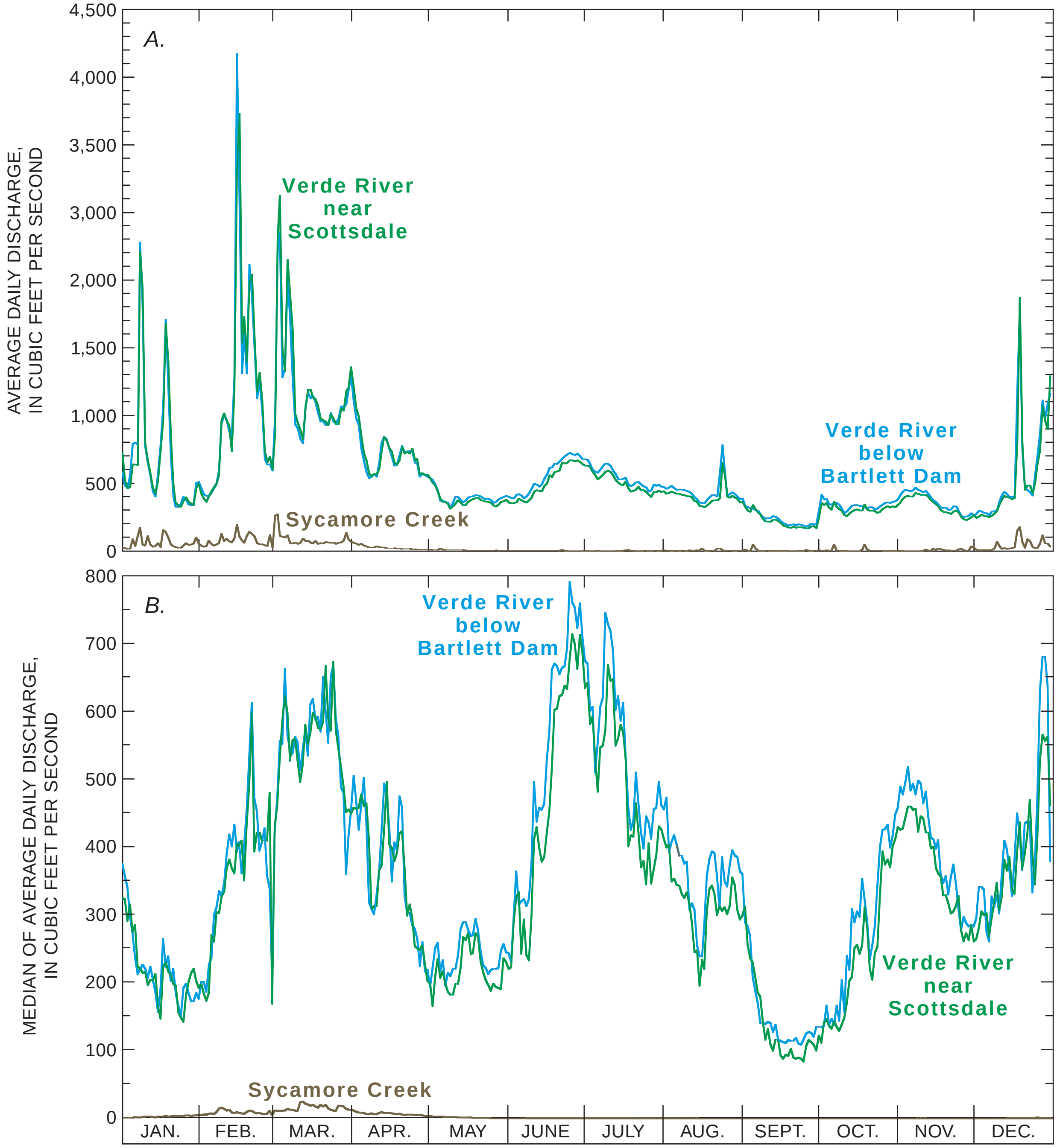


Figure 5. Average and median daily discharge, northern boundary area, Fort McDowell Indian Reservation, Arizona. *A*, Average daily discharge at the Verde River below Bartlett Dame, the Verde River near Scottsdale, and Sycamore Creek near Fort McDowell, 1962–99. *B*, Median daily discharge at the Verde River below Bartlett Dam, the Verde River near Scottsdale, and Sycamore Creek near Fort McDowell, 1962–99. *C*, Difference in average daily discharge between the Verde River below Bartlett Dam and the Verde River near Scottsdale, 1962–99. *D*, Difference in median daily discharge between the Verde River below Bartlett Dam and the Verde River near Scottsdale, 1962–99.

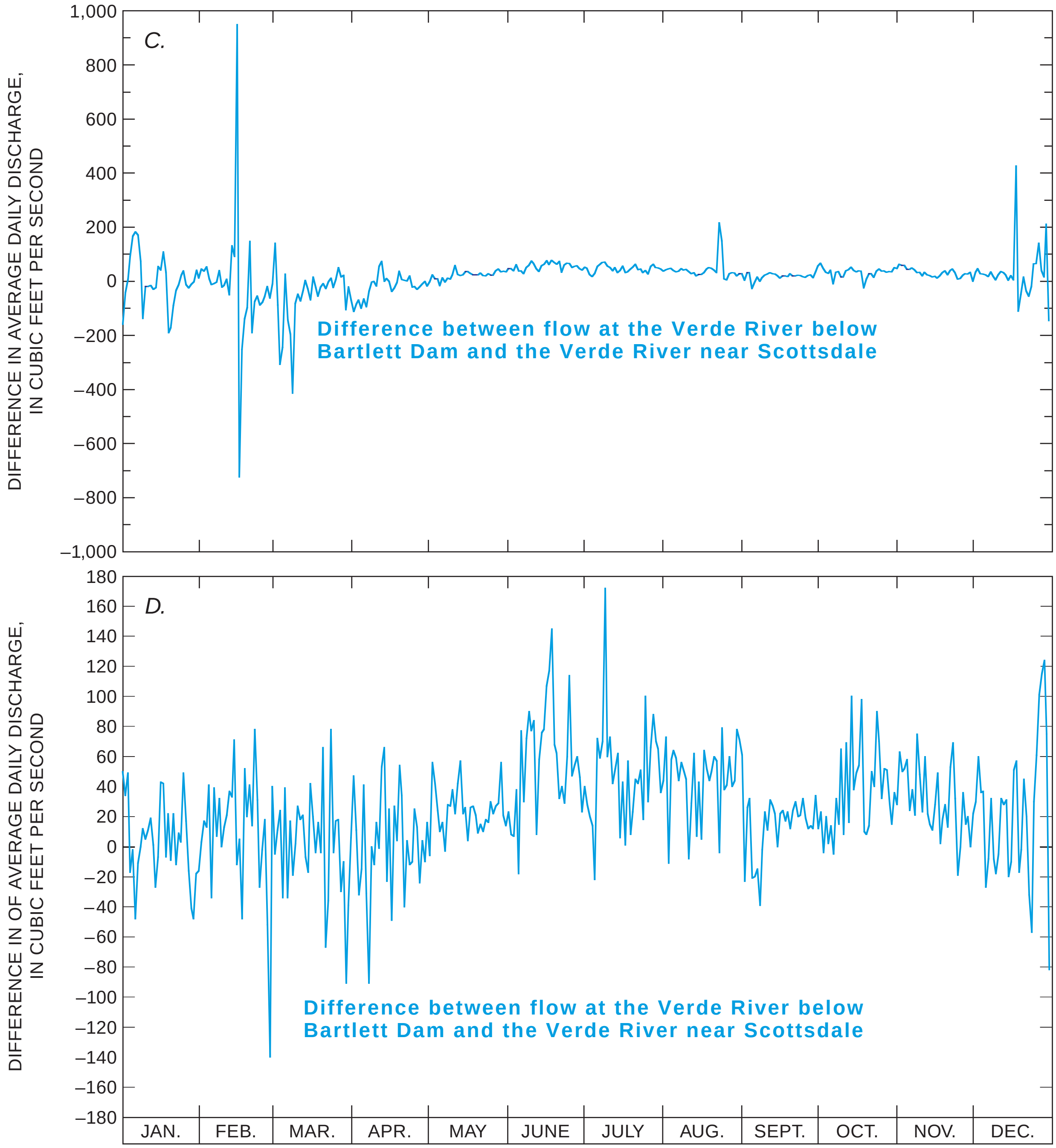


Figure 5. Continued.

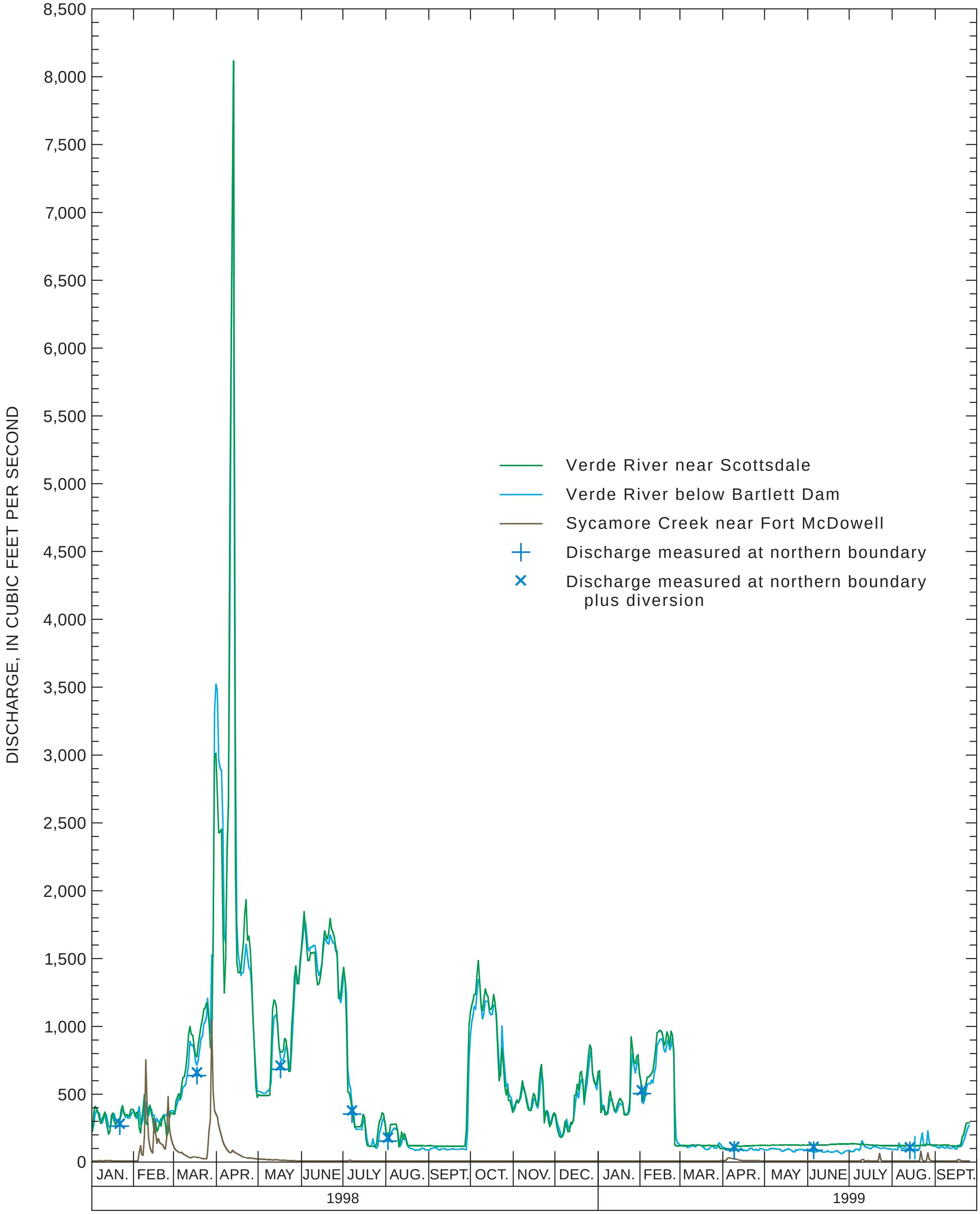


Figure 6. Discharge at the Verde River below Bartlett Dam, the Verde River near Scottsdale, Sycamore Creek near Fort McDowell, and discharge measurements on the Verde River at the northern boundary, Fort McDowell Indian Reservation, Arizona, 1998–99.

