WATER-QUALITY ASSESSMENT OF THE RIO GRANDE VALLEY, COLORADO, NEW MEXICO, AND TEXAS—Surface-Water Quality, Shallow Ground-Water Quality, and Factors Affecting Water Quality in the Rincon Valley, South-Central New Mexico, 1994-95

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

Water-Resources Investigations Report 02-4188

National Water-Quality Assessment Program

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By Scott K. Anderholm

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U.S. DEPARTMENT OF THE INTERIOR
GALE A. NORTON, Secretary

U.S. GEOLOGICAL SURVEY
Charles G. Groat, Director

For additional information write to:

District Chief
U.S. Geological Survey
Water Resources Division
5338 Montgomery Blvd. NE, Suite 400
Albuquerque, NM 87109-1311

Copies of this report can be purchased from:

U.S. Geological Survey
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FOREWORD

The U.S. Geological Survey (USGS) is committed to serve the Nation with accurate and timely scientific information that helps enhance and protect the overall quality of life and facilitates effective management of water, biological, energy, and mineral resources. Information on the quality of the Nation's water resources is of critical interest to the USGS because it is so integrally linked to the long-term availability of water that is clean and safe for drinking and recreation and that is suitable for industry, irrigation, and habitat for fish and wildlife. Escalating population growth and increasing demands for the multiple water uses make water availability, now measured in terms of quantity *and* quality, even more critical to the long-term sustainability of our communities and ecosystems.

The USGS implemented the National Water-Quality Assessment (NAWQA) Program to support national, regional, and local information needs and decisions related to water-quality management and policy. Shaped by and coordinated with ongoing efforts of other Federal, State, and local agencies, the NAWQA Program is designed to answer: What is the condition of our Nation's streams and ground water? How are the conditions changing over time? How do natural features and human activities affect the quality of streams and ground water, and where are those effects most pronounced? By combining information on water chemistry, physical characteristics, stream habitat, and aquatic life, the NAWQA Program aims to provide science-based insights for current and emerging water issues. NAWQA results can contribute to informed decisions that result in practical and effective water-resource management and strategies that protect and restore water quality.

Since 1991, the NAWQA Program has implemented interdisciplinary assessments in more than 50 of the Nation's most important river basins and aquifers, referred to as study units. Collectively, these study units account for more than 60 percent of the overall water use and population served by public water supply and are representative of the Nation's major hydrologic landscapes, priority ecological resources, and agricultural, urban, and natural sources of contamination.

Each assessment is guided by a nationally consistent study design and methods of sampling and analysis. The assessments thereby build local knowledge about water-quality issues and trends in a particular stream or aquifer while providing an understanding of how and why water quality varies regionally and nationally. The consistent, multiscale approach helps to determine if certain types of water-quality issues are isolated or pervasive and allows direct comparisons of how human activities and natural processes affect water quality and ecological health in the Nation's diverse geographic and environmental settings. Comprehensive assessments on pesticides, nutrients, volatile organic compounds, trace metals, and aquatic ecology are developed at the national scale through comparative analysis of the Study-Unit findings.

The USGS places high value on the communication and dissemination of credible, timely, and relevant science so that the most recent and available knowledge about water resources can be applied in management and policy decisions. We hope this NAWQA publication will provide you the needed insights and information to meet your needs and thereby foster increased awareness and involvement in the protection and restoration of our Nation's waters.

The NAWQA Program recognizes that a national assessment by a single program cannot address all water-resource issues of interest. External coordination at all levels is critical for a fully integrated understanding of watersheds and for cost-effective management, regulation, and conservation of our Nation's water resources. The program, therefore, depends extensively on the advice, cooperation, and information from other Federal, State, interstate, tribal, and local agencies, non-government organizations, industry, academia, and other stakeholder groups. The assistance and suggestions of all are greatly appreciated.

Robert M. Hirsch
Associate Director for Water

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CONVERSION FACTORS AND DATUMS

Multiply	By	To obtain
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
acre	0.004047	square kilometer (km^2)
quart (qt)	0.9464	liter (L)
acre-foot (acre-ft)	1,233	cubic meter (m^3)
pound (lb)	0.4536	kilogram (kg)
cubic foot per second (ft^3s)	0.02832	cubic meter per second (m^3/s)
cubic foot per second per mile (ft^3s/mi)	0.01760	cubic meter per second per kilometer ($m^3/s/km$)
atmosphere, standard (atm)	101.3	kilopascal (kPa)

Temperature in degrees Fahrenheit (°F) or degrees Celsius (°C) may be converted as follows:

$$°C = (°F - 32) / 1.8$$

$$°F = (1.8 \cdot ° C) + 32$$

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (∝S/cm at 25 ˚C).

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

WATER-QUALITY ASSESSMENT OF THE RIO GRANDE VALLEY, COLORADO, NEW MEXICO, AND TEXAS—Surface-Water Quality, Shallow Ground-Water Quality, and Factors Affecting Water Quality in the Rincon Valley, South-Central New Mexico, 1994-95

By Scott K. Anderholm

ABSTRACT

As part of the National Water-Quality Assessment Program, surface-water and ground-water samples were collected in 1994 and 1995 for analysis of common constituents, nutrients, dissolved organic carbon, trace elements, radioactivity, volatile organic compounds, and pesticides to characterize surface-water quality and shallow ground-water quality and to determine factors affecting water quality in the Rincon Valley, south-central New Mexico. Samples of surface water were collected from three sites on the Rio Grande and from sites on three agricultural drains in the Rincon Valley in January 1994 and 1995, April 1994, and October 1994. Ground-water samples were collected in late April and early May 1994 from 30 shallow wells that were installed during the investigation.

Dissolved-solids concentrations in surface water ranged from 434 to 1,510 milligrams per liter (mg/L). Dissolved-solids concentrations were smallest in water from the Rio Grande below Caballo Dam and largest in the drains. Nitrite plus nitrate concentrations ranged from less than 0.05 to 3.3 mg/L as nitrogen, and ammonia concentrations ranged from less than 0.015 to 0.33 mg/L as nitrogen in surface-water samples.

Trace-element concentrations in surface water were significantly smaller than the acute-fisheries standards. One or more pesticides were detected in 34 of 37 surface-water samples. DCPA (dacthal) and metolachlor were the most commonly detected pesticides. No standards have been established for the pesticides analyzed for in this study.

Dissolved-solids concentrations in shallow ground water ranged from 481 to 3,630 mg/L. All but 2 of 30 samples exceeded the secondary maximum contaminant level for dissolved solids of 500 mg/L. Water from about 73 percent of the wells sampled exceeded the secondary maximum contaminant level of 250 mg/L for sulfate, and water from about 7 percent of the wells sampled exceeded the secondary maximum contaminant level of 250 mg/L for chloride. Nitrite plus nitrate concentrations ranged from less than 0.05 to 33 mg/L as nitrogen in shallow ground water. Water from about 17 percent of the well samples exceeded the maximum contaminant level of 10 mg/L as nitrogen for nitrite plus nitrate.

Trace-element concentrations in shallow ground water generally were small (1 to 10 micrograms per liter). The proposed maximum contaminant level of 20 micrograms per liter for uranium was exceeded in about 13 percent of the samples. The secondary maximum contaminant level of 300 micrograms per liter for iron was exceeded in about 17 percent of the samples and of 50 micrograms per liter for manganese was exceeded in about 83 percent of the samples. Samples from about 23 percent of the wells exceeded the maximum contaminant level of 15 picocuries per liter for gross alpha activity.

One or more pesticides were detected in water from 12 of 30 wells sampled. The pesticides or pesticide metabolites diazinon, metolachlor, napropamide, p,p'-DDE, and prometon were detected in one or more samples. Metolachlor and prometon were the most commonly detected pesticides. Health advisories for the pesticides detected in shallow ground water (no maximum contaminant levels have been established for the pesticides detected) are 10 to 300 times larger than the concentrations detected.

Infiltration, evaporation, and transpiration of irrigation water are important factors affecting the concentrations of common constituents in shallow ground water in the Rincon Valley. Dissolution and precipitation of minerals and mixing of shallow ground water and inflow of ground water from adjacent areas also affect the composition of shallow ground water and water in the drains.

Relatively large nitrite plus nitrate concentrations in several shallow ground-water samples indicate leaching of fertilizers in some areas of the Rincon Valley. Molybdenum and uranium concentrations in part of the Rincon Valley are affected by inflow of ground water to the valley from adjacent areas. A large amount of the gross alpha activity in shallow ground water is from uranium isotopes. Gross beta activity increases with dissolved potassium,

indicating that part of the dissolved gross beta activity is from potassium-40.

The detection of a larger number of different pesticides in surface water than in ground water indicates that pesticides are entering surface water as runoff from fields or that the number of ground-water samples collected and the time of year that the samples were collected did not adequately represent the composition of ground water in the Rincon Valley that discharges to the drains.

On the basis of pesticide concentrations detected in shallow ground water in the Rincon Valley, large amounts of the pesticides analyzed for are not leaching from land surface into ground water. There is some indication that several pesticides are leaching downward into shallow ground water (metolachlor and prometon especially); however, the concentrations detected in shallow ground water are significantly smaller than any standards or health advisories issued by the U.S. Environmental Protection Agency.

INTRODUCTION

The U.S. Geological Survey (USGS) began to implement the full-scale National Water-Quality Assessment (NAWQA) Program in 1991. The Rio Grande Valley was one of the first 20 NAWQA study units selected for study of the status of and trends in the quality of ground water and surface water. One of the goals of the NAWQA Program is to provide a scientific understanding of the natural and human factors affecting the quality of ground water and surface water in the Nation. Distinguishing the difference between natural and human-related factors that affect water quality can be difficult, especially in areas of mixed land-use practices. Land-use activities can have particularly significant effects on ground-water and surface-water quality in areas where ground-water recharge is occurring or where the ground-water system discharges to surface-water bodies. Relations between a particular land-use activity and water quality can be directly assessed with the least difficulty in areas with relatively homogeneous land use.

Surface-water quality and shallow ground-water quality in the agricultural area of the Rincon Valley were investigated as part of the Rio Grande Valley NAWQA study. The Rincon Valley is similar to other agricultural areas in the Rio Grande Valley study unit and throughout the arid Western United States, and the results of the investigation could be applicable to these areas.

The Rincon Valley is located along the Rio Grande in the southern part of the Rio Grande Valley NAWQA study unit (fig. 1). The Rincon Valley was chosen for study because land use in this area is dominantly agricultural; vegetables, grains, cotton, alfalfa, and pecan orchards are flood irrigated with surface water diverted from the Rio Grande. Shallow ground water and surface water were sampled because they are in equilibrium, and a change in the amount or quality of one affects the other. Seepage of water from canals or irrigated land changes the depth to water and the amount of ground water that discharges to surface-water bodies; a change in the amount or quality of surface water used for irrigation changes the depth to water and the quality of ground water and surface water.

Purpose and Scope

This report describes water quality and factors affecting water quality in the Rincon Valley, south-central New Mexico. Water quality in the Rincon Valley was determined by collecting 37 surface-water samples, 30 ground-water samples, and 3 bed-material samples and analyzing these samples for a variety of physical properties and inorganic and organic constituents. As many as about 200 individual constituents were measured or analyzed for in some of the samples. Surface-water samples were collected near the upstream ends and near the mouths of three agricultural drains and from three sites on the Rio Grande during four sampling events from January 1994 to January 1995. Shallow ground-water samples were collected from 30 wells, which were installed for this investigation, in April and May 1994. Bed-material samples were collected from a site near the mouths of the three drains in January 1995. Natural and human-related factors affecting water quality were determined using the water-quality data collected.

Previous Work

Although few hydrologic studies have been conducted in the Rincon Valley, the studies that have been done are comprehensive. Conover (1954) conducted an extensive study of the ground-water

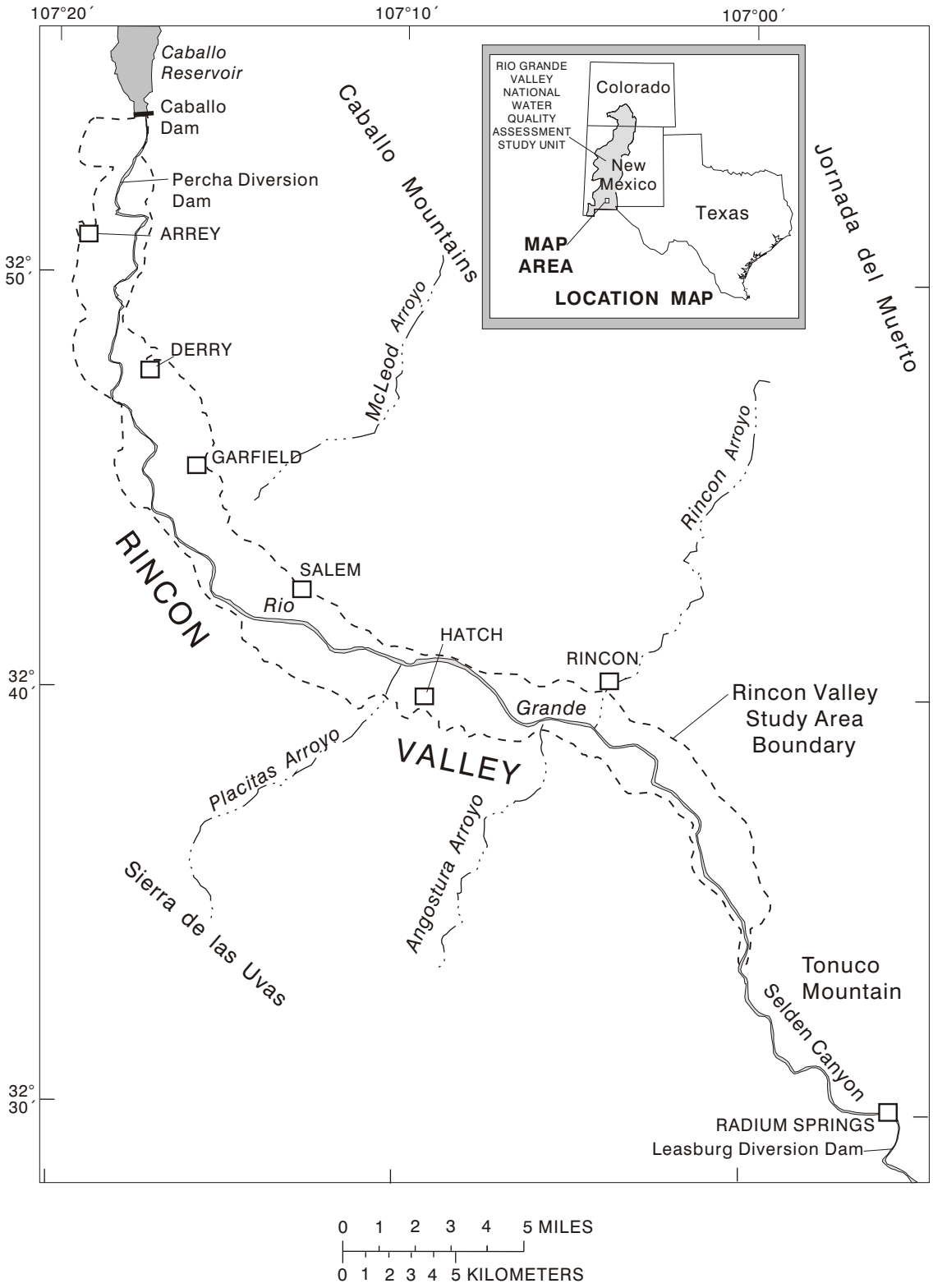

Figure 1. Location of the Rincon Valley study area.

resources of the Rincon Valley that included inventorying many wells in the area, examining the interaction of ground water and surface water, and presenting data on water-quality conditions in the valley. Conover (1954, p. 79) noted that because of evaporation and transpiration, ground water generally has larger concentrations of dissolved ions than surface water applied for irrigation.

Wilcox (1968) presented a summary for a 30-year period of monitoring discharge and salt burden on the Rio Grande that included the Rincon Valley. Wilcox discussed a positive salt balance between Caballo Dam and Leasburg Diversion Dam over this 30-year period, indicating that more salt was removed from the Rincon Valley than entered the valley from the Rio Grande.

King and others (1971) presented a discussion of the geologic framework and geohydrology of the Rincon Valley. They reported that no wells in the Rincon Valley produce large quantities of water from depths greater than 80 ft and that the basin-fill deposits at depths greater than about 80 ft are fine grained (p. 58). King and others (1971, p. 58) also reported ground-water inflow to the valley from the west near Hatch and ground-water inflow from the east in the southern Rincon Valley (Jornada del Muerto).

Wilson and others (1981) compiled data on the water resources of the Rincon Valley and adjacent areas. They reported that recharge from the Rio Grande and irrigation canals affects the quality of ground water and that ground-water discharge to drains affects the volume and water quality in the Rio Grande.

Acknowledgments

The Board of Directors of the Elephant Butte Irrigation District (EBID) supported the concept of this study and their cooperation is greatly appreciated. Michael Riley and Henry Magallanez of the EBID assisted in site-selection approval for shallow wells and provided information on land use, land ownership, acreages of crops grown, and streamflow data. Conrad Keyes assisted in approval for shallow wells on land administered by the International Boundary and Water Commission. R. David Fischer of the Natural Resources Conservation Service assisted in the initial planning stages of the study. The study would not have been possible without the cooperation of the land owners of the Rincon Valley who allowed access to their lands for sampling and installation of shallow wells. The support from the members of the Caballo Soil and Water Conservation District also is greatly appreciated.

DESCRIPTION OF STUDY AREA

The Rincon Valley study area is defined as the Rio Grande erosional valley (Rio Grande flood plain) from Caballo Dam on the north to Selden Canyon on the south (fig. 1). The study area is about 38 mi long, generally less than 2 mi wide, relatively flat, and is bordered by steep bluffs 50 to 100 ft high. The active channel of the Rio Grande, which is bounded by levees throughout most of the Rincon Valley, is generally the lowest point in the flood plain. The altitude of the Rio Grande below Caballo Dam is about 4,170 ft above sea level and at the north end of Selden Canyon is about 3,990 ft. A piedmont slope extends outward from the steep bluffs that border the study area to adjacent mountainous areas.

Several geographic features are adjacent to the Rincon Valley. The Caballo Mountains and Tonuco Mountain are on the east side of the valley. The Jornada del Muerto, a large alluvial basin, also is adjacent to the east side. The Sierra de las Uvas, a mountainous area, is on the southwest side of the valley. Many ephemeral channels (arroyos) enter the Rincon Valley from the adjacent piedmont, but many of them have dams that prevent storm runoff from flowing into the valley. In Rincon Arroyo, one of the largest of the arroyos, runoff is not impounded by a dam but is routed into the Rio Grande.

Climate

The arid climate of the Rincon Valley is characterized by clear skies, large daily fluctuations in temperature, low relative humidity, and potential evaporation exceeding precipitation throughout the year (Tuan and others, 1969). Temperature can fluctuate more than 39 °F in a 24-hour period, and daily temperature fluctuations generally are largest in April (Tuan and others, 1969, p. 71). The mean temperature generally is coldest in December and January and warmest in July (National Oceanic and Atmospheric Administration, 1993). The mean annual precipitation at Caballo Dam for 1961-90 was 10.17 in. (National Oceanic and Atmospheric Administration, 1993). The largest fraction of annual precipitation generally falls

in July, August, and September from intense thunderstorms; the smallest fraction of annual precipitation falls in March and April (National Oceanic and Atmospheric Administration, 1993).

Mean annual potential evapotranspiration is the amount of evapotranspiration that would occur in a year in an area completely covered with vegetation and no deficiency of water in the soil. Potential evapotranspiration is generally assumed to be about equal to free water-surface evaporation (Linsley and others, 1975, p. 178). Potential evapotranspiration in the Rincon Valley is about 75 in. per year (Farnsworth and others, 1982), about seven times greater than precipitation.

Surface-Water/Irrigation System

The Rio Grande is the main drainage through the Rincon Valley (fig. 2). The only perennial tributaries to the Rio Grande in the valley are manmade agricultural drains (drains). Discharge in the Rio Grande has large variation because it is generally controlled by releases from Caballo Reservoir in response to demands for irrigation water downstream. During most years, little or no water is released from mid-October until January (fig. 3). During periods of no releases from Caballo Reservoir, discharge at the streamflow gage Rio Grande below Caballo Dam is generally less than 10 ft^3/s. Discharge in the Rio Grande increases downstream because of ground-water discharge to the river and inflow from drains. Small releases (less than 500 ft^3/s) start in early to mid-January and increase until about March 1 (fig. 3). From about March 1 until mid-October, discharge at Rio Grande below Caballo Dam is generally greater than 1,000 ft^3/s. The largest discharges in the Rio Grande generally are in June, July, and August (fig. 3).

Most surface water used for irrigation in the Rincon Valley is diverted from the Rio Grande into the Arrey Canal and Percha Lateral at Percha Diversion Dam, which is about 1.5 mi downstream from the streamflow gage below Caballo Dam (fig. 2). A small amount of water also is diverted from the Rio Grande below Caballo Dam into the Bonita Community Ditch, which supplies water to fields in the northern part of the valley. From 1993 to 1995, annual diversions into the Arrey Canal ranged from 102,000 to 127,000 acre-ft, and annual diversions into the Percha Lateral ranged from 1,080 to 1,440 acre-ft (Michael Riley, Elephant Butte Irrigation District, written commun., 1996) (table 1; all tables are in the back of the report). Diversion into the Arrey Canal generally ranges from 200 to 300 ft^3/s during the irrigation season (mid-February to mid-October), which is about 10 percent of the mean daily discharge in the Rio Grande (fig. 3).

A complex system of canals moves irrigation water to individual fields in the Rincon Valley (fig. 2). Most canals are constructed above the level of the fields so water can be diverted into the fields by gravity. Water leaks from these canals because the canals are above the water table and are unlined. Part of this leakage recharges shallow ground water.

Not all water diverted from the Rio Grande for irrigation is used for crop irrigation. Leakage of water from irrigation canals to shallow ground water, evaporation from canal surfaces, and transpiration from plants along the canals, which together are referred to as canal losses, accounted for 29 to 57 percent of total water diverted in the Rincon Valley from 1930 to 1975 (Conover, 1954, p. 138; Wilson and others, 1981, p. 505-506). Because of cancellation of water deliveries after the water has been diverted into the irrigation system, 2 to 35 percent of the diverted water is returned to the river or the drains (canal-return flow). The amount of irrigation water delivered to farms ranged from 20 to 55 percent of the water diverted in the Rincon Valley from 1930 to 1975 (Conover, 1954, p. 138; Wilson and others, 1981, p. 505-506). Water applied to fields is consumed by crops (transpires or becomes plant biomass), evaporates from the soil, infiltrates and recharges shallow ground water, or flows across the fields and into a drain.

Drains were constructed in the Rincon Valley to maintain water levels below land surface by intercepting and draining off shallow ground water. The drains are open channels 10 to 15 ft below land surface. The five drains in the Rincon Valley that discharge water to the Rio Grande are the Fera Drain, Garfield Drain, Hatch Drain, Angostura Drain, and Rincon Drain (fig. 2). The Garfield, Hatch, and Rincon drains are the longest drains and drain most of the valley. The Hatch wastewater-treatment plant discharges into the Hatch Drain east of Hatch (fig. 2). Streamflow gages generally upstream from the mouth are operated by the EBID at sites on these drains (fig. 2). Hydrographs of mean daily discharge of the Garfield, Hatch, and Rincon Drains for 1993-95 are shown in figure 4.

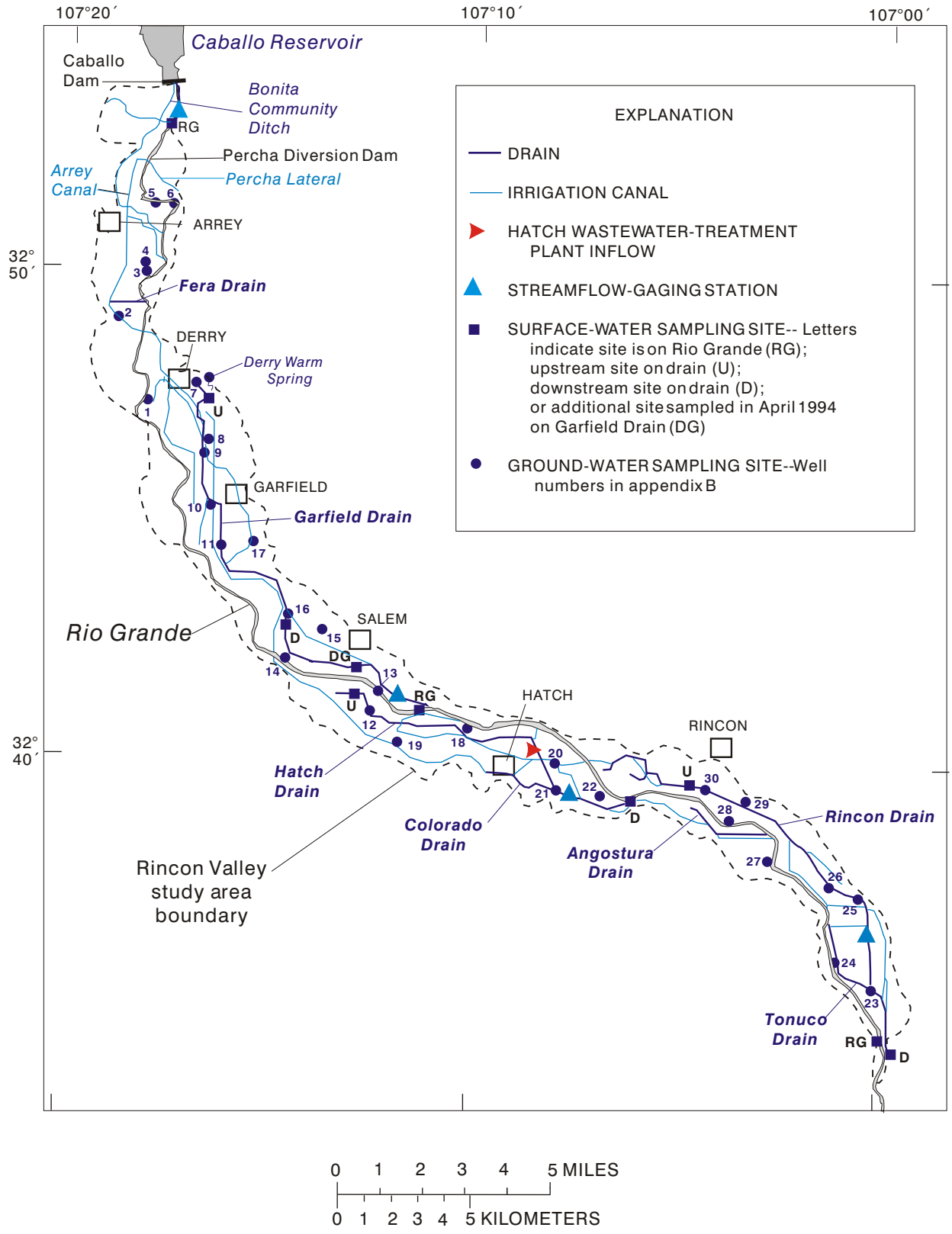

Figure 2. Location of major irrigation canals and drains and surface-water and ground-water sampling sites in the Rincon Valley study area.

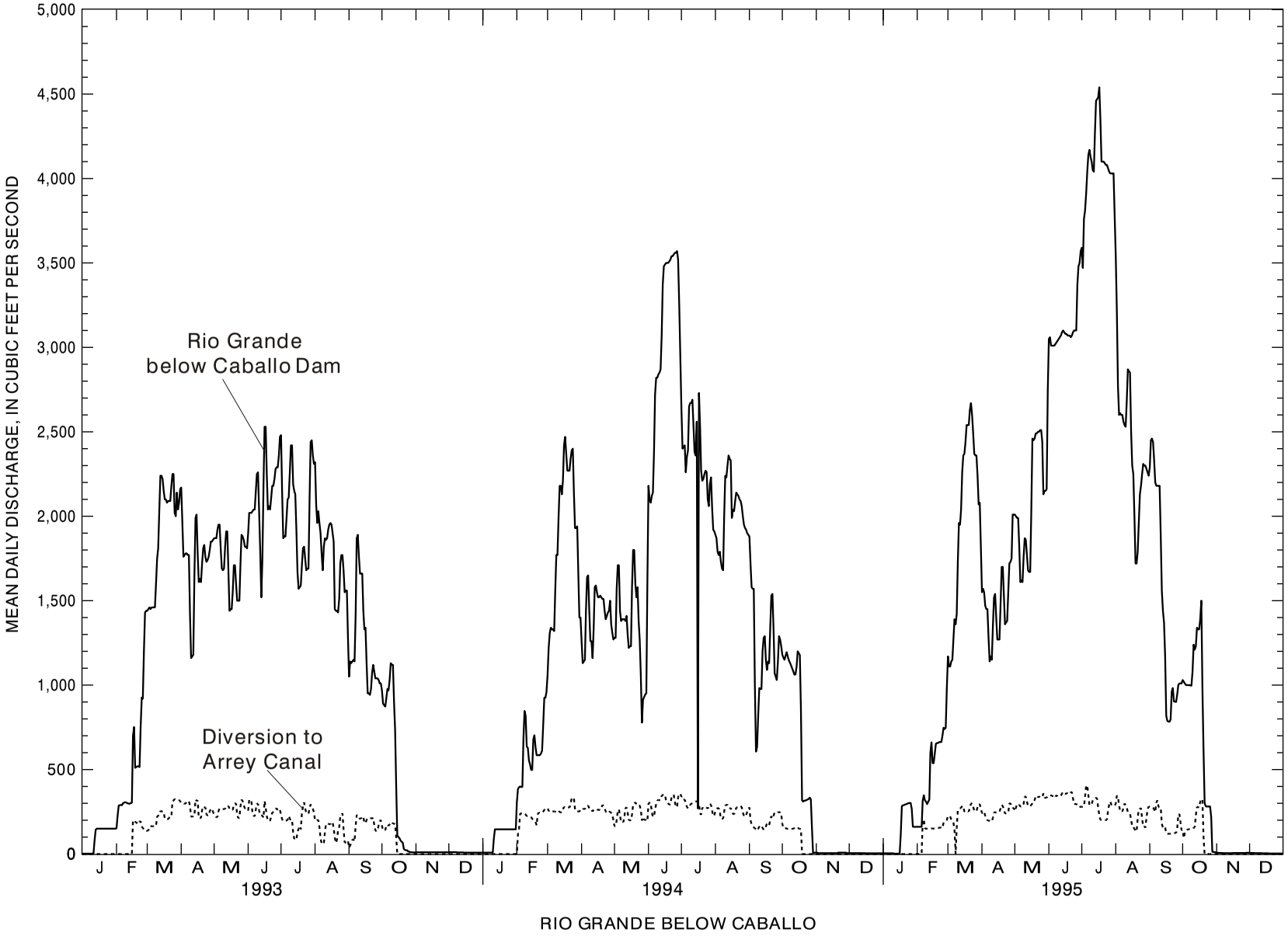

Figure 3. Mean daily discharge of the Rio Grande below Caballo Dam and diversions to Arrey Canal, 1993-95 (data from Elephant Butte Irrigation District).

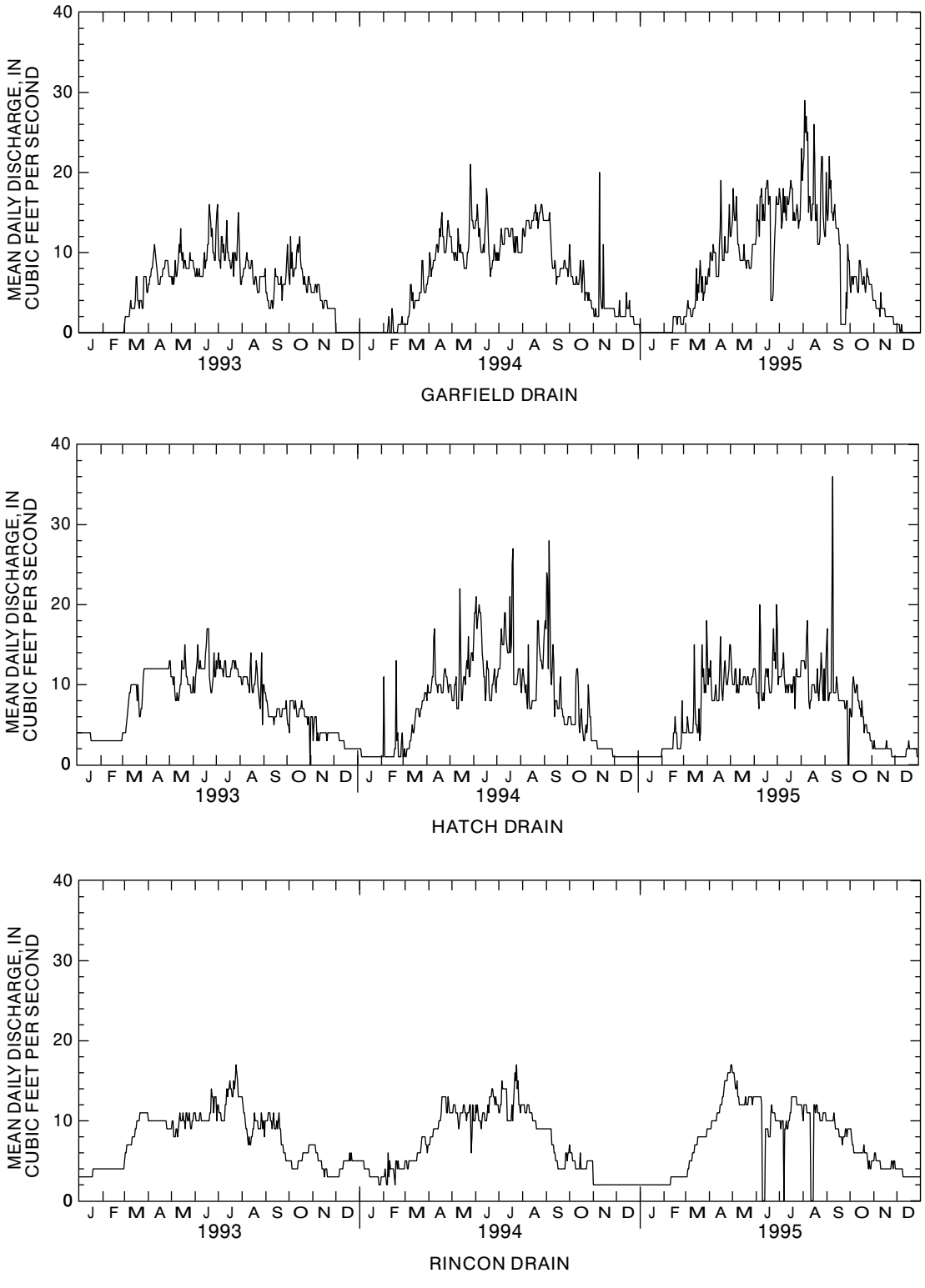

Figure 4. Mean daily discharge of the Garfield Drain, Hatch Drain, and Rincon Drain, 1993-95.

The hydrographs for the three main drains in the Rincon Valley show the largest amount of discharge generally in June, July, and August and the smallest amount of discharge in December, January, and February (fig. 4). Discharge increases from the beginning of March until June and decreases from August until December; discharge is relatively constant from December until March. Most of the discharge in the drains is due to ground-water discharge. The increase in discharge in the drains during the irrigation season suggests that ground water discharging to the drains is derived from infiltration of water diverted from the Rio Grande and that ground water moves toward and discharges to the drains soon after the irrigation diversions start. The relatively rapid increases in discharge for short periods of time during the irrigation season probably result from canal waste discharged to the drain or water applied to a field that runs off to a drain (tail water). The annual discharge at the gages for each drain is similar and did not vary substantially from 1993 to 1995 (table 1). The sum of annual discharge from the drains to the Rio Grande measured at the streamflow gages was about 15,000 acre-ft for 1993-95 (table 1). This is about 12 percent of the annual diversion to the Arrey Canal (table 1). Most discharge from the drains to the Rio Grande occurs during the irrigation season when discharge in the Rio Grande is greater than 1,000 ft^3/s. During the irrigation season, total discharge from the three drains to the Rio Grande is small (about 30 ft^3/s) relative to discharge in the Rio Grande.

Ground-Water Hydrology

The Rincon Valley is underlain by basin-fill deposits that can be divided into the Santa Fe Group of Tertiary age and the overlying valley-fill deposits of Quaternary age. The Santa Fe Group underlying the Rincon Valley consists of clay-sized material and does not yield substantial quantities of water (King and others, 1971, p. 17). This fine-grained facies is as much as 2,000 ft thick in the area near Hatch (King and others, 1971, p. 17). Most of the Rincon Valley is underlain by this fine-grained facies of the Santa Fe Group.

The Quaternary valley fill, which generally is less than 80 ft thick, consists of gravel, sand, silt, and clay-sized sediment and is the aquifer used in the Rincon Valley (King and others, 1971, p. 23-24). The areal extent of the Quaternary valley fill is limited to the Rincon Valley and the narrow arroyo channels adjacent to the valley. Conover (1954, p. 26) reported the average depth to clay or the Santa Fe Group to be less than 70 ft below land surface in the Rincon Valley. The lower 30 to 40 ft of the valley-fill deposits are relatively coarse grained; above this coarse-grained material there is much lateral variation in grain size and sorting of the deposits.

Ground-water recharge to the Quaternary valley-fill deposits is from infiltration of precipitation, water from the Rio Grande, and irrigation water and inflow of ground water from adjacent areas. Although there is some infiltration of precipitation, most recharge to the Quaternary valley-fill deposits is from infiltration of water from the Rio Grande, irrigation water in canals, and irrigation water applied to fields but not consumed by crops. Ground-water inflow from adjacent areas occurs along the area north and west of Caballo Dam, the arroyo channels adjacent to the Rincon Valley, the area west of Hatch (King and others, 1971, p. 58), and the Jornada del Muerto (King and others, 1971, p. 58; Wilson and others, 1981, p. 62).

Discharge of ground water from the Quaternary valley-fill deposits of the Rincon Valley is from ground-water discharge to the Rio Grande and drains, ground-water flow through Selden Canyon, ground-water pumpage, and evapotranspiration. Ground-water discharge to the Rio Grande and drains probably accounts for most of the total discharge of ground water from the Rincon Valley. Ground-water flow through Selden Canyon is probably small because of the limited thickness of Quaternary valley-fill deposits in the canyon (Conover, 1954, p. 78). Ground water removed from storage as the result of ground-water pumpage is replaced by infiltrating irrigation water because ground-water levels have not significantly changed in the Rincon Valley since installation of the drains. The net effect of ground-water pumpage is a reduction of drain flow in the area until water levels return to levels controlled by the drains. Evapotranspiration from ground water is probably limited to areas of native vegetation because most crops do not have roots extending to or below the zone of saturation.

Ground-water movement in the Rincon Valley is generally down the valley. In the shallow part of the Quaternary valley-fill deposits, the interaction of the Rio Grande, irrigation canals, irrigated fields, drains, and irrigation wells has created many localized flow systems. Ground-water flow in these localized systems

generally is from the irrigation canals or fields toward the drains or, in some cases, toward the Rio Grande.

Ground-Water/Surface-Water Relations

Infiltration of surface and (or) irrigation water is the main source of ground-water recharge to the ground-water system, and discharge of ground water to the drains and to the Rio Grande is the main source of discharge from the ground-water system; therefore, a change in surface-water supplies affects the ground-water system and discharge to the drains. Because of little variation in the amount of water diverted from the Rio Grande and discharge from drains from 1993 to 1995 (table 1), the surface-water and ground-water systems may have approached steady state. At steady state, recharge to the ground-water system may be approximately equal to discharge from the ground-water system.

The rapid increase in discharge in the drains at the beginning of the irrigation season (March), relatively large discharge in the drains during the irrigation season (March-October), rapid decrease in discharge in the drains after the irrigation season (October-November), and small discharge in the drains in December, January, and February (fig. 4) indicate that increases or decreases in ground-water recharge rapidly increase or decrease ground-water discharge to the drains. During sampling in April and October 1994 (irrigation season), discharge increased from the upstream to downstream sites on the Garfield, Hatch, and Rincon Drains (fig. 5), indicating ground-water discharge to the drains and (or) flow of tail water or canal-return flow into the drains. As previously discussed, the contribution of tail water and canal-return flow in the drains is thought to be small. Increases in drain discharge between the upstream and downstream sites (on the drains) generally were larger in April than in October, possibly because diversions and recharge generally were larger in April than in October (figs. 3, 4, and 5). The discharge in the drains decreased from August to December (fig. 4), probably in response to decreases in recharge and subsequent decrease in ground-water discharge to the drains, indicating that these drains quickly remove ground water from the ground-water system. In December and January discharge in the drains is at a minimum for the year (fig. 4) probably because of little ground-water discharge to the drains. During sampling in January 1994 and 1995, discharge in the Rincon Drain increased about 5 ft^3/s between the upstream and downstream sites (fig. 5), indicating ground-water discharge. In January 1994 and 1995, discharge at the upstream and downstream sites was essentially the same (fig. 5) on both the Garfield and Hatch Drains, indicating little or no ground-water discharge to either drain.