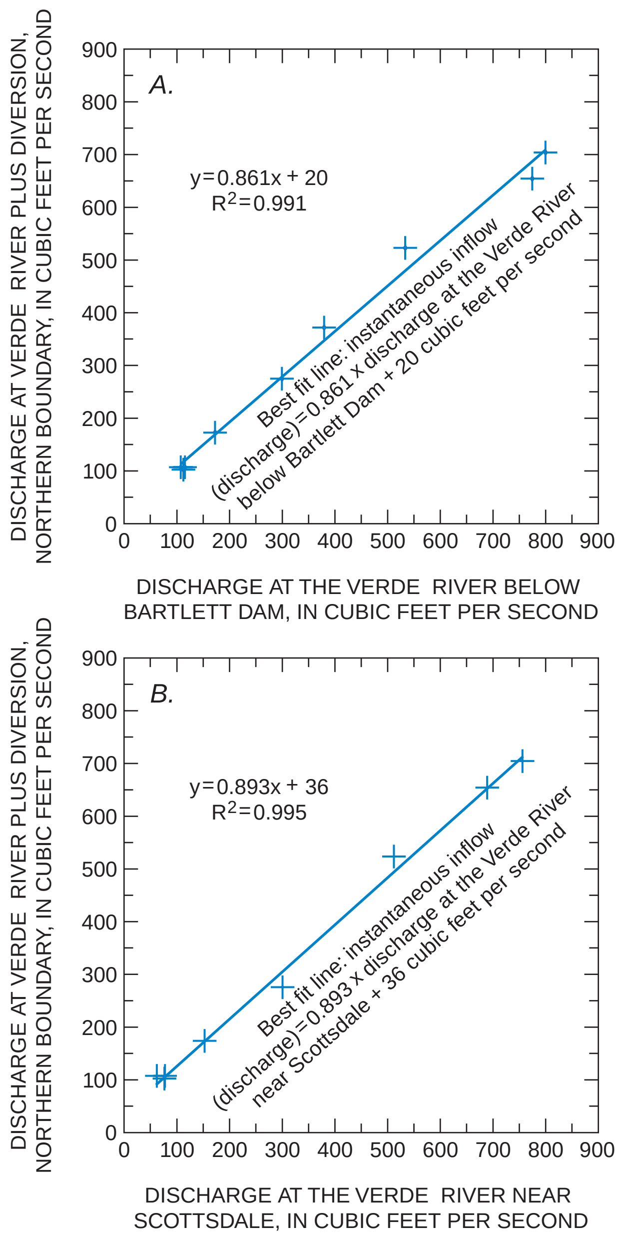


Figure 7. Relation between discharge of the Verde River at the northern boundary of Fort McDowell Indian Reservation and discharge below Bartlett Dam and near Scottsdale. *A*, Below Bartlett Dam. *B*, Near Scottsdale.

The correlation coefficient between inflow measurements and time-corresponding discharges at the Verde River near Scottsdale also is large (0.995; fig. 7b). Inflows at the northern boundary can be estimated using the equation:

$$\textit{instantaneous inflow} = 0.893(\textit{discharge at the Verde River near Scottsdale}) + 36\ ft^3/s.$$

These regression equations were developed using discharge measurements that ranged from 102 to 704 ft^3/s at the northern boundary. Consequently, predictions for flows onto the reservation outside this range (102–704 ft^3/s) may be less accurate.

GROUND-WATER INFLOW

Ground-water inflow at the northern boundary through the Verde River stream-channel deposits is minor compared to the flow of the Verde River onto the reservation. Ground-water inflow was estimated using water-level gradients between drive-point wells and the estimated thickness of the stream-channel deposits. Periodic water-level measurements made at all nine drive-point wells, combined with surface-water elevation surveys along the west bank of the Verde River, indicate that ground water flows south approximately parallel to the river (**fig. 8**) at a gradient of about 0.006. Although flow is roughly parallel to the river, a small component of ground water flows into the river when the ground-water levels and river stage are relatively low—river stage of less than about 5 ft above local datum; in contrast, when ground-water levels and river stage are relatively high—river stage greater than 5 ft above local datum—water flows from the river into the stream-channel deposits. Water levels in the drive-point wells respond to variations in river stage (**fig. 9**); however, the gradient between drive-point wells remains relatively consistent.

The thickness of the stream-channel deposits was estimated by using modeled EM and VES soundings along the flood plain of the river. A two-layer model was simulated; the upper layer represented stream-channel deposits and (or) recent alluvium and the lower layer represented the finer-grained basin-fill sediments. Results of the EM and VES models are shown in **figures 10** and **11**. The uppermost model layer representing the saturated stream-channel deposits has a resistivity that ranges from 68 to 455 ohm•m and averages 115 ohm•m (fig. 10 and 11). Sediments probably become finer with increasing distance from the river as indicated by decreasing resistivity values in the westward direction from the river. The most resistive sediments are south of the current stream channel in an abandoned channel that dates prior to 1993. Thickness of the saturated stream-channel deposits beneath the flood plain is estimated to range from 41 to 68 ft (fig. 10) and averages about 54 ft.

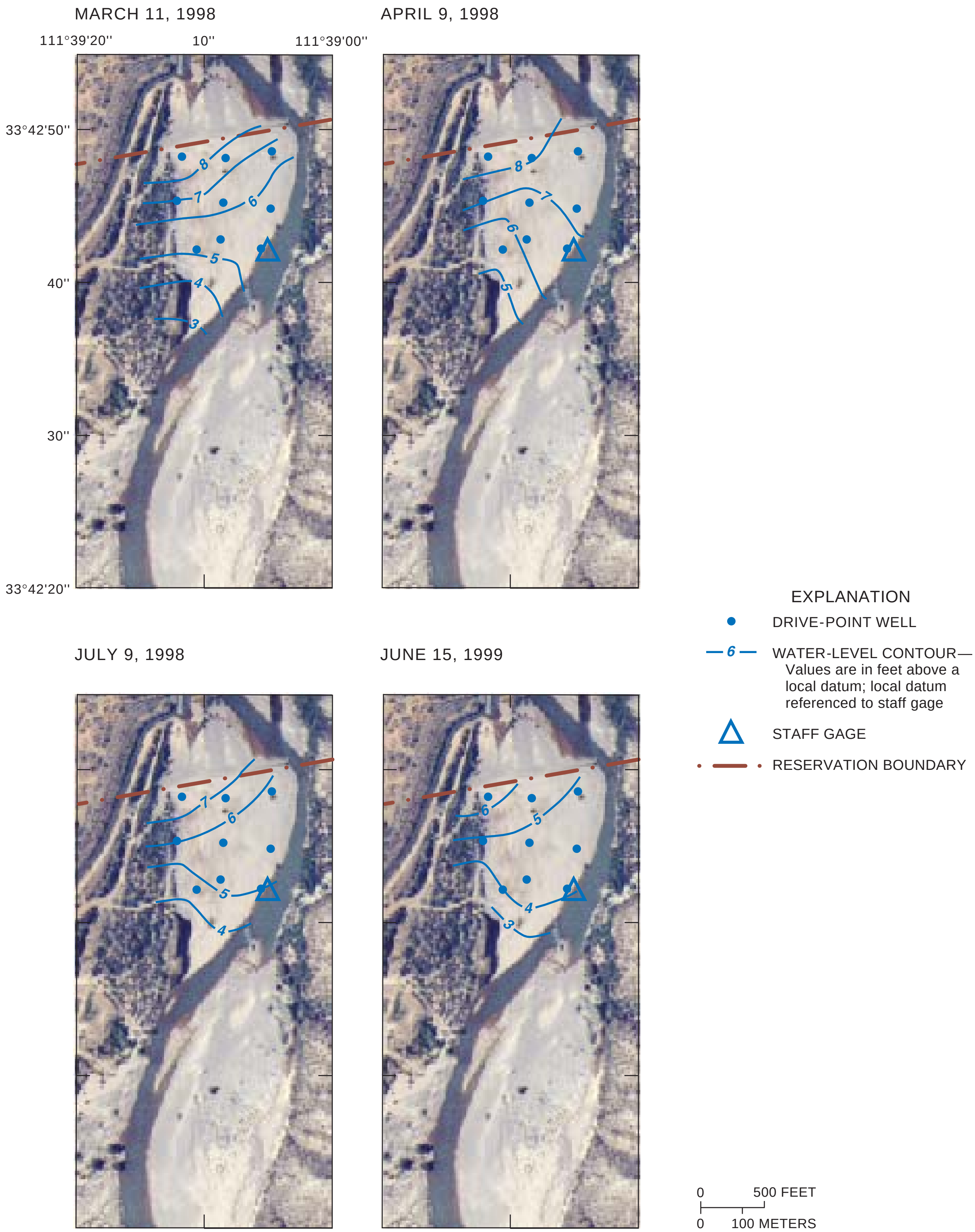


Figure 8. Altitude of the water table in the stream-channel deposits beneath the Verde River flood plain, northern boundary area, Fort McDowell Indian Reservation, Arizona.