Ground water discharges into the Rio Grande when water is not being released from Caballo Reservoir. On January 5, 1994, streamflow measurements were made at 10 locations along the Rio Grande to quantify ground-water/surface-water interaction. These measurements were made in January because water had not been released from Caballo Reservoir since the middle of October (fig. 3), discharge from drains to the Rio Grande was at an annual minimum (less than or equal to 1 ft^3/s at the Garfield and Hatch Drains), and the amount of evaporation and transpiration was at an annual minimum. The streamflow measurements showed the largest ground-water discharges to be along the Rio Grande from Caballo Dam to about 24 mi downstream (near Hatch) (fig. 6). Discharge increased from about 5 to 40 ft^3/s in a distance of about 23 mi; thus, ground-water inflow was about 1.5 ft^3/s per river mi. The rate of inflow was relatively constant throughout this reach of the Rio Grande (fig. 6). Wilson and others (1981, p. 66) reported that ground-water inflow in this same reach was about 0.58 ft^3/s per mi in February 1974 and 1.2 ft^3/s per mi in January 1975.

The increase in discharge in the Rio Grande downstream from the site near Hatch to the site above the Rincon Drain (4 ft^3/s in about 14 mi) was much less than in the reach upstream from Hatch (fig. 6). The Hatch Drain also discharges into the Rio Grande in this reach, which increases discharge in the Rio Grande. On January 4, 1994, discharge to the Rio Grande from the Hatch Drain was about 0.4 ft^3/s or about 10 percent of the measured increase in discharge (4 ft^3/s). The rate of ground-water discharge to the Rio Grande between the Hatch and Rincon Drains is about 0.3 ft^3/s per river mi. Wilson and others (1981, p. 66) reported a slight gain in this reach in February 1974 and a slight loss in January 1975.

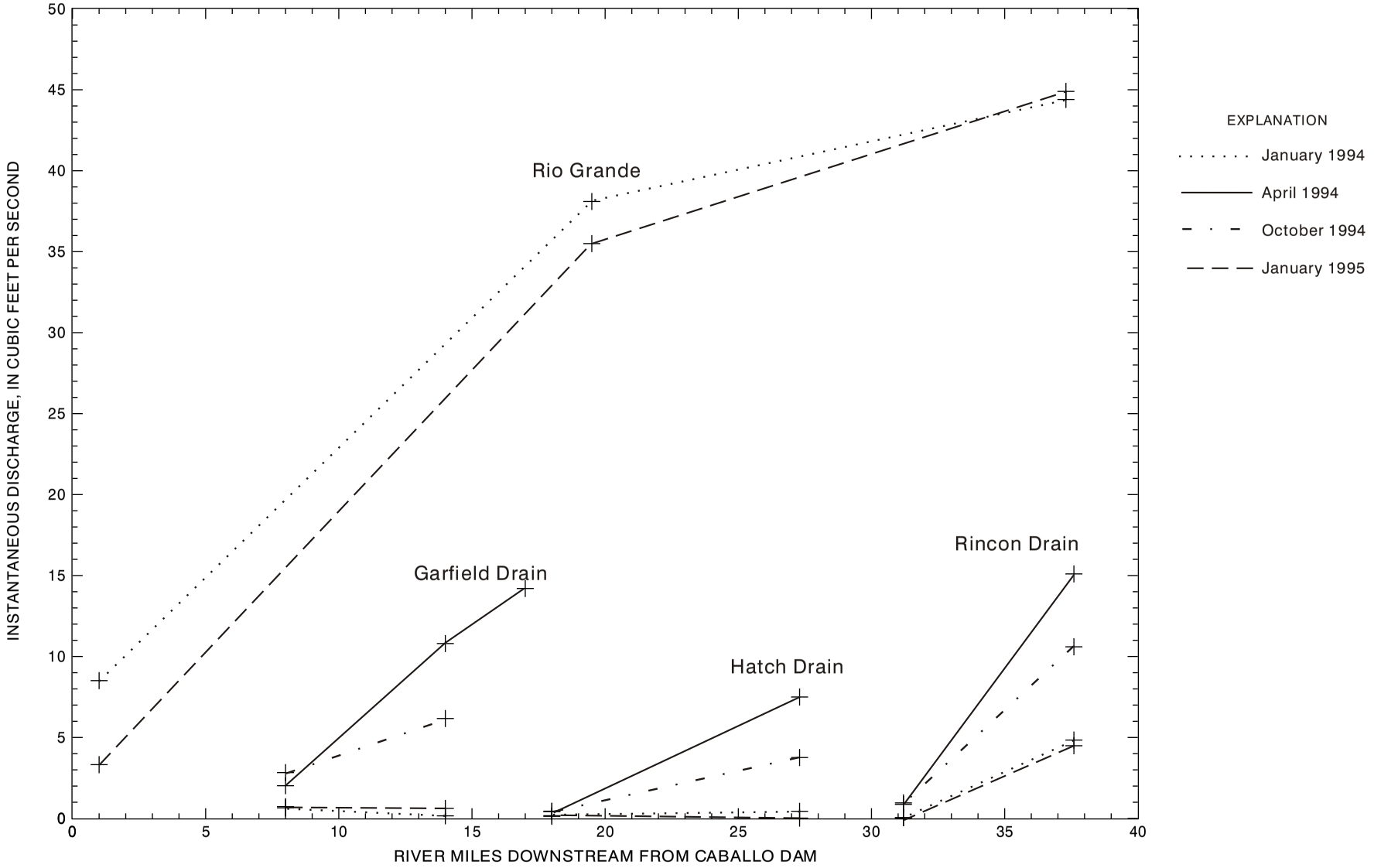

Figure 5. Relation between instantaeous discharge and river miles downstream from Caballo Dam, 1994-95.

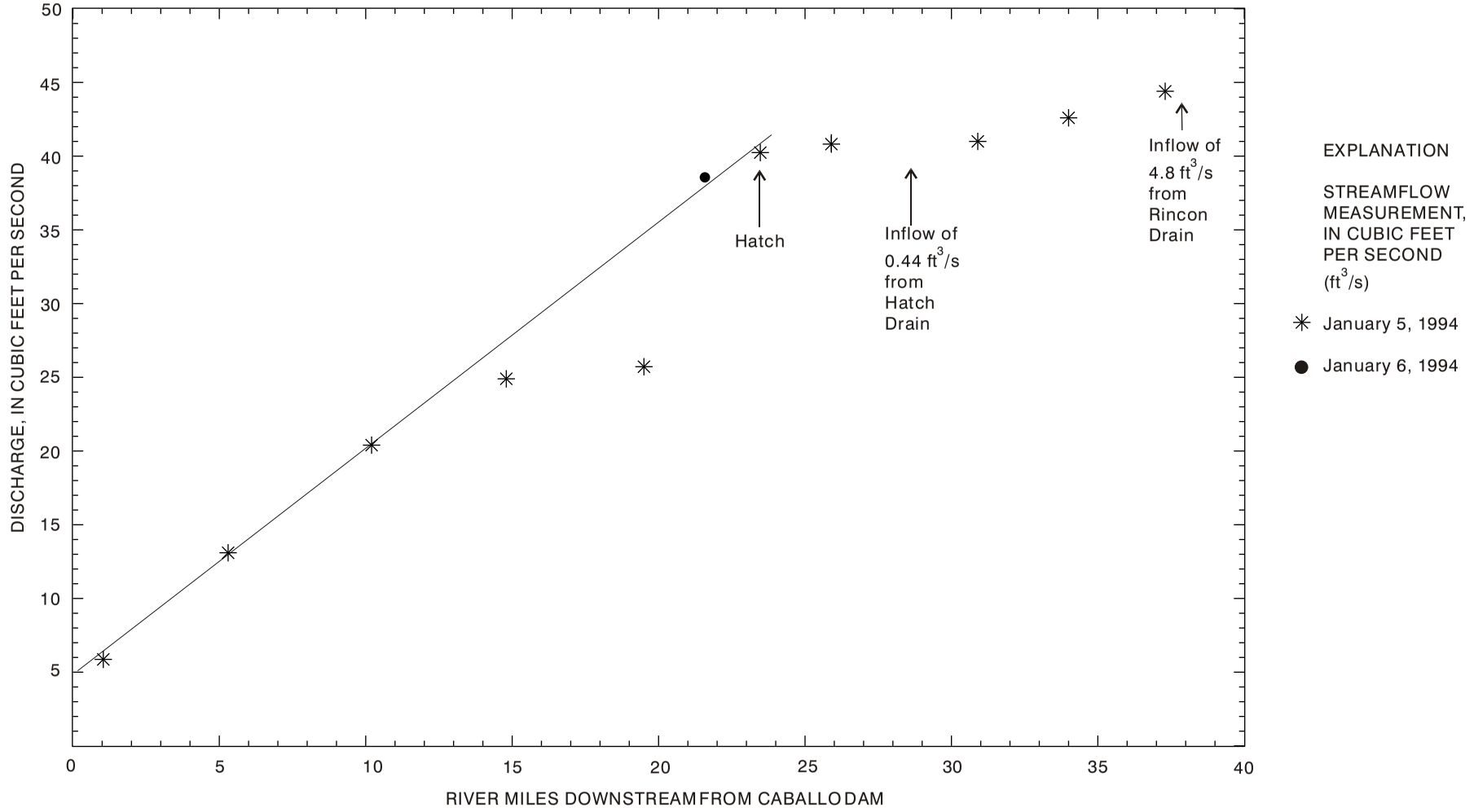

Figure 6. Instantaneous discharge at selected sites on the Rio Grande, January 5 and 6, 1994.

The increase in discharge in the Rio Grande from Caballo Dam to near Hatch due to ground-water discharge and a lack of ground-water discharge to the Garfield Drain probably mean that the Rio Grande drains the ground-water system in this part of the Rincon Valley during the winter months or nonirrigation period. The altitude of the river channel could be much lower than that of the channels of the drains, which would cause ground water to move toward the Rio Grande and water in the drain to infiltrate and recharge the ground-water system in this part of the Rincon Valley.

Land Use/Land Cover

Land use/land cover in the Rincon Valley is predominantly agricultural but also includes the categories residential, urban, vacant, roadways, and water. An aerial photograph of the Salem area shows that nonagricultural land use/land cover generally occupies little of the area and is generally surrounded by agricultural land use (fig. 7). Agricultural land use can be characterized as areas with flood-irrigated crops. Most of the area south and west of Salem in figure 7 can be characterized as agricultural land use. In most of the Rincon Valley, homes representing residential land use are located on small parcels (less than one-half acre) surrounded by fields. Home sites can be identified in figure 7 by areas where fields surround buildings and trees. Urban areas in the Rincon Valley include Arrey, Derry, Garfield, Salem, and Hatch (fig. 2). Hatch, which had a population of 1,136 in 1990 (U.S. Department of Commerce, 1991), is the largest urban area in the Rincon Valley. Vacant land includes the area between the levees that bound the Rio Grande (fig. 7), areas of the arroyo channels that enter the Rincon Valley, and areas of native vegetation that are not irrigated. These areas are found throughout the Rincon Valley, but, with the exception of the area between the levees, do not represent large, contiguous land areas. The water land-use/land-cover category includes the Rio Grande, main canals, and drains.

The main crops grown in the Rincon Valley are alfalfa, peppers, onions, wheat, cotton, and pecans (table 2). Planting dates vary for these different crops; for example, peppers and cotton are generally planted in late March to early April, whereas some varieties of wheat are planted in October. Fields planted in alfalfa are generally left in alfalfa for several years. Pecan orchards take several years to establish and once established are generally not used for production of other crops. Typical crop rotation in the Rincon Valley is 2 years of peppers or onions followed by 1 year of wheat or other grains.

Fertilizer generally is applied to crops several times during the year. In the spring prior to or during planting, fertilizer is applied or mixed into the soil. If fertilizer is needed during the growing season, it generally is added to irrigation water. This is generally done by pumping or siphoning liquid fertilizer into the irrigation canals used to irrigate the specific field.

The amounts of specific pesticides used in the Rincon Valley are unknown. Although many pesticides are labeled for specific crops that are grown in the Rincon Valley, little information is available concerning particular pesticides used in the valley.

STUDY DESIGN

To assess the quality of water in the Rincon Valley and determine factors affecting water quality, samples of surface water, ground water, and bed material (sediment in channels of drains) were collected and analyzed for a variety of constituents. During collection of surface-water and ground-water samples, specific conductance, pH, temperature, dissolved oxygen, and alkalinity (field properties) were measured in the field. Surface-water and shallow ground-water samples were sent to the USGS National Water Quality Laboratory (NWQL) for analysis of common constituents, nutrients, organic carbon, trace elements, and pesticides (tables 3 and 4). Pesticides were analyzed using two methods (Zaugg and others, 1995; Werner and others, 1996) and are grouped as A or B in tables 3 and 4 depending on which method was used for analysis. Shallow ground-water samples were also analyzed for radioactivity, 18 samples were analyzed for radon-222, and 20 samples were analyzed for volatile organic compounds (VOC's) (table 4). Samples of bed sediment were collected at the downstream sampling sites on each drain in January 1995 for analysis of 21 pesticides or pesticide metabolites, gross polychlorinated biphenols (PCB's), and gross polychlorinated naphthalenes (PCN's) (table 5). The pesticide metabolites dacthal mono-acid; DDD; deethyl atrazine; 2,6, -diethylaniline; and p,p'-DDE are also included in tables 3, 4, or 5. Although DDD and p,p'-DDE were occasionally used as pesticides, in this

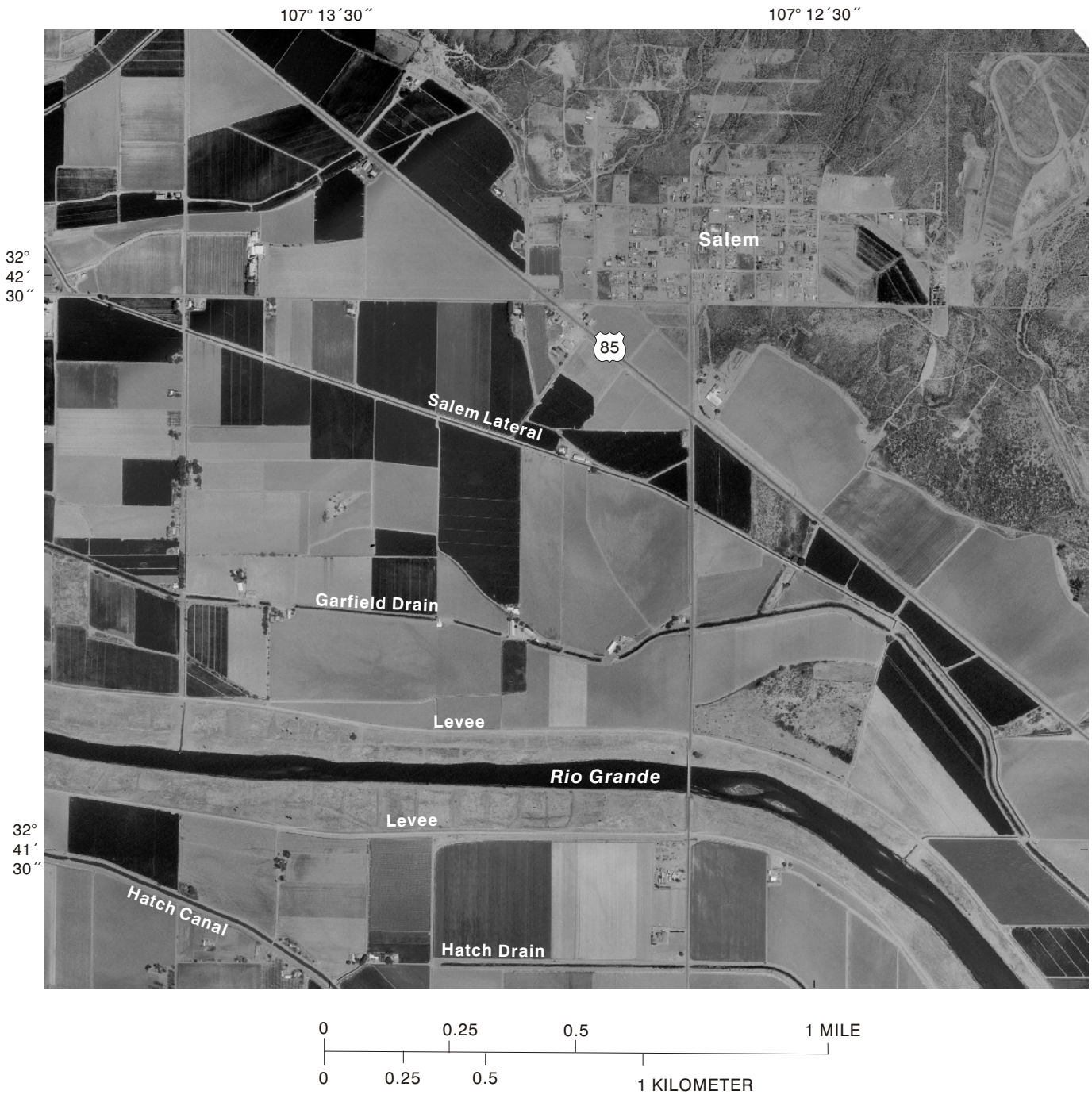

Figure 7. Land use/land cover in part of the Rincon Valley.

report they are referred to as pesticide metabolites. Water-quality data are presented in appendixes A, B, and C. Only VOC's and pesticides that were detected in one or more samples are included in the appendixes.

Samples were collected from three sites on the Rio Grande (fig. 2) to characterize water that enters the Rincon Valley and is used for irrigation and to determine changes in water quality as water moves in the Rio Grande through the Rincon Valley. Surface-water samples were collected from an upstream (near the beginning of the drain) and downstream (near the mouth of the drain) site on the Garfield, Hatch, and Rincon Drains (fig. 2) to determine variations in the quality of water in drains throughout the Rincon Valley. These drains were sampled because they traverse a large part of the Rincon Valley, and water in them represents ground-water discharge from areas adjacent to the drain.

Surface-water samples were collected during January 1994, April 1994, October 1994, and January 1995 to characterize water quality during three different hydrologic conditions or seasons. During sampling in January 1994 and 1995, no water was released from Caballo Reservoir for irrigation and most flow in the Rio Grande was the result of ground-water and drain discharge. During sampling in April 1994, flow in the Rio Grande and the drains was near the maximum for the year, most of the crops were planted, and the farmers were irrigating crops throughout the Rincon Valley. During the October 1994 sampling, water was being released from Caballo Dam, flow in the drains was decreasing, and most crops were not being irrigated.

Samples of shallow ground water were collected from 30 wells, installed during this investigation, to characterize the quality of recently recharged ground water. Well screens were located at or just below the water table to ensure that water from the upper part of the ground-water system (recently recharged water) was sampled.

Ground-water samples were collected from April 18 to May 7, 1994. Although this is early in the growing season for some crops, many of the fertilizers and pesticides used are incorporated into the soil prior to planting and could be leached by irrigation water to the ground-water system early in the irrigation season. Therefore, sampling shallow ground water early in the irrigation season may increase the probability of detecting agricultural chemicals in ground water because of the suspected rapid movement of irrigation water to the ground-water system.

Composite samples of bed material were collected at the downstream sampling site on the drains in January 1995 for analysis of 21 pesticides or pesticide metabolites, PCB's, and PCN's. Pesticides in bed material at the mouth of the drains could be the result of sediment transport from fields to the drains or the result of absorption of pesticides from water in the drains or ground water moving through the bed of the drains.

Methods

Methods used during this study also were used by personnel of the other NAWQA study units to ensure that data collected for the NAWQA Program are compatible. These methods are discussed in detail in Horowitz and others (1994), Shelton (1994), Koterba and others (1995), and Lapham and others (1995).

Well Site Selection

To prevent bias in the data, the locations of possible sites where wells would be installed for shallow ground-water sampling were determined using a computer program that randomly selected the locations (Scott, 1990). The area of study was delineated on a map to include the Rincon Valley from Caballo Dam to the upper part of Selden Canyon (fig. 1). Land use within the study area was grouped into two categories: agricultural or nonagricultural. Agricultural land use included small areas of residential, urban, vacant, roadways, and water land use/land cover because the areas generally were small and surrounded by agricultural land use. Nonagricultural land use included the urban area of Hatch, an area of native vegetation east of Hatch, and the area between the levees that border the Rio Grande where crops generally are not grown.

The area of agricultural land use was divided into 30 cells of equal size using a computer program (Scott, 1990) (fig. 8). A primary and three alternate sites in each agricultural land-use cell were then randomly selected from a population of 28 to 39 possible points in each cell. The land owner of the primary or alternate site was contacted; if a location at or within 500 ft of the site was acceptable, a well was installed.

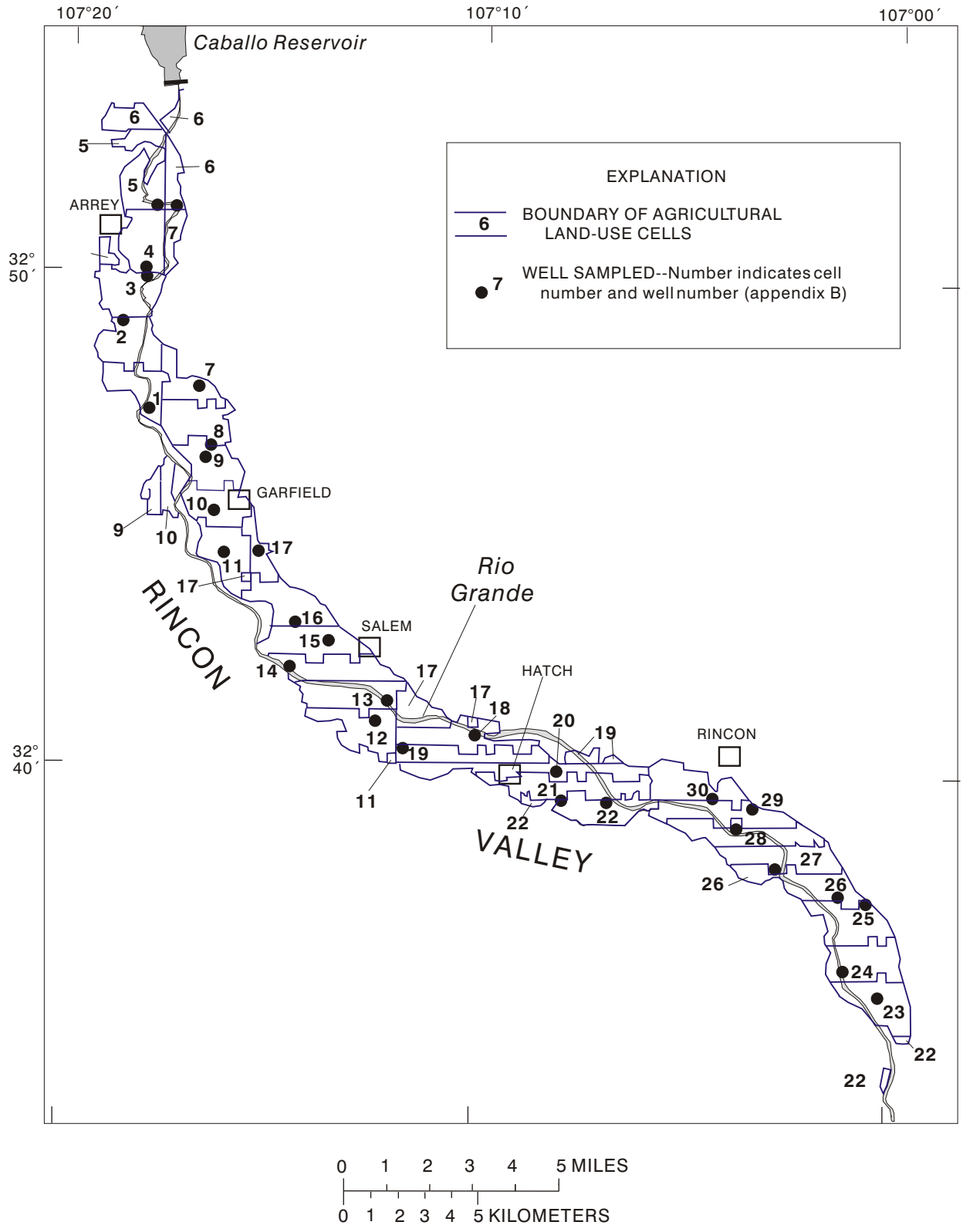

Figure 8. Location of agricultural land-use cells and wells sampled in the Rincon Valley study area.

Well Installation

Wells were installed in March 1994 using a hollow stem auger following protocols outlined by Lapham and others (1995). A hole was augured to a depth of about 10 ft below the top of the zone of saturation. The wells were constructed using 2-in. PVC pipe and 10 ft of PVC well screen. The top of the well screen was set at the top of the zone of saturation. The wells were developed within 2 weeks of installation and allowed to stand for 2 to 3 weeks prior to sampling. Well numbers were assigned to each well on the basis of the agricultural land-use cell in which the well was located (fig. 8 and app. B).

Water Sampling

The equal-width-increment sampling method and a DH-81 1-liter teflon bottle sampler were used to collect most surface-water samples following protocols outlined by Shelton (1994). The samples for dissolved organic carbon (DOC), total organic carbon, or suspended organic carbon analysis were collected by submerging a sample bottle below the water surface at the center of flow. Ground water was sampled using a 1.8-in.-diameter stainless steel pump and teflon discharge lines following protocols outlined by Koterba and others (1995). The pump was set at a depth 2 to 5 ft below the initial water level in the well. After three casing volumes of water had been pumped from the well, specific conductance, pH, temperature, dissolved oxygen, and turbidity were monitored until these field properties stabilized (generally less than 10-percent variation). When the field properties had stabilized, samples were collected. Samples for analysis of common constituents, nutrients, DOC, trace elements, and radioactivity were filtered using a 0.45-micron pore-size filter. Samples for pesticide analysis were filtered using a 0.7-micron pore-size baked glass fiber filter. VOC samples were not filtered but were preserved using 2 drops of concentrated hydrochloric acid. After collection of samples, sampling equipment was cleaned following protocols outlined by Shelton (1994) and Koterba and others (1995), and the clean equipment was stored in plastic bags.

Bed-Material Sampling

Composite samples of bed material were collected by obtaining subsamples at several locations across the channel of a drain. A plastic tube was pushed into the bed material to a depth of about 3 in. to obtain subsamples. Subsamples were placed in a 0.5-liter jar until the jar was filled. The jar was then chilled, stored, and shipped on ice to the NWQL. The sampling tube was cleaned after drain sampling using the same procedure as that used for the surface-water sampling bottles (Shelton, 1994).

U.S. Geological Survey National Water Quality Laboratory Methods

All samples were analyzed at the USGS NWQL. The methods used for analysis of common constituents and nutrients are outlined in Fishman (1993). Trace elements were analyzed by inductively coupled plasma/mass spectrometer techniques (Faires, 1993). Gross alpha and gross beta analytical methods are described in Thatcher and others (1977). Radon-222 was analyzed by liquid scintillation counting. Methods used for analysis of VOC's are described in Rose and Shroeder (1995). Group A pesticides were analyzed by the C-18 solid-phase extraction method (Zaugg and others, 1995), and group B pesticides were analyzed by the Carbopak-B solid-phase extraction method (Werner and others, 1996). Methods used for analysis of pesticides in bed sediment are described in Wershaw and others (1987). The NWQL has a quality-assurance program (Friedman and Erdmann, 1982; Pritt and Raese, 1992), but the specifics of the program are not addressed in this report.

The minimum reporting level (MRL) or method detection limit (MDL) for each constituent is determined by the analytical methods used. The MRL is the lowest measured concentration of a constituent that may be reliably reported using a given analytical method (Timme, 1995, p. 92) and is used when documentation of an analytical method is not available. The MDL's in tables 3 and 4 were defined and determined at the NWQL (Zaugg and others, 1995; Peter Rogerson, National Water Quality Laboratory, written commun., 1996). An MDL is the minimum concentration of a particular analyte that can be identified, measured, and reported with 99-percent confidence that the analyte concentration is greater than zero (Zaugg and others, 1995). In some samples, a particular pesticide was positively identified at a concentration less than the MDL; for these samples, the concentration of the pesticide was estimated and the confidence in the concentration measured is less than 99 percent. Constituents that were not measured at a

concentration equal to or greater than the MRL or MDL or were not positively identified in a sample are referred to as not detected.

Quality Assurance/Quality Control of Data

A quality-assurance program allowed evaluation of the data to ensure that the sampling procedures and characteristics of the water sampled (matrix bias or interferences) were not resulting in poor-quality data. Field-blank samples, replicate samples, and spike samples were collected as part of the quality control used in this investigation. The results of the quality-assurance program presented are a compilation of all quality-assurance samples (surface-water and ground-water samples) collected during this investigation.

Seven field blanks were collected and sent to the NWQL to ensure that chemical constituents were not being introduced into samples as the result of sampling and laboratory procedures. Field blanks were collected using surface- and ground-water sampling equipment following protocols described in Shelton (1994) and Koterba and others (1995).

Results of the field-blank samples indicate that many of the constituents were not detected or were detected at concentrations significantly smaller than those detected in the surface-water and ground-water samples (table 6). This indicates that the sampling and laboratory procedures used did not result in the addition of these chemical constituents to the samples at concentrations that would have an effect on interpretation of the surface-water and ground-water data. Nitrite, ammonia, phosphorus, aluminum, chromium, iron, zinc, and methylchloride were detected in the field-blank samples (table 6) at concentrations near the MRL and in about the same range as concentrations detected in some of the surface-water or ground-water samples. Nitrite, phosphorus, and iron were detected only in one of seven field-blank samples at concentrations equal to or slightly greater than the MRL, indicating that these constituents were infrequently added to the samples as a result of sampling or laboratory procedures. Ammonia, aluminum, and zinc were detected in more than one-half of the blank samples at concentrations similar to those detected in many of the surface- and ground-water samples, indicating that samples were commonly contaminated. Ammonia concentrations in the surface- and ground-water samples greater than 0.06 mg/L (two to three times higher than the concentrations in the blanks (0.02 mg/L)) are indicative of ammonia in the samples; however, concentrations smaller than 0.06 mg/L in the surface- or ground-water samples could be due to contamination. All aluminum and zinc concentrations measured in the surface- and ground-water samples could be the result of sample contamination; thus, they are not discussed in this report. Methylchloride was detected in both field-blank samples at concentrations similar to those detected in ground-water samples, so methylchloride was probably introduced into the samples during sampling or in the laboratory and is not present in ground water. Because methylene chloride was not detected in any ground-water samples, methylene chloride was probably in the organic-free water used to prepare the field blanks (table 6).

Replicate samples are two samples split from one sample. Seven pairs of replicate samples were sent to the NWQL to determine precision of sampling procedures or laboratory procedures for an individual sample site. The relative-percent difference was calculated for each pair of replicates. Relative-percent difference is the difference in the concentration of an analyte in the two samples divided by the average concentration of the two samples multiplied by 100. Minimum, median, and maximum relative-percent differences for constituents analyzed in the replicates are presented in table 7. Comparison of analytical results for the replicate samples shows that the median relative-percent difference was zero for most constituents, indicating good precision of the sampling and laboratory procedures. The trace elements chromium, copper, and nickel had some of the largest relative-percent differences. The measured concentrations of these trace elements are in the same range as the MRL or MDL. For these constituents, the differences in concentrations in the replicate samples could be from the analytical procedures used.

Surrogate compounds, which are generally not found in the environment, were added at the time of collection to all surface- and ground-water pesticide samples to determine the precision and accuracy of the analytical methods. Several surface- and ground-water samples were spiked in the field or in the laboratory (field or laboratory spikes); most of the pesticides or VOC's were analyzed for to evaluate the accuracy and precision of the analytical method for different compounds in different sample matrixes and to evaluate degradation of compounds during shipping and handling of the samples. Surrogate (or spike)

recoveries less than 100 percent indicate that not all the surrogate (or spike) added to the sample is detected (results biased low), and recoveries greater than 100 percent indicate that concentrations detected in the sample are larger than the actual concentration in the sample (results biased high).

For the three surrogates used for the group A pesticide analysis, surrogate recoveries ranged from 68 to 132 percent (app. A and B), indicating acceptable method performance. The surrogate recovery for the surrogate used for group B pesticides ranged from 0 to 110 percent (app. A and B). The relatively small surrogate recoveries for group B pesticides are not necessarily indicative of poor performance of the method because "the surrogates chosen did not perform as expected for a variety of reasons, including co-elution with target analytes, natural background concentration, and poor reproducibility" (U.S. Geological Survey National Water Quality Assessment/ National Water Quality Laboratory Quality Assurance Committee, written commun., 1995). The results for group B pesticides could be biased low on the basis of the surrogate recoveries.

The median percent recovery for most of the spiked compounds for group A pesticide analyses ranged from 75 to 120 percent (table 8), indicating little bias in the analytical results. Many of the spiked compounds used in the samples for group B pesticide analyses (table 9) had relatively small recoveries. Low spike recoveries were found in samples submitted to the laboratory for group B pesticides analysis from throughout the country, and the low spike recoveries were evaluated by a quality-assurance committee (U.S. Geological Survey National Water Quality Assessment/National Water Quality Laboratory Quality Assurance Committee, written commun., 1995). The quality-assurance committee determined that the recovery and precision for all compounds with the exception of aldicarb, aldicarb sulfone, carbaryl, carbofuran, methiocarb, 1-napthol, and oxamyl "generally are high enough and consistent enough that the data are acceptable for publication and useful for data analysis" (U.S. Geological Survey National Water Quality Assessment/National Water Quality Laboratory Quality Assurance Committee, written commun., 1995). The low spike recoveries could indicate that the results for group B pesticides are biased low.

The results of the six VOC spike samples show that the percent recovery for the laboratory spikes ranged from 70 to 115 and for the field spikes and field spike replicates ranged from 30 to 85 percent (table 10). The smaller percent recovery for the field spikes could be due to the procedures used in the field relative to the procedures used in the laboratory or to degradation of compounds during shipping and handling prior to analysis. If the smaller recoveries in the field spikes relative to laboratory spikes are the result of degradation of compounds during shipping, the results of the VOC analyses could be biased low.

The results for the spike samples (pesticides and VOC's) indicate that the methods used were appropriate for most compounds and no significant degradation of compounds occurred during shipping and handling. Spiked compounds that have percent recoveries less than 100 percent may be present in the unspiked samples and not be detected, or the concentrations measured in a sample may be smaller than the actual concentration in the sample (biased low). If recovery of a compound in the spiked samples was consistently greater than 100 percent and the compound was detected in an unspiked sample, the reported concentration in the unspiked sample could be larger than the actual concentration in the sample (biased high).

SURFACE-WATER QUALITY

Surface-water-quality standards for the Rio Grande, which are based on the designated uses of water in the stream reach (New Mexico Water Quality Control Commission, 1994), are compared to surface-water quality in the Rincon Valley in the following section. For the reach of the Rio Grande from below Caballo Dam to 1 mi below Percha Diversion Dam, the designated uses include irrigation, warm-water fishery, livestock watering, wildlife habitat, and primary contact recreation (New Mexico Water Quality Control Commission, 1994, p. 13). For the reach of the Rio Grande from 1 mi below Percha Diversion Dam to the southern end of the Rincon Valley, the designated uses include irrigation, limited warm-water fishery, livestock watering, wildlife habitat, and secondary contact recreation (New Mexico Water Quality Control Commission, 1994, p. 13). Each designated use has standards for specific constituents; some constituents could be included in the standards for several designated uses. For the constituents analyzed for during this investigation, the standards for the two

different reaches are essentially the same with the exception of pH and temperature (table 11). No State water-quality standards have been established for water in drains. Water quality in the drains is compared to the standards (table 11), however, because discharge from the drains can affect water quality in the Rio Grande. The standards applicable to a particular river reach with several use designations are those that protect and sustain the most sensitive case, which in the Rincon Valley are the fisheries standards (New Mexico Water Quality Control Commission, 1994). Fisheries standards include both acute and chronic standards. Acute standards are designed to protect most species from deleterious effects of contaminants for short periods of time, are applied to single grab samples, and shall not be exceeded. Chronic standards are designed to protect most species from deleterious effects from contaminants for extended periods of time, are applied to the arithmetic mean concentration of four samples collected on each of 4 consecutive days, and shall not be exceeded more than once every 3 years (New Mexico Water Quality Control Commission, 1994, p. 50). Because samples were not collected on 4 consecutive days during this investigation, data in this report cannot be compared to chronic standards.

Field Properties and Common Constituents

Specific conductance, a measure related to dissolved-solids concentration, was generally larger in samples from the drains than in samples from the Rio Grande (app. A). The pH was generally larger in samples from the Rio Grande than in samples from the drains. In January, the pH generally increased downstream in the Rio Grande; in April and October there was no clear change in pH downstream. Water temperature was similar in the Rio Grande and in the drains and varied depending on the time of year (warmer in the summer). Dissolved oxygen concentrations showed relatively large variation during different sampling events at a particular site (app. A). In general, dissolved oxygen concentrations were larger in water from the Rio Grande than in water from the drains. At all sites, except those on the Garfield Drain, dissolved oxygen concentrations were about 1 mg/L or more larger in January 1994 and 1995 than in April 1994 or October 1994.

No samples from the Rio Grande or the drains exceeded surface-water-quality standards for pH or temperature. Dissolved oxygen was less than the standard of 5 mg/L in five samples from the drains.

Dissolved-solids concentrations in surface water ranged from 434 to 1,510 mg/L (table 12). Concentrations were smallest in water from the Rio Grande below Caballo Dam and largest in water from the drains (app. A). Dissolved-solids concentrations in the Rio Grande increased downstream from Caballo Dam during all sampling events; the largest increases were in January 1994 and 1995 (fig. 9). On the Hatch and Rincon Drains, dissolved-solids concentrations also were smaller at the upstream sampling sites than at the downstream sampling sites during all sampling events (fig. 9). The dissolved-solids concentration increased downstream in the Garfield Drain in October 1994 and January 1995, but decreased in January 1994 (fig. 9). In April 1994, an additional site near the lower end of the Garfield Drain was sampled; the dissolved-solids concentration increased in the upper reach and decreased in the lower reach. In general, the largest increases in concentration between the upstream and downstream sampling sites were in water from the Hatch and Rincon Drains; the dissolved-solids concentration in water from the drains was largest in January. The smallest temporal variation in dissolved-solids concentration at a sampling site was at both sampling sites on the Hatch Drain and at the upstream site on the Rincon Drain (fig. 9).

The concentrations of common constituents in surface-water samples (fig. 10 and table 12) varied widely. In general, the relative variation in dissolved-solids concentration at a given site is similar to the relative variation of individual common constituents. Sulfate generally had the largest concentrations and the most variation of the common constituents in surface-water samples (fig. 10 and table 12). Bicarbonate and sodium had the next largest concentrations. Concentrations of magnesium, potassium, carbonate, fluoride, and silica were smaller than concentrations of the other common constituents (less than 40 mg/L) in all samples (fig. 10 and table 12). The largest sulfate concentrations generally were in samples from the downstream sampling site on the Rincon Drain. Sodium, potassium, and fluoride concentrations generally were largest in samples from the upstream

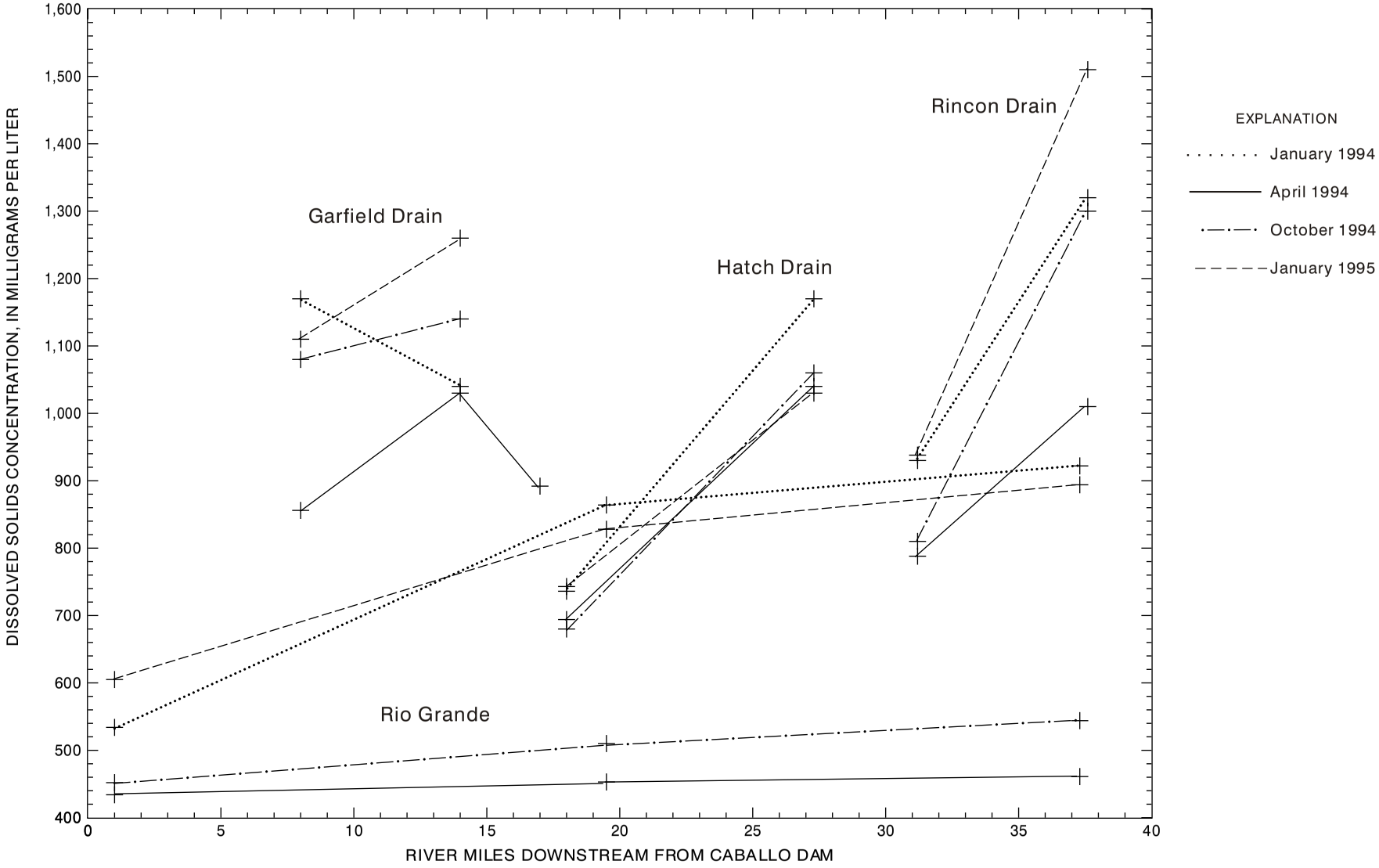

Figure 9. Relation between dissolved-solids concentration in surface water and river miles downstream from Caballo Dam, 1994-95.

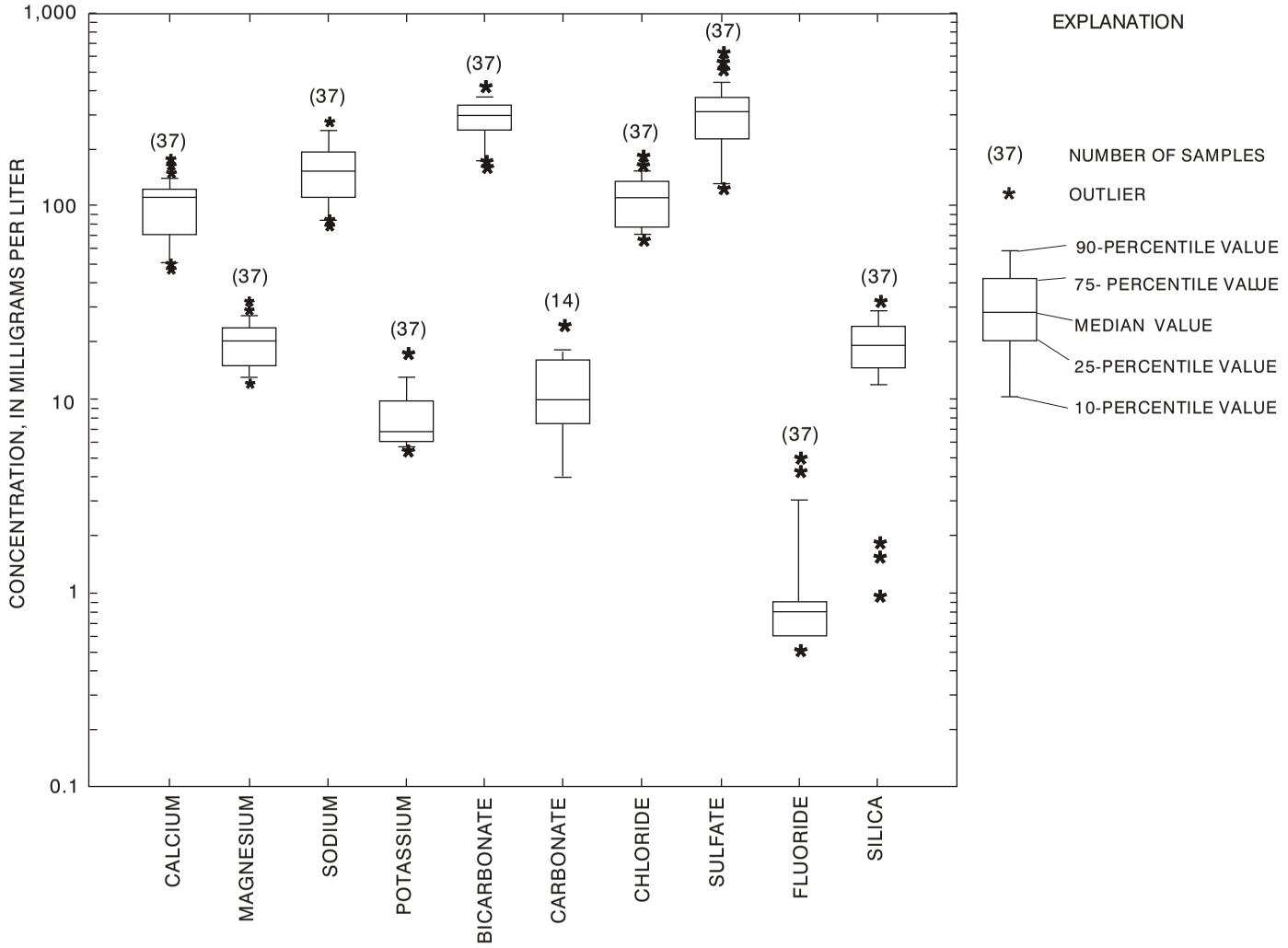

Figure 10. Distribution of selected constituent concentrations in surface water in the Rincon Valley study area.

sampling site on the Garfield Drain (app. A). The largest silica concentrations were generally from the downstream Hatch Drain site. Silica concentrations in samples collected from all sites on the Rio Grande in April 1994 were about 10 times smaller than any other silica concentrations measured during this investigation.

A Durov plot of water compositions shows variations in the percentage of different anions and cations in each water sample (fig. 11) and can be used to compare the compositions of a large number of samples. The plot consists of two trilinear diagrams that represent concentrations as percentages of major cations or anions (in milliequivalents per liter) as a point in each respective trilinear diagram. Projections of the data points from the two trilinear diagrams to the central rectangular plot intersect to define a point that represents the major ion composition of each sample. Projections from the central rectangular plot to two adjacent rectangular plots are used to represent variations in major compositions of the chosen constituents, in this case dissolved solids.

In the Durov plot, most of the water has a similar distribution of cations and anions, and the distribution of cations does not change systematically with variations in dissolved-solids concentrations. However, the distribution of anions does change systematically with variations in dissolved-solids concentration (fig. 11). Calcium and sodium account for about equal percentages of total cations (40 percent). Magnesium was similar (about 20 percent) in all samples. Sulfate and bicarbonate plus carbonate account for about equal percentages of the total anions (40 percent). Six samples had percentages of calcium less than 30, which generally were less than the percentage of calcium in most samples; four of these samples were from the upstream sampling site on the Garfield Drain and the other two samples were from the Rio Grande below Caballo Dam in January of 1994 and 1995. Samples with larger dissolved-solids concentrations generally have larger percentages of sulfate and smaller percentages of bicarbonate plus carbonate (fig. 11).

Nutrients and Dissolved Organic Carbon

The concentrations of dissolved nutrient species in surface water in the Rincon Valley varied considerably. Nitrite plus nitrate concentrations ranged from less than 0.05 to 3.3 mg/L as nitrogen, and dissolved ammonia concentrations ranged from less than 0.015 to 0.33 mg/L as nitrogen in surface-water samples (table 12 and app. A). Nitrite concentrations were generally small (less than 0.11 mg/L as nitrogen), indicating that nitrite accounts for a small amount of nitrogen in the nitrite plus nitrate analyses.

Nitrite plus nitrate concentrations generally were larger in samples collected from the drains than in samples collected from the Rio Grande (fig. 12). At sampling sites on the drains, nitrite plus nitrate concentrations generally were largest in water from the downstream sampling site on the Hatch Drain and smallest in water from the sampling sites on the Rincon Drain (fig. 12). Nitrite plus nitrate concentrations generally increased downstream on the Hatch and Rincon Drains and decreased downstream in the Garfield Drain. Concentrations in samples from the Rio Grande in April and October (irrigation season) were smaller than concentrations in January (nonirrigation season).

Ammonia concentrations generally were larger in samples from the drains than from the Rio Grande (app. A). In the Rio Grande, ammonia concentrations were less than 0.1 mg/L as nitrogen and did not vary consistently with time of year or between sampling sites (app. A). The largest ammonia concentrations were in samples from the upstream and downstream sampling sites on the Hatch Drain in January 1995 and the downstream sampling site on the Hatch Drain in January 1994. Ammonia concentrations increased downstream during all sampling periods at the two sites on the Rincon Drain (app. A), but showed no clear trend between the upstream and downstream sampling sites on the other two drains.

The surface-water-quality standard for total ammonia varies depending on the pH and temperature of the sample (New Mexico Water Quality Control Commission, 1994, p. 48). No samples were collected for analysis of total ammonia so the results of this study cannot be compared to the total ammonia standard.

Ammonia plus organic nitrogen concentrations in the Rincon Valley (app. A; table 12) showed no trends or significant variation. Most ammonia plus organic nitrogen concentrations were equal to or slightly greater than the MRL of 0.2 mg/L as nitrogen.

There was little or no variation in phosphorous and orthophosphate concentrations, which were equal to or slightly greater than the MRL of 0.01 mg/L as phosphorus at many sites. Water collected from the

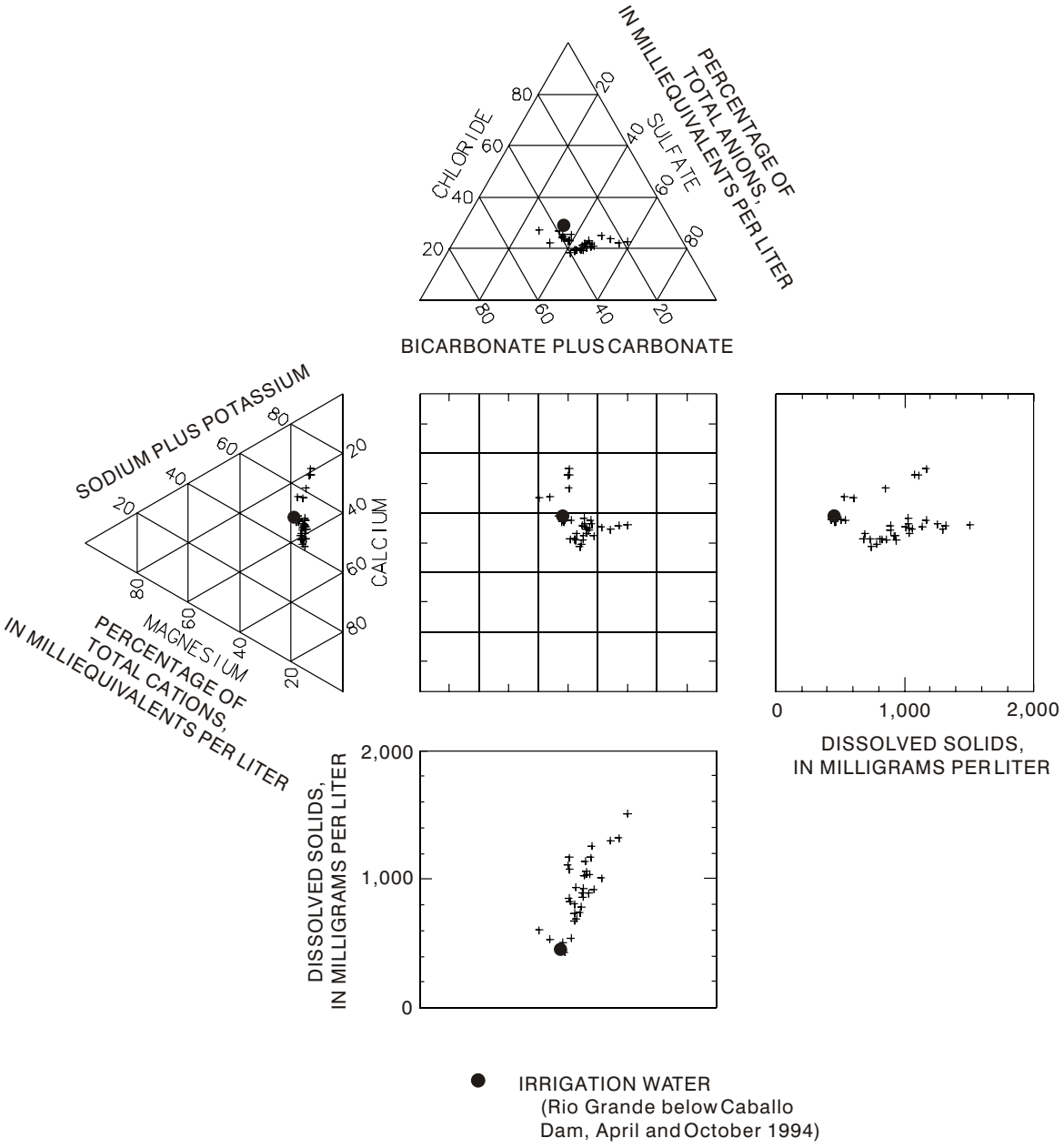

Figure 11. Surface-water composition in the Rincon Valley study area, April and October 1994.

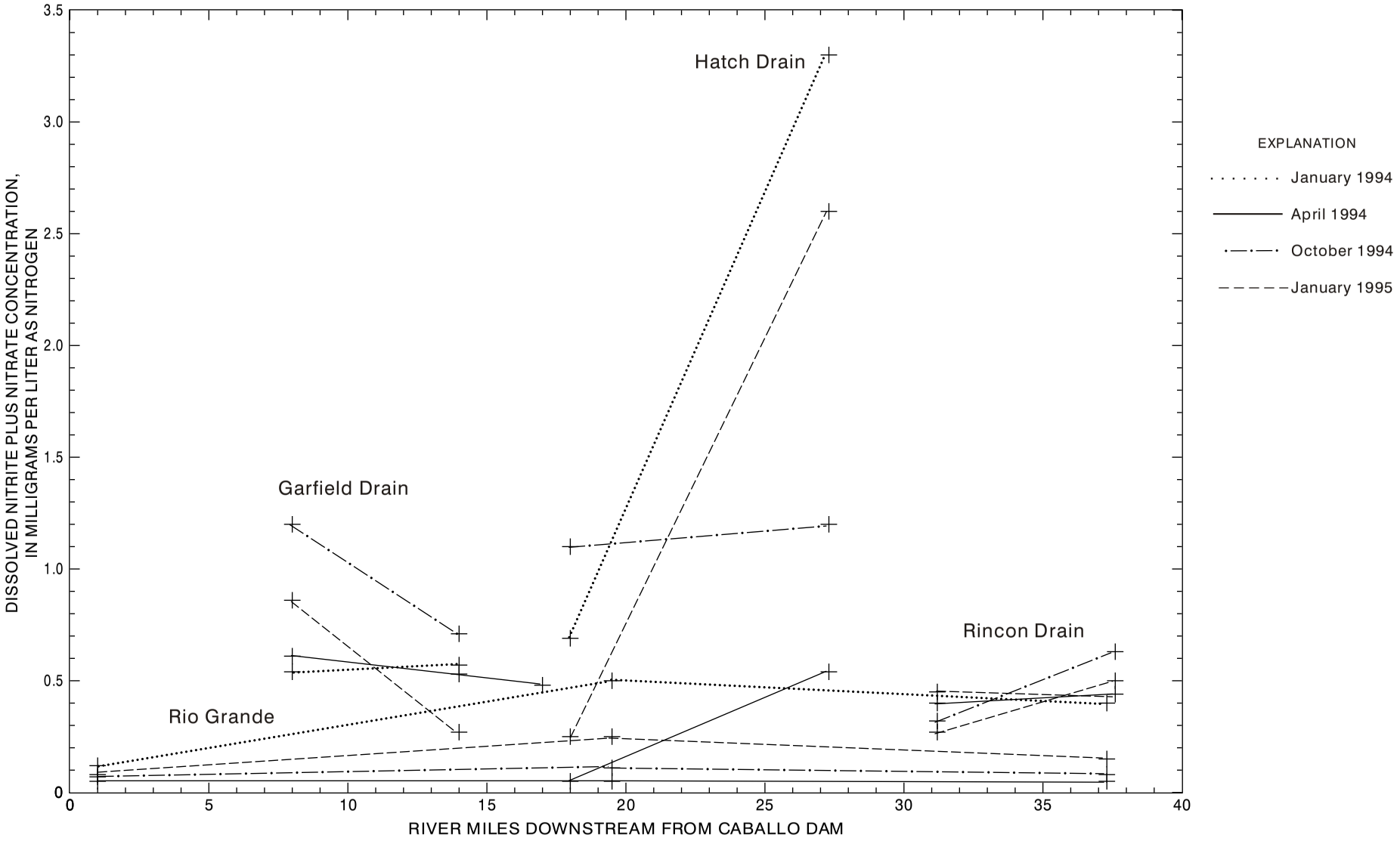

Figure 12. Relation between dissolved nitrite plus nitrate concentration in surface water and river miles downstream from Caballo Dam, 1994-95.

downstream sampling site on the Hatch Drain had phosphorous and orthophosphate concentrations ranging from 0.18 to 0.73 mg/L as phosphorus and were much larger than concentrations measured at any other sites.

DOC concentrations in water from the Rio Grande generally were in the same range as those in water from the drains (fig. 13). Concentrations generally were smaller in samples collected in January than in samples collected in April or October on the Rio Grande. During all sampling on Garfield Drain, DOC concentrations generally were smaller at the upstream sampling site than at the downstream sampling site (fig. 13). Concentrations showed no clear pattern or trend relative to sampling sites or time of sampling on the Hatch and Rincon Drains.

Trace Elements

Concentrations of many trace elements in surface water in the Rincon Valley were small or less than the MRL (table 12). Aluminum, barium, boron, bromide, copper, iron, manganese, molybdenum, uranium, and zinc were detected in one or more samples at concentrations larger than 10 ∝g/L (table 12). No samples had detectable concentrations of antimony, beryllium, cobalt, or silver. Cadmium was detected at a concentration of 6 ∝g/L in one sample, and selenium was detected at a concentration of 1 ∝g/L in one sample.

In general, there was little spatial or temporal variation in the concentrations of arsenic, chromium, copper, lead, molybdenum, nickel, and uranium. Barium concentrations generally were largest in samples from the Rio Grande and in samples from the upstream sampling sites on the Hatch and Rincon Drains (app. A). Boron concentrations generally were largest in samples from the upstream sampling site on the Garfield Drain and the downstream sampling site on the Hatch and Rincon Drains (app. A). Concentrations of iron, molybdenum, and uranium were also larger in samples from the upstream site on the Garfield Drain. Bromide concentrations generally were largest in the samples from the drains and smallest in samples from the Rio Grande in April and October 1994 (app. A). Manganese concentrations generally were smaller than 10 ∝g/L in samples from the Rio Grande in April and October. Samples collected at the upstream sampling sites on the Hatch and Rincon Drains generally had the largest manganese concentrations compared with samples from other sites. Manganese concentrations generally were larger in samples collected in January than in April or October.

The acute fisheries standards for many trace elements are dependent on the hardness (as $CaCO_3$) of the water (for example, dissolved copper std 1 ∝g/L = e (0.9422 [ln(water hardness in mg/L as $CaCO_3$)]-1.464)) (New Mexico Water Quality Control Commission, 1994). The standards listed in table 11 were calculated using a hardness of 150 mg/L as $CaCO_3$, which is less than the hardness of any of the samples collected. The 32-∝g/L copper concentration from the upstream site on the Rincon Drain exceeded the standard calculated using a hardness of 150 mg/L. The standard was recalculated using the actual hardness of the sample (350 mg/L), and the measured concentration was less than the recalculated standard (58 ∝g/L). The trace-element concentrations in surface-water samples were significantly smaller than the acute fisheries standards (table 11).

Pesticides

Thirty-seven samples were analyzed for 88 pesticides or pesticide metabolites (hereinafter referred to as pesticides) with MDL's ranging from 0.001 to 0.050 ∝g/L (table 3). One or more pesticides were detected in 34 of 37 samples (app. A). Thirteen of the 88 pesticides analyzed for were detected in one or more samples. The most commonly detected pesticides, DCPA (dacthal) and metolachlor, which are herbicides, were each detected 27 times. Carbofuran, which is an insecticide, was detected eight times. The degradation product of DDT, p,p'-DDE, was detected seven times. The herbicide EPTC was detected six times, and the herbicides prometon and simazine were each detected four times. Diazinon, an insecticide, was detected three times. Chloropyrifos, an insecticide, and dacthal mono-acid, a degradation product of DCPA, were each detected twice. Atrazine, pendimethalin, and trifluralin, which are herbicides, were each detected once.

In general, pesticides were more commonly detected in April 1994 in samples from the drains and in January 1994 in samples from the Rio Grande than during the other sampling events. More pesticide detections were in samples from the downstream sites

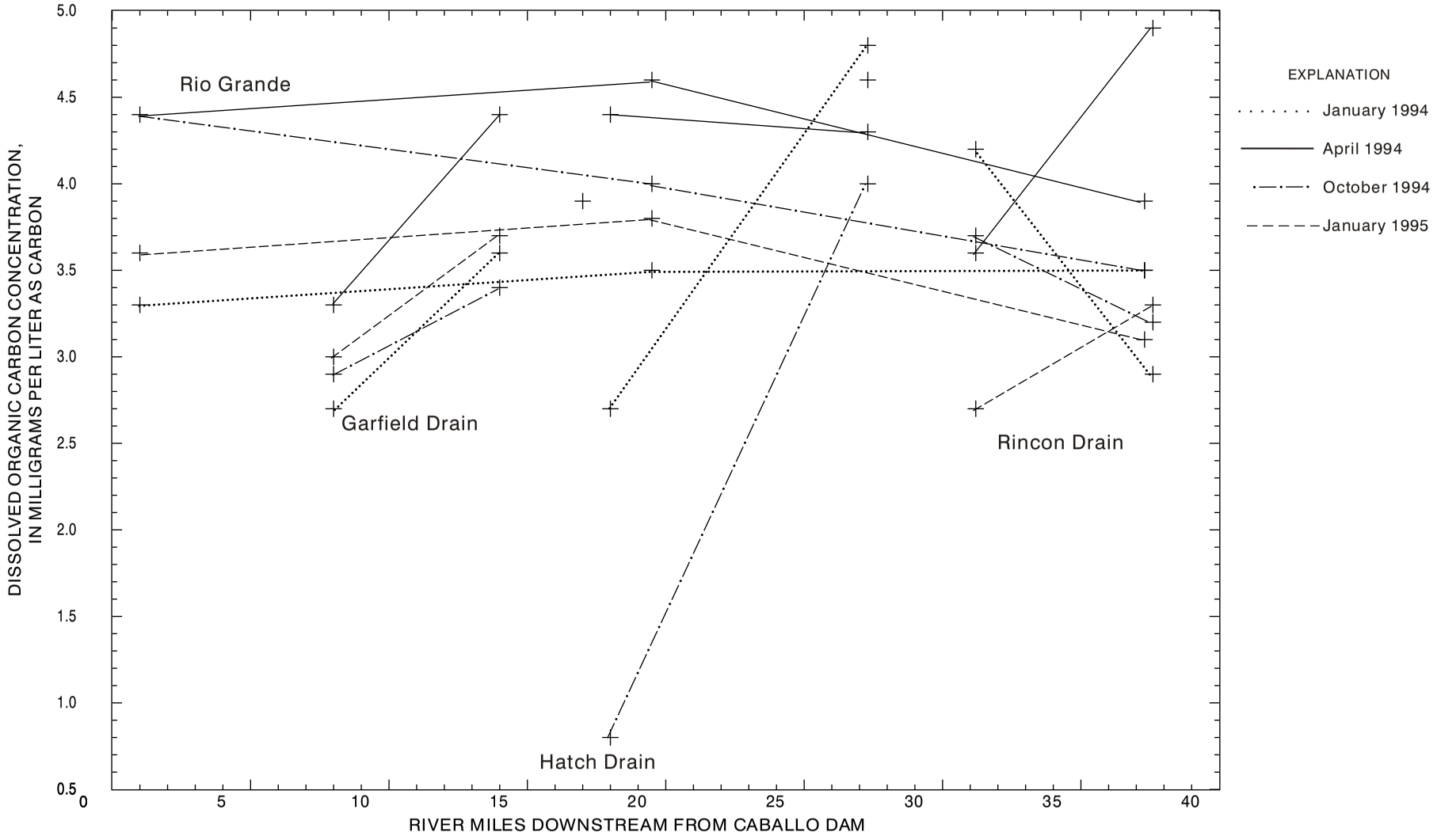

Figure 13. Relation between dissolved organic carbon concentration in surface water and river miles downstream from Caballo Dam, 1994-95.

on the drains than in samples from the upstream sites on the drains. Pesticides were detected more frequently in samples from the downstream site on the Rincon Drain and least frequently in samples from the upstream site on the Rincon Drain and the site on the Rio Grande below Caballo Dam.

The concentrations of pesticides detected generally were small (less than 0.05 ∝g/L) (app. A). Pesticide concentrations were generally larger in samples from the drains than in samples from the Rio Grande. Metolachlor was detected at a concentration of 0.41 ∝g/L in a sample from the Hatch Drain. Metolachlor concentrations generally were larger in samples from the downstream site on the Hatch Drain and the downstream site on the Rincon Drain. DCPA concentrations generally were larger in samples from the downstream sites on the drains than in samples from the upstream sites (fig. 14). DCPA concentrations in samples from the Rio Grande generally were small relative to concentrations in samples from the drains. The New Mexico Water Quality Control Commission (1994) has not established standards for the 13 pesticides detected.

SHALLOW GROUND-WATER QUALITY

In the following discussion, shallow ground-water quality in the Rincon Valley is compared to U.S. Environmental Protection Agency (USEPA) drinking water standards although none of the wells sampled are used for drinking water. Water from these wells is from the shallow part of the aquifer, whereas most domestic and irrigation wells in the area are completed in the deeper parts of the aquifer. Shallow ground water could move downward in the aquifer, however, and affect water quality in deeper parts of the aquifer.

The USEPA has established national primary drinking water regulations for constituents that, if present in drinking water, may cause adverse human health effects (U.S. Environmental Protection Agency, 1996). For regulated constituents, the regulations specify either a maximum contaminant level (MCL) or an action level that requires a treatment technique. Treatment techniques are specified in place of MCL's when establishing a quantifiable level of a constituent for compliance purposes is not economically or technically feasible. Secondary maximum contaminant levels (SMCL's) are established for constituents that can adversely affect the odor or appearance of water and result in discontinuation of its use. SMCL's generally are established for aesthetic purposes and are not based on adverse health effects. Health advisories, which are also established by the USEPA, are nonregulatory levels of constituents that can be used for guidance when regulatory limits have not been established. Health advisories are estimates of concentrations that result in no known health effects based on assumptions about body weight and amount of drinking water consumed per day. Lifetime health advisories used in this report assume a 70-year exposure period for a person weighing about 155 lbs and drinking about 2 qts of water per day.

Symbols representing different ranges in concentrations are shown on maps in the following sections to demonstrate areal variations in the concentrations of selected constituents. The rationale for grouping different concentration ranges (symbols) is based on statistical summaries of the concentrations for a particular constituent (table 13). Concentrations between the maximum and 75th percentile are depicted by a triangle pointing upward, concentrations between the 25th percentile and the minimum are depicted by a triangle pointing downward, and the remainder of the concentrations are depicted by a square.

Field Properties and Common Constituents

The specific conductance of shallow ground water ranged from 790 to 5,280 ∝S/cm. About 75 percent of the samples had a specific conductance between 1,000 and 2,000 ∝S/cm (table 13). The pH varied little in shallow ground water; about 80 percent of the samples had a pH between 7.20 and 7.63. The temperature of shallow ground water was between 15.4 and 18.7 °C in about 80 percent of the samples. Dissolved oxygen concentrations generally were less than 1 mg/L (table 13). The larger dissolved oxygen concentrations were in samples from wells located near irrigation canals.

Bicarbonate and sulfate concentrations generally were the largest of the common constituents, and sulfate concentrations generally had the largest variation (fig. 15). Sodium and calcium concentrations had the next largest concentrations of the common constituents (fig. 15). Magnesium and potassium concentrations were generally much smaller than

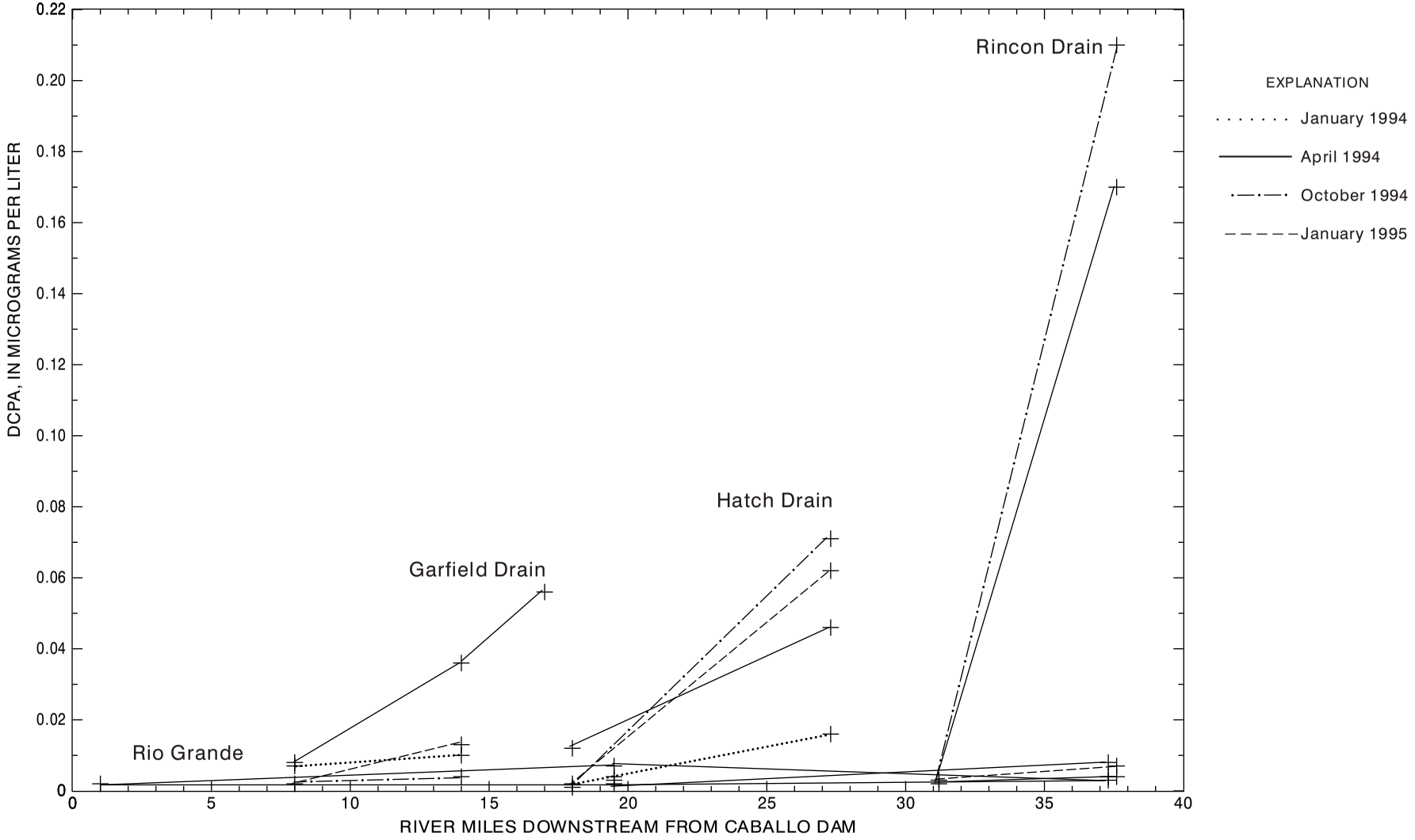

Figure 14. Relation between DCPA concentration in surface water and river miles downstream from Caballo Dam, 1994-95.

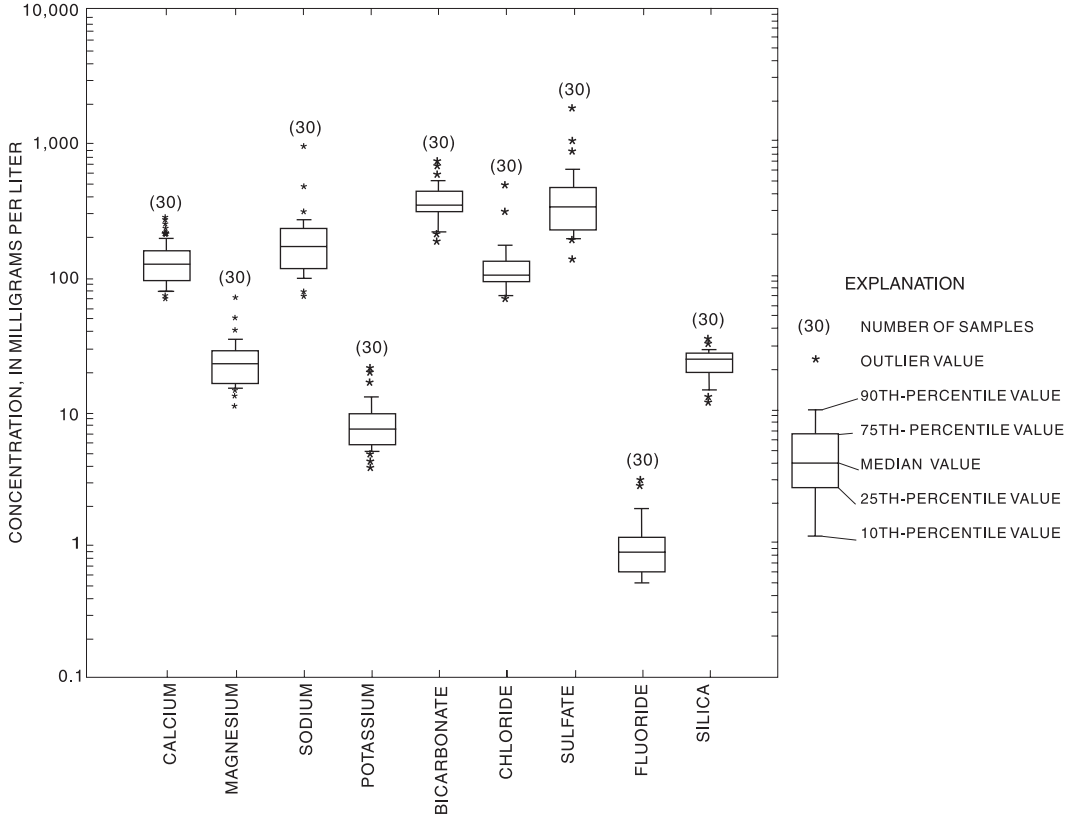

Figure 15. Distribution of selected constituent concentrations in shallow ground water in the Rincon Valley study area.

sodium and calcium concentrations, and chloride concentrations were generally smaller than the bicarbonate and sulfate concentrations. Three samples had fluoride concentrations between 2.6 and 2.9 mg/L (wells 7, 8, and 25), which were much larger than those detected in the rest of the samples (app. B). In general, there was a small range in silica concentrations (table 13).

Dissolved-solids concentrations in shallow ground water ranged from 481 to 3,630 mg/L (table 13). Some of the largest dissolved-solids concentrations were in wells south and east of Rincon (wells 25, 26, 27, and 29) (fig. 16). Dissolved-solids concentrations can vary widely between wells a relatively short distance apart (fig. 16; app. B). For example, the dissolved-solids concentration in samples from wells 25 and 26, which are about one-half mi apart, differ by about 2,000 mg/L.

A Durov plot of water compositions indicates little variation in the percentages of the different anions (bicarbonate, sulfate, and chloride) and a relatively constant percentage of magnesium in the samples; there is, however, variation in the percentages of calcium and sodium (fig. 17). Although the percentages of anions in shallow ground water have little variation, the samples with larger percentages of sulfate have larger dissolved-solids concentrations (fig. 17). The variation in percentages of calcium and sodium is not related to dissolved-solids concentration.

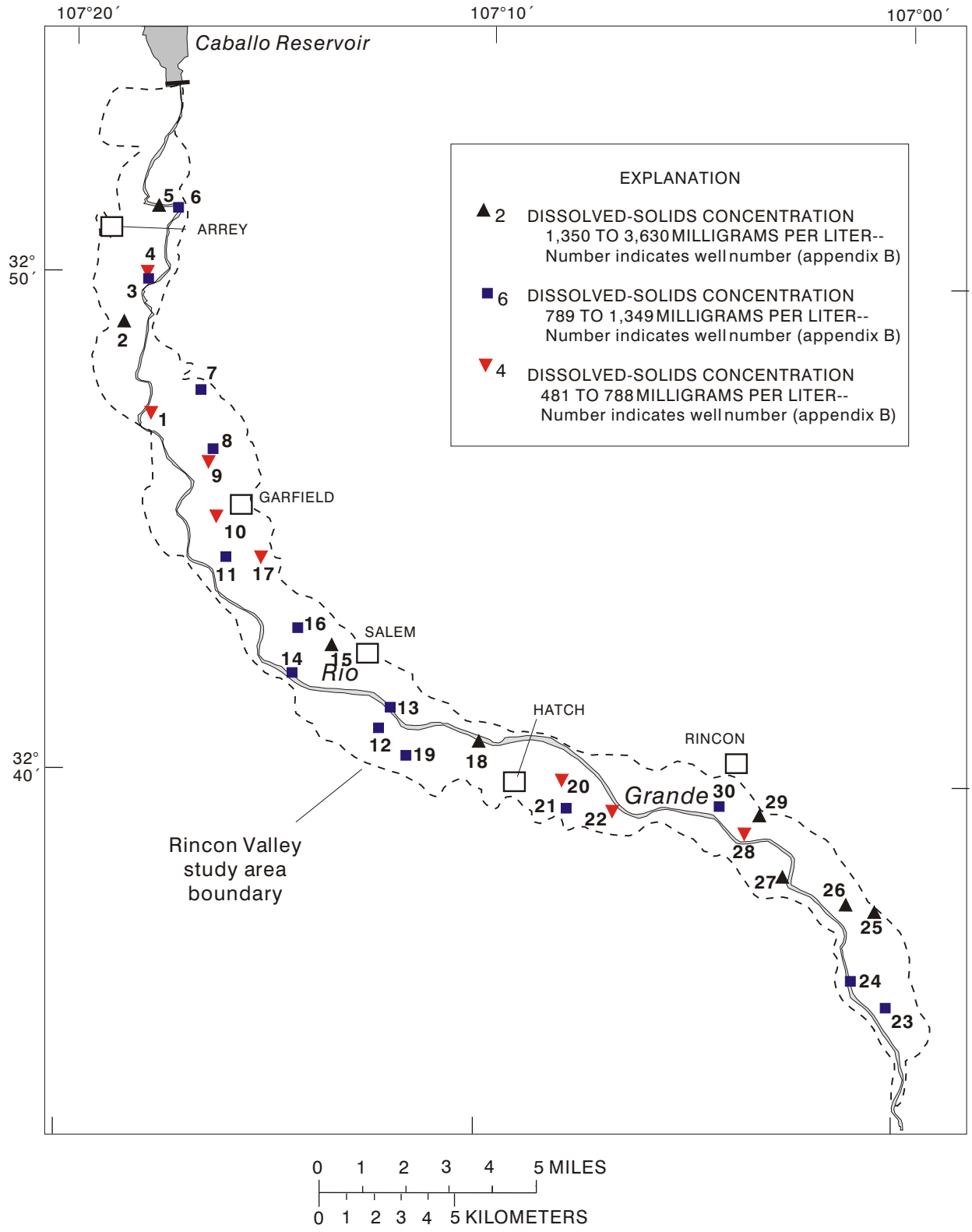

Figure 16. Dissolved-solids concentrations in shallow ground water in the Rincon Valley study area.