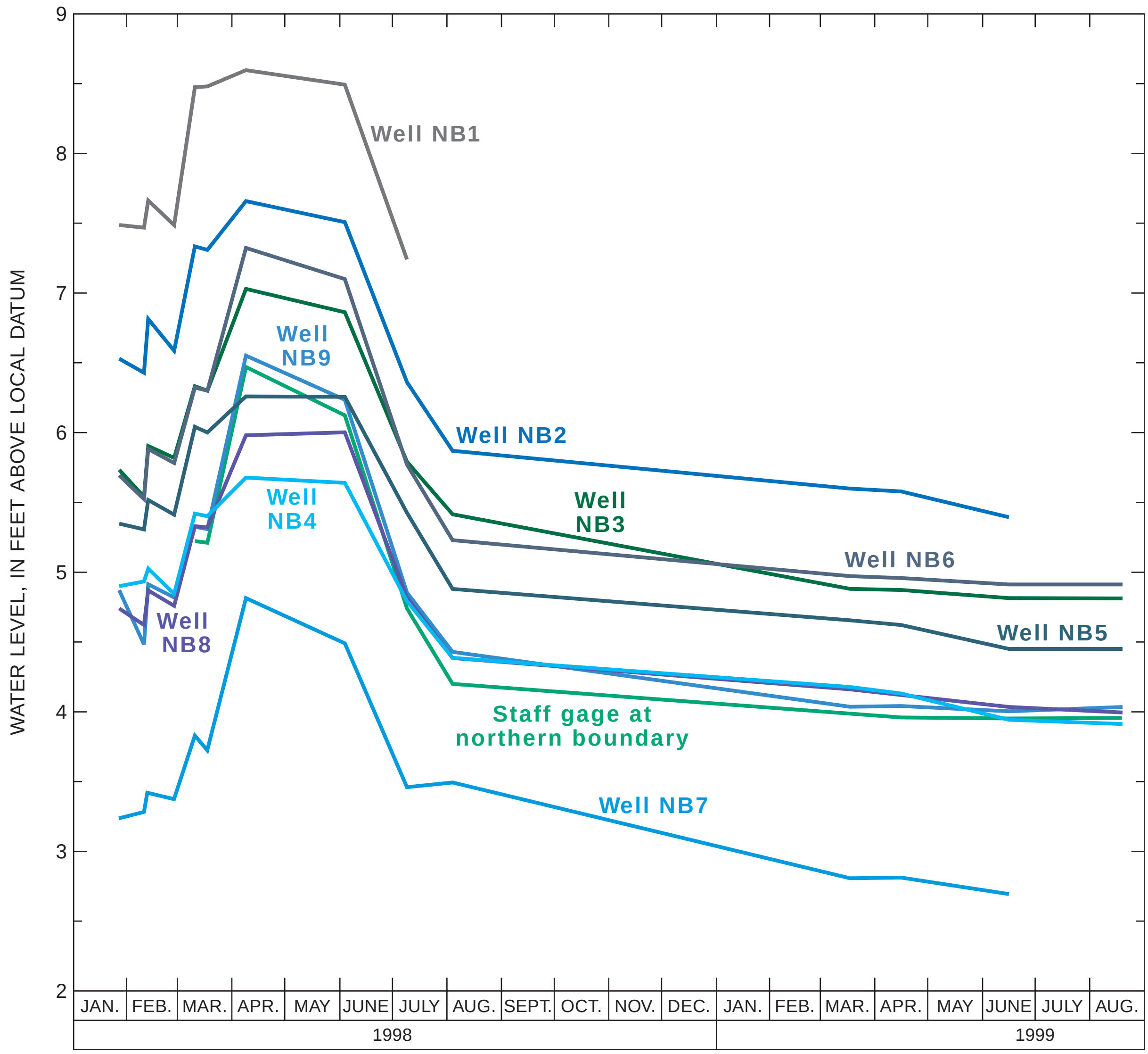
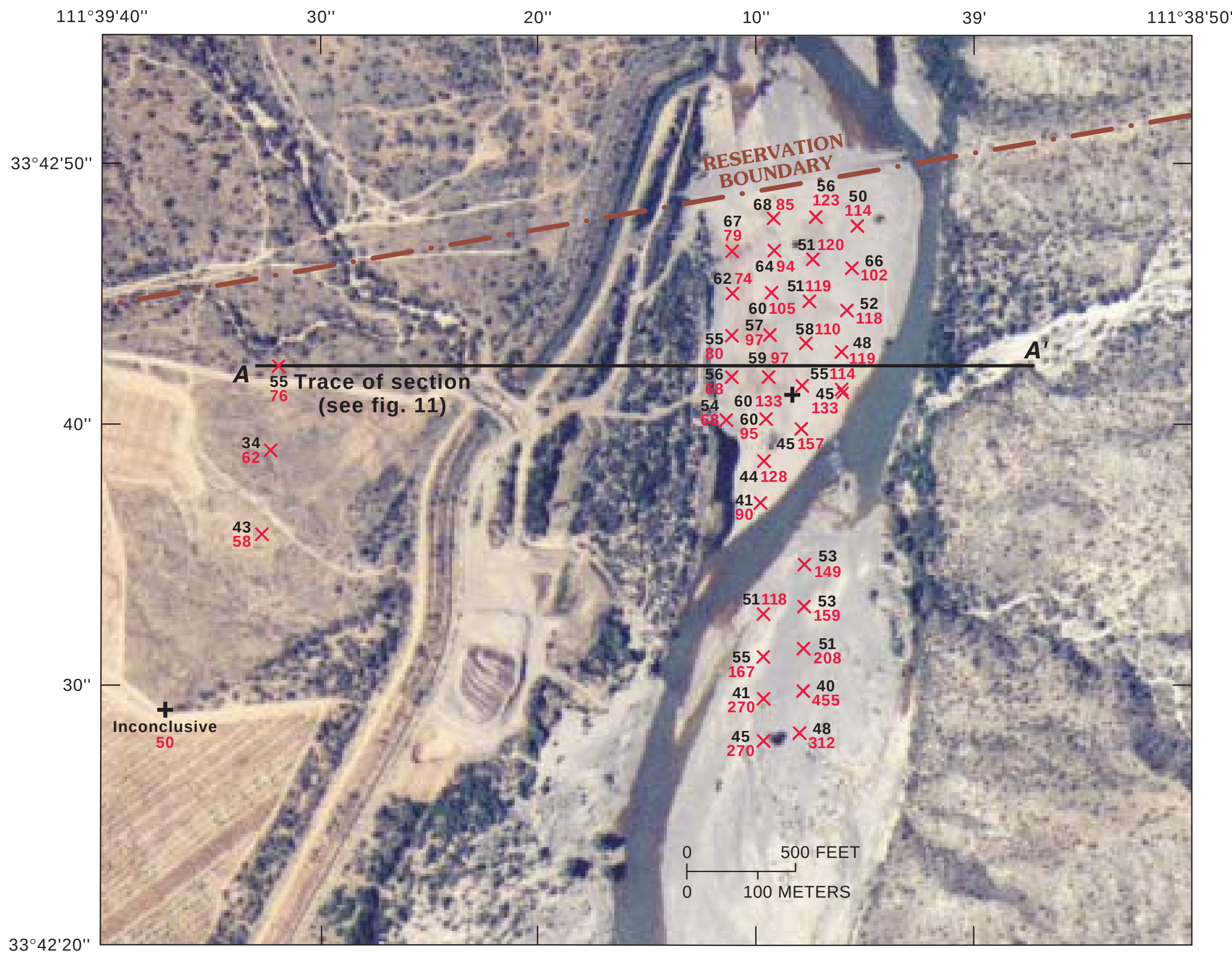


Figure 9. Altitude of the water table in drive-point wells completed in the stream-channel deposits beneath the Verde River flood plain and stage of the Verde River, northern boundary area, Fort McDowell Indian Reservation, Arizona, 1998–99.



(Aerial photograph by Kenney Aerial Mapping Company, 1995)

EXPLANATION

× ELECTROMAGNETIC (EM) SOUNDING

✚ RESISTIVITY (VES) SOUNDING

55
76
BLACK NUMBER REPRESENTS ESTIMATED THICKNESS OF SATURATED STREAM-CHANNEL DEPOSITS AND RECENT ALLUVIUM, IN FEET. RED NUMBER IS MODELED LAYER 1 RESITIVITIES, IN OHM METERS

Figure 10. Apparent resistivity and estimated thickness of deposits beneath the Verde River flood plain, northern boundary area, Fort McDowell Indian Reservation, Arizona.

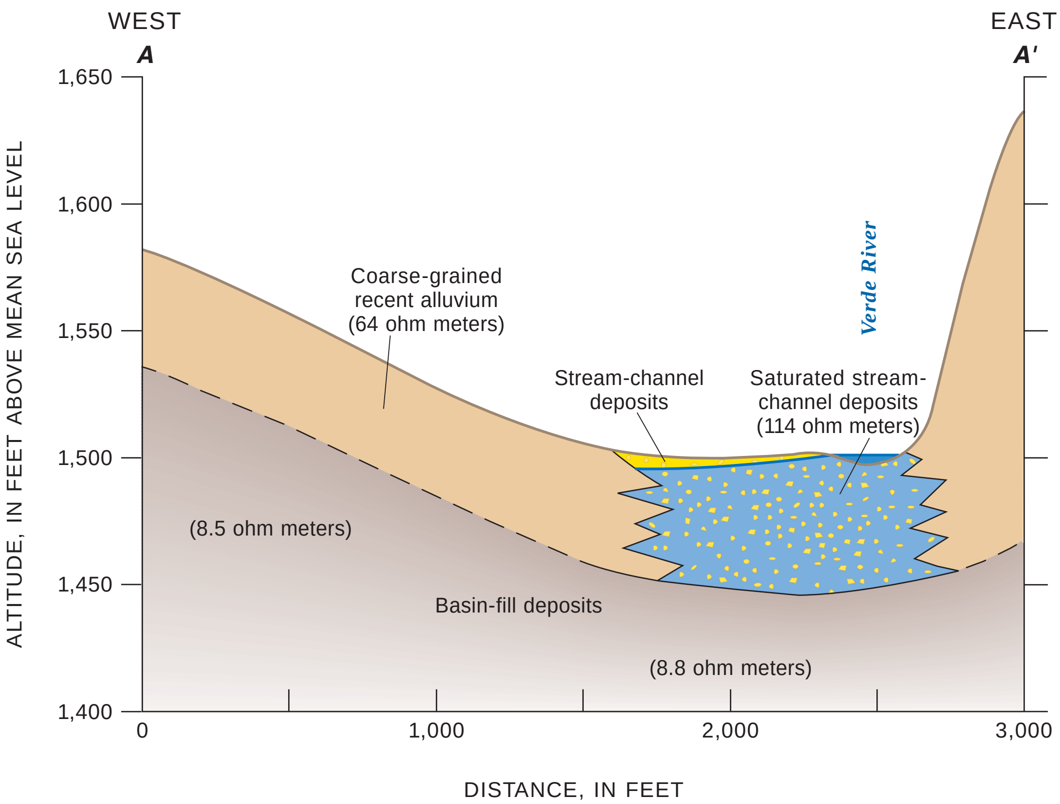


Figure 11. Generalized geologic section showing thickness and resistivity of stream-channel deposits, coarse-grained recent alluvium, and underlying basin-fill deposits (see figs. 2 and 10 for trace of section), northern boundary area, Fort McDowell Indian Reservation, Arizona.