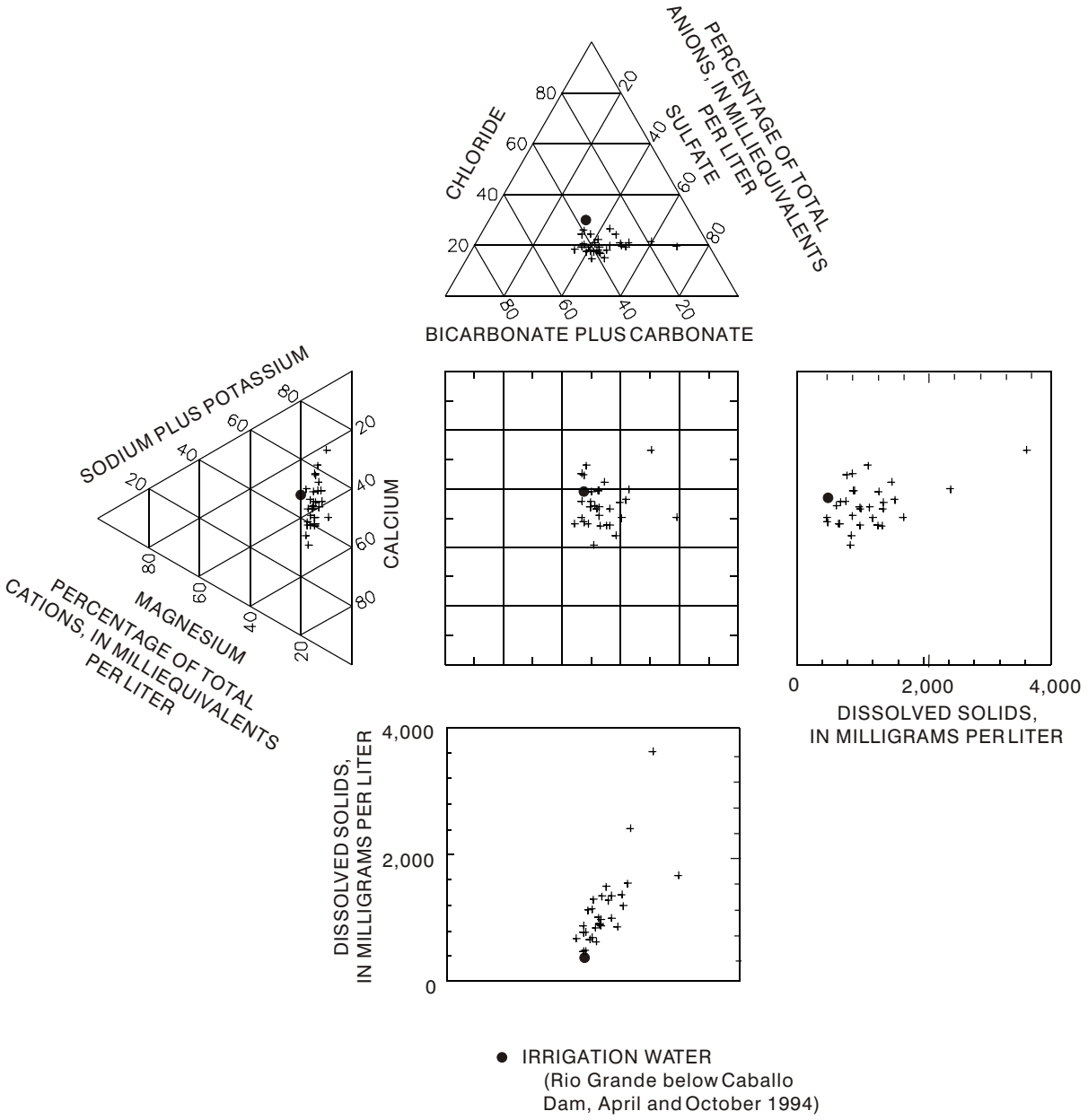

Figure 17. Shallow ground-water composition in the Rincon Valley study area, April and October 1994.

All but 2 of 30 samples exceeded the SMCL of 500 mg/L for dissolved solids. Chloride in water from two wells (6.7 percent) exceeded the SMCL of 250 mg/L for chloride, and water from 22 wells (73 percent) equaled or exceeded the SMCL of 250 mg/L for sulfate (table 14). The MCL for fluoride of 4 mg/L was not exceeded in any samples.

Nutrients and Dissolved Organic Carbon

Nitrite plus nitrate concentrations, which were the largest of the analyzed nutrient concentrations, ranged from less than 0.05 to 33 mg/L as nitrogen (table 13). Nitrite concentrations were less than 0.11 mg/L as nitrogen, indicating nitrate as the dominant nitrogen species in the nitrite plus nitrate analyses. The distribution of nitrite plus nitrate concentrations had no areal pattern in the Rincon Valley (fig. 18). In some areas, dissolved nitrite plus nitrate concentrations varied considerably in water from wells small distances apart. For example, the nitrite plus nitrate concentration in water from well 3 was 2.00 mg/L as nitrogen and in water from well 4, which is about 700 ft from well 3, was 13.0 mg/L (app. B). Water from five wells (about 17 percent) exceeded the MCL of 10 mg/L for nitrite plus nitrate as nitrogen (table 14).

Ammonia and ammonia plus organic nitrogen concentrations were generally small (less than 0.1 mg/L and 0.4 mg/L as nitrogen, respectively) (table 13). The largest ammonia and ammonia plus organic nitrogen concentrations generally were in samples from wells south and east of Hatch in the southern part of the Rincon Valley (app. B). Phosphorous and orthophosphate concentrations were generally less than 0.05 mg/L as phosphorus (table 13) and varied little among the wells (app. B). The DOC concentrations ranged from 1.1 to 5.3 mg/L (table 13) and showed no areal pattern in shallow ground water.

Trace Elements

The concentrations of many trace elements were small (less than 10 ∝g/L) in shallow ground water in the Rincon Valley. Barium, bromide, copper, iron, manganese, molybdenum, uranium, and zinc were the only trace elements that were in one or more samples at concentrations larger than 10 ∝g/L (app. B). Cadmium, cobalt, and selenium were detected above the MRL in three or fewer samples. No samples had detectable concentrations of antimony, beryllium, lead, or silver.

Barium, bromide, copper, and molybdenum were detected in all the samples (table 13). Iron was detected in 21 samples, manganese in 28 samples, and uranium in 27 samples. Barium concentrations were largest in samples from wells 18 and 24. The bromide concentration in water from well 25 was 0.97 mg/L, which was much larger than the concentration in any other samples. Copper concentrations generally were less than 6 ∝g/L; however, samples from wells 25, 26, and 27 had concentrations of 18, 11, and 21 ∝g/L, respectively. A large copper concentration (32 ∝g/L) was also detected in a surface-water sample from the upstream sampling site on the Rincon Drain, which is in the same area as wells 25, 26, and 27. Nineteen samples had iron concentrations less than 10 ∝g/L (app. B). Manganese concentrations were typically larger than 100 ∝g/L. Samples with manganese concentrations larger than 1,000 ∝g/L also generally had large iron concentrations. The largest molybdenum concentration was from well 7 (app. B), which is located near the upstream sampling site on the Garfield Drain where relatively large molybdenum concentrations were also measured (app. A). In general, the larger uranium concentrations were from wells in the northern part of the Rincon Valley (fig. 19).

The concentrations of uranium, iron, and manganese exceeded USEPA MCL's or SMCL's in some instances (table 14). The proposed MCL of 20 ∝g/L for uranium (U.S. Environmental Protection Agency, 1996) was exceeded in about 13 percent of the samples (four samples). The SMCL of 300 ∝g/L for iron was exceeded in about 17 percent of the samples (5 samples), and the SMCL of 50 ∝g/L for manganese was exceeded in about 83 percent of the samples (25 samples) (table 14). Concentrations of cadmium and molybdenum were in the same range but less than the standards. Concentrations of the other trace elements that have standards (aluminum, antimony, arsenic, barium, beryllium, chromium, copper, lead, nickel, selenium, silver, and zinc) were much smaller than drinking water standards or health advisories (table 14).

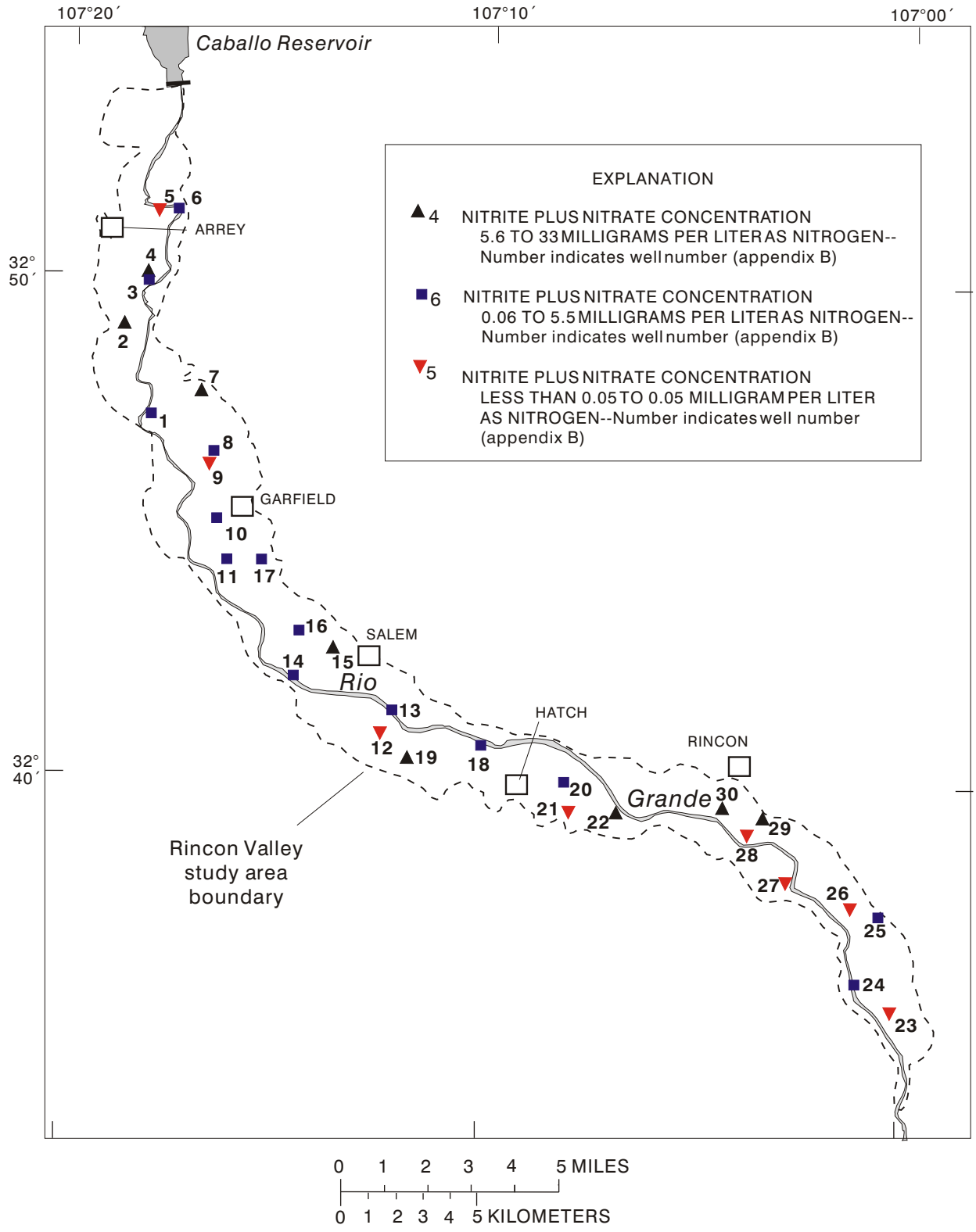

Figure 18. Dissolved nitrite plus nitrate concentrations in shallow ground water in the Rincon Valley study area.

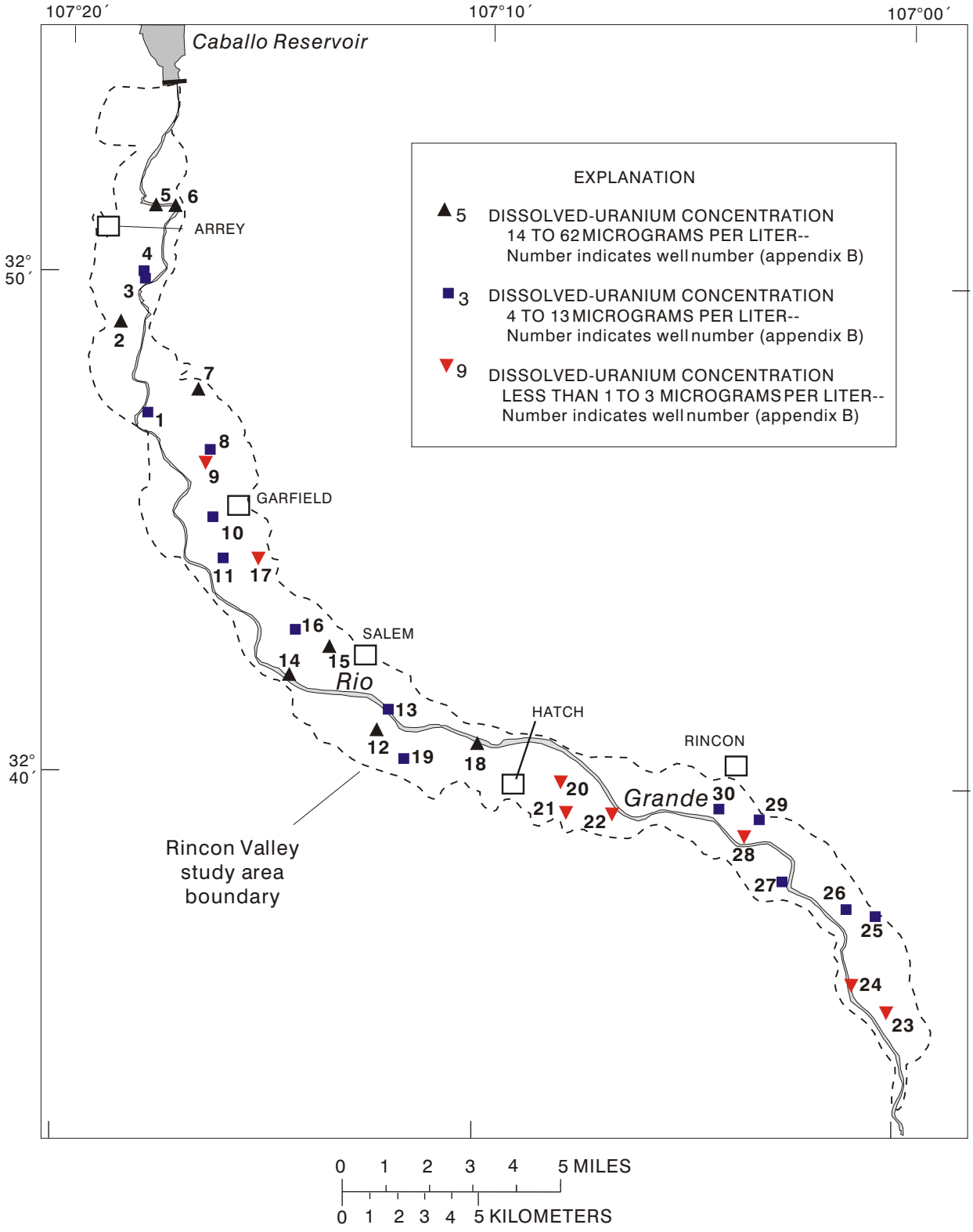

Figure 19. Dissolved-uranium concentrations in shallow ground water in the Rincon Valley study area.

Radioactivity and Radon-222

Gross alpha activity and gross beta activity were measured in filtered samples, and radon-222 concentration was measured in unfiltered samples (table 13 and app. B). Gross alpha activity is a measure of all alpha radiation (positively charged helium nuclei) in a sample. Gross beta activity is a measure of all beta radiation (electrons or positrons) in a sample. Activity is a measure of radiation emitted by a sample; it is not a concentration. Several different substances in a sample can emit alpha or beta radiation. All alpha or beta radiation in a sample is measured and is reported in terms of one particular substance that emits alpha or beta radiation. Gross alpha activity is reported in terms of the amount of natural uranium, in micrograms per liter, that would emit the same radiation. Gross beta activity is reported in terms of the equilibrium strontium-90/yttrium-90 (Sr-90/Y-90) that would give the same count rates.

Gross alpha activity ranged from 0.8 to 67 ∝g/L as uranium (table 13). The largest gross alpha activities were in samples from the northern part of the Rincon Valley, where the largest uranium concentrations also were detected. Gross beta activity ranged from 4.7 to 29 pCi/L as Sr-90/Y-90 (table 13). Gross beta activity showed no areal pattern in the Rincon Valley.

Radon-222 concentrations ranged from 210 to 440 pCi/L in 18 samples. Twelve of 18 samples had radon-222 concentrations ranging from 240 to 260 pCi/L, indicating a relatively small range in radon-222 concentrations throughout the Rincon Valley. No clear areal pattern was apparent in radon-222 concentrations in the valley.

The MCL for gross alpha activity is 15 pCi/L (table 14) (U.S. Environmental Protection Agency, 1996). For gross alpha activity reported as equivalent uranium in micrograms per liter, the mass to activity conversion factor used to determine gross alpha activity as uranium, in picocuries per liter, was 1.3 ∝g/L per picocuries per liter. Samples from about 23 percent of the wells (seven wells) exceeded the MCL. The MCL for gross beta activity is 4 millirems per year. This MCL is based on an annual dose and cannot be compared to the activity measured in the shallow ground-water samples.

Volatile Organic Compounds

Twenty samples were analyzed for 60 VOC's with an MDL of 0.2 ∝g/L (table 4). Methylchloride (in 8 of 19 samples) and xylene (in 3 of 20 samples) were the only VOC's detected (app. B). Concentrations of methylchloride detected in field-blank samples indicate that contamination occurred during sampling or analysis and that methylchloride detected in ground-water samples does not represent environmental conditions. Xylene, which is a common compound in many petroleum products such as gasoline, was detected at concentrations ranging from 0.3 to 2.8 ∝g/L (app. B). The MCL for xylene is 10,000 ∝g/L, which is significantly larger than the concentration in any ground-water sample (table 14).

Pesticides

Thirty samples were analyzed for 88 pesticides with MDL's ranging from 0.001 to 0.050 ∝g/L (table 4). One or more pesticides were detected in 12 of 30 samples (app. B). Five of the 88 pesticides analyzed for were detected in one or more samples. Metolachlor (in nine samples) and prometon (in five samples) were the most commonly detected pesticides. Diazinon, napropamide (an herbicide), and p,p'-DDE were each detected once.

When pesticides were detected, the concentrations generally were small (less than 0.1 ∝g/L in 12 of 17 detections or less than or equal to 0.01 ∝g/L in 8 of 17 detections) (app. B). Metolachlor was the pesticide with the largest measured concentration (5.4 ∝g/L in the sample from well 22). Two or more pesticides were detected in samples from wells 4, 10, 22, and 28. In general, pesticides were detected less frequently in samples from wells in the northern part of the Rincon Valley (fig. 20).

Concentrations of pesticides detected in shallow ground water in the Rincon Valley were less than health-based standards established by the USEPA (U.S. Environmental Protection Agency, 1996). The USEPA has not established MCL's for any pesticides detected in the Rincon Valley but has established health advisories for three of the pesticides (table 14). The health advisory for diazinon is 0.6 ∝g/L, which is about 10 times the concentration detected in well 28. The health advisory for metolachlor is 100 ∝g/L, which is about 20 times the largest concentration of metolachlor

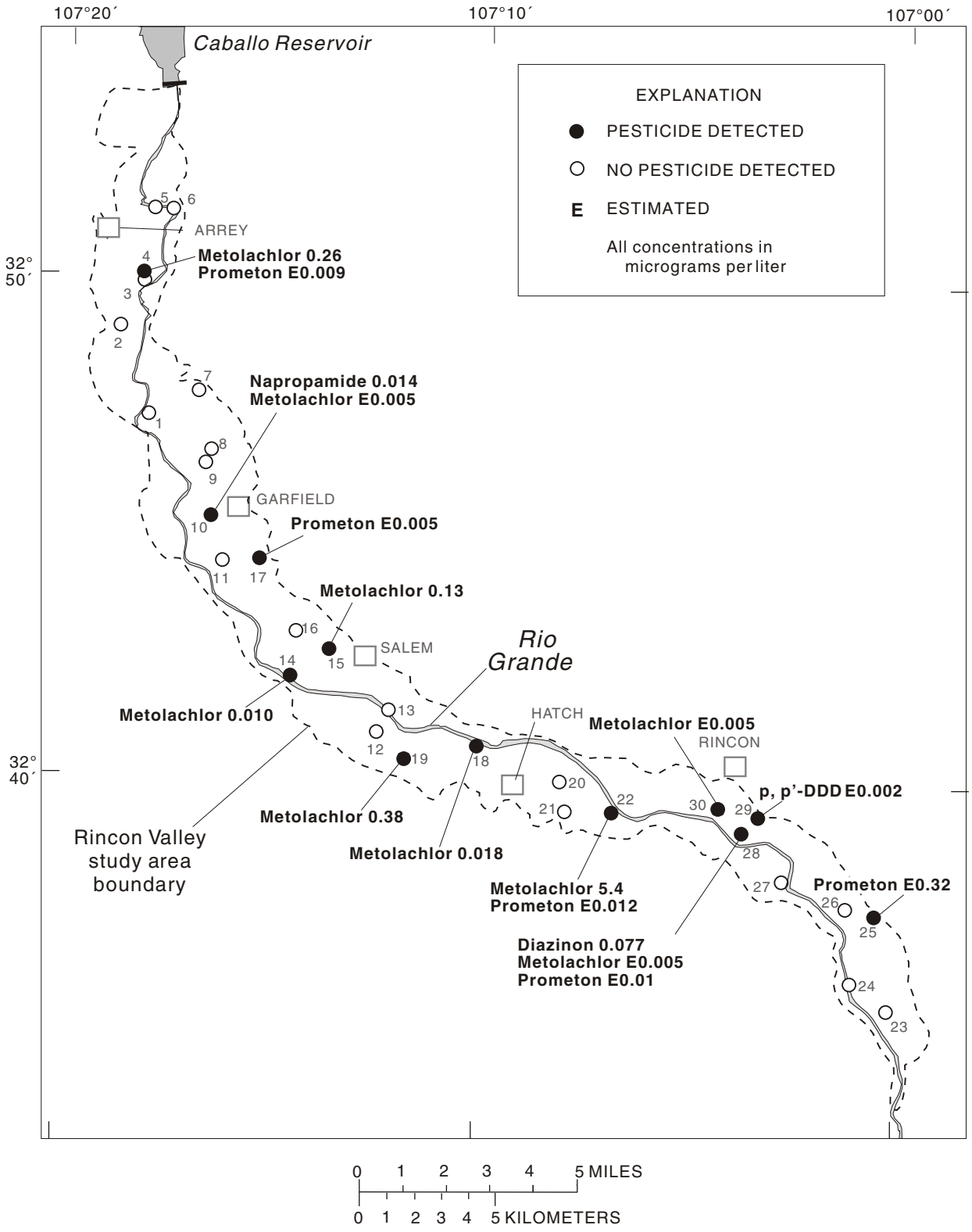

Figure 20. Concentrations of pesticides detected in shallow ground water in the Rincon Valley study area.

detected in shallow ground water (well 22). The health advisory for prometon is 100 ∝g/L, which is about 300 times the largest concentration of prometon detected in shallow ground water.

Pesticides, Pesticide Metabolites, Gross Polychlorinated Biphenols, and Gross Polychlorinated Napthalenes in Bed Material

Bed-material samples were collected at the three downstream sites on the drains in January 1995. DDT, which is an insecticide that has been banned from use in the United States since 1973, and DDD and p,p'-DDE, which are common degradation products of DDT, were the only compounds detected of 23 compounds analyzed for (table 5 and app. C). These three compounds were detected at all three sites. DDT was detected at concentrations ranging from 0.3 to 0.5 ∝g/kg, DDD was detected at concentrations ranging from 0.2 to 1.4 ∝g/kg, and p,p'-DDE was detected at concentrations ranging from 1.5 to 44 ∝g/kg (app. C). The presence of DDT indicates that it was probably used in the area and has not completely degraded.

FACTORS AFFECTING WATER QUALITY IN THE RINCON VALLEY

The quality of surface water used for irrigation affects ground-water quality and the quality of ground water affects surface-water quality because of interaction between the surface- and ground-water systems. Surface water infiltrates and recharges the ground-water system, and ground water discharges to the drains and the Rio Grande. Most recharge to the ground-water system occurs during the irrigation season when surface water is released from Caballo Reservoir and diverted from the Rio Grande into the canals. Recharge to the shallow ground-water system results from infiltration of water applied to fields and leakage from canals. Increases or decreases in recharge result in rapid increases or decreases in ground-water discharge to the drains.

The amount of ground-water discharge to the drains and the subsequent amount of discharge from the drains to the Rio Grande vary throughout the year and are largest during June, July, and August (fig. 4). During December, January, and February, ground-water discharge to the drains is small. Discharge in the Rio Grande and the source of water in the Rio Grande also vary throughout the year (fig. 3). During the irrigation season (about March to mid-October), most discharge in the Rio Grande is from releases from Caballo Reservoir, and discharge from the drains to the Rio Grande is a small percentage of total discharge in the Rio Grande. From about mid-October to mid-January, no water is released from Caballo Reservoir and discharge in the Rio Grande is from ground-water discharge and discharge from the drains. From mid-January through February, releases from Caballo Reservoir begin and slowly increase to more than 1,000 ft^3/s, resulting in varying mixtures of water from Caballo Reservoir, ground-water discharge, and discharge from the drains.

The quality of water diverted from the Rio Grande during the irrigation season (irrigation water) is an important factor affecting the quality of surface water and shallow ground water in the Rincon Valley. Irrigation water is the source of most ground-water recharge and the starting composition from which ground water evolves. The quality of water in the drains throughout the year and of water in the Rio Grande when no water is being released from Caballo Reservoir is also related to irrigation water because ground-water discharge accounts for most water in the drains and Rio Grande at these times.

Comparing the quality of irrigation water, shallow ground water, water in the drains, and water from the Rio Grande when no water is being released from Caballo Reservoir helps determine how irrigation water quality changes (evolves) as it infiltrates to the ground-water system, as ground water moves through the aquifer to the drains or the Rio Grande, and as water moves downstream in the drains and Rio Grande. Areal variations in shallow ground-water quality, differences in water quality in the drains, and temporal variations in water quality at sites on drains can be useful for determining factors that result in these areal or temporal differences in water quality.

The composition of irrigation water was assumed to be the average composition of water samples from the Rio Grande below Caballo Reservoir in April and October 1994 (app. A). No samples were collected between April, near the beginning of the irrigation season, and October, near the end of the irrigation season, that could be used to document changes in the composition of irrigation water during the irrigation season. Comparison of the composition

of water in April to that of water in October indicates little difference in most dissolved constituents. Variations in the composition of irrigation water are probably small during the irrigation season because the two large reservoirs upstream from the Rincon Valley tend to damp out large variations.

Common Constituents

Concentrations of common constituents in surface water and ground water are affected by natural and human-related factors. Natural factors include mineral dissolution, precipitation or weathering, ion exchange, and mixing of water with different compositions. Human-related factors include composition of infiltrating irrigation water, evapotranspiration resulting from crop irrigation, or leaching of agricultural chemicals.

Dissolved-solids concentrations, which essentially are the sums of concentrations of common constituents, generally were smallest (about 450 mg/L) in irrigation water (Rio Grande below Caballo Dam in April and October 1994) (fig. 9). During the irrigation season, ground-water discharge to the Rio Grande and discharge from the drains to the Rio Grande have little effect on dissolved-solids concentrations in the river because the amount of water being released from Caballo Reservoir is much larger than the amount of ground-water discharge and discharge from the drains to the Rio Grande. Dissolved-solids concentrations in samples from the Rio Grande increased downstream between Caballo Dam and above the Rincon Drain about 30 mg/L in April 1994 and about 90 mg/L in October 1994 (fig. 9).

Concentrations of dissolved solids generally were larger and increased downstream in water from the Rio Grande when no water was being released from Caballo Reservoir (January 1994 and 1995) than during the irrigation season (April and October 1994) (fig. 9) because discharge of shallow ground water and discharge from the drains account for most flow in the Rio Grande. Dissolved-solids concentrations in samples from the Rio Grande increased downstream from Caballo Dam to above the Rincon Drain about 400 mg/L in January 1994 and about 300 mg/L in January 1995. Dissolved-solids concentrations in samples from the downstream sites on the drains were larger than those in the Rio Grande (fig. 9).

Dissolved-solids concentrations varied in water from different drains, from the upstream and downstream sampling sites on a given drain, and temporally at sites on drains (fig. 9). Concentrations generally were largest in samples from the downstream sampling site on the Rincon Drain and smallest in samples from the upstream sampling site on the Hatch Drain. The dissolved-solids concentration increased downstream during all samplings on the Rincon and Hatch Drains (fig. 9), indicating generally larger dissolved-solids concentrations in ground water near the downstream parts of the drains than at the upstream parts. At the upstream and downstream sites on the Rincon Drain, dissolved-solids concentrations generally were larger in January than during April or October 1994, indicating smaller concentrations in ground water discharging to this drain during the irrigation season (fig. 9).

Dissolved-solids concentrations in shallow ground water ranged from 481 to 3,630 mg/L and generally were larger in the southeastern part of the Rincon Valley (fig. 16). The large variation in dissolved-solids concentrations indicates differences in the influence of particular factors or the number of factors affecting the concentrations of common constituents throughout the valley. Dissolved-solids concentrations in samples from wells 17 (481 mg/L) and 20 (486 mg/L) were about the same as those in irrigation water (450 mg/L), indicating few factors affecting the composition of water near these wells. Water from wells 25 and 27 had much larger dissolved-solids concentrations (3,630 and 2,420 mg/L) than the rest of the surface-water and ground-water samples (app. A and B); these samples may be affected by different factors than the rest of the samples. King and others (1971) and Wilson and others (1981, p. 62) indicated ground-water inflow to the Rincon Valley near well 25. This inflow is probably affecting shallow ground water near well 25. Water from well 27 also contains relatively large concentrations of dissolved solutes (app. B). What factors are affecting water quality in water from this well is not clear.

Because the Durov plots (figs. 11 and 17) indicate only slight variations in the percentages of major cations and anions (common constituents) in most samples, similar factors could be affecting common constituent concentrations. In general, dissolved-solids concentrations are larger in water from the drains and shallow ground water (figs. 11 and 17) than in irrigation water, possibly indicating concentration of solutes during infiltration of irrigation water.

Evapotranspiration (evaporation and transpiration) of irrigation water could be an important factor affecting the composition of common constituents in shallow ground water and surface water. Irrigation water applied to fields evaporates or is transpired by plants during infiltration. Evapotranspiration results in increases in constituents but no change in the proportions of individual cations or anions. If evapotranspiration is the only factor affecting the concentrations of individual constituents, the increases in concentrations are a function of the amount of evapotranspiration that has occurred. For example, if the volume of irrigation water is reduced by one-half as the result of evapotranspiration, the concentration of all dissolved constituents will double, but the proportion of individual ions relative to other ions will remain constant.

To compare the composition of irrigation water, shallow ground water, water from the drains, and water from the Rio Grande when no water was being released from Caballo Reservoir (January of 1994 and 1995) (nonirrigation season) and the effect of evapotranspiration on irrigation water, dissolved sulfate, bicarbonate, calcium, sodium, and silica concentrations were plotted in relation to dissolved chloride concentration (figs. 21-25). Chloride was used in all plots because it is relatively conservative in water and does not enter into many reactions (Hem, 1985, p. 118-120); therefore chloride concentration can be used to estimate the effect of evapotranspiration. Magnesium and potassium are not discussed because the concentrations were small. Samples from wells 25 and 27 are not included in figures 21-25 because of the large concentrations of solutes in samples from these wells relative to the other samples.

Evaporation paths of irrigation water (average composition of samples collected from the Rio Grande below Caballo Dam in April and October 1994) and relatively dilute ground water (average composition water from wells 1, 4, 9, and 22) have been calculated and also plotted in figures 21-24 to demonstrate how evapotranspiration affects water composition. If no constituents are assumed to be added to or removed from the starting solution (irrigation water or dilute ground water) during evapotranspiration, the evaporation paths represent concentrations of constituents as irrigation water and dilute ground water evapotranspire. A 2X concentration value is also shown on the evaporation paths; this point represents the concentrations of constituents in irrigation water or dilute ground water after evapotranspiration of one-half the original volume.

The plots show a wide range in sulfate, bicarbonate, calcium, sodium, and chloride concentrations in surface water and shallow ground water. Because many of the samples plot along slopes similar to the evaporation paths and are bounded by the evaporation paths (figs. 21-24), evapotranspiration could be an important factor affecting these concentrations. Many samples have chloride concentrations less than the 2X chloride concentrations (fig. 21), indicating that the amount of irrigation water that evapotranspires probably is less than one-half the amount diverted. The scatter of points around the evaporation paths indicates factors other than evapotranspiration also affecting water composition.

Water from wells 1, 4, 9, and 22 (dilute ground water) has about the same concentration of chloride (mean 72.5 mg/L) as irrigation water (mean 66 mg/L), indicating little or no evapotranspiration of irrigation water during infiltration near these wells (figs. 21-24). Water from these wells represents irrigation water that infiltrates through the root zone quickly prior to evapotranspiration. The concentrations of sulfate, bicarbonate, calcium, and sodium in the average composition of water from these wells are about 70, 100, 50, and 30 mg/L larger, respectively, than those in irrigation water (figs. 21-24), indicating factors other than evapotranspiration causing increases in these constituents during infiltration. Dissolution of minerals such as gypsum ($CaSO_4$) and calcite ($CaCO_3$), calcium/sodium ion exchange, or weathering of a variety of silicate minerals could account for the increases in these constituents.

Because most samples have sulfate concentrations that plot above the evaporation path of irrigation water (fig. 21), more sulfate may be in the samples than can be accounted for by evapotranspiration of irrigation water. The larger sulfate concentrations in dilute ground water and most of the other samples relative to irrigation water indicate that increases in sulfate occur throughout the Rincon Valley. Dissolution of minerals containing sulfur, such as gypsum, or sulfur applied to fields as a soil amendment could account for the increased sulfate. The saturation index of gypsum was less than zero in ground-water samples, indicating that gypsum, if present in the soil zone or aquifer, would tend to dissolve (table 15).

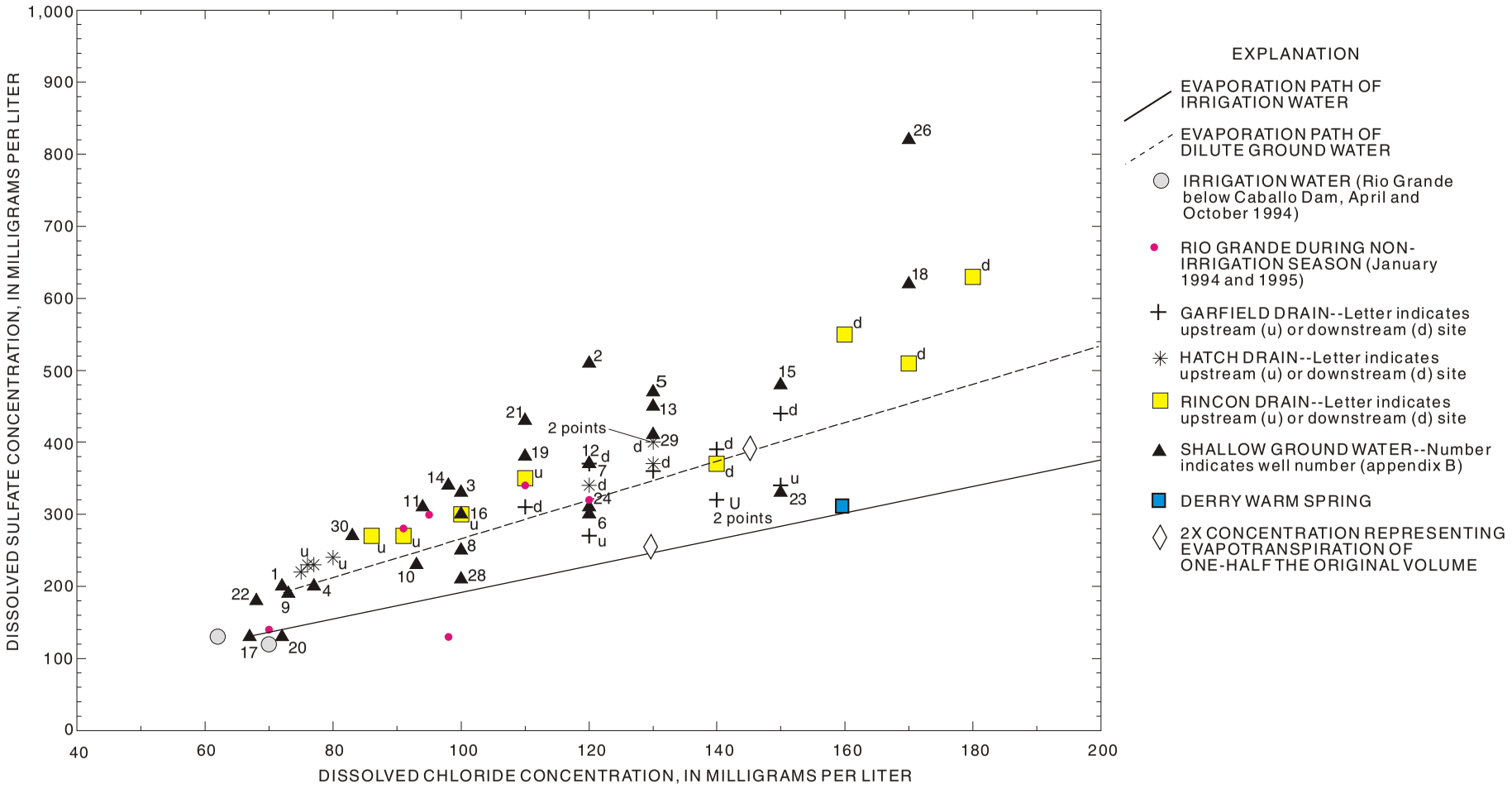

Figure 21. Relation between dissolved sulfate and chloride concentrations in surface water and shallow ground water in the Rincon Valley study area.

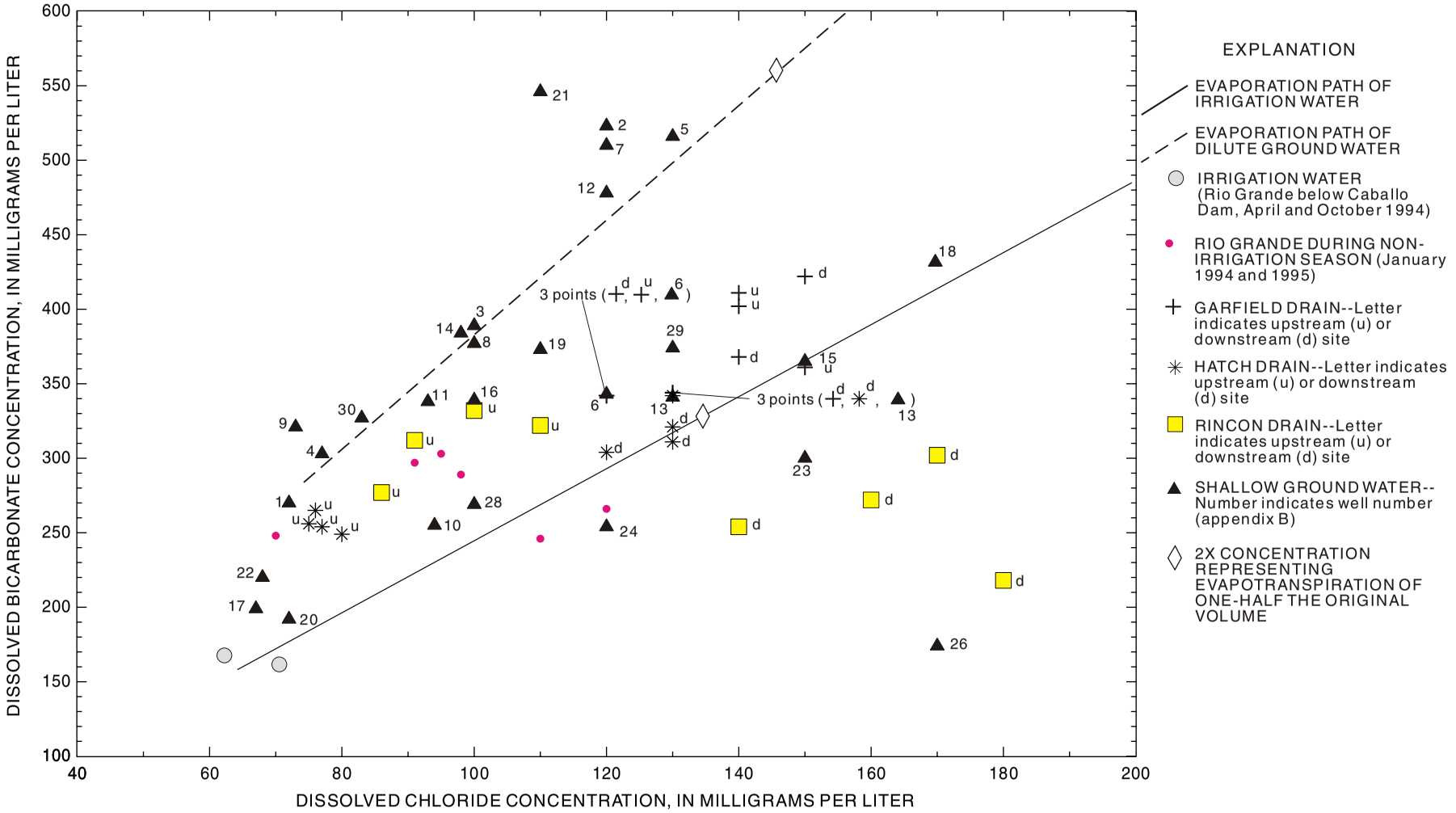

Figure 22. Relation between dissolved bicarbonate and chloride concentrations in surface water and shallow ground water in the Rincon Valley study area.