Resistivity of the recent alluvium adjacent to the stream-channel deposits averages 64 ohm•m (fig. 11). The lower model layer, which probably represents basin-fill deposits, has a resistivity that ranges from 6 to 12 ohm•m and averages about 9 ohm•m (fig 11).

Although aquifer-test data are not available, hydraulic conductivity of the stream-channel deposits is estimated to be about 300 ft/d. This value is within the range of values derived from other studies of alluvial basins in southern Arizona (Anderson and others, 1992)—200 to 400 ft/d for stream alluvium and 30 to 90 ft/d for basin-fill deposits. The saturated thickness of the stream-channel deposits averages about 54 ft (fig. 11). The saturated width of the stream-channel deposits is about 1,000 ft on the basis of the flood-plain geometry (fig. 11). Thus, the saturated cross-sectional area is about 54,000 ft^2 (average saturated thickness multiplied by saturated width).

The inflow of ground water onto the reservation through the stream-channel deposits was calculated using Darcy's Law to be about 97,200 ft^3/d (1.1 ft^3/s).

$$Q = KIA,$$

where

Q = flux of ground water, in ft^3/d;

K = hydraulic conductivity, in ft/d (300 ft/d);

I = hydraulic gradient (0.006 ft/ft)

A = cross-sectional area of flow, in ft^2 (54,000 ft^2).

Ground-water flow probably ultimately discharges into the Verde River. The average annual discharge in the Verde River is 675 ft^3/s (Tadayon and others, 1999) on the basis of 111 years of record at the Verde River below Bartlett Dam. Flux of ground water to the river through the stream-channel deposits, therefore, is minor compared to the discharge of the river.

SUMMARY

The Fort McDowell Yavapai Nation relies on the Verde River for agricultural, recreational, and domestic water supplies. The river is home to many types of aquatic life, and supports dense riparian vegetation on the adjacent flood plain, which serves as habitat for many types of wildlife. The demand for the river water for agricultural and domestic purposes has increased in recent years. Water for agricultural use is diverted directly from the river and also is withdrawn from wells that are connected hydraulically with the river. Increased agricultural and recreational activities and recent population growth within the Verde River basin have led to concerns about the quality and quantity of surface water and ground water flowing onto the reservation at its northern boundary. The Verde River enters the reservation at the northern boundary and bisects the reservation. This study determined the quality and quantity of surface and ground water flowing onto the reservation and developed an empirical relation to estimate flow onto the reservation on the basis of nearby continuous-recording streamflow-gaging stations.

The quality of surface water entering the reservation at the northern boundary through the Verde River is good, and the water is suitable for most uses. Dissolved-oxygen concentrations varied seasonally, ranging from 5.8 to 11.3 mg/L, and were near 100 percent saturation in most of the samples. The concentration in only one sample (5.8 mg/L) was less than the minimum State of Arizona Water Quality Standard for “Aquatic and Wildlife warm water” (6.0 mg/L). Algae was seen along the banks and on submerged cobbles. E. coli and fecal coliform bacteria, indicators of the presence of animal-waste products, were only detected once (August 1998) and were measured at 6 and 77 colonies per 100 mL of water, respectively. Fecal streptococci, also an indicator of animal-waste products, were detected at concentrations of 11 to 80 colonies per 100 mL of water. Field values of pH ranged from 8.3 to 8.6; one value (8.6) exceeded the SMCL of 8.5. Dissolved-solids concentrations and specific conductance values were low, ranging from 176 to 350 mg/L and from 313 to 613 μS/cm, respectively. Concentrations of major ions, nutrients, and metals were low. Arsenic concentrations ranged from 10 to 13 μg/L, which are equal to or higher than the January 22, 2001 USEPA MCL of 10 μg/L. Concentrations of suspended sediment were low. Six organic compounds were detected in the surface water, but concentrations of these compounds were below the MCLs. The presence of these organic compounds indicate that the quality of the water has been affected by anthropogenic activities.

The quality of ground water in the stream-channel deposits beneath the flood plain on the west bank of the Verde River also is good, and the water is suitable for most uses. Concentrations of dissolved solids, major ions, and metals generally were similar to those in samples from the river. Total coliform and fecal streptococci were not detected; dissolved-oxygen concentrations were 10–25 percent of saturation values; and nutrient concentrations were low. One organic compound was detected in the ground water at a concentration below the laboratory calibration standard. Arsenic concentrations ranged from 6 to 9 μg/L.

Surface-water inflow onto the reservation was estimated using discharge measurements at the northern boundary and data from gaging stations at the Verde River below Bartlett Dam and at the Verde River near Scottsdale. During years in which rainfall is less than 20 in., the average annual discharge onto the reservation is about 13 ft^3/s lower than at the Verde River below Bartlett Dam or 17.5 ft^3/s higher than at the Verde River near Scottsdale. During years of high rainfall (greater than 20 in.), discharge at the Verde River near Scottsdale typically is higher than at the Verde River below Bartlett Dam. Under these conditions, reliable estimates of inflow at the northern boundary could not be made. For the months of May through November, average daily discharge onto the reservation also is about 13 ft^3/s lower than discharge at the Verde River below Bartlett Dam and 18.7 ft^3/s higher than discharge at the Verde River near Scottsdale. Discharge onto the reservation for December through April is less predictable because of large variations between discharges at the Verde River below Bartlett Dam and the Verde River near Scottsdale.

Correlation between nine discharge measurements at the northern boundary and discharges at the two streamflow-gaging stations is high; correlation coefficients were between 0.991 and 0.995. Inflows onto the reservation can be estimated using discharges at the Verde River below Bartlett Dam and the Verde River near Scottsdale using the equations:

$$\textit{instantaneous inflow} = 0.861(\textit{instantaneous discharge at the Verde River below Bartlett Dam}) + 20\ ft^3/s, \textit{ and,}$$

$$\textit{instantaneous inflow} = 0.893(\textit{instantaneous discharge at the Verde River near Scottsdale}) + 36\ ft^3/s$$

for discharges that range from 102 to 704 ft^3/s at the northern boundary.

Ground water flows onto the reservation approximately parallel to the flow of the Verde River. Ground water is a minor contributor to streamflow when the river stage is less than about 5 feet above the local datum. There is a minor component of flow from the river into the stream-channel deposits when the river stage is greater than about 5 feet above the local datum. Ground-water inflow onto the reservation through the Verde River stream-channel deposits is about 1.1 ft^3/s and is relatively minor compared to the average annual discharge of 675 ft^3/s in the Verde River.

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BASIC DATA

Table 4. Water-quality data for the Verde River at the northern boundary of Fort McDowell Indian Reservation, Arizona

[ft, feet; NGVD, National Geodetic Vertical Datum of 1929; μS/cm, microsiemens per centimeter at 25 degrees Celsius; deg. C, degrees Celsius; mg/L milligrams per liter, ac-ft, acre-feet; cols./100 mL, colonies per 100 milliliters; μg/L, micrograms per liter, t/d, metric tons per day; dashes indicate no data are available; K, non-ideal colony count; E, estimated; <, less than]

Date	Stream width (ft)	Gage height (ft)	Discharge, inst, (cubic feet per second)	Elevation of land surface datum (ft above NGVD)	Specific conductance (μS/cm)	pH standard units)	Temperature, water (deg. C)	Temper-ature, air (deg. C)	Barometric pressure (mm of Hg)
1-21-1998	---	---	254	1480	588	8.4	17.0	---	720
8-4-1998	---	4.20	150	1480	313	8.3	23.1	---	717
2-5-1999	168	5.00	500	1480	547	8.6	11.7	19.5	724
4-13-1999	104	3.96	82	1480	536	8.5	16.1	18.5	725
6-10-1999	71.0	---	79	1480	613	8.3	20.6	---	721
8-19-1999	102	3.95	78	1480	575	8.3	25.2	33.5	721

Date	Turbidity (severity)	Detergent suds (severity)	Suspended sediment (mg/L)	Suspended sediment, discharge (t/day)	Debris, floating (severity)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)	Oxygen demand, chemical (high level, mg/L)	Carbon dioxide, dissolved (mg/L as CO_2)
1-21-1998	---	--	---	---	---	11.3	124	<10	1.7
8-4-1998	---	--	---	---	---	5.8	85	---	---
2-5-1999	---	--	13	18	---	11.1	108	<10	---
4-13-1999	---	--	19	4.2	---	9.1	97	52	---
6-10-1999	1	--	21	4.5	1	7.9	94	---	---
8-19-1999	1	1	9	1.9	1	7.7	99	--	--

Date	Carbon, organic, total (mg/L as C)	Residue, total at 105 deg. C, suspended (mg/L)	Hardness, total (mg/L as $CaCO_3$)	Hardness, noncarbonate, dissolved as $CaCO_3$ (mg/L)	Alkalinity, field (mg/L as $CaCO_3$)	Solids, sum of constituents, dissolved (mg/L)	Solids, dissolved (tons per ac-ft)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)
1-21-1998	2.4	7	230	---	---	350	.48	43	31
8-4-1998	---	---	130	---	134	176	.24	30	14
2-5-1999	---	---	210	---	214	315	.43	41	27
4-13-1999	---	---	210	1	209	308	.42	41	26
6-10-1999	---	---	220	17	205	320	.44	43	28
8-19-1999	--	--	220	1	214	321	.44	41	27

Date	Sodium dissolved (mg/L as Na)	Sodium percent	Sodium adsorption ratio	Potassium, dissolved (mg/L as K)	Bicarbonate (mg/L as HCO_3)	Carbonate (mg/L as CO_3)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)
1-21-1998	37	25	1	2.7	---	---	61	24	---
8-4-1998	13	18	.5	1.9	154	5	14	7	.24
2-5-1999	30	23	.9	2.4	249	6.00	50	18	.34
4-13-1999	30	24	.9	2.5	238	8.00	49	19	.38
6-10-1999	33	24	1	2.6	240	5.00	52	21	.35
8-19-1999	33	25	1	2.7	254	4.00	49	21	.39

Table 4. Water-quality data for the Verde River at the northern boundary of Fort McDowell Indian Reservation, Arizona—Continued