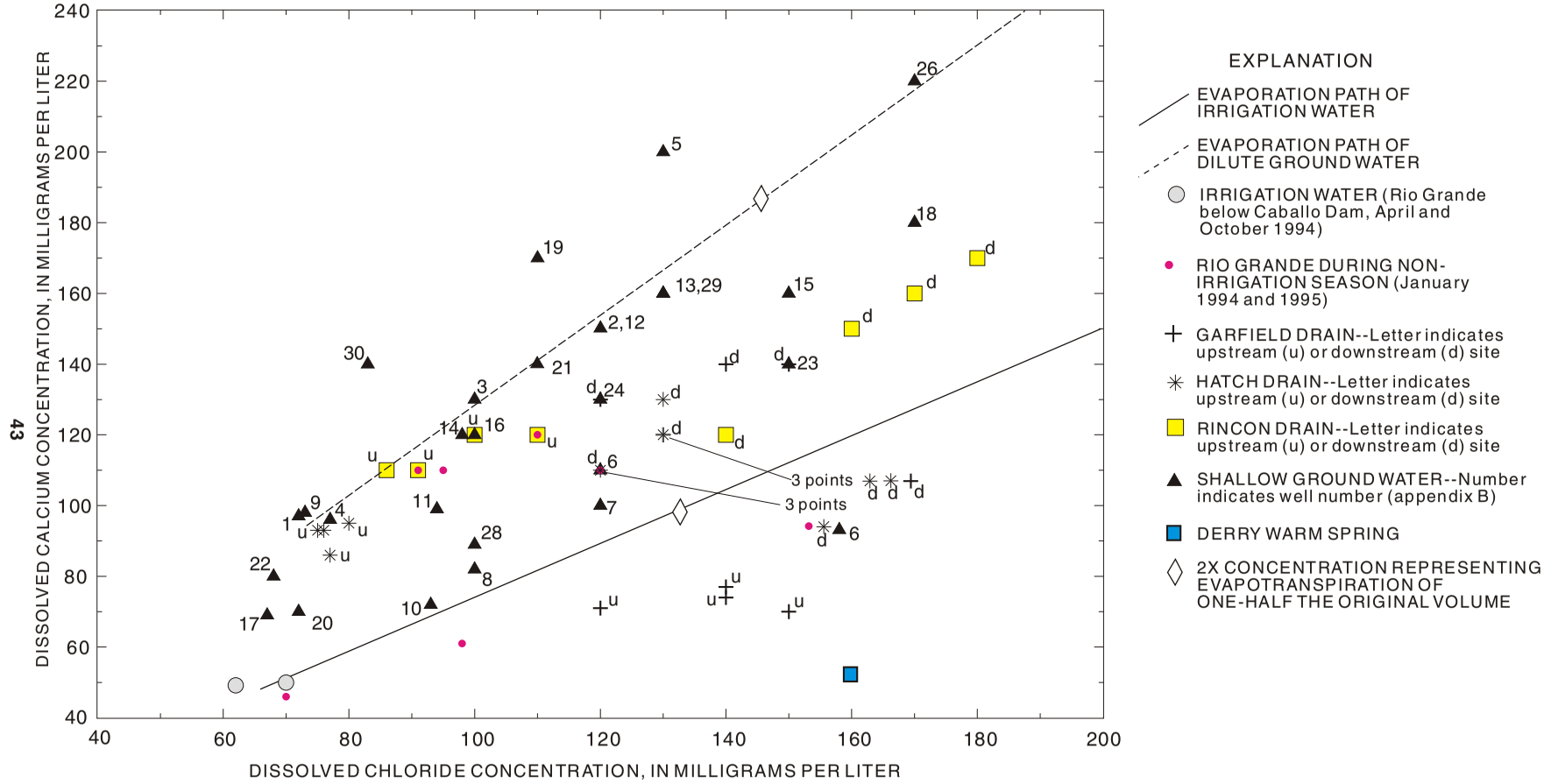

Figure 23. Relation between dissolved calcium and chloride concentrations in surface water and shallow ground water in the Rincon Valley study area.

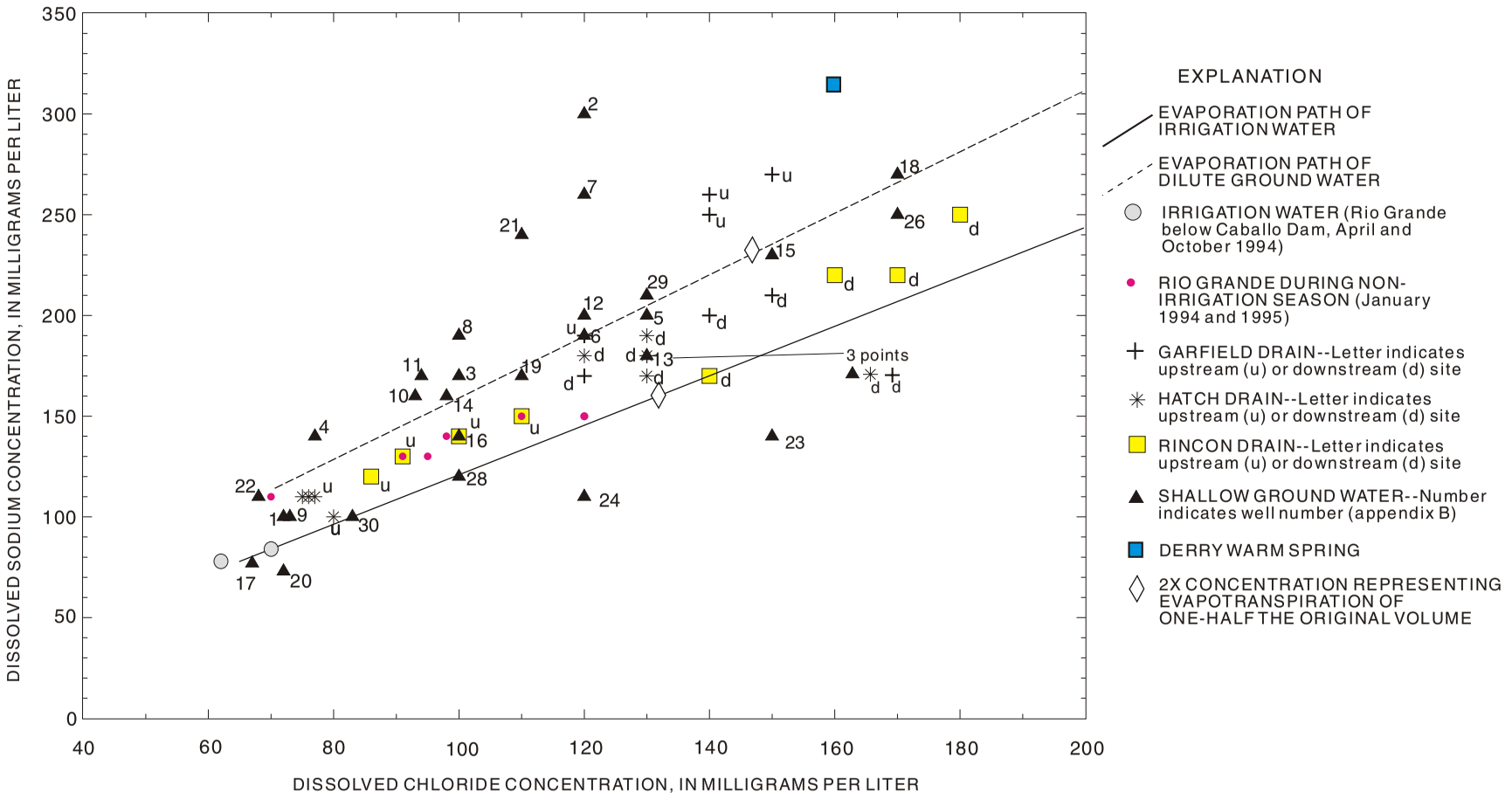

Figure 24. Relation between dissolved sodium and chloride concentrations in surface water and shallow ground water in the Rincon Valley study area.

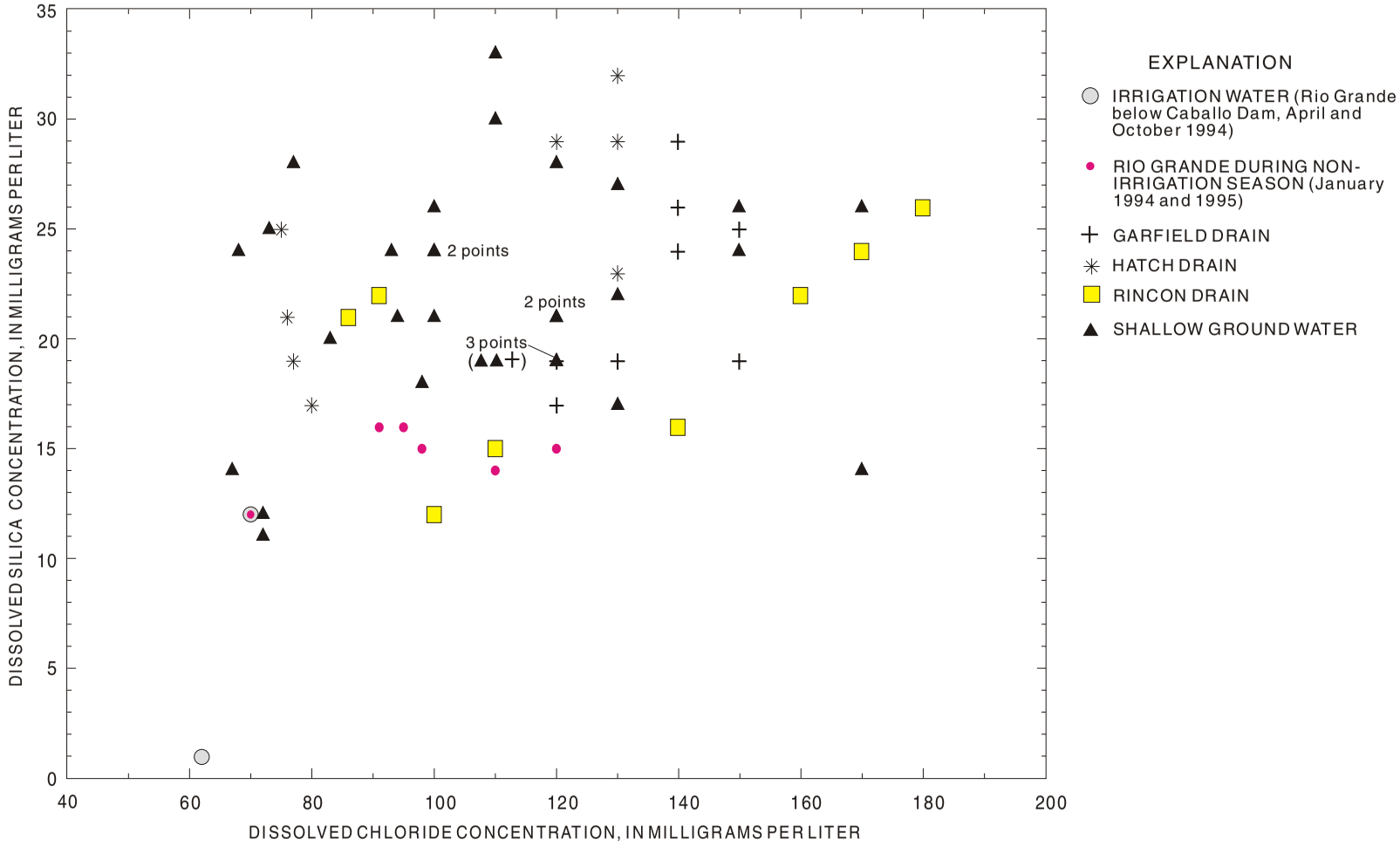

Figure 25. Relation between dissolved silica and chloride concentrations in surface water and shallow ground water in the Rincon Valley study area.

The bicarbonate and chloride and calcium and chloride plots (figs. 22 and 23) show that many of the samples plot between the evaporation paths for irrigation water and dilute ground water. Dilute ground water had bicarbonate and calcium concentrations greater than irrigation water, indicating increases in bicarbonate and calcium concentrations during infiltration. Bicarbonate concentrations in water can be related to the partial pressure of carbon dioxide in the soil zone or aquifer and dissolution/precipitation of calcite. Dissolution/precipitation of calcite would also affect calcium concentrations. The calculated partial pressure of carbon dioxide in ground-water samples, which reflects the partial pressure of carbon dioxide in the aquifer, ranged from about $10^{-1.65}$ to $10^{-2.42}$ atm, whereas the calculated partial pressure of carbon dioxide in irrigation water was about $10^{-3.2}$ atm (table 15), indicating larger partial pressures of carbon dioxide in the aquifer relative to surface water in contact with the atmosphere. Because the saturation index of calcite in ground water and surface water generally was equal to or greater than zero (table 15), the water was probably in equilibrium with calcite. The increase in bicarbonate and calcium concentrations in the ground-water samples relative to irrigation water is probably due to the larger partial pressure of carbon dioxide in the soil zone/aquifer. Irrigation water infiltrating through the soil zone would equilibrate with the carbon dioxide in the soil zone and calcite, if present, would tend to dissolve. The water would dissolve calcite until the water was at calcite saturation (saturation index equal to zero). Larger partial pressure of carbon dioxide in the aquifer results in dissolution of more calcite, which in turn results in larger bicarbonate and calcium concentrations, as is seen in the sample from well 5 (table 15 and figs. 22 and 23).

The sodium and chloride concentration plot (fig. 24) shows that many of the samples plot along and between the evaporation paths of irrigation water and dilute ground water. The sodium concentration in dilute ground water is about 30 mg/L larger than in irrigation water, indicating increases in sodium during infiltration. The source of the sodium is unknown but could be due to calcium/sodium ion exchange or dissolution of sodium sulfate in the soil.

Surface water and shallow ground water show no linear trend in silica and chloride concentrations (fig. 25), indicating that silica concentrations are not affected by evapotranspiration (figs. 21-24). Dissolved silica concentrations in most surface water and ground water generally are larger than those in irrigation water. Weathering or dissolution of silicate minerals is a factor that could cause increases in dissolved silica, bicarbonate, sodium, and calcium concentrations. Because most shallow ground-water samples are undersaturated with respect to amorphous silica (table 15), dissolution of amorphous silica during infiltration may represent the source of silica in surface and ground water.

The mixing of irrigation water and ground-water inflow from areas adjacent to the Rincon Valley is another factor that could affect water quality. The composition of water at the upstream sampling site on the Garfield Drain is probably affected by Derry Warm Spring, which is located near the beginning of the Garfield Drain and discharges into the drain. Water from Derry Warm Spring contains 160 mg/L chloride, 309 mg/L sulfate, 52 mg/L calcium, and 303 mg/L sodium plus potassium as sodium (Conover, 1954, p. 152-153) and probably represents the general composition of ground-water inflow to the aquifer in this part of the Rincon Valley. Water from well 7, which is located along the Garfield Drain near Derry Warm Spring, is also probably affected by ground-water inflow in the area. Water from the upstream site on the Garfield Drain and from well 7 has smaller calcium concentrations (fig. 23) and larger sodium concentrations (fig. 24) than other samples in the Rincon Valley with similar chloride concentrations.

The composition of water from wells 25 and 26, which are located in the southern area of the Rincon Valley near the Rincon Drain, and of water from the downstream sampling site on the Rincon Drain generally had larger chloride and sulfate concentrations than most water in the valley (fig. 21 and app. B). Ground-water inflow from adjacent areas and irrigation water are probably mixing in this area. The relatively large dissolved-solids concentrations in water from the downstream site on the Rincon Drain during January (fig. 9) indicate that ground-water inflow from adjacent areas affects the composition of water in the drain during the nonirrigation season.

Fluoride concentrations in surface water and shallow ground water generally range from 0.5 to 1.5 mg/L (app. A and B). Fluoride concentrations in irrigation water (about 0.7 mg/L) are about the same as those in many of the surface-water (median 0.8 mg/L) and shallow ground-water (median 0.9 mg/L) samples, indicating little concentration of fluoride by evapotranspiration of irrigation water. Fluoride concentrations in water from the upstream site on the Garfield Drain (3.0 to 4.9 mg/L) and in water from well

7 (2.6 mg/L) are much larger than those in most other samples collected in the Rincon Valley. Derry Warm Spring, which contains large concentrations of fluoride (5.8 mg/L) (Conover, 1954, p. 153), probably affects the composition of water from well 7 and Garfield Drain near the upstream sampling site.

Nutrients

Nutrients (nitrogen and phosphorous compounds) in water can be from natural and human-related sources. Natural sources of nutrients include plant material, minerals, animal wastes, production of organic nitrogen compounds from nitrogen gas by plants (nitrogen fixation), and precipitation. Human-related nutrient sources include emissions from burning of fossil fuels, sewage effluent, and fertilizers. In agricultural areas, leaching of fertilizers can result in significant increases of nutrients in ground water and surface water.

Nutrients can be removed from water by many processes. Nitrogen and phosphorus are essential nutrients to many plants and organisms and can be removed from water to form biomass. In surface water, uptake by plants and adsorption to clays and iron oxides reduce dissolved nitrogen and phosphorous concentrations. In ground water, biologically mediated reactions can affect which forms of nitrogen are present. Denitrification, which is the reduction of nitrate to nitrogen gas (a stable compound that diffuses out of the water), can be an important process that removes nitrogen from ground water. Dissolved phosphorous concentrations are generally small in ground water because phosphorous minerals are relatively insoluble (Freeze and Cherry, 1979, p. 422) and phosphorus is adsorbed by clays in the soil zone/aquifer.

The occurrence and movement of different forms (species) of nitrogen, such as nitrate or ammonia, are related to the oxidation/reduction state of the aqueous environment. Under reducing conditions (anaerobic or small dissolved oxygen) ammonia or ammonium (in this report, ammonia includes ammonia and ammonium) typically is most common, and under oxidizing conditions (aerobic or presence of dissolved oxygen) nitrate typically is most common. Nitrate is usually found at larger concentrations in water than ammonia because nitrate is very soluble and is not adsorbed to clays or iron oxides, whereas ammonia generally is removed rapidly by plants, is strongly adsorbed to clay and iron oxides, and diffuses out of the water.

Nitrite plus nitrate concentrations ranged from less than 0.05 to 33 mg/L as nitrogen, and ammonia concentrations ranged from less than 0.01 to 0.33 mg/L as nitrogen in surface- and ground-water samples (tables 12 and 13). Ammonia concentrations are generally larger in samples with small nitrite plus nitrate concentrations (fig. 26) as would be expected if oxidation/reduction conditions control which form of nitrogen is dominant. Ground-water samples with ammonia concentrations larger than 0.05 mg/L as nitrogen generally had dissolved oxygen concentrations equal to or less than 0.2 mg/L (app. B), indicating oxidation/reduction conditions controlling nitrogen speciation in ground water. Because the surface-water samples with ammonia concentrations larger than 0.05 mg/L as nitrogen had dissolved oxygen concentrations larger than 1 mg/L (app. A), factors other than oxidation/reduction conditions may affect ammonia concentrations in surface water. Irrigation water (Rio Grande below Caballo Dam in April and October) has small concentrations of nitrite plus nitrate (less than 0.05 and 0.07 mg/L, respectively, as nitrogen) and ammonia (0.01 and 0.08 mg/L as nitrogen), indicating small nitrogen concentrations in surface water entering the Rincon Valley and diverted for irrigation. The small nitrogen concentrations in irrigation water relative to nitrogen concentrations in most other samples from the Rincon Valley indicate natural and land-use factors affecting nitrogen concentrations in the area.

The relatively small ammonia concentrations in surface water and ground water indicate that natural and land-use factors generally do not result in large ammonia concentrations in the Rincon Valley. Some of the largest ammonia concentrations were detected in samples from the downstream site on the Hatch Drain (app. A). These relatively large ammonia concentrations (0.27 and 0.33 mg/L as nitrogen) could be due to discharge from the Hatch wastewater treatment plant.

Nitrite plus nitrate concentrations were generally larger in ground water than in surface water (fig. 26), although the median concentration of nitrite plus nitrate in ground water (0.48 mg/L as nitrogen) was similar to the median concentration in surface water (0.44 mg/L as nitrogen). Twelve ground-water samples and two surface-water samples (downstream site on the

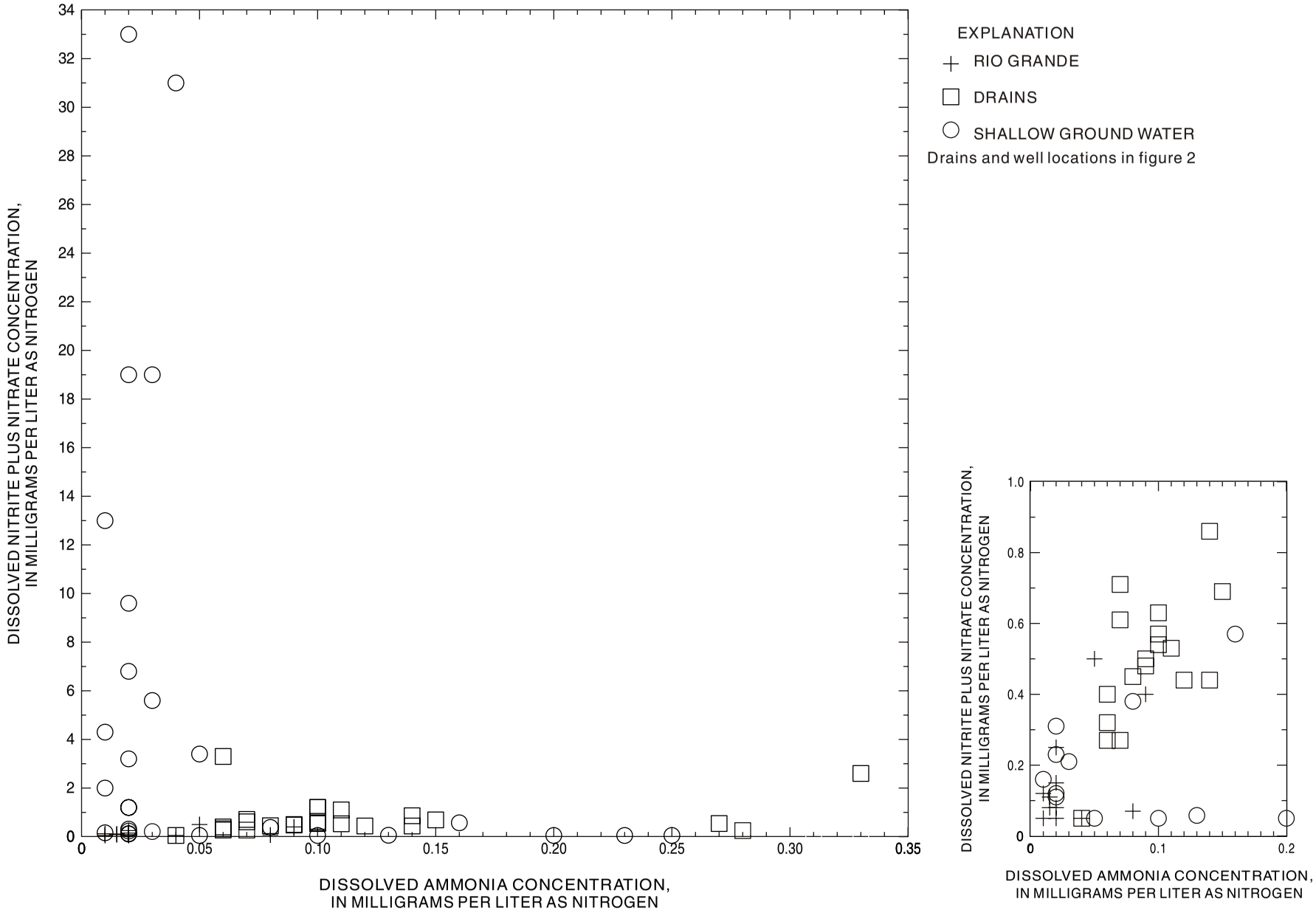

Figure 26. Relation between dissolved nitrite plus nitrate and ammonia concentrations in the Rio Grande, drains, and shallow ground water in the Rincon Valley study area.

Hatch Drain) had nitrite plus nitrate concentrations equal to or greater than 2 mg/L as nitrogen (app. B; fig. 26). Nitrite plus nitrate concentrations were generally larger in samples from the drains than in samples from the Rio Grande (fig. 26). The larger nitrite plus nitrate concentrations in the drains than in the Rio Grande probably are due to larger nitrite plus nitrate concentrations in ground water, which discharges to the drains. Samples from the downstream site on the Hatch Drain had much larger nitrite plus nitrate concentrations in January than during April or October, possibly because discharge from the Hatch wastewater treatment plant is a larger part of total flow in the drain in January than during April and October when flow in the drains is larger.

Fertilizers are probably leaching downward to the aquifer in some parts of the Rincon Valley on the basis of large nitrite plus nitrate concentrations in samples from some of the wells relative to irrigation water. Elevated nitrite plus nitrate concentrations do not seem to be located in one particular area of the Rincon Valley (fig. 18), so leaching of fertilizers probably is not limited to specific areas in the valley. The large range and relatively wide variation in nitrite plus nitrate concentrations in short distances (such as well 3 with a concentration of 2.00 mg/L as nitrogen and well 4 with a concentration of 13.0 mg/L) indicate variations in leaching or chemical processes affecting nitrogen concentrations in infiltrating irrigation water and ground water.

Phosphorous concentrations in surface water and ground water generally were small: 75 percent of the surface-water samples had phosphorous concentrations equal to or less than 0.02 mg/L (table 12), and 75 percent of the shallow ground-water samples had phosphorous concentrations equal to or less than 0.05 mg/L (table 13). The relatively small phosphorous concentrations in most surface-water and shallow ground-water samples indicate that they are not significantly affected by the application of phosphorus-containing fertilizers in the Rincon Valley.

Samples from the downstream sampling site on the Hatch Drain were the only surface-water samples with phosphorous concentrations larger than 0.03 mg/L (app. A). The largest concentrations were in the Hatch Drain in January when flows were smallest (app. A). These large phosphorous concentrations probably are due to inflow of treated effluent from the Hatch wastewater treatment plant. Snoeyink and Jenkins (1980, p. 301) indicated that phosphorous concentrations range from 3 to 15 mg/L in domestic wastewater. Healy (1995) measured phosphorous concentrations as large as 3.9 mg/L in wastewater treatment plant effluent in southern New Mexico.

Trace Elements

The sources and concentrations of trace elements in water can be affected by natural and human-related factors. Natural factors include dissolution of naturally occurring minerals, adsorption, and complexing by organic ligands. Some trace elements are relatively rare and therefore generally are not naturally found in water. The solubility of minerals containing trace elements is probably one of the most important factors affecting trace-element concentrations in water. Many trace elements can exist in various oxidation states; therefore, dissolved concentrations are related to oxidation/reduction conditions of the subsurface. Human activities that can affect the availability of minerals that contain trace elements or trace-element concentrations in water include mining, application of pesticides (arsenic and copper were used as pesticides), burning of fossil fuels, and improper disposal of household and industrial wastes. Evapotranspiration resulting from crop irrigation can also affect trace-element concentrations in water.

The concentrations of many trace elements were small, not measurable, or had little spatial or temporal variation in concentration; therefore, they are not discussed. The trace elements barium, bromide, iron, manganese, molybdenum, and uranium are discussed in detail because they had measurable concentrations in most samples and spatial variations in concentrations among samples.

The concentration of barium in surface-water and ground-water samples ranged from 29 to 120 ∝g/L (tables 12 and 13). Because barium concentrations in irrigation water (Rio Grande below Caballo Dam in April and October 1994) were generally larger than those in shallow ground water, concentrations probably decrease (adsorption or mineral precipitation) during infiltration of irrigation water. The concentration of barium in water can be controlled by the solubility of barite ($BaSO_4$) and by ion exchange or adsorption by clays (Robertson, 1991, p. 22). Irrigation water and many ground-water samples have barite saturation indexes greater than 0.5 (table 15), indicating that barite tends to precipitate from these samples.

Bromide is relatively conservative in water and probably is affected by evapotranspiration. Large concentrations of bromide also can occur in geothermal water. Anthropogenic sources include bromide compounds used in gasoline or as fumigants (Hem, 1985, p. 146). Bromide concentrations in irrigation water were about 0.06 mg/L (app. A) and in shallow ground water ranged from 0.13 to 0.97 mg/L with a median of 0.27 mg/L (table 13). Concentrations of bromide generally were larger in ground water than in drain water. On the basis of the amount of evapotranspiration of irrigation water estimated using concentrations of common constituents, bromide concentrations generally are larger in ground water than can be accounted for by concentration by evapotranspiration. This means that the Rincon Valley must have another source of bromide, possibly ground-water inflow from adjacent areas. Why concentrations of bromide are larger in shallow ground water than in drain water is not clear.

Iron and manganese minerals are very common in the environment. Iron and manganese can exist in several oxidation states and generally are more soluble in the reduced form than in the oxidized form. Iron and manganese concentrations detected in ground-water samples (app. B) generally were much larger than those in irrigation water (app. A), so irrigation water is probably not the source of iron and manganese in the valley. Manganese was detected at larger concentrations in ground water (median about 370 ∝g/L) and in surface water (median 159 ∝g/L) than iron (ground-water median 6.5 ∝g/L; surface-water median 5 ∝g/L), indicating oxidation/reduction conditions in which manganese has been reduced but iron has not. The larger manganese concentrations in ground water than in surface water are probably related to more reducing conditions in the aquifer than in surface water (app. A and B).

Molybdenum is present in many ore minerals and is relatively soluble or mobile in water (Hem, 1985, p. 140). In surface water and shallow ground water, molybdenum concentrations generally ranged from 6 to 13 ∝g/L (app. A and B). Molybdenum concentrations in irrigation water (6 and 7 ∝g/L, app. A) generally were smaller than those in shallow ground water (median 10.5 ∝g/L) and in the drains (generally 10 ∝g/L), possibly indicating molybdenum in irrigation water concentrated by evapotranspiration. Samples from the upstream sampling site on the Garfield Drain and in water from well 7, located near the Garfield Drain, had relatively large molybdenum concentrations compared with water in other areas of the Rincon Valley (app. A and B), possibly a result of mixing of ground-water inflow from adjacent areas and shallow ground water.

Uranium concentrations ranged from less than 1 to 62 ∝g/L in surface- and ground-water samples, indicating that several factors could be affecting uranium concentrations. Uranium can exist in different oxidation states and generally is more soluble in the oxidized form than in the reduced form (Hem, 1985, p. 148). Because the concentration of uranium in irrigation water (about 3 ∝g/L, app. A) generally was smaller than that in shallow ground water (median 8.5 ∝g/L), uranium concentrations may increase during infiltration/evapotranspiration of irrigation water. Samples with uranium concentrations larger than about 10 ∝g/L are probably due to factors other than concentration of irrigation water. The relatively large uranium concentrations in samples from the upstream sampling site on the Garfield Drain (12 to 20 ∝g/L) and from well 7 (62 ∝g/L) indicate that ground-water inflow from areas adjacent to the Rincon Valley may be affecting uranium concentrations in water in this area. Because most of the larger uranium concentrations in ground water are in samples from wells in the northern part of the Rincon Valley, ground-water inflow from adjacent areas possibly affects uranium concentrations in the northern part of the Rincon Valley.

Radioactivity and Radon-222

Radionuclides in water are from natural sources, such as weathering of rocks and interaction of cosmic rays with atmospheric particles, or from human activities, such as testing of nuclear weapons and industrial/medical uses of radionuclides. Human activities also can indirectly affect radionuclide concentrations in water. For example, human activities that result in changes in the concentration of solutes in water as a result of evapotranspiration could affect radionuclide concentrations. The main alpha-emitting substances in water are decay products of uranium and thorium, which generally occur naturally. Gross beta-emitting substances include potassium-40 and radium-228, which occur naturally, and cesium-137 and strontium-90, which are related to human activities. Radon-222 is in the uranium-238 decay series and is the decay product of radium-226.

Radium-226 can be present in aquifer material or be dissolved in ground water.

A plot of gross alpha activity and dissolved uranium concentration shows a linear relation (fig. 27), indicating that a large amount of the measured gross alpha activity in shallow ground water is from dissolved uranium. Three isotopes of uranium produce alpha activity, and variations in the ratio of these isotopes dissolved in water will result in different gross alpha activities because the isotopes have different half-lives (Thomas and others, 1993, p. 454). Most shallow ground-water samples from the Rincon Valley have dissolved gross alpha activity larger than alpha activity estimated from the uranium concentration assuming a uranium-234 to uranium-238 activity ratio of 1 (data plot above the line; fig. 27), indicating that the uranium-234 to uranium-238 activity ratio could be greater than 1. Other alpha emitters such as radium-226 and thorium-230 dissolved in shallow ground water or counting uncertainty during analysis could also account for the larger gross alpha activity than would be estimated from a uranium-234 to uranium-238 activity ratio of 1.

A plot of gross beta activity and dissolved potassium concentration (fig. 28A) shows gross beta activity increasing with increasing dissolved potassium concentration, suggesting that some gross beta activity is due to potassium-40. The beta activity (picocuries per liter as Sr-90/Y-90) due to potassium-40 can be estimated by multiplying the potassium concentration (milligrams per liter) by 0.818, which assumes a natural ratio of potassium-40 to total potassium of 0.0117 percent and a half-life of potassium-40 of 1.28 x 10^9 years (Thomas and others, 1993, p. 463). Welch and others (1995) reported that radioactive decay of dissolved uranium-238 in the sample between time of collection and time of analysis results in the daughter products thorium-234 and protactinium-234, which decay and produce beta activity. These uranium-238 daughter products, which are relatively insoluble in ground water but would be soluble in an acidified sample, can result in significant beta activity in a

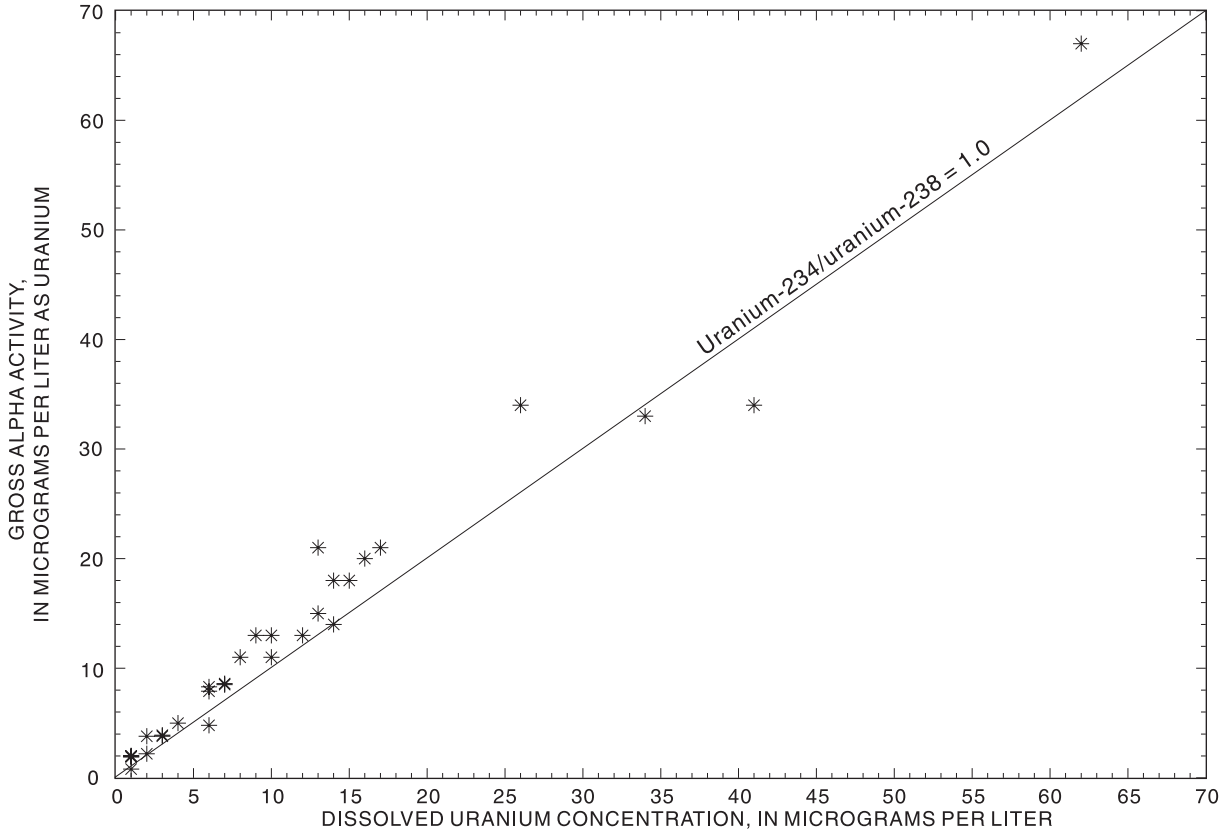

Figure 27. Relation between gross alpha activity and dissolved uranium concentration in shallow ground water in the Rincon Valley study area.

sample that is distinct from the beta activity of the water when the sample was collected or distinct from water in the aquifer. The effect of uranium-238 daughter products can be estimated by subtracting the beta activity due to potassium-40 from the gross beta activity and plotting the adjusted value against the uranium concentration in the sample (fig. 28B). This plot shows that in many samples most beta activity can be accounted for by potassium-40 (adjusted values close to zero). For samples in which the adjusted value is greater than zero, the adjusted beta activity generally increases with increasing uranium concentration, indicating that uranium-238 daughter products account for part of the gross beta activity in the samples (fig. 28B). Gross beta activity not accounted for by potassium-40 and dissolved uranium could be due to gross beta activity from radium-228 or from counting uncertainty during analysis of the samples.

Radon-222, which is the result of decay of radium-226, probably does not travel far from the source because the half-life of radon-222 is about 4 days. Thomas and others (1993, p. 451) reported that radium-226 is relatively immobile in water and that most radium-226 probably is part of the aquifer material. Because of the relatively small concentrations of radon-222 in most ground water in the Rincon Valley, uranium and therefore radium-226 probably are not found in large concentrations in shallow aquifer material in the valley.

Volatile Organic Compounds

VOC's in water generally result from human activities because most VOC's do not occur naturally. VOC's come from a variety of sources including gasoline, asphalt, paints, adhesives, solvents, wood preservatives, dry-cleaning agents, pesticides, cosmetics, and refrigerants. The presence of VOC's in ground water generally is due to leaching of VOC's applied to or spilled on the land surface, infiltration of industrial or municipal wastewater, infiltration of domestic septic-tank effluent, and infiltration of precipitation containing VOC's.

Xylene was detected in wells 16, 21, and 26. These wells are adjacent to asphalt-covered roads. Infiltration of runoff from the roads could be the source of the xylene. The xylene concentration in water from well 21 was 0.70 ∝g/L and from well 26 was 0.30 ∝g/L (app. B). Well 26 was sampled on the same day and immediately after well 21 was sampled, so the xylene in water from well 26 could be due to carryover of xylene on the equipment between the two wells. Because of the small number of VOC detections, human activities probably have not resulted in widespread VOC contamination of the shallow aquifer.

Pesticides

Pesticides are used to control a wide variety of pests (Meister, 1995), including insects (insecticides) and weeds (herbicides). Approximately 1.1 billion lbs of pesticides are used annually in the United States (Barbash and Resek, 1996, p. 3). Although a large number of pesticides are used that were not analyzed for in the samples collected during this study, many of the most widely used pesticides were analyzed for.

Many factors affect pesticides that are applied to soil or crops. Many pesticides break down or are transformed into common chemical constituents as the result of biochemical, photochemical, or other chemical processes (Barbash and Resek, 1996, p. 203). Sometimes pesticides break down in steps and some of the breakdown or degradation products can be toxic to plants and organisms. Dacthal mono-acid, DDD, and p,p'-DDE are degradation products that were detected in samples from the Rincon Valley. Although these compounds are generally not used as pesticides, they are referred to as pesticides in the following discussion. Pesticides can evaporate or volatilize from the soil or crops to the atmosphere. Pesticides applied to soil or crops can be leached by infiltrating irrigation water or precipitation and transported to the ground-water system. Runoff of irrigation water or precipitation from fields where pesticides have been applied and ground water discharging to drains can transport pesticides to surface water. Many pesticides are adsorbed by organic carbon or clay minerals, thereby reducing dissolved concentrations and reducing the rate at which pesticides move through the soil zone, ground-water system, or surface-water body.