Date	Bromide, dissolved (mg/L as Br)	Silica, dissolved (mg/L as SiO_2)	Nitrogen, ammonia + organic, dissolved (mg/L as N)	Nitrogen, ammonia + organic, total (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, organic, dissolved (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as NH_4)	Nitrogen, NO_2+ NO_3, dissolved (mg/L as N)	Nitrogen, nitrite, dissolved (mg/L as NO_2)
1-21-1998	---	17	---	<.1	<.02	---	---	<.05	.05
8-4-1998	.01	15	.12	---	.04	.1	.05	<.05	---
2-5-1999	.04	16	.11	---	<.02	---	---	<.05	---
4-13-1999	.05	15	.12	---	<.02	---	---	<.05	---
6-10-1999	.04	17	.13	---	<.02	---	---	<.05	---
8-19-1999	.05	18	.14	---	<.02	---	---	<.05	---

Date	Nitrogen, nitrite, dissolved (mg/L as N)	Phosphate, ortho, dissolved (mg/L as PO_4)	Phosphorus, dissolved (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Phosphorus, total (mg/L as P)	Aluminum, dissolved (μg/L as Al)	Antimony, dissolved (μg/L as Sb)	Arsenic, dissolved (μg/L as As)	Barium, dissolved (μg/L as Ba)
1-21-1998	.016	---	<.01	---	<.01	---	---	---	47
8-4-1998	<.01	.07	<.01	.02	---	<10.0	6	10	29
2-5-1999	<.01	---	.007	<.01	---	<10.0	<1	11	49
4-13-1999	<.01	.05	.005	.02	---	<10.0	<1	10	39
6-10-1999	<.01	.03	.009	.01	---	<10.0	<1	13	41
8-19-1999	<.01	.10	.011	.03	---	<15	<1	11	39

Date	Beryllium, dissolved (μg/L as Be)	Boron, dissolved (μg/L as B)	Cadmium, dissolved (μg/L as Cd)	Cadmium, total (μg/L as Cd)	Chromium, dissolved (μg/L as Cr)	Chromium, total recoverable (μg/L as Cr)	Cobalt, dissolved (μg/L as Co)	Copper, dissolved (μg/L as Cu)	Copper, total recoverable (μg/L as Cu)
1-21-1998	<1.0	---	<8	<1	<14	<1.0	<12	<10	2
8-4-1998	<1.0	67.4	<8	---	<14	---	<12	<10	---
2-5-1999	<1.6	129	<8	---	<14	---	<7	<10	---
4-13-1999	<1.6	124	<8	---	<14	---	<7	<10	---
6-10-1999	<1.6	139	<8	---	<14	---	<7	<10	---
8-19-1999	<1.6	144	<8	---	<14	---	<13	<10	---

Date	Cyanide, total (μg/L)	Iron, dissolved (μg/L as Fe)	Lead, dissolved (μg/L as Pb)	Lead, total recoverable (μg/L as Pb)	Lithium, dissolved (μg/L as Li)	Manganese, dissolved (μg/L as Mn)	Mercury, dissolved (μg/L as Hg)	Mercury, total recoverable (μg/L as Hg)	Molybdenum, dissolved (μg/L as Mo)
1-21-1998	---	<10	<100	<1	30	5	---	<.1	<60
8-4-1998	---	<10	<100	---	14	12	<.1	---	<60
2-5-1999	<.01	<10	<100	---	26	E3	<.1	---	<50
4-13-1999	<.01	<10	<100	---	22	7	<.1	---	<50
6-10-1999	---	<10	<100	---	27	5	<.1	---	<50
8-19-1999	---	<10	<100	---	29	9	<.1	---	<30

Table 4. Water-quality data for the Verde River at the northern boundary of Fort McDowell Indian Reservation, Arizona—Continued

Date	Nickel, dissolved (µg/L as Ni)	Nickel, total recoverable (µg/L as Ni)	Selenium, dissolved (µg/L as Se)	Selenium, total (µg/L as Se)	Silver, dissolved (µg/L as Ag)	Silver, total recoverable (µg/L as Ag)	Silver, unfiltered, total recoverable, EPA contract (µg/L as Ag)	Strontium, dissolved (µg/L as Sr)	Thallium, total (µg/L as Tl)
1-21-1998	<40	2	---	<1	<4	<1	<.001	720	<.01
8-4-1998	<40	---	<1	---	<4	---	---	330	---
2-5-1999	<40	---	<1	---	<4	---	---	610	---
4-13-1999	<40	---	1	---	<4	---	---	580	---
6-10-1999	<40	---	<1	---	<4	---	---	620	---
8-19-1999	<40	---	<1	---	<7	---	---	580	---

Date	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)	Zinc, total recoverable (µg/L as Zn)	Tritium, total (pCi/L)	Oil and grease, total recoverable (mg/L)	Phenols, total (µg/L)	2,6-Di-ethylaniline (µg/L)	Acetochlor (µg/L)
1-21-1998	<10	<20	<10	---	<1	1	---	---
8-4-1998	<10	<20	---	17	---	---	---	---
2-5-1999	E9	E9	---	---	<1	<4	<.003	<.002
4-13-1999	<10	<20	---	---	<1	9	<.003	<.002
6-10-1999	<10	<20	---	---	---	---	---	---
8-19-1999	<10	<20	---	---	---	---	---	---

Date	Alachlor, dissolved (µg/L)	Atrazine, dissolved (µg/L)	Methyl azinphos (µg/L)	Benfluralin (µg/L)	Butylate, dissolved (µg/L)	Carbofuran (µg/L)	Chlorpyrifos, dissolved (µg/L)	Cyanazine, dissolved (µg/L)	DCPA (µg/L)
1-21-1998	---	---	---	---	---	---	---	---	---
8-4-1998	---	---	---	---	---	---	---	---	---
2-5-1999	<.002	<.001	<.001	<.002	<.002	<.003	<.004	<.004	<.002
4-13-1999	<.002	<.001	<.001	<.002	<.002	<.003	<.004	<.004	<.002
6-10-1999	---	---	---	---	---	---	---	---	---
8-19-1999	---	---	---	---	---	---	---	---	---

Date	Deethyl atrazine, dissolved (µg/L)	Diazinon, dissolved (µg/L)	Dieldrin, dissolved (µg/L)	Disulfoton (µg/L)	EPTC (µg/L)	Ethal-fluralin (µg/L)	Ethoprop (µg/L)	Fonofos (µg/L)	Lindane (µg/L)
1-21-1998	---	---	---	---	---	---	---	---	---
8-4-1998	---	---	---	---	---	---	---	---	---
2-5-1999	<.002	<.002	<.001	<.017	<.002	<.004	<.003	<.003	<.004
4-13-1999	<.002	<.002	<.001	<.017	<.002	<.004	<.003	<.003	<.004
6-10-1999	---	---	---	---	---	---	---	---	---
8-19-1999	---	---	---	---	---	---	---	---	---

Table 4. Water-quality data for the Verde River at the northern boundary of Fort McDowell Indian Reservation, Arizona—Continued

Date	Linuron (μg/L)	Malathion, dissolved (mg/L)	Metolachlor, dissolved (mg/L)	Metribuzin sencor, dissolved (mg/L)	Molinate (mg/L)	Napropamide (mg/L)	Parathion, dissolved (mg/L)	Methyl parathion (mg/L)	Pebulate (mg/L)
1-21-1998	---	---	---	---	---	---	---	---	---
8-4-1998	---	---	---	---	---	---	---	---	---
2-5-1999	<.002	<.005	<.002	<.004	<.004	<.003	<.004	<.006	<.004
4-13-1999	<.002	<.005	<.002	<.004	<.004	<.003	<.004	<.006	<.004
6-10-1999	---	---	---	---	---	---	---	---	---
8-19-1999	---	---	---	---	---	---	---	---	---

Date	Pendim-ethalin (mg/L)	Phorate (mg/L)	Prometon, dissolved (mg/L)	Propachlor, dissolved (mg/L)	Propanil (mg/L)	Propargite (mg/L)	Pronamide (mg/L)	Simazine, dissolved (mg/L)	Tebuthiuron (mg/L)
1-21-1998	---	---	---	---	---	---	---	---	---
8-4-1998	---	---	---	---	---	---	---	---	---
2-5-1999	<.004	<.002	<.018	<.007	<.004	<.013	<.003	<.005	<.010
4-13-1999	<.004	<.002	<.018	<.007	<.004	<.013	<.003	<.005	<.010
6-10-1999	---	---	---	---	---	---	---	---	---
8-19-1999	---	---	---	---	---	---	---	---	---

Date	Terbacil (mg/L)	Terbufos (mg/L)	Thiobencarb (mg/L)	Triallate (mg/L)	Trifluralin (mg/L)	Alpha BHC, dissolved (mg/L)	Permethrin, cis (mg/L)	p,p'-DDE, dissolved (mg/L)	2,4,5-T, dissolved (mg/L)
1-21-1998	---	---	---	---	---	---	---	---	---
8-4-1998	---	---	---	---	---	---	---	---	---
2-5-1999	<.007	<.013	<.002	<.001	<.002	<.002	<.005	<.006	<.035
4-13-1999	<.007	<.013	<.002	<.001	<.002	<.002	<.005	<.006	<.035
6-10-1999	---	---	---	---	---	---	---	---	---
8-19-1999	---	---	---	---	---	---	---	---	---

Date	2,4-D, dissolved (mg/L)	2,4-DB (mg/L)	Silvex, dissolved (mg/L)	3-Hydroxy-carbofuran (mg/L)	DNOC (mg/L)	Acifluorfen (mg/L)	Aldicarb (mg/L)	Aldicarb sulfone (mg/L)	Aldicarb sulfoxide (mg/L)
1-21-1998	---	---	---	---	---	---	---	---	---
8-4-1998	---	---	---	---	---	---	---	---	---
2-5-1999	<.15	<.24	<.021	<.014	<.42	<.035	<.55	<.1	<.021
4-13-1999	<.15	<.24	<.021	<.014	<.42	<.035	<.55	<.1	<.021
6-10-1999	---	---	---	---	---	---	---	---	---
8-19-1999	---	---	---	---	---	---	---	---	---

Table 4. Water-quality data for the Verde River at the northern boundary of Fort McDowell Indian Reservation, Arizona—Continued

Date	Bentazon (mg/L)	Bromocil (mg/L)	Brom-oxynil (mg/L)	Carbaryl (mg/L)	Chloro-thalonil (mg/L)	Clopyralid (mg/L)	Dacthal mono-acid (mg/L)	Dicamba (mg/L)	Dichlobenil (mg/L)
1-21-1998	---	---	---	---	---	---	---	---	---
8-4-1998	---	---	---	---	---	---	---	---	---
2-5-1999	<.014	<.035	<.035	<.008	<.48	<.23	<.017	<.035	<1.2
4-13-1999	<.014	<.035	<.035	<.008	<.48	<.23	<.017	<.035	<1.2
6-10-1999	---	---	---	---	---	---	---	---	---
8-19-1999	---	---	---	---	---	---	---	---	---