A larger number of pesticides were detected and detected more frequently in surface water than in ground water. Thirteen pesticides (nine herbicides and four insecticides) were detected in one or more surface-water samples, whereas only five pesticides (two herbicides and three insecticides) were detected in

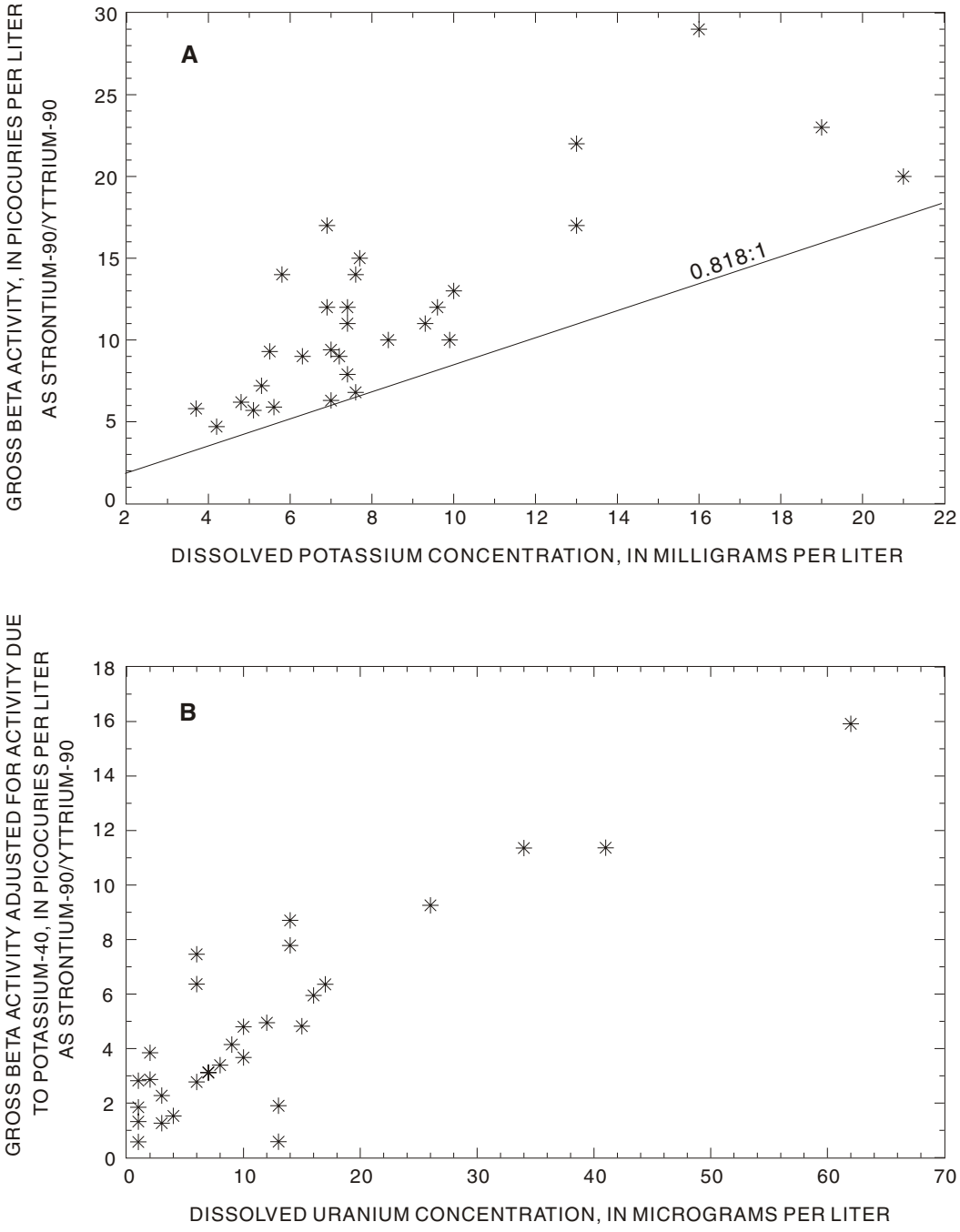

Figure 28. Relation between (A) gross beta activity and dissolved potassium concentration and (B) adjusted gross beta activity and dissolved uranium concentration in shallow ground water in the Rincon Valley study area.

ground-water samples (app. A and B). One or more pesticides were detected in 34 of 37 surface-water samples (92 percent) and in 12 of 30 ground-water samples (40 percent). DCPA and metolachlor were the most commonly detected pesticides in surface water, and metolachlor was the most commonly detected pesticide in ground water. DCPA was not detected in any ground-water samples. The detection of a larger number of different pesticides in surface water (13) than in ground water (5) indicates that pesticides are entering surface water as runoff from fields or that the number of ground-water samples collected and time of year that the samples were collected did not adequately represent the composition of ground water in the Rincon Valley that discharges to the drains. For example, some of the largest DCPA concentrations were detected in samples from the drains during the irrigation season (April and October 1994, fig. 14), but DCPA was not detected in any ground-water samples in April/May 1994, indicating that ground-water inflow to the drains is probably not the source of DCPA in the drains. Flow of irrigation water across the fields and into the drains could transport DCPA into the drains. During the non-irrigation season (January 1994 and 1995), DCPA was also detected in samples from the drains; however, no water would be flowing across the fields during this time of the year. Whether DCPA in the samples from the drains during the non-irrigation season is due to ground-water discharge to the drains or is leached from sediment in the drains is not clear. Additional ground-water sampling throughout the year would be required to determine the temporal variations in pesticide concentrations in shallow ground water and the source of DCPA in the drains.

Some pesticides detected in surface- and ground-water samples from the Rincon Valley could be transported into the valley in irrigation water. Prometon and simazine were detected in samples of irrigation water (app. A). Prometon detected in water from well 17, which is near an irrigation ditch, is probably the result of infiltration of irrigation water containing prometon. In three of four other samples containing prometon, the concentration was similar to that in surface water (estimated 0.011 ∝g/L), indicating that prometon in ground water could be from infiltrating irrigation water (app. A and B).

Five pesticides (DCPA, EPTC, metolachlor, prometon, and simazine) were detected during a particular sampling period in water from two or more sites on the Rio Grande, indicating transport of these pesticides down the Rio Grande (app. A). The concentrations of EPTC and metolachlor (January 1994) decreased as water moved downstream more than can be accounted for by dilution from increased discharge, possibly indicating adsorption or transformations. The concentrations of DCPA, prometon, and simazine detected in samples from the Rio Grande were relatively constant as the water moved downstream (app. A), indicating little dilution, adsorption, or transformation as these pesticides moved downstream.

Insecticides detected in surface water (carbofuran, chlorpyrifos, diazinon, and p,p'-DDE) generally were detected in April 1994 at drain sites (app. A). Carbofuran, the most commonly detected insecticide, was detected in samples from all drain sites sampled in April 1994 and in a sample from the upstream sampling site on the Garfield Drain in January 1995. Chlorpyrifos was detected in April 1994 at the two downstream sampling sites on the Garfield Drain. Carbofuran and chlorpyrifos were not detected in any ground-water samples, possibly indicating that these insecticides are adsorbed to material in the soil zone and do not leach downward into ground water but instead are transported into the drains by runoff from fields. Diazinon was detected at the downstream sampling site on the Rincon Drain in April 1994 and at the downstream site on the Hatch Drain in January 1994. The pesticide degradation product p,p'-DDE was detected in drain samples at small concentrations. Four of seven samples in which p,p'-DDE was detected were collected in April 1994. DDT and p,p'-DDE also were detected in samples of bed material from the three drains sampled in the Rincon Valley (app. C). Although DDT was not analyzed for in surface-water samples, DDT and p,p'-DDE could be leaching from bed sediment in the drains, resulting in the p,p'-DDE detected in surface water. Because p,p'-DDE was detected in only one ground-water sample (well 29), p,p'-DDE probably is not generally found in shallow ground water; thus, ground-water discharge is probably not the main source of p,p'-DDE in surface water.

Diazinon, metolachlor, napropamide, p,p'-DDE, and prometon were detected in one or more ground-water samples (app. B); their presence indicates that they are leaching from land surface into ground water in the Rincon Valley. Diazinon, napropamide, and p,p'-DDE were detected in only one ground-water sample. The concentrations of prometon in four of five samples where prometon was detected were in the

same range as those in irrigation water. Metolachlor, the most commonly detected pesticide in ground water and surface water, is probably the only pesticide that is leaching from the soil zone into ground water on a widespread basis. Metolachlor was detected in 6 of the 10 samples that had the largest nitrite plus nitrate concentrations, indicating that nitrogen and metolachlor are leaching into ground water in some areas of the Rincon Valley.

On the basis of pesticide concentrations detected in shallow ground water in the Rincon Valley, no large amounts of pesticides are leaching from land surface into ground water. Although there is some indication that several pesticides are leaching into shallow ground water (metolachlor and prometon especially), the concentrations are significantly smaller than any standards or health advisories issued by the USEPA.

SUMMARY AND CONCLUSIONS

As part of the National Water-Quality Assessment Program, surface-water and ground-water samples were collected in 1994 and 1995 for analysis of common constituents, nutrients, dissolved organic carbon, trace elements, radioactivity, radon-222, VOC's, and pesticides to characterize surface-water and shallow ground-water quality and to determine factors affecting water quality in the Rincon Valley, south-central New Mexico. Samples of surface water were collected from three sites on the Rio Grande and from sites on three agricultural drains in the Rincon Valley. Samples were collected in January of 1994 and 1995, in April of 1994, and in October of 1994. Ground-water samples were collected in late April and early May 1994 from 30 shallow wells that were installed during the investigation.

The Rincon Valley is an agricultural area that includes the area of the Rio Grande flood plain between Caballo Reservoir and Seldon Canyon. Crops in the Rincon Valley are irrigated with surface water diverted into irrigation canals from the Rio Grande, which is the main drainage in the valley. Flow in the Rio Grande is controlled by releases from Caballo Reservoir. From about mid-October to early January little or no water is released from Caballo Dam into the Rio Grande. A complex set of unlined irrigation canals are used to move irrigation water from the point of diversion to individual fields. Shallow ground water discharges into open drains to maintain water levels below land surface. The largest drain flow occurs in June, July, and August during the peak of the irrigation season, and the smallest flow occurs in December, January, and February. When no water is being released from Caballo Dam, all flow in the Rio Grande below Caballo Dam is from ground-water discharge and discharge from the drains to the river. The annual discharge to the Rio Grande from the drains equals about 12 percent of the water diverted to the Arrey Canal from the Rio Grande.

The main aquifer in the Rincon Valley consists of the Quaternary valley fill, which is about 80 ft thick and consists of gravel, sand, silt, and clay. The main sources of recharge to the aquifer are infiltration of water from the Rio Grande, infiltration of water in irrigation canals, and infiltration of water applied to fields. Discharge from the aquifer is mainly the result of discharge to the Rio Grande and drains. In the winter months, ground water discharges to the Rio Grande, but relatively little or no ground water discharges to the Hatch and Garfield Drains. The surface-water and ground-water systems are closely connected; therefore, a change in surface-water supplies or surface-water quality affects ground-water supplies or ground-water quality.

Dissolved oxygen concentrations generally were larger in samples from the Rio Grande than in samples from the drains and generally were larger in samples collected in January of 1994 and 1995 than in samples collected in April and October of 1994. All samples from the Rio Grande had dissolved oxygen concentrations larger than 5 mg/L, which is the surface-water-quality standard.

Dissolved-solids concentrations in surface water ranged from 434 to 1,510 mg/L. Dissolved-solids concentrations were smallest in water from the Rio Grande below Caballo Dam and largest in the drains. Sulfate concentrations generally were the largest and had the most variation of the common constituents, and bicarbonate and sodium had the next largest concentrations in surface-water samples. Nitrite plus nitrate concentrations ranged from less than 0.05 to 3.3 mg/L as nitrogen, and ammonia concentrations ranged from less than 0.015 to 0.33 mg/L as nitrogen in surface-water samples. Nitrite plus nitrate and ammonia concentrations generally were larger in water from the drains than in water from the Rio Grande.

Concentrations of many trace elements in surface water in the Rincon Valley were small (less than 10 ∝g/L). Aluminum, barium, boron, bromide,

copper, iron, manganese, molybdenum, uranium, and zinc were the only trace elements analyzed for that were in one or more samples at concentrations larger than 10 ∝g/L. The trace-element concentrations in surface water were significantly smaller than acute-fisheries standards. One or more pesticides were detected in 34 of 37 surface-water samples. Thirteen of 88 pesticides analyzed for in each sample were detected in one or more samples. DCPA (dacthal) and metolachlor were the most commonly detected pesticides, and metolachlor was detected at the largest concentration. No surface-water-quality standards have been established for the pesticides analyzed for in this study.

Although the wells sampled are not used for drinking water, shallow ground-water quality in the Rincon Valley was compared to MCL's, SMCL's, and health advisories established for drinking water. Dissolved-solids concentrations in shallow ground water ranged from 481 to 3,630 mg/L. Some of the largest dissolved-solids concentrations were in water from wells south and east of Rincon. Dissolved-solids concentrations in water from wells a short distance apart have a relatively large variation. Bicarbonate and sulfate concentrations generally were the largest of the common constituents. All but 2 of 30 samples exceeded the SMCL of 500 mg/L for dissolved solids. Water from about 73 percent of the wells sampled exceeded the SMCL of 250 mg/L for sulfate and from about 7 percent of the wells sampled exceeded the SMCL of 250 mg/L for chloride.

Nitrite plus nitrate concentrations ranged from less than 0.05 to 33 mg/L as nitrogen, and ammonia concentrations were generally less than 0.1 mg/L as nitrogen in shallow ground water. Nitrite plus nitrate concentrations showed no areal pattern and varied considerably over short distances. Water from about 17 percent of the well samples exceeded the MCL of 10 mg/L for nitrite plus nitrate as nitrogen.

The concentrations of trace elements in shallow ground water generally were small (less than 10 ∝g/L). Barium, bromide, copper, iron, manganese, molybdenum, and uranium were the only trace elements analyzed for that were in one or more samples at concentrations larger than 10 ∝g/L. The proposed MCL of 20 ∝g/L for uranium was exceeded in about 13 percent of the samples, the SMCL of 300 ∝g/L for iron was exceeded in about 17 percent of the samples, and the SMCL of 50 ∝g/L for manganese was exceeded in about 83 percent of the samples.

Gross alpha activity ranged from 0.8 to 67 ∝g/L as uranium, and the largest gross alpha activities were in samples from the northern part of the Rincon Valley. Samples from about 23 percent of the wells exceeded the MCL of 15 pCi/L. Gross beta activity ranged from 4.7 to 29 pCi/L as Sr-90/Y-90, and radon-222 concentrations ranged from 210 to 440 pCi/L in shallow ground water.

Xylene was detected in 3 of 20 samples at concentrations ranging from 0.3 to 2.8 ∝g/L. The MCL for xylene is 10,000 ∝g/L, which is significantly larger than any concentration detected in ground-water samples in the Rincon Valley.

Five (diazinon, metolachlor, napropamide, p,p'-DDE, and prometon) of the 88 pesticides or pesticide degradation products analyzed for were detected in one or more shallow ground-water samples. One or more pesticides or degradation products were detected in water from 12 of 30 wells sampled. Metolachlor and prometon were the most commonly detected pesticides. Health advisories for the pesticides detected in shallow ground water are 10 to 300 times larger than the concentrations detected.

Infiltration and evapotranspiration of irrigation water are important factors affecting shallow ground-water quality in the Rincon Valley. Dissolution of calcite and gypsum are potentially important factors affecting the concentrations of common constituents. In some areas of the Rincon Valley, ground-water inflow from adjacent areas possibly influences the composition of shallow ground water and water in the drains. Although silica concentrations in ground water and drain water could be affected by weathering and dissolution of silicate rocks, silica concentrations do not appear to be affected by evaporation and transpiration.

Nitrate and ammonia concentrations generally were small in surface water entering the Rincon Valley (irrigation water), and nitrogen concentrations in water in the Rio Grande did not increase from ground-water discharge and drain discharge to the river during most of the year. Because of relatively large nitrite plus nitrate concentrations in several shallow ground-water samples (as much as 33 mg/L), fertilizers may be leaching to ground water in some areas of the Rincon Valley. Wide variations in nitrite plus nitrate concentrations in short distances indicate variations in leaching or chemical processes affecting nitrogen concentrations in ground water.

Phosphorous concentrations in surface water and ground water in the Rincon Valley generally were less than 0.05 mg/L as phosphorus, indicating that phosphorous concentrations in the valley are not significantly affected by application of phosphorous-containing fertilizers. The largest phosphorous concentrations were detected in samples from the downstream sampling site on the Hatch Drain and are probably due to inflow of treated effluent to the drain from the Hatch wastewater treatment plant.

Because barium concentrations generally were larger in irrigation water than in shallow ground water or drain water, they probably decrease during infiltration and evaporation of irrigation water. Bromide concentrations in water in the Rincon Valley are probably affected by evapotranspiration of irrigation water and inflow of ground water from adjacent areas. Although relatively large manganese concentrations were detected in both surface water and ground water, iron concentrations generally were small, indicating oxidation/reduction conditions where manganese has been reduced but iron has not. Molybdenum and uranium concentrations were relatively larger in samples from the upstream sampling site on the Garfield Drain and from well 7, indicating that ground-water inflow to the Rincon Valley from adjacent areas influences the composition of shallow ground water in this area.

A large amount of dissolved gross alpha activity in shallow ground water is from uranium isotopes. Because dissolved gross beta activity increases with dissolved potassium concentration, part of the dissolved gross beta activity is due to potassium-40.

Xylene was the only VOC detected in shallow ground water. Infiltration of runoff from the roadways adjacent to the wells could be the source of the xylene.

A larger number of different pesticides were detected and detected more frequently in surface water than in ground water. This indicates that pesticides are entering surface water as runoff from fields or that the number of ground-water samples collected and time of year that the samples were collected did not adequately represent the composition of ground water in the Rincon Valley that discharges to the drains. Pesticides may also be leaching from sediment in the drains, resulting in the observed concentrations of pesticides in surface water. Some of the pesticides detected could be transported into the valley in irrigation water. Prometon and simazine were detected in water that was diverted into the irrigation canals.

The insecticide carbofuran was not detected in ground-water samples but was detected in all samples from the drain sites sampled in April 1994. This may mean that carbofuran does not leach into ground water but instead is transported into the drains by runoff from fields.

On the basis of pesticide concentrations detected in shallow ground water in the Rincon Valley, large amounts of the pesticides analyzed for in this study are not leaching into ground water. Although there is some indication that several pesticides are leaching into shallow ground water (metolachlor and prometon especially), the concentrations detected in shallow ground water are significantly smaller than any standards or health advisories issued by the USEPA.

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Table 1. Annual diversions and discharge in drains in the Rincon Valley study area, 1993-95

[Data from Elephant Butte Irrigation District. All values in acre-feet; location of streamflow gages on drains shown in figure 2]

	1993	1994	1995
		Diversions	
Arrey Canal	102,000	127,000	127,000
Percha Lateral	1,080	1,440	1,370
		Drains	
Garfield Drain	3,900	5,120	5,700
Hatch Drain	5,540	5,350	5,110
Rincon Drain	5,540	5,050	5,410

Table 2. Crops, in acres, irrigated in the Rincon Valley study area, 1993-95

[Data from Elephant Butte Irrigation District]

Crop	1993	1994	1995
Alfalfa hay	4,468	5,778	6,628
Barley	0	0	57
Cabbage	56	26	7
Carrots	55	0	0
Cotton, lint (Am, Pima)	588	969	1,067
Cotton, lint (upland)	590	640	809
Family gardens and orchards	32	34	18
Field crops (miscellaneous)	0	0	24
Hay (other)	92	39	31
Irrigated pasture	64	84	86
Lettuce	161	130	56
Nursery (total)	40	40	13
Oats	0	0	654
Onions, dry	2,495	1,912	1,982
Pecans	1,310	1,377	1,425
Peppers (all kinds)	3,776	2,833	2,145
Sileage or ensilage	911	1,165	901
Tomatoes (canning)	114	116	106
Vegetables (other)	0	40	79
Watermelons	0	0	54
Wheat	1,703	1,812	1,084

Table 3. List of common constituents, nutrients and organic carbon, trace elements, and pesticides analyzed for in surface-water samples

[Minimum reporting level, minimum concentration of an analyte that can be reliably measured and reported by the laboratory using a given analytical method (Timme, 1995). Method detection limit, minimum concentration of an analyte that can be measured and reported with 99-percent confidence that the concentration of the analyte is greater than zero (Zaugg and others, 1995). mg/L, milligrams per liter; mg/L, micrograms per liter. Pesticides listed in group A extracted by C-18 solid-phase extraction cartridge and analyzed by gas chromatography/mass spectrometric detector. Pesticides listed in group B extracted by Carbopak-B solid-phase extraction cartridge and analyzed by high-performance liquid chromatography]

COMMON CONSTITUENTS

Constituent	Minimum reporting level (mg/L)
Calcium	0.02
Magnesium	0.01
Sodium	0.20
Potassium	0.1
Bicarbonate	0.1
Carbonate	0.1
Alkalinity	0.1
Sulfate	0.1
Chloride	0.1
Fluoride	0.1
Silica	0.01
Dissolved solids	1.0

NUTRIENTS AND ORGANIC CARBON

Nitrite	0.01
Nitrite plus nitrate	0.05
Ammonia	0.015
Ammonia plus organic nitrogen	0.2
Phosphorus	0.01
Orthophosphate	0.01
Total organic carbon	0.1
Suspended organic carbon	0.1
Dissolved organic carbon	0.1

TRACE ELEMENTS

Constituent	Minimum reporting level (∝g/L)
Aluminum	1
Antimony	1
Arsenic	1
Barium	1
Beryllium	1
Boron	10
Bromide	10
Cadmium	1
Chromium	1
Cobalt	1
Copper	1
Iron	3
Lead	1
Manganese	1
Molybdenum	1
Nickel	1
Selenium	1
Silver	1
Uranium	1
Zinc	1

Table 3. List of common constituents, nutrients and organic carbon, trace elements, and pesticides analyzed for in surface-water samples--Concluded

PESTICIDES

GROUP A	
Name	**Method detection limit (∝g/L)**
Acetochlor	0.002
Alachlor	0.002
Atrazine	0.001
Benfluralin	0.002
Alpha HCH	0.002
Butylate	0.002
Carbaryl	0.003
Carbofuran	0.003
Chlorpyrifos	0.004
Cyanazine	0.004
DCPA	0.002
p,p'-DDE	0.006
Deethyl atrazine	0.002
Diazinon	0.002
Dieldrin	0.001
2,6-Diethylaniline	0.003
Disulfoton	0.017
EPTC	0.002
Ethalfluralin	0.004
Ethoprop	0.003
Fonofos	0.003
Lindane	0.004
Linuron	0.002
Malathion	0.005
Methyl azinphos	0.001
Methyl parathion	0.006
Metolachlor	0.002
Metribuzin	0.004
Molinate	0.004
Napropamide	0.003
Parathion	0.004
Pebulate	0.004
Pendimethalin	0.004
Permethrin	0.005
Phorate	0.002
Prometon	0.018
Pronamide	0.003
Propachlor	0.007
Propargite	0.013
Propanil	0.004
Simazine	0.005
Tebuthiuron	0.010
Terbacil	0.007
Terbufos	0.013
Thiobencarb	0.002
Triallate	0.001
Trifluralin	0.002

GROUP B	
Name	**Method detection limit (∝g/L)**
Acifluorfen	0.035
Aldicarb	0.016
Aldicarb sulfone	0.016
Aldicarb sulfoxide	0.021
Amiben	0.011
Bentazon	0.014
Bromacil	0.035
Bromoxynil	0.035
Carbaryl	0.008
Carbofuran	0.028
Chlorothalonil	0.035
Clopyralid	0.050
2,4-D	0.035
Dacthal mono-acid	0.017
2,4-DB	0.035
Dicamba	0.035
Dichlobenil	0.020
Dichlorprop	0.032
Dinoseb	0.035
Diuron	0.020
Esfenvalerate	0.019
Fenuron	0.013
Fluometuron	0.035
3-Hydroxycarbofuran	0.014
Linuron	0.018
MCPA	0.050
MCPB	0.035
Methiocarb	0.026
Methomyl	0.017
1-Naphthol	0.007
Neburon	0.015
Norflurazon	0.024
Ocresol	0.035
Oryzalin	0.019
Oxamyl	0.018
Picloram	0.050
Propham	0.035
Propoxur	0.035
Silvex	0.021
2,4,5-T	0.035
Triclopyr	0.050

Table 4. List of common constituents, nutrients and dissolved organic carbon, trace elements, radioactivity/radon, volatile organic compounds, and pesticides analyzed for in ground-water samples

[Minimum reporting level is the minimum concentration of an analyte that can be reliably measured and reported by the laboratory using a given analytical method (Timme, 1995). Method detection limit is the minimum concentration of an analyte that can be measured and reported with 99-percent confidence that the concentration of the analyte is greater than zero (Zaugg and others, 1995). mg/L, milligrams per liter; ∝g/L, micrograms per liter; pCi/L, picocuries per liter. Pesticides listed in group A extracted by C-18 solid-phase extraction cartridge and analyzed by gas chromatography/mass spectrometric detector. Pesticides listed in group B extracted by Carbopak-B solid-phase extraction cartridge and analyzed by high-performance liquid chromatography]

COMMON CONSTITUENTS

Constituent	Minimum reporting level (mg/L)
Calcium	0.02
Magnesium	0.01
Sodium	0.2
Potassium	0.1
Bicarbonate	0.1
Carbonate	0.1
Alkalinity	0.1
Sulfate	0.1
Chloride	0.1
Fluoride	0.1
Silica	0.01

NUTRIENTS AND DISSOLVED ORGANIC CARBON

Nitrite	0.01
Nitrite plus nitrate	0.05
Ammonia	0.015
Ammonia plus organic nitrogen	0.2
Phosphorus	0.01
Orthophosphate	0.01
Dissolved organic carbon	0.1

TRACE ELEMENTS

Constituent	Minimum reporting level (∝g/L)
Aluminum	1
Antimony	1
Arsenic	1
Barium	1
Beryllium	1
Bromide	10
Cadmium	1
Chromium	1
Cobalt	1
Copper	1
Iron	3
Lead	1
Manganese	1
Molybdenum	1
Nickel	1
Selenium	1
Silver	1
Uranium	1
Zinc	1

RADIOACTIVITY/RADON

Constituent	Minimum reporting level
Gross alpha activity as uranium	3.0 ∝g/L
Gross beta activity as strontium-90/yttrium-90	4.0 pCi/L
Radon-222	24 pCi/L

VOLATILE ORGANIC COMPOUNDS

Constituent	Minimum reporting level (∝g/L)
Benzene	0.2
Bromobenzene	0.2
Bromochloromethane	0.2
Bromoform	0.2
Carbon tetrachloride	0.2
Chlorobenzene	0.2
Chlorodibromomethane	0.2
Chloroethane	0.2
Chloroform	0.2
Cis-1,2-dichloroethene	0.2
Cis-1,3-dichloropropene	0.2
Dibromochloropropane	1.0
1,2-Dibromoethane	0.2
Dibromomethane	0.2
1,3-Dichlorobenzene	0.2
1,4-Dichlorobenzene	0.2
Dichlorobromomethane	0.2
Dichlorodifluoromethane	0.2
1,1-Dichloroethane	0.2
1,2-Dichloroethane	0.2
1,1-Dichloroethylene	0.2
1,2-Dichloropropane	0.2
1,3-Dichloropropane	0.2
2,2-Dichloropropane	0.2
1,1-Dichloropropene	0.2
Ethylbenzene	0.2
Freon-113	0.2
Hexachlorobutadiene	0.2
Isopropylbenzene	0.2
Mesitylene	0.2
Methylbromide	0.2
Methylchloride	0.2
Methylene chloride	0.2
Methyl tert-butyl ether (MTBE)	0.2
Napthalene	0.2
N-butylbenzene	0.2
N-propylbenzene	0.2
O-chlorobenzene	0.2
O-chlorotoluene	0.2
P-chlorotoluene	0.2
P-isopropyltoluene	0.2
Pseudocumene	0.2
Sec-butylbenzene	0.2
Styrene	0.2
Tertbutylbenzene	0.2
1,1,1,2-Tetrachloroethane	0.2
1,1,2,2-Tetrachloroethane	0.2
Tetrachloroethylene	0.2
Toluene	0.2
1,2-Transdichloroethene	0.2
Trans-1,3-dichloropropene	0.2
1,2,3-Trichlorobenzene	0.2
1,2,4-Trichlorobenzene	0.2
1,1,1-Trichloroethane	0.2
1,1,2-Trichloroethane	0.2
Trichloroethylene	0.2
Trichlorofluoromethane	0.2
1,2,3-Tricloropropane	0.2
Vinyl chloride	0.2
Xylene	0.2

Table 4. List of common constituents, nutrients and dissolved organic carbon, trace elements, radioactivity/radon, volatile organic compounds, and pesticides analyzed for in ground-water samples--Concluded

PESTICIDES

GROUP A

Name	Method detection limit (∝g/L)
Acetochlor	0.002
Alachlor	0.002
Atrazine	0.001
Benfluralin	0.002
Alpha HCH	0.002
Butylate	0.002
Carbaryl	0.003
Carbofuran	0.003
Chlorpyrifos	0.004
Cyanazine	0.004
DCPA	0.002
p,p'-DDE	0.006
Deethyl atrazine	0.002
Diazinon	0.002
Dieldrin	0.001
2,6-Diethylaniline	0.003
Disulfoton	0.017
EPTC	0.002
Ethalfluralin	0.004
Ethoprop	0.003
Fonofos	0.003
Lindane	0.004
Linuron	0.002
Malathion	0.005
Methyl azinphos	0.001
Methyl parathion	0.006
Metolachlor	0.002
Metribuzin	0.004
Molinate	0.004
Napropamide	0.003
Parathion	0.004
Pebulate	0.004
Pendimethalin	0.004
Permethrin	0.005
Phorate	0.002
Prometon	0.018
Pronamide	0.003
Propachlor	0.007
Propargite	0.013
Propanil	0.004
Simazine	0.005
Tebuthiuron	0.010
Terbacil	0.007
Terbufos	0.013
Thiobencarb	0.002
Triallate	0.001
Trifuralin	0.002

GROUP B

Name	Method detection limit (∝g/L)
Acifluorfen	0.035
Aldicarb	0.016
Aldicarb sulfone	0.016
Aldicarb sulfoxide	0.021
Amiben	0.011
Bentazon	0.014
Bromacil	0.035
Bromoxynil	0.035
Carbaryl	0.008
Carbofuran	0.028
Chlorothalonil	0.035
Clopyralid	0.050
2,4-D	0.035
Dacthal mono-acid	0.017
2,4-DB	0.035
Dicamba	0.035
Dichlobenil	0.020
Dichlorprop	0.032
Dinoseb	0.035
Diuron	0.020
Esfenvalerate	0.019
Fenuron	0.013
Fluometuron	0.035
3-Hydroxycarbofuran	0.014
Linuron	0.018
MCPA	0.050
MCPB	0.035
Methiocarb	0.026
Methomyl	0.017
1-Naphthol	0.007
Neburon	0.015
Norflurazon	0.024
Ocresol	0.035
Oryzalin	0.019
Oxamyl	0.018
Picloram	0.050
Propham	0.035
Propoxur	0.035
Silvex	0.021
2,4,5-T	0.035
Triclopyr	0.050

Table 5. List of pesticides, pesticide metabolites, gross polychlorinated biphenols, and gross polychlorinated naphthalenes analyzed for in bed-material samples

[Minimum reporting level is the minimum concentration of an analyte that can be reliably measured and reported by the laboratory using a given analytical method (Timme, 1995)]

Name	Minimum reporting level (micrograms per kilogram)
Aldrin	0.1
Chlordane	0.1
DDD	0.1
p,p'-DDE	0.1
DDT	0.1
Diazinon	0.2
Dieldrin	0.1
Endosulfan	0.1
Endrin	0.1
Ethion	0.2
Heptachlor	0.1
Heptachlor, epoxide	0.1
Lindane	0.1
Malathion	0.2
Methoxychlor	0.1
Methyl parathion	0.2
Mirex	0.1
Parathion	0.2
Gross polychlorinated biphenols (PCB's)	1.0
Gross polychlorinated naphthalenes (PCN's)	1.0
Perthane	1.0
Toxaphene	10.0
Trithion	0.2

Table 6. Constituents detected in field-blank samples and ranges of concentrations detected in field-blank, shallow ground-water, and surface-water samples

[MRL, minimum reporting level; MDL, method detection limit; mg/L, milligrams per liter; ∝g/L, micrograms per liter; --, no data; *, only 2 samples analyzed for constituent; +, MRL changed to 0.015 mg/L after April/May sampling]

Constituent	MRL or MDL	Number of detections at or above MRL or MDL	Range of concentrations in field-blank samples	Range of concentrations detected in shallow ground water (app. B)	Range of concentrations detected in surface water (app. A)
Calcium (mg/L as Ca)	0.02	6	0.04-0.06	69-270	46-170
Magnesium (mg/L as Mg)	0.01	1	0.01	11-70	12-32
Alkalinity (mg/L as $CaCO_3$)	0.1	7	1.1-1.6	140-560	140-350
Sulfate (mg/L as SO_4)	0.1	1	0.2	130-1,700	120-630
Silica (mg/L as SiO_2)	0.01	6	0.01-0.16	11-33	0.96-32
Nitrite (mg/L as N)	0.01	1	0.01	0.01-0.10	0.01-0.11
Ammonia, dissolved (mg/L as N)	0.01^{+}	4	0.01-0.02	0.01-0.33	0.01-0.33
Phosphorus, dissolved (mg/L as P)	0.01	1	0.01	0.01-0.13	0.01-0.73
Suspended organic carbon (mg/L as C)	0.1	2^{*}	0.1	--	0.3-2.1
Dissolved organic carbon (mg/L as C)	0.1	5	0.1-0.8	1.1-5.3	0.8-4.9
Aluminum (∝g/L as Al)	1	6	1-4	1-6	2-17
Chromium (∝g/L as Cr)	1	2	1-2	1-10	1-10
Iron (∝g/L as Fe)	3	1	4	3-1,900	3-61
Zinc (∝g/L as Zn)	1	6	1-7	1-14	1-11
Methyl chloride (∝g/L)	0.2	2*	0.3-0.4	0.2-0.5	--
Methylene chloride (∝g/L)	0.2	2*	0.2-0.3	--	--

Table 7. Relative-percent difference for replicate samples from surface-water and ground-water sites

[mg/L, milligrams per liter; deg C, degrees Celsius; ∝g/L, micrograms per liter; pCi/L, picocuries per liter; --, no data]

	pH, laboratory (standard units)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Potassium, dissolved (mg/L as K)	Sulfate, dissolved (mg/L as SO_4)
Minimum	0	0	0	0	0	0
Median	0	0	0	0	1	0
Maximum	4	2	5	5	2	2

	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)	Dissolved solids, residue at 180 deg C (mg/L)	Nitrite, dissolved (mg/L as N)	Nitrite+ nitrate, dissolved (mg/L as N)	Ammonia, dissolved (mg/L as N)	Ammonia +organic nitrogen, dissolved (mg/L as N)
Minimum	0	0	0	0	0	0	0	0	0
Median	0	0	12	0	1	0	7	0	0
Maximum	5	15	130	5	15	12	9	29	40

	Phospho-rus, dissolved (mg/L as P)	Ortho-phosphate, dissolved (mg/L as P)	Dissolved organic carbon (mg/L as C)	Aluminum, dissolved (∝g/L as Al)	Antimony, dissolved (∝g/L as Sb)	Arsenic, dissolved (∝g/L as As)	Barium, dissolved (∝g/L as Ba)	Beryl-lium, dissolved (∝g/L as Be)	Cadmium, dissolved (∝g/L as Cd)
Minimum	0	0	0	0	0	0	1	0	0
Median	0	0	0	10	0	0	2	0	0
Maximum	40	0	6	66	0	0	4	0	0

Table 7. Relative-percent difference for replicate samples from surface-water and ground-water sites--Concluded

	Chromium, dissolved (∝g/L as Cr)	Cobalt, dissolved (∝g/L as Co)	Copper, dissolved (∝g/L as Cu)	Iron, dissolved (∝g/L as Fe)	Lead, dissolved (∝g/L as Pb)	Manganese, dissolved (∝g/L as Mn)	Molyb-denum, dissolved (∝g/L as Mo)	Nickel, dissolved (∝g/L as Ni)	Selenium, dissolved (∝g/L as Se)
Minimum	0	0	0	0	0	0	0	0	0
Median	28	0	23	3	0	9	0	40	0
Maximum	66	0	66	22	0	21	15	66	0

	Silver, dissolved (∝g/L as Ag)	Uranium, dissolved (∝g/L as U)	Zinc, dissolved (∝g/L as Zn)	Gross alpha, dissolved (∝g/L as U)	Gross beta, dissolved (pCi/L as Sr-90/Y-90)	Radon-222 (pCi/L)
Minimum	0	0	0	8	0	4
Median	0	0	0	16	0	7
Maximum	0	6	57	22	15	25

Table 8. Percent recovery of spiked Group A pesticides

[--, no data]

	Alachlor	Alpha BCH	Atrazine	Benflura-lin	Butylate	Carbaryl	Carbo-furan	Chlor-pyrifos
Field spikes								
Minimum	98	86	85	54	83	51	80	42
Median	109	89	93	87	92	84	93	88
Maximum	120	112	116	98	107	120	131	116
Laboratory spikes								
Minimum	92	80	76	51	82	60	80	60
Median	101	83	93	79	85	84	88	74
Maximum	111	101	101	85	90	102	93	87

	Cyanazine	DCPA	Deethyl atrazine	Diazinon	Dieldrin	2,6-Diethyl-aniline	Disulfoton	EPTC
Field spikes								
Minimum	67	94	23	62	73	74	59	79
Median	105	104	35	90	77	92	116	90
Maximum	143	146	57	112	121	107	139	125
Laboratory spikes								
Minimum	74	85	25	52	69	83	73	78
Median	93	101	37	87	73	89	126	84
Maximum	112	130	52	92	76	99	138	118

Table 8. Percent recovery of spiked Group A pesticides--Continued

Sample type	Ethalflur-alin	Ethoprop	Fonofox	Lindane	Linuron	Malathion	Methyl azinphos	Methyl parathion
Field spikes								
Minimum	77	81	48	62	58	45	51	60
Median	96	93	87	89	85	90	101	101
Maximum	116	116	116	143	121	103	177	152
Laboratory spikes								
Minimum	67	87	79	80	63	53	51	56
Median	89	90	83	84	81	83	84	78
Maximum	92	109	109	143	85	93	121	102

	Meto-lachlor	Metribuzin	Molinate	Napro-pamide	p,p′-DDE	Parathion	Pebulate	Pendi-methalin
Field spikes								
Minimum	103	69	89	68	46	59	80	46
Median	111	82	92	101	60	65	92	85
Maximum	137	93	125	125	79	116	125	116
Laboratory spikes								
Minimum	93	63	82	74	41	63	77	62
Median	102	74	90	90	57	63	87	72
Maximum	129	92	118	118	66	70	109	92

Table 8. Percent recovery of spiked Group A pesticides--Concluded

	Permethrin	Phorate	Prometon	Pronamide	Propachlor	Propanil	Propargite	Simazine
Field spikes								
Minimum	33	52	89	62	86	80	63	69
Median	52	81	107	83	92	95	77	101
Maximum	101	93	125	170	116	125	187	125
Laboratory spikes								
Minimum	25	60	89	64	77	76	66	89
Median	48	87	109	86	86	93	72	93
Maximum	106	91	111	160	92	109	80	110

	Tebuth-iuron	Terbacil	Terbufos	Thio-bencarb	Triallate	Trifluralin
Field spikes						
Minimum	71	15	63	63	80	66
Median	90	144	90	93	89	89
Maximum	303	426	131	170	103	98
Laboratory spikes						
Minimum	70	72	86	81	73	61
Median	87	163	92	87	85	76
Maximum	193	368	93	151	92	92

Table 9. Percent recovery of spiked Group B pesticides

[--, no data]

	Aldicarb	Aldicarb sulfone	Aldicarb sulfoxide	Bentazon	Bromacil	Bromoxynil	Carbaryl	Carbofuran
Field spikes								
Minimum	30	1	27	11	37	43	1	20
Median	49	12	47	61	65	62	14	69
Maximum	89	31	110	73	101	90	55	187
Laboratory spikes								
Minimum	21	1	37	10	42	42	8.4	37
Median	52	11	47	63	60	61	12	51
Maximum	79	19	62	74	78	89	30	136

	2, 4-D	2, 4-DB	2, 4, 5-T	Dicamba	Dichlorprop	Dinoseb	Diuron	Ocresol
Field spikes								
Minimum	43	24	40	11	39	36	17	39
Median	68	38	62	41	60	57	42	60
Maximum	113	44	118	213	77	77	62	74
Laboratory spikes								
Minimum	55	27	3	8	41	39	22	49
Median	63	38	45	46	59	57	41	53
Maximum	108	44	104	79	70	63	60	75

Table 9. Percent recovery of spiked Group B pesticides--Concluded

	Fenuron	Fluometuron	Linuron	MCPA	Methiocarb	Methomyl	1-Naphthol	Neburon
Field spikes								
Minimum	43	35	60	35	7	34	1	21
Median	87	69	132	59	19	71	3	52
Maximum	229	117	190	72	69	96	56	79
Laboratory spikes								
Minimum	52	36	75	49	9	40	1	34
Median	87	61	108	54	20	55	5	54
Maximum	168	92	165	76	40	83	25	70

	Oxamyl	Picloram	Propham	Propoxur	Silvex
Field spikes					
Minimum	2	5	68	21	46
Median	7	44	143	52	62
Maximum	71	53	196	190	80
Laboratory spikes					
Minimum	1	20	76	25	44
Median	18	51	119	61	64
Maximum	52	58	172	141	72

Table 10. Percent recovery of spiked volatile organic compounds

Sample type	Bromo-form	Carbon tetrachloride	Chlorodi-bromo-methane	1,4-Dichlo-robenzene	1,2-Dichlo-roethane	Dichloro-bromo-methane	1,1-Dichloro-ethylene
Laboratory spike	100	72	87	100	87	87	115
Field spike	85	48	70	80	70	70	60
Field spike replicate	80	44	65	70	65	61	60
Laboratory spike	75	72	74	95	78	70	100
Field spike	55	44	52	70	57	48	60
Field spike replicate	60	40	52	70	57	52	50

Sample type	Ethylben-zene	MTBE	Tetrachlo-roethylene	1,1,1-Trichlo-roethane	Trichlo-roethylene	Vinyl chloride
Laboratory spike	76	92	76	95	95	96
Field spike	60	72	56	60	65	30
Field spike replicate	52	72	48	55	60	44
Laboratory spike	88	76	88	90	95	113
Field spike	64	56	56	60	65	57
Field spike replicate	60	56	56	55	60	39

Table 11. Water-quality standards for the Rio Grande and ranges of concentrations in samples from the Rio Grande and from drains in the Rincon Valley study area

[Standards from New Mexico Water Quality Control Commission, 1994. Trace element standards based on the acute fisheries standard. <, less than; >, greater than; --, no data; *, value based on hardness of 150 milligrams per liter (mg/L) as $CaCO_3$; deg C, degrees Celsius, ∝g/L, micrograms per liter]

Property/constituent	Standard for Rio Grande from below Caballo Dam to 1 mile below Percha Diversion Dam (fig. 2)	Standard for Rio Grande from 1 mile below Percha Diversion Dam to southern end of Rincon Valley (fig. 2)	Range of concentrations in samples from Rio Grande below Caballo Dam (fig. 2)	Range of concentrations in samples from Rio Grande at Road 187 near Hatch and Rio Grande above Rincon Drain, near Rincon (fig. 2)	Range of concentrations in samples from drains (fig. 2)
pH	6.6-9.0	6.6-8.8	8.0-8.52	8.2-8.65	7.52-8.4
Temperature (deg C)	<32.2	<34	11.0-15.5	5-19.5	4.5-24
Dissolved oxygen (mg/L)	>5.0	>5.0	9.0-11.0	7.5-13.2	3.2-17.1
Aluminum (∝g/L as Al)	750	750	5-12	3-12	2-17
Arsenic (∝g/L as As)	20	20	2-3	<1-3	<1-3
Beryllium (∝g/L as Be)	130	130	<1	<1	<1
Boron (∝g/L as B)	50	50	--	200-210	170-350
Cadmium (∝g/L as Cd)	6.2*	6.2*	<1	<1	<1-6
Chromium (∝g/L as Cr)	2,420*	2,420*	<1-3	1-5	1-10
Cobalt (∝g/L as Co)	1,000*	1,000*	<1	<1	<1
Copper (∝g/L as Cu)	26*	26*	1	<1-3	<1-32
Lead (∝g/L as Pb)	137*	137*	<1-3	<1-2	<1-3
Nickel (∝g/L as Ni)	2,510*	2,510*	<1-3	<1-6	<1-9
Selenium (∝g/L as Se)	20	20	<1	<1	<1
Silver (∝g/L as Ag)	8.15*	8.15*	<1	<1	<1
Zinc (∝g/L as Zn)	165*	165*	1-7	<1-5	<1-11

Table 12. Statistical summary of selected data for surface water in the Rincon Valley study area

[No. < MRL, total number of samples with concentration less than minimum reporting level; inst, instantaneous; ∝S/cm, microsiemens per centimeter at 25 degrees Celsius (deg C); mg/L, milligrams per liter; it. field, field measurement by incremental titration; gran field, field measurement by gran titration; ∝g/L, micrograms per liter; <, less than. Summary statistics calculated using MRL or method detection limit concentration substituted for all less than values]

Property/constituent	No.	No. < MRL	Mean	Standard deviation	Minimum	Maximum	Percentile				
							10	25	50	75	90
Specific conductance, field (∝S/cm)	37	0	1,343	373	727	2,140	765	1,080	1,390	1,590	1,840
pH, field (standard units)	37	0	8.18	0.29	7.52	8.69	7.8	7.99	8.16	8.4	8.52
pH, laboratory (standard units)	37	0	7.79	0.17	7.3	8.1	7.6	7.7	7.8	7.9	8.0
Temperature, water (deg C)	37	0	13.4	5.6	4.7	24.2	5.2	8	13.4	17.5	21.9
Oxygen, dissolved (mg/L)	37	0	9	3.2	3.2	17.1	4.8	7.5	8.8	10.4	14.2
Hardness, (mg/L $CaCO_3$)	37	0	334	103	170	560	180	260	360	400	470
Calcium, dissolved (mg/L as Ca)	37	0	101	33	46	170	51	71	110	120	140
Magnesium, dissolved (mg/L as Mg)	37	0	20	5	12	32	13	15	20	23	27
Sodium, dissolved (mg/L as Na)	37	0	155.8	53.9	78	270	84	110	150	190	250
Sodium adsorption ratio	37	0	3.8	1.1	3	7	3	3	4	4	5
Sodium percent	37	0	49	6.4	42	68	43	45	48	49	60
Potassium, dissolved (mg/L as K)	37	0	8.4	3.3	5.2	17	5.7	6.1	6.8	9.8	13

Table 12. Statistical summary of selected data for surface water in the Rincon Valley study area--Continued

Property/constituent	No.	No. < MRL	Mean	Standard deviation	Minimum	Maximum	Percentile				
							10	25	50	75	90
Bicarbonate, dissolved it. field (mg/L as HCO_3)	37	0	285	69.8	158	422	172	249	297	332	368
Carbonate, dissolved it. field (mg/L as CO_3)	14		11.2	5.7	4	24	4	8	10	16	18
Alkalinity, dissolved gran field (mg/L as $CaCO_3$)	37	0	240	54.7	140	350	150	210	240	280	300
Sulfate, dissolved (mg/L as SO_4)	37	0	300	121	120	630	130	230	310	370	440
Chloride, dissolved (mg/L as Cl)	37	0	110	32.4	62	180	70	78	110	130	150
Fluoride, dissolved (mg/L as F)	37	0	1.16	1.15	0.5	4.9	0.6	0.6	0.8	0.9	3
Silica, dissolved (mg/L as SiO_2)	37	0	18.3	7.4	0.96	32	12	15	19	24	29
Dissolved solids, residue at 180 deg C (mg/L)	37	0	888	274	434	1,510	461	694	894	1,060	1,260
Nitrite, dissolved (mg/L as N)	37	7	0.03	0.03	<0.01	0.11	<0.01	0.01	0.03	0.04	0.08

Table 12. Statistical summary of selected data for surface water in the Rincon Valley study area--Continued

Property/constituent	No.	No. < MRL	Mean	Standard deviation	Minimum	Maximum	Percentile				
							10	25	50	75	90
Nitrite plus nitrate, dissolved (mg/L as N)	37	4	0.56	0.66	<0.05	3.3	<0.05	0.15	0.44	0.61	1.2
Ammonia, dissolved (mg/L as N)	37	2	0.09	0.07	<0.015	0.33	0.01	0.04	0.08	0.1	0.15
Ammonia + organic nitrogen, dissolved (mg/L as N)	37	4	0.33	0.16	<0.2	1.1	<0.2	0.2	0.3	0.3	0.5
Phosphorus, dissolved (mg/L as P)	37	17	0.05	0.13	<0.01	0.73	<0.01	<0.01	0.01	0.02	0.18
Orthophosphate, dissolved (mg/L as P)	37	17	0.05	0.14	<0.01	0.73	<0.01	<0.01	0.01	0.02	0.19
Total organic carbon (mg/L as C)	9	0	7.18	2.83	3.6	13	3.6	5.5	7.1	7.3	13
Suspended organic carbon (mg/L as C)	19	0	0.74	0.49	0.3	2.1	0.3	0.3	0.6	1.1	1.5
Dissolved organic carbon (mg/L as C)	36	0	3.62	0.78	0.8	4.9	2.7	3.25	3.6	4.25	4.6
Aluminum, dissolved (∝g/L as Al)	37	0	5.8	3.3	2	17	3	4	5	7	11

Table 12. Statistical summary of selected data for surface water in the Rincon Valley study area--Continued

Property/constituent	No.	No. < MRL	Mean	Standard deviation	Minimum	Maximum	Percentile				
							10	25	50	75	90
Antimony, dissolved (∝g/L as Sb)	37	37	1	0	<1	<1	<1	<1	<1	<1	<1
Arsenic, dissolved (∝g/L as As)	37	8	1.7	0.66	<1	3	<1	1	2	2	3
Barium, dissolved (∝g/L as Ba)	37	0	77.9	18.7	37	120	59	64	75	91	110
Beryllium, dissolved (∝g/L as Be)	37	37	1	0	<1	<1	<1	<1	<1	<1	<1
Boron, dissolved (∝g/L as B)	8	0	268	82.2	170	400	170	205	250	330	400
Bromide, dissolved (mg/L as Br)	28	0	0.17	0.07	0.06	0.31	0.07	0.11	0.17	0.22	0.26
Cadmium, dissolved (∝g/L as Cd)	37	36	1.1	0.8	<1	6	<1	<1	<1	<1	<1
Chromium, dissolved (∝g/L as Cr)	37	1	2.8	1.8	<1	10	1	2	2	3	6
Cobalt, dissolved (∝g/L as Co)	37	37	1	0	<1	<1	<1	<1	<1	<1	<1

Table 12. Statistical summary of selected data for surface water in the Rincon Valley study area--Continued

Property/constituent	No.	No. < MRL	Mean	Standard deviation	Minimum	Maximum	Percentile				
							10	25	50	75	90
Copper, dissolved (∝g/L as Cu)	37	4	2.7	5	<1	32	<1	1	2	3	4
Iron, dissolved (∝g/L as Fe)	37	8	10.8	12.2	<3	61	<3	4	5	15	28
Lead, dissolved (∝g/L as Pb)	37	27	1.2	0.6	<1	3	<1	<1	<1	1	2
Manganese, dissolved (∝g/L as Mn)	37	0	273	295	2	1,220	6	63	159	459	758
Molybdenum, dissolved (∝g/L as Mo)	37	0	11.7	8.2	6	42	7	7	9	12	22
Nickel, dissolved (∝g/L as Ni)	37	7	3.1	2.3	<1	9	<1	1	2	5	7
Selenium, dissolved (∝g/L as Se)	37	36	1	0	<1	1	<1	<1	<1	<1	<1
Silver, dissolved (∝g/L as Ag)	37	37	1	0	<1	<1	<1	<1	<1	<1	<1
Uranium, dissolved (∝g/L as U)	37	0	6.7	3.9	3	20	3	5	5	8	12

Table 12. Statistical summary of selected data for surface water in the Rincon Valley study area--Continued

Property/constituent	No.	No. < MRL	Mean	Standard deviation	Minimum	Maximum	Percentile				
							10	25	50	75	90
Zinc, dissolved (∝g/L as Zn)	37	3	2.9	2.3	<1	11	1	1	2	3	6
Atrazine, dissolved (∝g/L)	37	36	0.001	0	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Carbofuran, dissolved (∝g/L)	37	29	0.01	0.03	<0.003	0.15	<0.003	<0.003	<0.003	<0.003	0.05
Chlorpyrifos, dissolved (∝g/L)	37	35	0.004	0.001	<0.004	0.01	<0.004	<0.004	<0.004	<0.004	<0.004
Dacthal, mono-acid, dissolved (∝g/L)	36	34	0.02	0.03	<0.017	0.13	<0.02	<0.02	<0.02	<0.02	0.02
DCPA, dissolved (∝g/L)	37	12	0.02	0.05	<0.001	0.21	<0.002	<0.002	0.004	0.01	0.06
Diazinon, dissolved (∝g/L)	37	34	0.003	0.003	<0.001	0.02	<0.002	<0.002	<0.002	<0.002	0.002
EPTC, dissolved (∝g/L)	37	31	0.002	0.002	<0.001	0.01	<0.002	<0.002	<0.002	<0.002	0.004
Metolachlor, dissolved (∝g/L)	37	10	0.03	0.07	0.002	0.41	<0.002	<0.002	0.007	0.02	0.06
Pendimethalin, dissolved (∝g/L)	37	36	0.01	0.005	<0.004	0.03	<0.004	<0.004	<0.004	<0.004	<0.004

Table 12. Statistical summary of selected data for surface water in the Rincon Valley study area--CConcluded

Property/constituent	No.	No. < MRL	Mean	Standard deviation	Minimum	Maximum	Percentile				
							10	25	50	75	90
p,p'-DDE, dissolved (∝g/L)	37	30	0.01	0.002	<0.001	0.006	<0.002	<0.006	<0.006	<0.006	0.006
Prometon, dissolved (∝g/L)	37	33	0.02	0.003	<0.006	0.02	<0.01	<0.02	<0.02	<0.02	<0.02
Simazine, dissolved (∝g/L)	37	34	0.005	0	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Trifluralin, dissolved (∝g/L)	37	36	0.002	0	E0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Table 13. Statistical summary of selected data for wells sampled in the Rincon Valley study area

[No. < MRL, total number of samples with concentrations less than minimum reporting level (MRL); --, not applicable; mS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; gran field, field measurement by gran titration; <, less than; mg/L, micrograms per liter; pCi/L, picocuries per liter. Summary statistics calculated using MRL or method detection limit concentration substituted for all less than values and maximum detection limit for all greater than values]

Property/constituent	No.	No. < MRL	Mean	Standard deviation	Minimum	Maximum	Percentile				
							10	25	50	75	90
Well depth (feet)	30	--	19.6	2.80	14.89	24.19	15.57	17.47	19.94	22.04	23.13
Water level below land surface (feet)	30	--	8.24	2.38	3.92	12.28	5.62	6.3	7.97	10.11	11.95
Specific conductance, field (∝S/cm)	30	--	1,714	859	790	5,280	1,000	1,270	1,495	1,932	2,270
pH, field (standard units)	30	--	7.41	0.17	7.01	7.68	7.21	7.31	7.41	7.53	7.63
Temperature water, (degrees Celsius)	30	--	17.2	1.77	10	19.3	15.4	16.2	17.55	18.2	18.7
Oxygen, dissolved (mg/L)	30	--	0.76	1.25	0.1	5.6	0.1	0.1	0.2	0.9	1.90
Calcium, dissolved (mg/L as Ca)	30	0	135	51.5	69	270	76	97	130	160	210
Magnesium, dissolved (mg/L as Mg)	30	0	24.9	12.0	11	70	14.5	17	23.0	28.0	37.5
Sodium, dissolved (mg/L as Na)	30	0	205	157	73	920	100	120	170	230	285
Potassium, dissolved (mg/L as K)	30	0	8.52	4.12	3.7	21	5.0	5.8	7.4	9.6	14.5
Bicarbonate, dissolved (mg/L as HCO_3)	30	0	368	128	174	694	199	269.5	342	356	546
Alkalinity, gran field (mg/L as $CaCO_3$)	30	0	302	103	140	560	170	240	280	350	450

Table 13. Statistical summary of selected data for wells sampled in the Rincon Valley study area--Continued

Property/constituent	No.	No. < MRL	Mean	Standard deviation	Minimum	Maximum	Percentile				
							10	25	50	75	90
Sulfate, dissolved (mg/L as SO_4)	30	0	407	308	130	1,700	185	230	330	450	720
Chloride, dissolved (mg/L as Cl)	30	0	126	75	67	450	72	93	110	130	170
Fluoride, dissolved (mg/L as F)	30	0	1.05	0.65	0.5	2.9	0.5	0.6	0.9	1.1	2.2
Bromide, dissolved (mg/L as Br)	30	0	0.31	0.18	0.13	0.97	0.14	0.17	0.27	0.36	0.52
Silica, dissolved (mg/L as SiO_2)	30	0	22.5	5.39	11	33	14	19.0	24	26	28.5
Dissolved solids (mg/L)	30	0	1,140	618	481	3,630	646.5	788	995	1,350	1,615
Nitrite, dissolved (mg/L as N)	30	13	0.04	0.03	<0.01	0.10	<0.01	<0.01	0.02	0.06	0.09
Nitrite plus nitrate, dissolved (mg/L as N)	30	7	5.16	9.02	<0.05	33	<0.05	0.06	0.48	5.6	19
Ammonia, dissolved (mg/L as N)	30	3	0.08	0.09	<0.01	0.33	<0.01	0.02	0.03	0.1	0.24

Table 13. Statistical summary of selected data for wells sampled in the Rincon Valley study area--Continued

Property/constituent	No.	No. < MRL	Mean	Standard deviation	Minimum	Maximum	Percentile				
							10	25	50	75	90
Ammonia + organic nitrogen, dissolved (mg/L as N)	30	7	0.41	0.34	<0.2	1.5	<0.2	0.2	0.3	0.4	1
Phosphorus, dissolved (mg/L as P)	30	10	0.03	0.03	<0.01	0.13	<0.01	<0.01	0.02	0.05	0.07
Orthophosphate, dissolved (mg/L as P)	30	4	0.03	0.02	<0.01	0.06	<0.01	0.01	0.02	0.05	0.055
Dissolved organic carbon (mg/L as C)	30	1	2.77	1.02	1.1	5.3	1.5	2.2	2.8	3.4	4
Aluminum, dissolved (∝g/L as Al)	30	14	1.77	1.19	<1	6	<1	<1	1	2	3
Antimony, dissolved (∝g/L as Sb)	30	30	1.1	0.4	<1	3	<1	<1	<1	<1	<1
Arsenic, dissolved (∝g/L as As)	30	8	1.83	0.83	<1	4	<1	<1	2	2	3
Barium, dissolved (∝g/L as Ba)	30	0	66.8	23.4	29	110	38	49	63.5	83	100
Beryllium, dissolved (∝g/L as Be)	30	30	1.1	0.4	<1	<3	<1	<1	<1	<1	<1

Table 13. Statistical summary of selected data for wells sampled in the Rincon Valley study area--Continued

Property/constituent	No.	No. < MRL	Mean	Standard deviation	Minimum	Maximum	Percentile				
							10	25	50	75	90
Cadmium, dissolved (∝g/L as Cd)	30	28	1.2	0.66	<1	4	<1	<1	<1	<1	1.5
Chromium, dissolved (∝g/L as Cr)	30	2	4.27	1.93	<1	10	1.5	3	4	5	6.5
Cobalt, dissolved (∝g/L as Co)	30	29	1.13	0.57	<1	4	<1	<1	<1	<1	<1
Copper, dissolved (∝g/L as Cu)	30	0	4.83	4.45	1	21	2	3	4	5	8.5
Iron, dissolved (∝g/L as Fe)	30	9	222	484	<3	1,900	<3	<3	6.5	83	1,050
Lead, dissolved (∝g/L as Pb)	30	30	1.1	0.4	<1	<3	<1	<1	<1	<1	<1
Manganese, dissolved (∝g/L as Mn)	30	2	523	430	<1	2,130	9	172	370.5	1,000	1,370
Molybdenum, dissolved (∝g/L as Mo)	30	0	11.6	6.32	4	38	6	8	10.5	13	17.5
Nickel, dissolved (∝g/L as Ni)	30	1	2.23	1.33	<1	8	1	2	2	3	3
Selenium, dissolved (∝g/L as Se)	30	27	1.2	1.1	<1	7	<1	<1	<1	<1	<1

Table 13. Statistical summary of selected data for wells sampled in the Rincon Valley study area--Concluded

Property/constituent	No.	No. < MRL	Mean	Standard deviation	Minimum	Maximum	Percentile				
							10	25	50	75	90
Silver, dissolved (∝g/L as As)	30	30	1.1	0.4	<1	<3	<1	<1	<1	<1	<1
Uranium, dissolved (∝g/L as U)	30	3	12.1	13.4	<1	62	<1	3	8.5	14	30
Zinc, dissolved (∝g/L as Zn)	30	1	3.53	2.5	<1	14	2	2	3	4	5.5
Gross alpha, dissolved (∝g/L as U)	30	0	14	13.8	0.8	67	2	3.9	11	18	33.5
Gross beta, dissolved (pCi/L as SR-90/Y-90)	30	0	11.8	5.83	4.7	29	5.9	7.2	10.5	14	21
Radon-222, total (pCi/L)	18	0	274	56.1	210	440	240	250	260	280	390

Table 14. Drinking water standard or lifetime health advisory for constituents detected in shallow ground water, range of concentrations in shallow ground water, and percentage of shallow ground-water samples exceeding standard or lifetime health advisory

[F, final; D, draft; P, proposed; mg/L, milligrams per liter; ∝g/L, micrograms per liter; <, less than; pCi/L, picocuries per liter; E, estimated]

Property/constituent	Drinking water standard or lifetime health advisory (U.S. Environmental Protection Agency, 1996)	Status of standard	Range of concentrations in shallow ground water	Samples exceeding standard or advisory (percent)
pH (standard units)	[1]6.5 - 8.5	F	7.01-7.68	0
Sulfate (mg/L as SO_4)	[1]250	F	130-1,700	73
Chloride (mg/L as Cl)	[1]250	F	67-450	6.7
Fluoride (mg/L as F)	[2]4	F	0.50-2.9	0
Dissolved solids (mg/L)	[1]500	F	481-3,630	93.3
Nitrite (mg/L as N)	[2]1	F	<0.01 - 0.10	0
Nitrite plus nitrate (mg/L as N)	[2]10	F	<0.05 - 33.0	16.7
Aluminum (∝g/L as Al)	[1]50 - 200	F	<1 - 6	0
Antimony (∝g/L as Sb)	[2]6	F	<1 - <3	0
Arsenic (∝g/L as As)	[2]50	F	<1 - 4	0
Barium (∝g/L as Ba)	[2]2,000	F	29 - 110	0
Beryllium (∝g/L as Be)	[2]4	F	<1 - <3	0
Cadmium (∝g/L as Cd)	[2]5	F	<1 - 4	0
Chromium (∝g/L as Cr)	[2]100	F	<1 - 10	0
Copper (∝g/L as Cu)	[3]1,300	F	1 - 21	0
Iron (∝g/L as Fe)	[1]300	F	<3 - 1,900	16.7
Lead (∝g/L as Pb)	[3]15	F	<1 - <3	0

Table 14. Drinking water standard or lifetime health advisory for constituents detected in shallow ground water, range of concentrations in shallow ground water, and percentage of shallow ground-water samples exceeding standard or lifetime health advisory--Concluded

Property/constituent	Drinking water standard or lifetime health advisory (U.S. Environmental Protection Agency, 1996)	Status of standard	Range of concentrations in shallow ground water	Samples exceeding standard or advisory (percent)
Manganese (∝g/L as Mn)	[1]50	F	<1 - 2,130	83.3
Molybdenum (∝g/L as Mo)	[4]40	D	4 - 38	0
Nickel (∝g/L as Ni)	[5]100	F	<1 - 8	0
Selenium (∝g/L as Se)	[2]50	F	<1 - 7	0
Silver (∝g/L as Ag)	[1]100	F	<1 - <3	0
Uranium (∝g/L as U)	[2]20	P	<1 - 62	13.3
Zinc (∝g/L as Zn)	[1]5,000	F	<1 - 14	0
Gross alpha activity (pCi/L)	[2]15	F	[6]0.8 - 67	23.3
Diazinon (∝g/L)	[4]0.6	F	<0.002 - 0.077	0
Metolachlor (∝g/L)	[4]100	F	<0.002 - 5.4	0
Prometon (∝g/L)	[4]100	F	E0.005 - 0.32	0
Xylene (∝g/L)	[2]10,000	F	<0.2 - 2.8	0

[1]Secondary maximum contaminant level.
[2]Maximum contaminant level.
[3]Action level.
[4]Lifetime health advisory.
[5]Being remanded.
[6]Concentration in ∝g/L as uranium; multiply concentration by 0.77 to get concentration in pCi/L.

Table 15. Saturation index for selected minerals and partial pressure of carbon dioxide in irrigation water and shallow ground water in the Rincon Valley study area

[Values calculated using PHREEQE, Parkhurst and others, 1980]

Well number (fig. 8)	Calcite	Gypsum	Barite	Fluorite	Amorphous silica	Chalcedony	Partial pressure of carbon dioxide ($10^{-atmospheres}$)
Irrigation water, April 1994	0.77	-1.65	0.58	-1.53	-2.02	-1.15	-3.34
Irrigation water, October 1994	0.65	-1.67	0.54	-1.38	-0.91	-0.04	-3.21
1	0.03	-1.92	-0.07	-1.09	-0.90	-0.03	-2.18
2	0.15	-3.35	-1.94	-0.66	-0.57	0.29	-1.65
3	0.21	-1.77	-0.18	-0.92	-0.61	0.26	-2.01
4	0.11	-1.70	0.10	-0.94	-0.56	0.30	-2.06
5	0.51	-1.24	0.40	-1.09	-0.67	0.20	-1.87
6	0.38	-1.13	0.60	-0.90	-0.73	0.13	-2.09
7	0.36	-1.26	0.20	-0.09	-0.67	0.20	-1.90
8	0.11	-1.78	0.23	-0.00	-0.57	0.31	-2.03
9	0.11	-2.01	-0.27	-1.00	-0.60	0.27	-2.03
10	0.33	-1.35	0.58	-0.54	-0.64	0.22	-2.18
11	0.35	-1.15	0.44	-0.64	-0.69	0.18	-2.07
12	0.78	-0.94	0.50	-1.11	-0.69	0.18	-2.09
13	0.01	-2.25	-0.48	-1.09	-0.76	0.11	-2.15
14	0.39	-1.10	0.43	-1.16	-0.75	0.11	-2.02
15	0.14	-1.53	-0.07	-0.77	-0.61	0.26	-2.15
16	0.47	-1.08	0.50	-0.85	-0.68	0.18	-2.15
17	0.02	-1.56	0.32	-1.40	-0.85	0.01	-2.32
18	0.58	-0.74	1.03	-1.27	-0.79	0.10	-2.17
19	0.11	-2.94	-1.34	-0.57	-0.52	0.34	-1.90
20	0.09	-1.53	0.51	-1.54	-0.95	-0.08	-2.42
21	0.37	-1.67	-0.03	-0.61	-0.49	0.37	-1.80
22	0.13	-1.39	0.25	-0.87	-0.63	0.23	-2.28
23	0.49	-0.99	0.74	-1.39	-0.58	0.28	-2.24
24	0.28	-1.06	0.78	-1.40	-0.72	0.14	-2.22
25	-0.23	-3.46	-2.41	0.28	-0.58	0.28	-2.03
26	0.13	-0.54	0.40	-0.64	-0.59	0.27	-2.27
27	0.30	-1.74	-0.48	-1.07	-0.54	0.33	-1.95
28	0.18	-1.34	0.62	-1.23	-0.62	0.24	-2.17
29	0.11	-2.48	-1.09	-0.88	-0.57	0.30	-1.97
30	0.11	-2.50	-0.77	-0.70	-0.71	0.15	-1.95

Appendix A. Surface-water-quality data for selected sites in the Rincon Valley study area

[inst., instantaneous; ∝S/cm, microsiemens per centimeter at 25 degrees Celsius (deg C); mm, millimeters; mg/L, milligrams per liter; it. field, field measurement by incremental titration; gran field, field measurement by gran titration; ammonia + organic, dis., dissolved ammonia plus organic nitrogen; ∝g/L, micrograms per liter; --, no data; <, less than; E, estimated; lat, latitude; long, longitude]

Date	Time	Discharge, inst. (cubic feet per second)	Specific conductance, field (∝S/cm)	Specific conductance, laboratory (∝S/cm)	pH water, whole, field (standard units)	pH water, whole, laboratory (standard units)	Temperature water (deg C)	Temperature air (deg C)	Barometric pressure (mm of Hg)	Oxygen, dissolved (mg/L)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)
08362500 Rio Grande below Caballo Dam (lat 32°53′05″N., long 107°17′31″W.)												
01-03-94	1300	8.51	864	874	8.00	8.0	11.0	21.0	657	11.0	180	46
04-20-94	0750	1,510	727	719	8.52	7.7	15.5	19.0	655	9.0	170	49
10-24-94	1050	328	740	746	8.37	7.6	15.0	17.5	656	9.0	180	50
01-03-95	1200	3.3	1,020	1,000	8.00	7.8	12.5	--	655	10.7	220	61
324056107112103 Rio Grande at Road 187, near Hatch (lat 32°40′56″N., long 107°11′21″W.)												
01-06-94	0810	38	1,290	1,280	8.20	7.9	5.0	10.0	653	9.4	360	110
04-21-94	1140	1,140	745	734	8.47	8.0	19.5	26.0	657	8.4	180	51
10-25-94	1100	302	819	823	8.65	8.0	15.5	14.5	660	9.0	200	58
01-03-95	1245	36	1,280	1,280	8.50	7.8	9.0	10.0	662	13.2	360	110
323414106594903 Rio Grande above Rincon Drain, near Rincon (lat 32°34′14″N., long 106°59′49″W.)												
01-05-94	1150	44	1,410	1,400	8.40	7.8	8.0	16.5	657	10.3	390	120
04-22-94	0940	1,100	765	762	8.51	8.0	17.5	25.0	658	7.5	190	54
10-26-94	1030	464	862	872	8.52	7.9	15.5	13.5	662	8.60	210	61
01-03-95	1740	45	1,420	1,400	8.50	7.8	8.0	7.0	661	10.2	370	110
324708107164203 Garfield Drain SE of Derry (lat 32°47′08″N., long 107°16′42″W.)												
01-04-94	0900	0.65	1,820	1,820	7.80	7.8	5.0	6.5	662	4.8	260	70
04-20-94	1040	2.0	1,410	1,400	7.70	7.7	17.5	--	656	4.9	260	71
10-24-94	1340	2.83	1,660	1,680	7.92	7.6	19.0	25.5	656	14.2	270	77
01-05-95	0815	0.73	1,730	1,650	8.00	7.6	8.0	--	650	5.2	270	74

Appendix A. Surface-water-quality data for selected sites in the Rincon Valley study area--Continued

Date	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sodium adsorption ratio	Sodium (percent)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved it. field (mg/L as HCO_3)	Carbonate, dissolved it. field (mg/L as CO_3)	Alkalinity, dissolved gran field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)
08362500 Rio Grande below Caballo Dam (lat 32°53′05″N., long 107°17′31″W.)											
01-03-94	15	110	4	57	5.2	248	--	200	140	70	0.6
04-20-94	12	78	3	49	5.9	164	6	140	130	62	0.6
10-24-94	13	84	3	49	6.4	158	10	150	120	70	0.7
01-03-95	16	140	4	57	5.9	289	--	230	130	98	0.8
324056107112103 Rio Grande at Road 187, near Hatch (lat 32°40′56″N., long 107°11′21″W.)											
01-06-94	21	130	3	43	5.7	303	--	240	300	95	0.6
04-21-94	13	79	3	48	5.7	180	4	150	130	65	0.6
10-25-94	14	93	3	49	6.3	174	8	166	140	74	0.7
01-03-95	20	130	3	44	6.5	297	24	280	280	91	0.6
323414106594903 Rio Grande above Rincon Drain, near Rincon (lat 32°34′14″N., long 106°59′49″W.)											
01-05-94	23	150	3	45	6.1	246	16	230	340	110	0.6
04-22-94	13	83	3	48	6.1	168	8	150	130	65	0.6
10-26-94	15	97	3	49	6.2	172	11	160	160	78	0.7
01-03-95	22	150	3	47	6.6	266	8	230	320	120	0.6
324708107164203 Garfield Drain SE of Derry (lat 32°47′08″N., long 107°16′42″W.)											
01-04-94	20	270	7	68	17	422	--	350	340	150	4.9
04-20-94	19	190	5	60	13	342	--	280	270	120	3.0
10-24-94	20	260	7	66	17	402	--	330	320	140	4.3
01-05-95	20	250	7	65	17	411	--	330	320	140	4.9

Appendix A. Surface-water-quality data for selected sites in the Rincon Valley study area--Continued

Date	Silica, dissolved (mg/L as SiO_2)	Dissolved solids residue at 180 deg C (mg/L)	Nitrite, dissolved (mg/L as N)	Nitrite + nitrate, dissolved (mg/L as N)	Ammonia, dissolved (mg/L as N)	Ammonia + organic, dissolved (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Orthophosphate, dissolved (mg/L as P)	Total organic carbon (mg/L as C)	Suspended organic carbon (mg/L as C)	Dissolved organic carbon (mg/L as C)
08362500 Rio Grande below Caballo Dam (lat 32°53′05″N., long 107°17′31″W.)											
01-03-94	12	534	<0.01	0.12	0.01	<0.2	<0.01	<0.01	--	--	3.3
04-20-94	0.96	434	<0.01	<0.05	0.01	0.2	<0.01	<0.01	--	0.3	4.4
10-24-94	12	452	0.01	0.07	0.08	0.3	<0.01	<0.01	--	2.1	4.4
01-03-95	15	605	<0.01	0.08	0.02	<0.2	<0.01	0.02	7.1	--	3.6
324056107112103 Rio Grande at Road 187, near Hatch (lat 32°40′56″N., long 107°11′21″W.)											
01-06-94	16	864	0.04	0.50	0.05	0.2	0.02	<0.01	--	--	3.5
04-21-94	1.5	453	<0.01	<0.05	0.02	0.2	<0.01	<0.01	--	0.6	4.6
10-25-94	13	510	0.01	0.11	<0.015	0.2	<0.01	<0.01	--	1.5	4.0
01-03-95	16	828	0.02	0.25	0.02	<0.2	<0.01	<0.01	13	--	3.8
323414106594903 Rio Grande above Rincon Drain, near Rincon (lat 32°34′14″N., long 106°59′49″W.)											
01-05-94	14	922	0.02	0.40	0.09	0.2	<0.01	0.01	--	--	3.5
04-22-94	1.8	461	<0.01	<0.05	0.04	0.3	<0.01	<0.01	--	0.5	3.9
10-26-94	13	544	<0.01	0.08	<0.015	0.3	<0.01	<0.01	--	1.3	3.5
01-03-95	15	894	0.01	0.15	0.02	<0.2	<0.01	<0.01	7.3	--	3.1
324708107164203 Garfield Drain SE of Derry (lat 32°47′08″N., long 107°16′42″W.)											
01-04-94	25	1,170	0.03	0.54	0.10	0.3	<0.01	<0.01	--	--	2.7
04-20-94	19	856	0.05	0.61	0.07	0.3	<0.01	<0.01	--	0.3	3.3
10-24-94	29	1,080	0.08	1.20	0.10	0.3	0.02	0.02	--	0.4	2.9
01-05-95	26	1,110	0.04	0.86	0.14	0.3	<0.01	0.02	4.9	--	3.0

Appendix A. Surface-water-quality data for selected sites in the Rincon Valley study area--Continued

Date	Aluminum, dissolved (∝g/L as Al)	Antimony, dissolved (∝g/L as Sb)	Arsenic, dissolved (∝g/L as As)	Barium, dissolved (∝g/L as Ba)	Beryllium, dissolved (∝g/L as Be)	Boron, dissolved (∝g/L as B)	Bromide, dissolved (mg/L as Br)	Cadmium, dissolved (∝g/L as Cd)	Chromium, dissolved (∝g/L as Cr)	Cobalt, dissolved (∝g/L as Co)	Copper, dissolved (∝g/L as Cu)	Iron, dissolved (∝g/L as Fe)
08362500 Rio Grande below Caballo Dam (lat 32°53′05″N., long 107°17′31″W.)												
01-03-94	5	<1	2	63	<1	--	0.08	<1	3	<1	1	5
04-20-94	6	<1	2	90	<1	--	0.06	<1	1	<1	1	<3
10-24-94	12	<1	3	86	<1	--	0.06	<1	<1	<1	1	5
01-03-95	8	<1	2	82	<1	--	--	<1	1	<1	1	7
324056107112103 Rio Grande at Road 187, near Hatch (lat 32°40′56″N., long 107°11′21″W.)												
01-06-94	3	<1	1	78	<1	--	0.21	<1	2	<1	2	6
04-21-94	9	<1	2	92	<1	--	0.07	<1	5	<1	<1	6
10-25-94	11	<1	3	91	<1	--	0.08	<1	1	<1	1	<3
01-03-95	3	<1	1	98	<1	200	--	<1	3	<1	2	<3
323414106594903 Rio Grande above Rincon Drain, near Rincon (lat 32°34′14″N., long 106°59′49″W.)												
01-05-94	6	<1	2	81	<1	--	0.22	<1	2	<1	2	4
04-22-94	12	<1	1	85	<1	--	0.08	<1	3	<1	<1	7
10-26-94	9	<1	3	82	<1	--	0.09	<1	1	<1	1	4
01-03-95	7	<1	<1	95	<1	210	--	<1	1	<1	3	<3
324708107164203 Garfield Drain SE of Derry (lat 32°47′08″N., long 107°16′42″W.)												
01-04-94	3	<1	1	67	<1	--	0.19	<1	2	<1	3	15
04-20-94	7	<1	2	73	<1	--	0.17	<1	6	<1	1	28
10-24-94	5	<1	2	61	<1	--	0.22	<1	2	<1	1	22
01-05-95	3	<1	<1	59	<1	350	--	<1	3	<1	2	18

Appendix A. Surface-water-quality data for selected sites in the Rincon Valley study area--Continued

Date	Lead, dissolved (∝g/L as Pb)	Manganese, dissolved (∝g/L as Mn)	Molybdenum, dissolved (∝g/L as Mo)	Nickel, dissolved (∝g/L as Ni)	Selenium, dissolved (∝g/L as Se)	Silver, dissolved (∝g/L as Ag)	Uranium, dissolved (∝g/L as U)	Zinc, dissolved (∝g/L as Zn)	Atrazine, dissolved (∝g/L)	Carbofuran, dissolved (∝g/L)	Chlorpyrifos, dissolved (∝g/L)	Dacthal monoacid, dissolved (∝g/L)
08362500 Rio Grande below Caballo Dam (lat 32°53′05″N., long 107°17′31″W.)												
01-03-94	<1	63	9	<1	<1	<1	5	2	0.002	<0.003	<0.004	<0.017
04-20-94	<1	6	6	1	<1	<1	3	2	<0.001	<0.003	<0.004	<0.017
10-24-94	3	5	7	2	<1	<1	3	7	<0.001	<0.003	<0.004	<0.017
01-03-95	<1	82	8	3	<1	<1	5	1	<0.001	<0.003	<0.004	<0.017
324056107112103 Rio Grande at Road 187, near Hatch (lat 32°40′56″N., long 107°11′21″W.)												
01-06-94	1	480	7	<1	<1	<1	7	2	<0.001	<0.003	<0.004	<0.017
04-21-94	<1	9	6	<1	<1	<1	3	1	<0.001	<0.003	<0.004	<0.017
10-25-94	2	40	7	2	<1	<1	4	5	<0.001	<0.003	<0.004	<0.017
01-03-95	<1	460	7	6	<1	<1	6	2	<0.001	<0.003	<0.004	<0.017
323414106594903 Rio Grande above Rincon Drain, near Rincon (lat 32°34′14″N., long 106°59′49″W.)												
01-05-94	2	68	8	<1	<1	<1	6	3	<0.001	<0.003	<0.004	<0.017
04-22-94	<1	2	7	<1	<1	<1	3	<1	<0.001	<0.003	<0.004	<0.017
10-26-94	<1	3	7	3	<1	<1	3	4	<0.001	<0.003	<0.004	<0.017
01-03-95	<1	51	7	5	<1	<1	5	2	<0.001	<0.003	<0.004	<0.017
324708107164203 Garfield Drain SE of Derry (lat 32°47′08″N., long 107°16′42″W.)												
01-04-94	<1	159	42	3	<1	<1	20	4	<0.001	<0.003	<0.004	<0.017
04-20-94	<1	287	22	1	<1	<1	12	1	<0.001	E0.018	<0.004	<0.017
10-24-94	2	130	34	3	<1	<1	16	1	<0.001	<0.003	<0.004	--
01-05-95	<1	100	34	4	<1	<1	16	2	<0.001	E0.003	<0.004	<0.017