Date	Dichlorprop (mg/L)	Dinoseb (mg/L)	Diuron (mg/L)	Fenuron (mg/L)	Fluometuron (mg/L)	Linuron (mg/L)	MCPA (mg/L)	MCPB (mg/L)	Methiocarb (mg/L)
1-21-1998	---	---	---	---	---	---	---	---	---
8-4-1998	---	---	---	---	---	---	---	---	---
2-5-1999	<.032	<.035	<.02	<.013	<.035	<.018	<.17	<.14	<.026
4-13-1999	<.032	<.035	<.02	<.013	<.035	<.018	<.17	<.14	<.026
6-10-1999	---	---	---	---	---	---	---	---	---
8-19-1999	---	---	---	---	---	---	---	---	---

Date	Methomyl (mg/L)	Neburon (mg/L)	Norflurazon (mg/L)	Oryzalin (mg/L)	Oxamyl (mg/L)	Picloram (mg/L)	Propham (mg/L)	Propoxur (mg/L)	Triclopyr (mg/L)
1-21-1998	---	---	---	---	---	---	---	---	---
8-4-1998	---	---	---	---	---	---	---	---	---
2-5-1999	<.017	<.015	<.024	<.31	<.018	<.05	<.035	<.035	<.25
4-13-1999	<.017	<.015	<.024	<.31	<.018	<.05	<.035	<.035	<.25
6-10-1999	---	---	---	---	---	---	---	---	---
8-19-1999	---	---	---	---	---	---	---	---	---

Date	Coliform, fecal (cols./100 mL)	E. coli, MTEC (cols./100 mL)	Fecal Strep, KF (cols./100 mL)	Ethane, 1,1,1,2-Tetrachloro, unfiltered (mg/L)	1,1,1-Trichloro-ethane, total (mg/L)	Ethane, 1,1,2,2-Tetrachloro (mg/L)	1,1,2-Trichloroethane, total (mg/L)	Freon-113, unfiltered (mg/L)
1-21-1998	---	---	---	<.044	<.032	<.132	<.064	<.032
8-4-1998	77	6	11	---	---	---	---	---
2-5-1999	<1	K1	80	<.044	<.032	<.13	<.064	<.032
4-13-1999	K4	<1	23	<.044	<.032	<.13	<.064	<.032
6-10-1999	---	---	---	---	---	---	---	---
8-19-1999	---	---	---	---	---	---	---	---

Table 4. Water-quality data for the Verde River at the northern boundary of Fort McDowell Indian Reservation, Arizona—Continued

Date	1,1-Dichloro-ethane, total (mg/L)	1,1-Dichloro-ethylene, total (mg/L)	1,1-Dichloro-propene, total (mg/L)	1,2,3,4-Tetra-methyl-benzene, unfiltered (mg/L)	Isodurene, unfiltered (mg/L)	1,2,3-Trichloro-benzene (mg/L)	1,2,3-Tri-chloro-propane (mg/L)	Benzene, 1,2,3-Trimethyl (mg/L)	Benzene, 1,2,4-Trichloro (mg/L)
1-21-1998	<.066	<.044	<.026	<.23	<.24	<.266	<.07	<.124	<.188
8-4-1998	---	---	---	---	---	---	---	---	---
2-5-1999	<.066	<.044	<.026	<.23	<.2	<.27	<.16	<.12	<.19
4-13-1999	<.066	<.044	<.026	<.23	<.2	<.27	<.16	<.12	<.19
6-10-1999	---	---	---	---	---	---	---	---	---
8-19-1999	---	---	---	---	---	---	---	---	---

Date	Benzene, 1,2,4-Trimethyl, unfiltered (mg/L)	Dibromo-chloro-propane (mg/L)	Benzene, o-Dichloro, unfiltered (mg/L)	1,2-Dichloro-ethane, total (mg/L)	1,2-Dichloro-propane, total (mg/L)	Benzene, 1,3,5-Trimethyl, unfiltered (mg/L)	Benzene 1,3-Dichloro, unfiltered (mg/L)	1,3-Dichloro-propane, total (mg/L)	Benzene, 1,4-Dichloro, unfiltered (mg/L)
1-21-1998	<.056	<.214	<.048	<.134	<.068	<.044	<.054	<.116	E.022
8-4-1998	---	---	---	---	---	---	---	---	---
2-5-1999	<.056	<.21	<.048	<.13	<.068	<.044	<.054	<.12	E.0457
4-13-1999	<.056	<.21	<.048	<.13	<.068	<.044	<.054	<.12	E.0735
6-10-1999	---	---	---	---	---	---	---	---	---
8-19-1999	---	---	---	---	---	---	---	---	---

Date	2,2-Dichloro-propane, total (mg/L)	Methyl-ethyl-ketone, total | (mg/L)	o-Chloro-toluene, total (mg/L)	2-Hexanone, total (mg/L)	Propene, 3-Chloro, unfiltered (mg/L)	Toluene, p-Chlor, unfiltered (mg/L)	p-Isopropyl-toluene (mg/L)	Methyl isobutyl ketone, total (mg/L)	Acetone, total (mg/L)
1-21-1998	<.078	<1.65	<.042	<.746	<.196	<.056	<.11	<.374	<4.90
8-4-1998	---	---	---	---	---	---	---	---	---
2-5-1999	<.078	<1.6	<.042	<.7	<.2	<.056	<.11	<.37	<5
4-13-1999	<.078	<1.6	<.042	<.7	<.2	<.056	<.11	<.37	<5
6-10-1999	---	---	---	---	---	---	---	---	---
8-19-1999	---	---	---	---	---	---	---	---	---

Date	Acrylonitrile, total (mg/L)	Benzene, total (mg/L)	Bromo-benzene, total (mg/L)	Methane, Bromo-chloro, unfiltered (mg/L)	Bromo-dichloro-methane, total (mg/L)	Bromo-ethene, unfiltered (mg/L)	Bromoform, total (mg/L)	Methyl-bromide, total (mg/L)
1-21-1998	<1.23	<.032	<.036	<.044	<.048	<.1	<.104	<.148
8-4-1998	---	---	---	---	---	---	---	---
2-5-1999	<1.2	<.1	<.036	<.044	<.048	<.1	<.1	<.15
4-13-1999	<1.2	<.1	<.036	<.044	<.048	<.1	<.1	<.15
6-10-1999	---	---	---	---	---	--	---	---
8-19-1999	---	---	---	---	---	---	---	---

Table 4. Water-quality data for the Verde River at the northern boundary of Fort McDowell Indian Reservation, Arizona—Continued

Date	Benzene, N-Butyl, unfiltered (mg/L)	Carbon disulfide, total (mg/L)	Chloro-benzene, total (mg/L)	Chloroethane, total (mg/L)	Chloroform, total (mg/L)	Methyl-chloride, total (mg/L)	cis-1,2-Dichloro-ethene, total (mg/L)	cis-1,3-Dichloro-propene, total (mg/L)
1-21-1998	<.186	E.0078	<.028	<.12	E.0095	<.254	<.038	<.092
8-4-1998	---	---	---	---	---	---	---	---
2-5-1999	<.19	<.37	<.028	<.12	<.052	<.25	<.038	<.09
4-13-1999	<.19	<.37	<.028	E.0450	E.00663	E.0979	<.038	<.09
6-10-1999	---	---	---	---	---	---	---	---
8-19-1999	---	---	---	---	---	---	---	---

Date	Chloro-dibromo-methane, total (mg/L)	Dibromo-methane (mg/L)	Dichloro-difluoro-methane (mg/L)	Methylene chloride (mg/L)	Ether ethyl, unfiltered (mg/L)	Di-isopropyl-ether, unfiltered (μg/L)	Methacrylate ethyl, unfiltered (μg/L)	Ether tert-butyl ethyl, unfiltered (μg/L)
1-21-1998	<.182	<.05	<.096	<.382	<.17	<.098	<.278	<.054
8-4-1998	---	---	---	---	---	---	---	---
2-5-1999	<.18	<.05	<.14	<.38	<.17	<.098	<.28	<.054
4-13-1999	<.18	<.05	<.14	<.38	<.17	<.098	<.28	<.054
6-10-1999	---	---	---	---	---	---	---	---
8-19-1999	---	---	---	---	---	---	---	---

Date	Ethyl-benzene, total (μg/L)	Hexa-chloro-butadiene, total (mg/L)	Ethane, hexa-chloro, unfiltered (mg/L)	Isopropyl-benzene (mg/L)	Meta/para-xylene, unfiltered (mg/L)	Methyl-acrylate, unfiltered (mg/L)	Methacrylo-nitrile, unfiltered (mg/L)	Methyl-iodide, unfiltered (mg/L)
1-21-1998	<.03	<.142	<.362	<.032	<.064	<.612	<.57	<.076
8-4-1998	---	---	---	---	---	---	---	---
2-5-1999	<.03	<.14	<.36	<.032	<.06	<1.4	<.57	<.21
4-13-1999	<.03	<.14	<.36	<.032	<.06	<1.4	<.57	<.21
6-10-1999	---	---	---	---	---	---	---	---
8-19-1999	---	---	---	---	---	---	---	---

Date	Methacrylate methyl, unfiltered (mg/L)	Benzene, N-propy, unfiltered (mg/L)	Naphthalene, total (mg/L)	Toluene, o-ethyl, unfiltered (mg/L)	o-xylene, total (mg/L)	Benzene, sec butyl, unfiltered (mg/L)	Styrene, total (mg/L)	Methyl tert-butyl ether, unfiltered (mg/L)
1-21-1998	<.35	<.042	<.25	<.1	<.064	<.048	<.042	<.112
8-4-1998	---	---	---	---	---	---	---	---
2-5-1999	<.35	<.042	<.25	<.1	<.06	<.048	<.042	.182
4-13-1999	<.35	<.042	<.25	<.1	<.06	<.048	<.042	<.17
6-10-1999	---	---	---	---	---	---	---	---
8-19-1999	---	---	---	---	---	---	---	---

Table 4. Water-quality data for the Verde River at the northern boundary of Fort McDowell Indian Reservation, Arizona—Continued

Date	Benzene tert-butyl, unfiltered (μg/L)	Ether, tert-pentyl methyl, unfiltered (μg/L)	Tetrachloro-ethylene, total (μg/L)	Carbon tetra-chloride, total (μg/L)	Furan, tetra-hydro, unfiltered (μg/L)	Toluene, total (μg/L)	trans-1,2-dichloro-ethene, total (μg/L)	trans-1,3-Dichloroprope ne, total (μg/L)
1-21-1998	<.096	<.112	<.038	<.088	<1.15	<.038	<.032	<.134
8-4-1998	---	---	---	---	---	---	---	---
2-5-1999	<.1	<.11	<.1	<.088	<9	<.05	<.032	<.13
4-13-1999	<.1	<.11	<.1	<.088	<9	E.00865	<.032	<.13
6-10-1999	---	---	---	---	---	---	---	---
8-19-1999	---	---	---	---	---	---	---	---

Date	2-Butene trans-1,4-dichloro, unfiltered (μg/L)	Tri-chloro-ethylene, total (μg/L)	Trichloro-fluoro-methane, total (μg/L)	Vinyl chloride, total (μg/L)
1-21-1998	<.692	<.038	<.092	<.112
8-4-1998	---	---	---	---
2-5-1999	<.7	<.038	<.09	<.11
4-13-1999	<.7	<.038	<.09	<.11
6-10-1999	---	---	---	---
8-19-1999	---	---	---	---

Table 5. Water-quality data for drive-point well NB5, Fort McDowell Indian Reservation, Arizona

[gal/min, gallons per minute; ft, feet; NGVD, National Geodetic Vertical Datum of 1929; µS/cm, microsiemens per centimeter at 25 degrees Celsius; deg. C, degrees Celsius; NTU, nephelometric turbidity units; mg/L, milligrams per liter; cols./100 mL, colonies per 100 milliliters; µg/L, micrograms per liter; <, less than; dashes indicate no data are available; E, estimated]

Date	Time	Flow rate (gal/min)	Water level (depth below land surface, ft)	Depth of well (ft)	Elevation of land surface dataum (ft above NGVD)	Specific conductance (µS/cm)	pH water, whole, field (standard units)	Temperature, water (deg. C)	Temperature, air (deg. C)
8-4-1998	1330	0.6	---	3.90	1,480	566	7.4	30.1	45.5
3-17-1999	1250	.7	1.89	3.90	1,480	596	7.4	19.5	19.0
4-15-1999	1300	.500	1.92	3.90	1,480	623	7.3	22.3	29.0
6-15-1999	1305	.13	2.09	3.90	1,480	654	7.2	28.3	38.5
8-18-1999	1105	.200	2.09	3.90	1,480	648	7.2	28.3	39.0

Date	Barometric pressure (mm of Hg)	Turbidity (NTU)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)	Oxygen demand, chemical (high level, mg/L)	Hardness, total, (mg/L as $CaCO_3$)	Hardness, noncarbonate, dissolved, as $CaCO_3$ (mg/L)	Alkalinity, field (mg/L as $CaCO_3$)	Solids, sum of constituents, dissolved (mg/L)
8-4-1998	717	0	1.7	25	---	230	12	216	328
3-17-1999	721	1	2.1	24	<10	240	12	232	361
4-15-1999	722	0	1.3	16	---	250	13	224	367
6-15-1999	720	1	.72	10	---	250	21	233	372
8-18-1999	719	0	.80	11	---	260	26	231	369

Date	Solids, dissolved (tons per ac-ft)	Calcium, dissolved, (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sodium, percent	Sodium adsorption ratio	Potassium, dissolved (mg/L as K)	Bicarbonate (mg/L as HCO_3)	Carbonate, (mg/L as CO_3)
8-4-1998	.45	47	27	29	22	.8	2.9	264	---
3-17-1999	.49	50	28	33	23	.9	2.3	282	---
4-15-1999	.50	52	29	34	23	.9	2.1	288	0
6-15-1999	.51	53	29	35	23	1	1.9	284	0
8-18-1999	.50	55	29	36	23	1	2.0	282	---

Date	Sulfate, dissolved, (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Bromide, dissolved (mg/L as Br)	Silica, dissolved (mg/L as SiO_2)	Nitrogen, ammonia + organic, dissolved (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as NH_4)	Nitrogen, NO_2 + NO_3, dissolved (mg/L as N)
8-4-1998	43	19	.39	.09	26	<.1	.04	.05	.55
3-17-1999	56	25	.44	.12	25	<.1	<.02	---	.32
4-15-1999	54	25	.45	.13	26	<.1	<.02	---	.20
6-15-1999	58	25	.45	.10	28	E.06	<.02	---	<.05
8-18-1999	53	24	.46	.10	29	E.08	<.02	---	<.05

Table 5. Water-quality data for drive-point well NB5, Fort McDowell Indian Reservation, Arizona—Continued

Date	Nitrogen, nitrite, dissolved (mg/L as N)	Phosphate, ortho, dissolved (mg/L as PO_4)	Phosphorus, dissolved (mg/L as P)	Phosphorus, ortho, dissolved, (mg/L as P)	Aluminum, dissolved (mg/L as Al)	Antimony, dissolved (mg/L as Sb)	Arsenic, dissolved (mg/L as As)	Barium, dissolved (mg/L as Ba)	Beryllium, dissolved (mg/L as Be)
8-4-1998	<.01	.09	<.01	.03	<10.0	2	9	36	<1.0
3-17-1999	<.01	.05	.014	.01	<10.0	<1	9	34	<1.6
4-15-1999	<.01	.06	.007	.02	<10.0	<1	7	34	<1.6
6-15-1999	<.01	---	.005	<.01	<10.0	<1	9	37	<1.6
8-18-1999	<.01	---	.009	<.01	<15	<1	6	38	<1.6

Date	Boron, dissolved (mg/L as B)	Cadmium, disolved (mg/L as Cd)	Chromium, dissolved (mg/L as Cr)	Cobalt, dissolved (mg/L as Co)	Copper, dissolved (mg/L as Cu)	Cyanide, total (mg/L)	Iron, dissolved (mg/L as Fe)	Lead, dissolved (mg/L as Pb)	Lithium, dissolved (mg/L as Li)
8-4-1998	129	<8	<14	<12	<10	---	<10	<100	34
3-17-1999	121	<8	<14	<7	<10	<.01	<10	<100	29
4-15-1999	111	<8	<14	<7	<10	---	<10	<100	33
6-15-1999	117	<8	<14	<7	<10	---	58	<100	35
8-18-1999	108	<8	<14	<13	<10	---	190	<100	37

Date	Manganese, dissolved (mg/L as Mn)	Mercury, dissolved (mg/L as Hg)	Molybdenum, dissolved (mg/L as Mo)	Nickel, dissolved (mg/L as Ni)	Selenium, dissolved (mg/L as Se)	Silver, dissolved (mg/L as Ag)	Strontium, dissolved (mg/L as Sr)	Vanadium, dissolved (mg/L as V)	Zinc, dissolved (mg/L as Zn)
8-4-1998	<4	<.1	<60	<40	<1	<4	560	14	29
3-17-1999	<3	<.1	<50	<40	1	<4	590	E7	68
4-15-1999	<3	<.1	<50	<40	<1	<4	600	<10	25
6-15-1999	110	<.1	<50	<40	<1	<4	620	<10	E18
8-18-1999	86	<.1	<30	<40	<1	<7	600	<10	<20

Date	Tritum, total (pCi/L)	Oil and grease, total recoverable (mg/L)	Phenols, total (mg/L)	2,6-Diethyl-aniline (mg/L)	Acetochlor, rec (mg/L)	Alachlor, dissolved (mg/L)	Atrazine, dissolved, rec (mg/L)	Methyl-azinphos (mg/L	Benfluralin (mg/L)
8-4-1998	9.6	---	---	---	---	---	---	---	---
3-17-1999	---	<1	<4	<.003	<.002	<.002	<.001	<.001	<.002
4-15-1999	---	---	---	---	---	---	---	---	---
6-15-1999	---	---	---	---	---	---	---	---	---
8-18-1999	---	---	---	---	---	---	---	---	---

Date	Butylate, dissolved (mg/L)	Carbofuran (mg/L)	Chloropyrifos, dissolved (mg/L)	Cyanazine, dissolved (mg/L)	DCPA (mg/L)	Deethyl-atrazine, dissolved (mg/L)	Diazinon, dissolved (mg/L)	Dieldrin, dissolved (mg/L)	Disulfoton (mg/L)
8-4-1998	---	---	---	---	---	---	---	---	---
3-17-1999	<.002	<.003	<.004	<.004	<.002	<.002	<.002	<.001	<.017
4-15-1999	---	---	---	---	---	---	---	---	---
6-15-1999	---	---	---	---	---	---	---	---	---
8-18-1999	---	---	---	---	---	---	---	---	---

Table 5. Water-quality data for drive-point well NB5, Fort McDowell Indian Reservation, Arizona—Continued

Date	EPTC (mg/L)	Ethalfluralin (mg/L)	Ethoprop (mg/L)	Fonofos, dissolved (mg/L)	Lindane, dissolved (mg/L)	Linuron (mg/L)	Malathion, dissolved (mg/L)	Metolachlor, dissolved (mg/L)	Metribuzin sencor, dissolved (mg/L)
8-4-1998	---	---	---	---	---	---	---	---	---
3-17-1999	<.002	<.004	<.003	<.003	<.004	<.002	<.005	<.002	<.004
4-15-1999	---	---	---	---	---	---	---	---	---
6-15-1999	---	---	---	---	---	---	---	---	---
8-18-1999	---	---	---	---	---	---	---	---	---

Date	Molinate (mg/L)	Napropamide (mg/L)	Parathion, dissolved (mg/L)	Methyl parathion (mg/L)	Pebulate (mg/L)	Pendimethalin (mg/L)	Phorate (mg/L)	Prometon, dissolved (mg/L)	Propachlor, dissolved (mg/L)
8-4-1998	---	---	---	---	---	---	---	---	---
3-17-1999	<.004	<.003	<.004	<.006	<.004	<.004	<.002	<.018	<.007
4-15-1999	---	---	---	---	---	---	---	---	---
6-15-1999	---	---	---	---	---	---	---	---	---
8-18-1999	---	---	---	---	---	---	---	---	---

Date	Propanil (mg/L)	Propargite (mg/L)	Pronamide (mg/L)	Simazine, dissolved (mg/L)	Tebuthiuron (mg/L)	Terbacil (mg/L)	Terbufos (mg/L)	Thiobencarb (mg/L)	Triallate (mg/L)
8-4-1998	---	---	---	---	---	---	---	---	---
3-17-1999	<.004	<.013	<.003	<.005	<.010	<.007	<.013	<.002	<.001
4-15-1999	---	---	---	---	---	---	---	---	---
6-15-1999	---	---	---	---	---	---	---	---	---
8-18-1999	---	---	---	---	---	---	---	---	---

Date	Trifluralin (mg/L)	Alpha BHC, dissolved (mg/L)	Permethrin, cis (mg/L)	p,p'-DDE, dissolved (mg/L)	2,4,5-T, dissolved (mg/L)	2,4-D, dissolved (mg/L)	2,4-DB (mg/L)	Silvex, dissolved (mg/L)	3-Hydroxy-carbofuran (mg/L)
8-4-1998	---	---	---	---	---	---	---	---	---
3-17-1999	<.002	<.002	<.005	<.006	<.035	<.15	<.24	<.021	<.014
4-15-1999	---	---	---	---	---	---	---	---	---
6-15-1999	---	---	---	---	---	---	---	---	---
8-18-1999	---	---	---	---	---	---	---	---	---

Date	DNOC (mg/L)	Acifluorfen (mg/L)	Aldicarb (mg/L)	Aldicarb sulfone (mg/L)	Aldicarb sulfoxide (mg/L)	Bentazon (mg/L)	Bromocil (mg/L)	Bromoxynil (mg/L)	Carbaryl (mg/L)
8-4-1998	---	---	---	---	---	---	---	---	---
3-17-1999	<.42	<.13	<.55	<.1	<.021	<.014	<.035	<.035	<.008
4-15-1999	---	---	---	---	---	---	---	---	---
6-15-1999	---	---	---	---	---	---	---	---	---
8-18-1999	---	---	---	---	---	---	---	---	---

Table 5. Water-quality data for drive-point well NB5, Fort McDowell Indian Reservation, Arizona—Continued

Date	Chloro-thalonil (mg/L)	Clopyralid (mg/L)	Dacthal monoacid (mg/L)	Dicamba (mg/L)	Dichlobenil (mg/L)	Dichlorprop (mg/L)	Dinoseb (mg/L)	Diuron (mg/L)	Fenuron (mg/L)
8-4-1998	---	---	---	---	---	---	---	---	---
3-17-1999	<.48	<.23	<.017	<.035	<1.2	<.032	<.035	<.02	<.013
4-15-1999	---	---	---	---	---	---	---	---	---
6-15-1999	---	---	---	---	---	---	---	---	---
8-18-1999	---	---	---	---	---	---	---	---	---

Date	Fluo-meturon (mg/L)	Linuron (mg/L)	MCPA (mg/L)	MCPB (mg/L)	Methiocarb (mg/L)	Methomyl (mg/L)	Neburon (mg/L)	Norflurazon (mg/L)	Oryzalin (mg/L)
8-4-1998	---	---	---	---	---	---	---	---	---
3-17-1999	<.035	<.018	<.17	<.14	<.026	<.017	<.015	<.024	<.31
4-15-1999	---	---	---	---	---	---	---	---	---
6-15-1999	---	---	---	---	---	---	---	---	---
8-18-1999	---	---	---	---	---	---	---	---	---

Date	Oxamyl (mg/L)	Picloram (mg/L)	Propham (mg/L)	Propoxur (mg/L)	Triclopyr (mg/L)	Coliform, fecal (cols./ 100 mL	E. coli, MTEC (cols./ 100 mL)	Fecal Strep, KF (cols./ 100 mL)	Ethane, 1,1,1,2-Tetrachloro, unfiltered (mg/L)
8-4-1998	---	---	---	---	---	---	---	---	---
3-17-1999	<.018	<.05	<.035	<.035	<.25	<1	<1	<1	<.044
4-15-1999	---	---	---	---	---	---	---	---	---
6-15-1999	---	---	---	---	---	---	---	---	---
8-18-1999	---	---	---	---	---	---	---	---	---

Date	1,1,1-Tri-chloro-ethane, total (mg/L)	Ethane, 1,1,2,2-tetrachloro (mg/L)	1,1,2-Trichloro-ethane, total (mg/L)	Freon-113, unfiltered (mg/L)	1,1-Dichloro-ethane, total (mg/L)	1,1-Dichloro-ethylene, total (mg/L)	1,1-Dichloro-propene, total (mg/L)	1,2,3,4-Tetra methyl benzene, unfiltered (mg/L)	Isodurene, unfiltered (mg/L)
8-4-1998	---	---	---	---	---	---	---	---	---
3-17-1999	<.032	<.13	<.064	<.032	<.066	<.044	<.026	<.23	<.2
4-15-1999	---	---	---	---	---	---	---	---	---
6-15-1999	---	---	---	---	---	---	---	---	---
8-18-1999	---	---	---	---	---	---	---	---	---

Table 5. Water-quality data for drive-point well NB5, Fort McDowell Indian Reservation, Arizona—Continued

Date	1,2,3-Trichloro-benzene (mg/L)	1,2,3-Trichloro-propane (mg/L)	Benzene, 1,2,3-Trimethyl (mg/L)	Benzene, 1,2,4-Trichloro (mg/L)	Benzene, 1,2,4-trimethyl, unfiltered (mg/L)	Dibromo chloro-propane (mg/L)	1,2-Dibromo-ethane, total (mg/L)	Benzene, o-dichloro, unfiltered (mg/L)	1,2-Dichloro-ethane, total (mg/L)
8-4-1998	---	---	---	---	---	---	---	---	---
3-17-1999	<.27	<.16	<.12	<.19	<.056	<.21	<.036	<.048	<.13
4-15-1999	---	---	---	---	---	---	---	---	---
6-15-1999	---	---	---	---	---	---	---	---	---
8-18-1999	---	---	---	---	---	---	---	---	---

Date	1,2-Dichloro-propane, total (mg/L)	Benzene, 1,3,5-trimethyl, unfiltered (mg/L)	Benzene 1,3-dichloro, unfiltered (mg/L)	1,3-Dichloro-propane, total (mg/L)	Benzene, 1,4-dichloro, unfiltered (mg/L)	2,2-Dichloro-propane, total (mg/L)	Methyl-ethyl-ketone, total (mg/L)	o-Chloro-toluene, total (mg/L)	2-Hexanone, total (mg/L)
8-4-1998	---	---	---	---	---	---	---	---	---
3-17-1999	<.068	<.044	<.054	<.12	E.0659	<.078	<1.6	<.042	<.7
4-15-1999	---	---	---	---	---	---	---	---	---
6-15-1999	---	---	---	---	---	---	---	---	---
8-18-1999	---	---	---	---	---	---	---	---	---

Date	Propene, 3-Chloro, unfiltered (mg/L)	Toluene, p-chlor, unfiltered (mg/L)	p-Isopropyl-toluene (mg/L)	Methyl isobutyl ketone, total (mg/L)	Acetone, total (mg/L)	Acrylonitrile, total (mg/L)	Benzene, total (mg/L)	Bromo-benzene, total (mg/L)	Methane, bromo-chloro, unfiltered (mg/L)
8-4-1998	---	---	---	---	---	---	---	---	---
3-17-1999	<.2	<.056	<.11	<.37	<5	<1.2	<.1	<.036	<.044
4-15-1999									
6-15-1999									
8-18-1999									

Date	Bromo-dichloro-methane, total (mg/L)	Bromo-ethene, unfiltered (mg/L)	Bromoform, total (mg/L)	Methyl-bromide, total (mg/L)	Benzene, N-butyl, unfiltered (mg/L)	Carbon disulfide, total (mg/L)	Chloro-benzene, total (mg/L)	Chloro-ethane, total (mg/L)	Chloroform, total (mg/L)
8-4-1998	---	---	---	---	---	---	---	---	---
3-17-1999	<.048	<.1	<.1	<.15	<.19	<.37	<.028	<.12	<.052
4-15-1999	---	---	---	---	---	---	---	---	---
6-15-1999	---	---	---	---	---	---	---	---	---
8-18-1999	---	---	---	---	---	---	---	---	---

Table 5. Water-quality data for drive-point well NB5, Fort McDowell Indian Reservation, Arizona—Continued

Date	Methyl-chloride, total (mg/L)	cis-1,2-Dichloro-ethene, total (mg/L)	cis-1,3-Dichloro-propene, total (mg/L)	Chloro-dibromo-methane, total (mg/L)	Di-bromo-methane (mg/L)	Dichloro-difluoro-methane (mg/L)	Methylene chloride (mg/L)	Ether ethyl, unfiltered (mg/L)	Di-isopropyl-ether, unfiltered (mg/L)
8-4-1998	---	---	---	---	---	---	---	---	---
3-17-1999	<.25	<.038	<.09	<.18	<.05	<.14	<.38	<.17	<.098
4-15-1999	---	---	---	---	---	---	---	---	---
6-15-1999	---	---	---	---	---	---	---	---	---
8-18-1999	---	---	---	---	---	---	---	---	---

Date	Meth-acrylate ethyl, unfiltered (mg/L)	Ether tert-butyl ethyl, unfiltered (mg/L)	Ethyl-benzene, total (mg/L)	Hexa-chloro-butadiene, total (mg/L)	Ethane, hexa-chloro, unfiltered (mg/L)	Isopropyl-benzene (mg/L)	Meta/para-xylene, unfiltered (mg/L)	Methyl-acrylate, unfiltered (mg/L)	Methacrylo-nitrile, unfiltered (mg/L)
8-4-1998	---	---	---	---	---	---	---	---	---
3-17-1999	<.28	<.054	<.03	<.14	<.36	<.032	<.06	<1.4	<.57
4-15-1999	---	---	---	---	---	---	---	---	---
6-15-1999	---	---	---	---	---	---	---	---	---
8-18-1999	---	---	---	---	---	---	---	---	---

Date	Methyl-iodide, unfiltered (mg/L)	Methacrylate methyl, unfiltered (mg/L)	Benzene, N-propy, unfiltered (mg/L)	Naphth-alene, total (mg/L)	Toluene, o-ethyl, unfiltered (mg/L)	o-xylene, total (mg/L)	Benzene, sec butyl, unfiltered (mg/L)	Styrene, total (mg/L)	Methyl tert-butyl ether, unfiltered (mg/L)
8-4-1998	---	---	---	---	---	---	---	---	---
3-17-1999	<.21	<.35	<.042	<.25	<.1	<.06	<.048	<.042	<.17
4-15-1999	---	---	---	---	---	---	---	---	---
6-15-1999	---	---	---	---	---	---	---	---	---
8-18-1999	---	---	---	---	---	---	---	---	---

Date	Benzene tert-butyl, unfiltered (mg/L)	Ether tert-pentyl methyl, unfiltered (mg/L)	Tetrachloro-ethylene, total (mg/L)	Carbon tetrachloride, total (mg/L)	Furan, tetrahydro, unfiltered (mg/L)	Toluene, total (mg/L)	trans-1,2-Dichloro-ethene, total (mg/L)	trans-1,3-Dichloropro pene, total (mg/L)	2-Butene trans-1,4-dichloro, unfiltered (mg/L)
8-4-1998	---	---	---	---	---	---	---	---	---
3-17-1999	<.1	<.11	<.1	<.088	<9	<.05	<.032	<.13	<.7
4-15-1999	---	---	---	---	---	---	---	---	---
6-15-1999	---	---	---	---	---	---	---	---	---
8-18-1999	---	---	---	---	---	---	---	---	---

Table 5. Water-quality data for drive-point well NB5, Fort McDowell Indian Reservation, Arizona—Continued

Date	Trichloroeth ylene, total (μg/L)	Trichloro-fluoro-methane, total (μg/L)	Vinyl chloride, total (μg/L)
8-4-1998	---	---	---
3-17-1999	<.038	<.09	<.11
4-15-1999	---	---	---
6-15-1999	---	---	---
8-18-1999	---	---	---