Appendix A. Surface-water-quality data for selected sites in the Rincon Valley study area--Continued

Date	DCPA, dissolved (∝g/L)	Diazinon, dissolved (∝g/L)	EPTC, dissolved (∝g/L)	Metolachlor, dissolved (∝g/L)	Pendimethalin, dissolved (∝g/L)	p,p′-DDE, dissolved (∝g/L)	Prometon, dissolved (∝g/L)	Simazine, dissolved (∝g/L)	Trifluralin, dissolved (∝g/L)	Group A pesticide surrogates			Group B pesticide surrogate
										Diazinon (percent recovery)	HCH alpha (percent recovery)	Terbuthylazine (percent recovery)	BDMC (percent recovery)
08362500 Rio Grande below Caballo Dam (lat 32°53′05″N., long 107°17′31″W.)													
01-03-94	E0.001	E0.001	<0.002	<0.002	<0.004	<0.006	<0.018	E0.004	<0.002	88	96	105	0
04-20-94	<0.002	<0.002	<0.002	<0.002	<0.004	<0.006	E0.011	<0.005	<0.002	90	88	108	0
10-24-94	<0.002	<0.002	<0.002	<0.002	<0.004	<0.006	<0.018	0.005	<0.002	92	83	100	E7.0
01-03-95	<0.002	<0.002	<0.002	<0.002	<0.004	<0.006	<0.018	<0.005	<0.002	101	99	131	83
324056107112103 Rio Grande at Road 187, near Hatch (lat 32°40′56″N., long 107°11′21″W.)													
01-06-94	0.004	<0.002	0.010	0.024	<0.004	<0.006	<0.018	<0.005	<0.002	91	91	87	17
04-21-94	<0.002	<0.002	<0.002	<0.002	<0.004	<0.006	E0.010	<0.005	<0.002	82	93	112	10
10-25-94	0.007	<0.002	<0.002	<0.002	<0.004	<0.006	<0.018	<0.005	<0.002	99	89	97	0
01-03-95	0.003	<0.002	0.009	0.009	<0.004	<0.006	<0.018	<0.005	<0.002	99	95	107	56
323414106594903 Rio Grande above Rincon Drain, near Rincon (lat 32°34′14″N., long 106°59′49″W.)													
01-05-94	0.004	<0.002	0.003	0.018	<0.004	<0.006	<0.018	<0.005	<0.002	86	89	86	12
04-22-94	0.008	<0.002	<0.002	0.005	<0.004	<0.006	<0.018	<0.005	<0.002	100	96	106	34
10-26-94	0.003	<0.002	<0.002	0.003	<0.004	<0.006	E0.006	0.005	<0.002	93	87	97	0
01-03-95	0.003	<0.002	0.004	0.009	<0.004	<0.006	<0.018	<0.005	<0.002	122	102	104	80
324708107164203 Garfield Drain SE of Derry (lat 32°47′08″N., long 107°16′42″W.)													
01-04-94	0.008	<0.002	<0.002	0.062	<0.004	<0.006	<0.018	<0.005	<0.002	91	96	104	0
04-20-94	0.007	<0.002	<0.002	0.037	<0.004	<0.006	<0.018	<0.005	<0.002	92	88	109	86
10-24-94	<0.002	<0.002	<0.002	0.034	<0.004	<0.006	<0.018	<0.005	<0.002	95	88	98	--
01-05-95	<0.002	<0.002	<0.002	0.020	<0.004	<0.006	<0.018	<0.005	<0.002	115	97	116	72

Appendix A. Surface-water-quality data for selected sites in the Rincon Valley study area--Continued

Date	Time	Discharge, inst. (cubic feet per second)	Specific conductance, field (∝S/cm)	Specific conductance, laboratory (∝S/cm)	pH water, whole, field (standard units)	pH water, whole, laboratory (standard units)	Temperature water (deg C)	Temperature air (deg C)	Barometric pressure (mm of Hg)	Oxygen, dissolved (mg/L)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)
324255107142703 Garfield Drain at Road 390 near Salem (lat 32°42'55"N., long 107°14'27"W.)												
01-06-94	1010	0.16	1,590	1,580	7.9	7.7	8.0	14.5	653	7.5	430	130
04-20-94	1600	10.8	1,240	1,550	7.52	7.8	22.5	--	654	8.8	400	120
10-24-94	1600	6.17	1,660	1,700	8.05	7.8	18.0	21.0	656	7.8	450	140
01-05-95	1040	0.62	1,840	1,860	8.3	8.1	9.0	--	650	9.9	470	140
324154107124603 Garfield Drain at Road 391, near Salem (lat 32°41'54"N., long 107°12'46"W.)												
04-20-94	1350	14	1,390	1,380	8.11	7.9	19.5	34.5	656	9.9	370	110
323931107042003 Rincon Drain 0.5 mile east of 140 near Rincon (lat 32°39'31"N., long 107°04'20"W.)												
01-05-94	1430	0.05	1,470	1,470	8.3	7.8	13.0	21.0	659	17.1	400	120
04-21-94	1630	0.87	1,220	1,190	8.01	7.8	22.5	--	655	7.6	350	110
10-25-94	1630	0.958	1,230	1,230	8.16	7.8	22.0	20.5	657	7.5	350	110
01-04-95	0830	0.04	1,350	1,370	7.8	7.6	4.5	2.0	660	8.8	390	120
323410106594403 Rincon Drain at Rio Grande, near Rincon (lat 32°34'10"N., long 106°59'44"W.)												
01-05-94	0920	4.8	1,890	1,910	8.3	7.9	11.0	4.5	559	11.5	490	150
04-22-94	0800	15	1,530	1,540	7.88	7.3	18.0	17.5	658	3.2	390	120
10-26-94	0840	10.6	1,890	1,910	8.04	7.8	12.5	11.0	662	5.1	510	160
01-03-95	1330	4.5	2,140	2,170	8.4	7.6	13.5	14.5	660	14.2	560	170
324121107124603 Hatch Drain at Road 391, near Salem (lat 32°41'21"N., long 107°12'46"W.)												
01-04-94	1220	0.13	1,100	1,090	8.1	7.8	8.0	15.5	662	10.4	290	93
324105107122710 Hatch Drain SE of Road 391, near Salem (lat 32°41'05"N., long 107°12'27"W.)												
04-21-94	1450	0.42	1,080	1,050	7.86	7.6	24.0	26.0	653	4.6	280	86

Appendix A. Surface-water-quality data for selected sites in the Rincon Valley study area--Continued

Date	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sodium adsorption ratio	Sodium (percent)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved it. field (mg/L as HCO_3)	Carbonate, dissolved it. field (mg/L as CO_3)	Alkalinity, dissolved gran field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)
324255107142703 Garfield Drain at Road 390 near Salem (lat 32°42'55"N., long 107°14'27"W.)											
01-06-94	26	170	4	46	7.7	342	--	280	370	120	0.9
04-20-94	24	180	4	49	8.9	344	--	280	360	130	1.3
10-24-94	25	200	4	48	10	368	--	300	390	140	1.4
01-05-95	28	210	4	49	10	361	4	300	440	150	1.5
324154107124603 Garfield Drain at Road 391, near Salem (lat 32°41'54"N., long 107°12'46"W.)											
04-20-94	22	160	4	48	8.7	310	--	250	310	110	1.1
323931107042003 Rincon Drain 0.5 mile east of 140 near Rincon (lat 32°39'31"N., long 107°04'20"W.)											
01-05-94	24	150	3	45	6.8	322	10	280	350	110	0.6
04-21-94	19	120	3	42	6.8	277	--	220	270	86	0.7
10-25-94	19	130	3	44	6.9	312	--	250	270	91	0.7
01-04-95	22	140	3	43	6.6	332	--	270	300	100	0.5
323410106594403 Rincon Drain at Rio Grande, near Rincon (lat 32°34'10"N., long 106°59'44"W.)											
01-05-94	28	220	4	49	9.8	272	--	220	550	160	0.7
04-22-94	23	170	4	48	9.8	254	--	210	370	140	0.7
10-26-94	27	220	4	48	10	302	--	240	510	170	0.8
01-03-95	32	250	5	49	13	218	18	210	630	180	0.8
324121107124603 Hatch Drain at Road 391, near Salem (lat 32°41'21"N., long 107°12'46"W.)											
01-04-94	15	110	3	44	5.3	265	--	215	230	76	0.8
324105107122710 Hatch Drain SE of Road 391, near Salem (lat 32°41'05"N., long 107°12'27"W.)											
04-21-94	15	110	3	46	6.0	254	--	210	230	77	0.9

Appendix A. Surface-water-quality data for selected sites in the Rincon Valley study area--Continued

Date	Silica, dissolved (mg/L as SiO_2)	Dissolved solids residue at 180 deg C (mg/L)	Nitrite, dissolved (mg/L as N)	Nitrite + nitrate, dissolved (mg/L as N)	Ammonia, dissolved (mg/L as N)	Ammonia + organic, dissolved (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Orthophosphate, dissolved (mg/L as P)	Total organic carbon (mg/L as C)	Suspended organic carbon (mg/L as C)	Dissolved organic carbon (mg/L as C)
324255107142703 Garfield Drain at Road 390 near Salem (lat 32°42'55"N., long 107°14'27"W.)											
001-06-94	17	1,040	0.03	0.57	0.10	0.3	0.03	0.02	--	--	3.6
04-20-94	19	1,030	0.03	0.53	0.11	0.4	0.01	<0.01	--	0.7	4.4
10-24-94	24	1,140	0.03	0.71	0.07	0.3	0.01	0.01	--	1.1	3.4
01-05-95	19	1,260	0.02	0.27	0.06	0.3	<0.01	0.01	10	--	3.7
324154107124603 Garfield Drain at Road 391, near Salem (lat 32°41'54"N., long 107°12'46"W.)											
04-20-94	15	892	0.03	0.48	0.09	0.3	<0.01	<0.01	--	0.4	3.9
323931107042003 Rincon Drain 0.5 mile east of 140 near Rincon (lat 32°39'31"N., long 107°04'20"W.)											
01-05-94	15	930	0.02	0.45	0.080	0.3	0.02	0.01	--	--	4.2
04-21-94	21	788	0.01	0.40	0.06	0.3	<0.01	<0.01	--	0.5	3.6
10-25-94	22	810	<0.01	0.32	0.06	0.3	0.02	0.02	--	0.7	3.7
01-04-95	12	938	0.03	0.27	0.07	0.4	<0.01	<0.01	6.0	--	2.7
323410106594403 Rincon Drain at Rio Grande, near Rincon (lat 32°34'10"N., long 106°59'44"W.)											
01-05-94	22	1,320	0.03	0.44	0.14	0.3	0.03	0.02	--	--	2.9
04-22-94	16	1,010	0.03	0.44	0.12	0.5	0.02	0.02	--	0.8	4.9
10-26-94	24	1,300	0.02	0.63	0.10	0.3	0.02	0.02	--	0.9	3.2
01-03-95	26	1,510	0.02	0.50	0.09	0.3	0.03	0.02	3.6	--	3.3
324121107124603 Hatch Drain at Road 391, near Salem (lat 32°41'21"N., long 107°12'46"W.)											
01-04-94	21	736	0.05	0.69	0.15	0.4	0.03	0.030	--	--	2.7
324105107122710 Hatch Drain SE of Road 391, near Salem (lat 32°41'05"N., long 107°12'27"W.)											
04-21-94	19	694	0.01	<0.05	0.04	0.3	0.01	<0.01	--	0.3	4.4

Appendix A. Surface-water-quality data for selected sites in the Rincon Valley study area--Continued

Date	Aluminum, dissolved (∝g/L as Al)	Antimony, dissolved (∝g/L as Sb)	Arsenic, dissolved (∝g/L as As)	Barium, dissolved (∝g/L as Ba)	Beryllium, dissolved (∝g/L as Be)	Boron, dissolved (∝g/L as B)	Bromide, dissolved (mg/L as Br)	Cadmium, dissolved (∝g/L as Cd)	Chromium, dissolved (∝g/L as Cr)	Cobalt, dissolved (∝g/L as Co)	Copper, dissolved (∝g/L as Cu)	Iron, dissolved (∝g/L as Fe)
324255107142703 Garfield Drain at Road 390 near Salem (lat 32°42'55"N., long 107°14'27"W.)												
01-06-94	7	<1	<1	80	<1	--	0.23	<1	3	<1	2	6
04-20-94	2	<1	1	70	<1	--	0.21	<1	3	<1	3	11
10-24-94	4	<1	2	62	<1	--	0.26	<1	2	<1	1	4
01-05-95	2	<1	<1	71	<1	290	--	<1	3	<1	2	5
324154107124603 Garfield Drain at Road 391, near Salem (lat 32°41'54"N., long 107°12'46"W.)												
04-20-94	4	<1	<1	64	<1	--	0.17	<1	6	<1	1	10
323931107042003 Rincon Drain 0.5 mile east of 140 near Rincon (lat 32°39'31"N., long 107°04'20"W.)												
01-05-94	3	<1	<1	110	<1	--	0.16	<1	2	<1	2	5
04-21-94	17	<1	1	53	<1	--	0.15	6	10	<1	32	30
10-25-94	5	<1	2	100	<1	--	0.15	<1	2	<1	<1	3
01-04-95	5	<1	<1	110	<1	210	--	<1	4	<1	2	5
323410106594403 Rincon Drain at Rio Grande, near Rincon (lat 32°34'10"N., long 106°59'44"W.)												
01-05-94	4	<1	2	60	<1	--	0.28	<1	2	<1	3	4
04-22-94	4	<1	2	72	<1	--	0.20	<1	3	<1	4	17
10-26-94	4	<1	2	73	<1	--	0.31	<1	2	<1	2	<3
01-03-95	5	<1	2	63	<1	400	--	<1	1	<1	4	<9
324121107124603 Hatch Drain at Road 391, near Salem (lat 32°41'21"N., long 107°12'46"W.)												
01-04-94	3	<1	1	110	<1	--	0.14	<1	2	<1	2	4
324105107122710 Hatch Drain SE of Road 391, near Salem (lat 32°41'05"N., long 107°12'27"W.)												
04-21-94	6	<1	2	75	<1	--	0.12	<1	6	<1	<1	61

Appendix A. Surface-water-quality data for selected sites in the Rincon Valley study area--Continued

Date	Lead, dissolved (∝g/L as Pb)	Manganese, dissolved (∝g/L as Mn)	Molybdenum, dissolved (∝g/L as Mo)	Nickel, dissolved (∝g/L as Ni)	Selenium, dissolved (∝g/L as Se)	Silver, dissolved (∝g/L as Ag)	Uranium, dissolved (∝g/L as U)	Zinc, dissolved (∝g/L as Zn)	Atrazine, dissolved (∝g/L)	Carbofuran, dissolved (∝g/L)	Chlorpyrifos, dissolved (∝g/L)	Dacthal monoacid, dissolved (∝g/L)
324255107142703 Garfield Drain at Road 390 near Salem (lat 32°42'55"N., long 107°14'27"W.)												
01-06-94	1	657	10	<1	<1	<1	8	2	<0.001	<0.003	<0.004	<0.017
04-20-94	<1	178	13	1	<1	<1	9	3	<0.001	E0.048	0.005	<0.017
10-24-94	1	128	13	5	<1	<1	8	9	<0.001	<0.003	<0.004	<0.017
01-05-95	<1	277	12	8	<1	<1	8	2	<0.001	<0.003	<0.004	<0.017
324154107124603 Garfield Drain at Road 391, near Salem (lat 32°41'54"N., long 107°12'46"W.)												
04-20-94	<1	33	11	2	<1	<1	8	2	<0.001	E0.15	0.010	<0.017
323931107042003 Rincon Drain 0.5 mile east of 140 near Rincon (lat 32°39'31"N., long 107°04'20"W.)												
01-05-94	1	758	9	1	<1	<1	5	2	<0.001	<0.003	<0.004	<0.017
04-21-94	<1	242	9	2	<1	<1	5	3	<0.001	E0.047	<0.004	<0.017
10-25-94	<1	542	8	5	<1	<1	3	<1	<0.001	<0.003	<0.004	<0.017
01-04-95	<1	1,220	6	9	<1	<1	3	1	<0.001	<0.003	<0.004	<0.017
323410106594403 Rincon Drain at Rio Grande, near Rincon (lat 32°34'10"N., long 106°59'44"W.)												
01-05-94	3	341	10	2	<1	<1	5	2	<0.001	<0.003	<0.004	<0.017
04-22-94	<1	129	8	2	<1	<1	5	5	<0.001	E0.052	<0.004	<0.017
10-26-94	<1	224	9	6	<1	<1	5	3	<0.001	<0.003	<0.004	0.13
01-03-95	<1	386	9	8	1	<1	5	2	<0.001	<0.003	<0.004	<0.017
324121107124603 Hatch Drain at Road 391, near Salem (lat 32°41'21"N., long 107°12'46"W.)												
01-04-94	<1	796	13	2	<1	<1	10	3	<0.001	<0.003	<0.004	<0.017
324105107122710 Hatch Drain SE of Road 391, near Salem (lat 32°41'05"N., long 107°12'27"W.)												
04-21-94	<1	459	12	<1	<1	<1	7	1	<0.001	E0.019	<0.004	<0.017

Appendix A. Surface-water-quality data for selected sites in the Rincon Valley study area--Continued

Date	DCPA, dissolved (∝g/L)	Diazinon, dissolved (∝g/L)	EPTC, dissolved (∝g/L)	Metolachlor, dissolved (∝g/L)	Pendimethalin, dissolved (∝g/L)	p,p′-DDE, dissolved (∝g/L)	Prometon, dissolved (∝g/L)	Simazine, dissolved (∝g/L)	Trifluralin, dissolved (∝g/L)	Group A pesticide surrogates: Diazinon (percent recovery)	Group A pesticide surrogates: HCH alpha (percent recovery)	Group A pesticide surrogates: Terbuthylazine (percent recovery)	Group B pesticide surrogate: BDMC (percent recovery)
324255107142703 Garfield Drain at Road 390 near Salem (lat 32°42′55″N., long 107°14′27″W.)													
01-06-94	0.010	<0.002	<0.002	0.007	<0.004	<0.006	<0.018	<0.005	<0.002	91	85	84	20
04-20-94	0.036	<0.002	<0.002	0.013	<0.004	<0.006	<0.018	<0.005	<0.002	79	91	110	24
10-24-94	0.004	<0.002	<0.002	0.007	<0.004	<0.006	<0.018	<0.005	<0.002	90	85	89	E4.0
01-05-94	0.013	<0.002	<0.002	0.008	<0.004	<0.006	<0.018	<0.005	<0.002	132	115	126	47
324154107124603 Garfield Drain at Road 391, near Salem (lat 32°41′54″N., long 107°12′46″W.)													
04-20-94	0.056	<0.002	<0.002	0.020	<0.004	E0.002	<0.018	0.005	<0.002	85	82	103	17
323931107042003 Rincon Drain 0.5 mile east of 140 near Rincon (lat 32°39′31″N., long 107°04′20″W.)													
01-05-94	0.002	<0.002	E0.001	<0.002	<0.004	<0.006	<0.018	<0.005	<0.002	91	87	80	100
04-21-94	<0.002	<0.002	<0.002	<0.002	<0.004	E0.001	<0.018	<0.005	<0.002	95	76	107	76
10-25-94	<0.002	<0.002	<0.002	<0.002	<0.004	<0.006	<0.018	<0.005	<0.002	95	90	103	E10
01-04-95	0.003	<0.002	<0.002	0.003	<0.004	<0.006	<0.018	<0.005	<0.002	95	114	111	64
323410106594403 Rincon Drain at Rio Grande, near Rincon (lat 32°34′10″N., long 106°59′44″W.)													
01-05-94	0.004	<0.002	<0.002	0.008	<0.004	E0.002	<0.018	<0.005	E0.001	92	96.5	104	10
04-22-94	0.17	0.004	<0.002	0.003	<0.004	E0.001	<0.018	<0.005	<0.002	98	83	114	82
10-26-94	0.21	<0.002	<0.002	0.013	<0.004	E0.002	<0.018	<0.005	<0.002	98	89	97	1.0
01-03-95	0.007	<0.002	<0.002	0.003	<0.004	<0.006	E0.007	<0.005	<0.002	114	100	119	60
324121107124603 Hatch Drain at Road 391, near Salem (lat 32°41′21″N., long 107°12′46″W.)													
01-04-94	<0.002	<0.002	<0.002	<0.002	<0.004	<0.006	<0.018	<0.005	<0.002	86	94	97	34
324105107122710 Hatch Drain SE of Road 391, near Salem (lat 32°41′05″N., long 107°12′27″W.)													
04-21-94	0.012	<0.002	<0.002	0.12	0.033	E0.001	<0.018	<0.005	<0.002	87	92	108	8.0

Appendix A. Surface-water-quality data for selected sites in the Rincon Valley study area--Continued

Date	Time	Discharge, inst. (cubic feet per second)	Specific conductance, field (∝S/cm)	Specific conductance, laboratory (∝S/cm)	pH water, whole, field (standard units)	pH water, whole, laboratory (standard units)	Temperature water (deg C)	Temperature air (deg C)	Barometric pressure (mm of Hg)	Oxygen, dissolved (mg/L)	Hardness, total (mg/L $CaCO_3$)	Calcium, dissolved (mg/L as Ca)
324121107124603 Hatch Drain at Road 391, near Salem (lat 32°41'21"N., long 107°12'46"W.)												
10-25-94	0830	0.447	1,040	1,030	7.99	7.7	14.5	11.5	659	5.7	290	93
01-04-95	0830	0.17	1,130	1,100	8.2	7.5	5.0	6.5	665	8.0	300	95
323917107055603 Hatch Drain at Rio Grande, near Hatch (lat 32°39'17"N., long 107°05'56"W.)												
01-04-94	1450	0.44	1,690	1,690	8.7	8.1	8.0	14.0	662	15.3	390	120
04-21-94	0730	7.5	1,540	1,530	7.94	7.6	16.0	12.0	658	4.7	400	120
10-25-94	1450	3.76	1,570	1,580	8.36	8.0	16.0	19.0	659	8.50	420	130
01-04-95	1150	0.02	1,530	1,540	8.5	7.9	7.0	5.5	658	11.4	370	110

Appendix A. Surface-water-quality data for selected sites in the Rincon Valley study area--Continued

Date	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sodium adsorption ratio	Sodium (percent)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved, it. field (mg/L as HCO_3)	Carbonate, dissolved, it. field (mg/L as CO_3)	Alkalinity, dissolved, gran field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)
324121107124603 Hatch Drain at Road 391, near Salem (lat 32°41'21"N., long 107°12'46"W.)											
10-25-94	15	110	3	44	6.0	256	--	210	220	75	0.80
01-04-95	15	100	3	42	5.5	249	--	200	240	80	0.70
323917107055603 Hatch Drain at Rio Grande, near Hatch (lat 32°39'17"N., long 107°05'56"W.)											
01-04-94	23	190	4	50	10	342	--	280	400	130	0.80
04-21-94	24	170	4	48	8.0	321	--	260	370	130	0.80
10-25-94	23	180	4	48	8.8	311	16	280	370	130	0.90
01-04-95	22	180	4	51	9.7	304	14	270	340	120	0.80

Appendix A. Surface-water-quality data for selected sites in the Rincon Valley study area--Continued

Date	Silica, dissolved (mg/L as SiO_2)	Dissolved solids residue at 180 deg C (mg/L)	Nitrite, dissolved (mg/L as N)	Nitrite + nitrate, dissolved (mg/L as N)	Ammonia, dissolved (mg/L as N)	Ammonia + organic, dissolved (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Orthophosphate, dissolved (mg/L as P)	Total organic carbon (mg/L as C)	Suspended organic carbon (mg/L as C)	Dissolved organic carbon (mg/L as C)	Aluminum, dissolved (∝g/L as Al)
324121107124603 Hatch Drain at Road 391, near Salem (lat 32°41'21"N., long 107°12'46"W.)												
10-25-94	25	680	0.05	1.10	0.11	0.20	0.02	0.03	--	0.3	0.8	4
01-04-95	17	743	0.03	0.25	0.28	0.40	0.01	0.01	5.5	--	--	3
323917107055603 Hatch Drain at Rio Grande, near Hatch (lat 32°39'17"N., long 107°05'56"W.)												
01-04-94	32	1,170	0.11	3.30	0.06	0.50	0.73	0.73	--	--	4.8	11
04-21-94	23	1,040	0.08	0.54	0.27	0.60	0.18	0.19	--	1.1	4.3	4
10-25-94	29	1,060	0.04	1.20	0.10	0.40	0.19	0.19	--	0.3	4.0	4
01-04-95	29	1,030	0.09	2.60	0.33	1.1	0.37	0.40	7.2	--	4.6	4

Appendix A. Surface-water-quality data for selected sites in the Rincon Valley study area--Continued

Date	Antimony, dissolved (∝g/L as Sb)	Arsenic, dissolved (∝g/L as As)	Barium, dissolved (∝g/L as Ba)	Beryllium, dissolved (∝g/L as Be)	Boron, dissolved (∝g/L as B)	Bromide, dissolved (mg/L as Br)	Cadmium, dissolved (∝g/L as Cd)	Chromium, dissolved (∝g/L as Cr)	Cobalt, dissolved (∝g/L as Co)	Copper, dissolved (∝g/L as Cu)	Iron, dissolved (∝g/L as Fe)	Lead, dissolved (∝g/L as Pb)
324121107124603 Hatch Drain at Road 391, near Salem (lat 32°41'21"N., long 107°12'46"W.)												
10-25-94	<1	2	93	<1	--	0.15	<1	2	<1	1	15	3
01-04-95	<1	<1	120	<1	170	--	<1	4	<1	1	4	<1
323917107055603 Hatch Drain at Rio Grande, near Hatch (lat 32°39'17"N., long 107°05'56"W.)												
01-04-94	<1	2	37	<1	--	0.22	<1	3	<1	4	40	<1
04-21-94	<1	2	66	<1	--	0.23	<1	3	<1	3	17	<1
10-25-94	<1	2	69	<1	--	0.24	<1	2	<1	3	<3	<1
01-04-95	<1	3	45	<1	310	--	<1	2	<1	2	<3	<1

Appendix A. Surface-water-quality data for selected sites in the Rincon Valley study area--Continued

Date	Manganese, dissolved (∝g/L as Mn)	Molybdenum, dissolved (∝g/L as Mo)	Nickel, dissolved (∝g/L as Ni)	Selenium, dissolved (∝g/L as Se)	Silver, dissolved (∝g/L as Ag)	Uranium, dissolved (∝g/L as U)	Zinc, dissolved (∝g/L as Zn)	Atrazine, dissolved (∝g/L)	Carbofuran, dissolved (∝g/L)	Chlorpyrifos, dissolved (∝g/L)	Dacthal monoacid, dissolved (∝g/L)	DCPA, dissolved (∝g/L)
324121107124603 Hatch Drain at Road 391, near Salem (lat 32°41'21"N., long 107°12'46"W.)												
10-25-94	483	10	3	<1	<1	5	<1	<0.001	<0.003	<0.004	<0.017	<0.002
01-04-95	940	11	7	<1	<1	8	6	<0.001	<0.003	<0.004	<0.017	E0.001
323917107055603 Hatch Drain at Rio Grande, near Hatch (lat 32°39'17"N., long 107°05'56"W.)												
01-04-94	41	10	2	<1	<1	7	11	<0.001	<0.003	<0.004	<0.017	0.016
04-21-94	167	10	1	<1	<1	7	4	<0.001	E0.037	<0.004	<0.017	0.046
10-25-94	99	12	5	<1	<1	6	1	<0.001	<0.003	<0.004	E0.11	0.071
01-04-95	73	9	5	<1	<1	4	2	<0.001	<0.003	<0.004	<0.017	0.062

Appendix A. Surface-water-quality data for selected sites in the Rincon Valley study area--Concluded

Date	Diazinon, dissolved (∝g/L)	EPTC, dissolved (∝g/L)	Metolachlor, dissolved (∝g/L)	Pendimethalin, dissolved (∝g/L)	p,p′-DDE, dissolved (∝g/L)	Prometon, dissolved (∝g/L)	Simazine, dissolved (∝g/L)	Trifluralin, dissolved (∝g/L)	Group A pesticide surrogates: Diazinon (percent recovery)	Group A pesticide surrogates: HCH alpha (percent recovery)	Group A pesticide surrogates: Terbuthylazine (percent recovery)	Group B pesticide surrogate: BDMC (percent recovery)
324121107124603 Hatch Drain at Road 391, near Salem (lat 32°41′21″N., long 107°12′46″W.)												
10-25-94	<0.002	<0.002	0.005	<0.004	<0.006	<0.018	<0.005	<0.002	86	80	88	0.00
01-04-95	<0.002	<0.002	0.004	<0.004	E0.002	<0.018	<0.005	<0.002	106	104	110	70
323917107055603 Hatch Drain at Rio Grande, near Hatch (lat 32°39′17″N., long 107°05′56″W.)												
01-04-94	0.022	<0.002	0.050	<0.004	<0.006	<0.018	<0.005	<0.002	95	97	115	15
04-21-94	<0.002	<0.002	0.10	<0.004	<0.006	<0.018	<0.005	<0.002	80	95	118	22
10-25-94	<0.002	0.009	0.027	<0.004	<0.006	<0.018	<0.005	<0.002	98	87	103	E9.0
01-04-95	<0.002	<0.002	0.41	<0.004	<0.006	<0.018	<0.005	<0.002	105	98	106	79

Appendix B. Shallow ground-water-quality data for wells sampled in the Rincon Valley study area

[∝S/cm, microsiemens per centimeter at 25 degrees Celsius (deg C); mm, millimeters; mg/L, milligrams per liter; it. field, field measurement by incremental titration; gran field, field measurement by gran titration; ∝g/L, micrograms per liter; count, 2 sigma, 2-sigma percision estimate of analysis; pCi/L, picocuries per liter; <, less than; >, greater than; --, no data; E, estimated]

Well number (fig. 8)	Latitude	Longitude	Date	Time	Altitude of land surface datum (feet above sea level)	Depth of well (feet)	Water-level depth below land surface (feet)	Specific conduct-ance, field (∝S/cm)	pH water, whole field (standard units)	pH water, whole laboratory (standard units)	Temper-ature water (deg C)	Temper-ature air (deg C)
1	32°47′14"N.	107°18′02"W.	04-25-94	1000	4,110	18.32	10.11	1,000	7.39	7.3	15.0	10.5
2	32°48′55"N.	107°18′46"W.	04-26-94	1340	4,135	22.87	11.02	2,180	7.10	7.2	19.0	23.0
3	32°49′55"N.	107°18′09"W.	04-19-94	1020	4,135	17.49	6.62	1,490	7.35	7.2	16.0	30.0
4	32°50′02"N.	107°18′12"W.	04-19-94	1420	4,135	20.27	7.80	1,200	7.37	7.2	18.0	24.5
5	32°51′23"N.	107°17′57"W.	05-03-94	0940	4,140	21.83	8.20	1,930	7.35	7.3	18.0	11.5
6	32°51′21"N.	107°17′26"W.	05-07-94	1140	4,140	20.9	9.50	1,450	7.53	7.6	18.5	25.0
7	32°47′38"N.	107°16′52"W.	04-26-94	0930	4,118	16.94	6.16	1,840	7.46	7.5	16.0	12.0
8	32°46′28"N.	107°16′34"W.	04-23-94	0850	4,108	15.04	6.77	1,380	7.41	7.5	15.0	14.5
9	32°46′12"N.	107°16′38"W.	04-23-94	1300	4,107	19.98	7.92	1,090	7.35	7.4	17.0	29.0
10	32°45′10"N.	107°16′26"W.	04-23-94	1620	4,104	18.35	8.15	1,270	7.63	7.4	19.0	29.5
11	32°44′19"N.	107°16′08"W.	04-24-94	1630	4,090	23.08	11.78	1,420	7.53	7.4	18.0	28.5
12	32°40′59"N.	107°12′23"W.	04-27-94	0940	4,060	19.89	6.97	1,700	7.68	7.7	18.0	12.5
13	32°41′22"N.	107°12′08"W.	04-28-94	0930	4,062	22.04	12.24	1,740	7.27	7.3	16.0	12.5
14	32°42′02"N.	107°14′31"W.	04-28-94	1430	4,075	24.19	12.28	1,500	7.48	7.5	18.0	20.5
15	32°42′36"N.	107°13′37"W.	05-02-94	1420	4,078	17.47	5.74	1,970	7.35	7.2	16.0	26.5
16	32°42′57"N.	107°14′26"W.	04-22-94	1530	4,080	20.27	8.02	1,400	7.59	7.6	18.0	28.0
17	32°44′22"N.	107°15′22"W.	05-02-94	1700	4,098	23.18	12.11	790	7.53	7.4	17.0	28.0
18	32°40′41"N.	107°10′00"W.	04-24-94	0900	4,053	16.06	5.48	2,270	7.64	7.4	10.0	16.0
19	32°40′21"N.	107°11′43"W.	04-27-94	1410	4,065	16.98	6.70	1,820	7.18	7.3	17.0	17.5
20	32°39′59"N.	107°07′54"W.	04-18-94	1430	4,050	20.76	9.61	800	7.62	7.4	16.0	30.0
21	32°39′26"N.	107°07′51"W.	05-06-94	0930	4,040	21.5	5.61	1,890	7.31	7.3	18.5	18.0
22	32°39′20"N.	107°06′46"W.	05-07-94	1430	4,050	22.9	11.2	1,000	7.54	7.6	18.5	27.5
23	32°35′27"N.	107°00′07"W.	05-04-94	0930	4,007	15.07	3.92	1,520	7.62	7.5	17.0	12.5
24	32°36′01"N.	107°01′00"W.	05-04-94	1230	4,008	14.89	5.63	1,360	7.51	7.5	17.5	31.5
25	32°37′22"N.	107°00′28"W.	05-04-94	1520	4,008	23.02	9.63	5,280	7.01	7.1	19.5	33.5
26	32°37′33"N.	107°01′10"W.	05-06-94	1230	4,008	18.1	6.45	2,270	7.40	7.4	18.0	28.5
27	32°38′02"N.	107°02′41"W.	05-06-94	1520	4,020	16.9	5.84	3,420	7.25	7.3	17.5	31.5
28	32°38′52"N.	107°03′38"W.	05-07-94	0830	4,027	18.3	8.74	1,160	7.50	7.5	17.5	13.0
29	32°39′17"N.	107°03′16"W.	05-05-94	1500	4,025	18.17	6.30	1,990	7.23	7.2	17.0	35.0
30	32°39′30"N.	107°04′14"W.	05-05-94	1000	4,030	23.25	10.78	1,290	7.23	7.6	18.5	15.5

Appendix B. Shallow ground-water-quality data for selected sites in the Rincon Valley study area--Continued

Well number (fig. 8)	Latitude	Longitude	Barometric pressure (mm of Hg)	Oxygen, dissolved (mg/L)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sodium adsorption ratio	Sodium (percent)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved it. field (mg/L as HCO_3)
1	32°47′14"N.	107°18′02"W.	651	4.2	300	97	15	100	2	41	5.1	270
2	32°48′55"N.	107°18′46"W.	649	1.1	490	150	28	300	6	57	5.8	523
3	32°49′55"N.	107°18′09"W.	656	0.2	420	130	24	170	4	46	5.5	389
4	32°50′02"N.	107°18′12"W.	654	0.1	290	96	13	140	4	51	3.7	303
5	32°51′23"N.	107°17′57"W.	655	0.2	620	200	30	200	3	41	7.4	516
6	32°51′21"N.	107°17′26"W.	657	0.2	360	110	20	190	4	53	6.9	343
7	32°47′38"N.	107°16′52"W.	650	0.2	350	100	24	260	6	61	16	510
8	32°46′28"N.	107°16′34"W.	654	1.8	290	82	20	190	5	58	7.6	377
9	32°46′12"N.	107°16′38"W.	653	0.1	310	98	15	100	2	41	5.6	321
10	32°45′10"N.	107°16′26"W.	651	0.2	250	72	17	160	4	57	9.3	338
11	32°44′19"N.	107°16′08"W.	649	0.3	310	99	15	170	4	54	7.0	255
12	32°40′59"N.	107°12′23"W.	652	0.1	470	150	22	200	4	48	6.9	478
13	32°41′22"N.	107°12′08"W.	658	1.1	510	160	26	180	3	43	9.9	341
14	32°42′02"N.	107°14′31"W.	655	0.2	390	120	23	160	4	46	7.6	384
15	32°42′36"N.	107°13′37"W.	653	0.9	510	160	28	230	4	49	10	365
16	32°42′57"N.	107°14′26"W.	652	0.7	390	120	23	140	3	43	7.2	339
17	32°44′22"N.	107°15′22"W.	650	2.1	220	69	11	77	2	43	5.3	199
18	32°40′41"N.	107°10′00"W.	653	0.1	610	180	40	270	5	48	13	434
19	32°40′21"N.	107°11′43"W.	650	0.8	560	170	33	170	3	39	7.7	373
20	32°39′59"N.	107°07′54"W.	657	5.6	230	70	14	73	2	40	4.8	192
21	32°39′26"N.	107°07′51"W.	656	0.1	470	140	30	240	5	52	7.4	546
22	32°39′20"N.	107°06′46"W.	656	0.1	260	80	15	110	3	47	4.2	220
23	32°35′27"N.	107°00′07"W.	660	0.2	450	140	25	140	3	40	7.0	300
24	32°36′01"N.	107°01′00"W.	658	0.3	430	130	25	110	2	35	6.3	254
25	32°37′22"N.	107°00′28"W.	656	0.1	880	270	49	920	14	69	19	694
26	32°37′33"N.	107°01′10"W.	657	0.2	620	220	18	250	4	46	13	174
27	32°38′02"N.	107°02′41"W.	656	0.1	910	250	70	460	7	52	9.6	641
28	32°38′52"N.	107°03′38"W.	658	1.3	290	89	17	120	3	45	21	269
29	32°39′17"N.	107°03′16"W.	655	0.2	540	160	35	210	4	45	7.4	374
30	32°39′30"N.	107°04′14"W.	660	0.2	440	140	23	100	2	32	8.4	327

Appendix B. Shallow ground-water-quality data for selected sites in the Rincon Valley study area--Continued

Well number (fig. 8)	Latitude	Longitude	Alkalinity, dissolved, gran field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Dissolved solids, residue at 180 deg C (mg/L)	Nitrite, dissolved (mg/L as N)	Nitrite + nitrate, dissolved (mg/L as N)	Ammonia, dissolved (mg/L as N)
1	32°47′14"N.	107°18′02"W.	220	200	72	0.70	12	664	<0.01	1.20	0.02
2	32°48′55"N.	107°18′46"W.	430	510	120	1.1	28	1,500	0.09	19.0	0.02
3	32°49′55"N.	107°18′09"W.	320	330	100	0.80	24	1,010	0.02	2.00	<0.01
4	32°50′02"N.	107°18′12"W.	250	200	77	0.90	28	776	0.10	13.0	<0.01
5	32°51′23"N.	107°17′57"W.	420	470	130	0.60	22	1,350	<0.01	<0.05	0.10
6	32°51′21"N.	107°17′26"W.	280	300	120	1.0	19	910	0.06	3.20	0.02
7	32°47′38"N.	107°16′52"W.	420	370	120	2.6	21	1,130	0.10	6.80	0.02
8	32°46′28"N.	107°16′34"W.	310	250	100	2.8	26	882	0.06	4.30	0.01
9	32°46′12"N.	107°16′38"W.	260	190	73	0.80	25	680	<0.01	<0.05	0.20
10	32°45′10"N.	107°16′26"W.	270	230	93	1.8	24	788	0.02	0.11	0.02
11	32°44′19"N.	107°16′08"W.	290	310	94	1.4	21	894	<0.01	0.12	0.02
12	32°40′59"N.	107°12′23"W.	390	370	120	0.70	21	1,150	0.01	<0.05	0.33
13	32°41′22"N.	107°12′08"W.	280	450	130	0.60	17	1,200	0.03	1.20	0.02
14	32°42′02"N.	107°14′31"W.	310	340	98	0.70	18	990	0.02	0.31	0.02
15	32°42′36"N.	107°13′37"W.	300	480	150	0.90	24	1,370	0.06	19.0	0.03
16	32°42′57"N.	107°14′26"W.	270	300	100	1.0	21	888	<0.01	0.23	0.02
17	32°44′22"N.	107°15′22"W.	160	130	67	0.60	14	481	<0.01	0.21	0.03
18	32°40′41"N.	107°10′00"W.	350	620	170	0.50	14	1,550	0.09	3.40	0.05
19	32°40′21"N.	107°11′43"W.	300	380	110	1.1	30	1,280	0.03	33.0	0.02
20	32°39′59"N.	107°07′54"W.	160	130	72	0.50	11	486	<0.01	0.16	<0.01
21	32°39′26"N.	107°07′51"W.	450	430	110	1.2	33	1,300	<0.01	<0.05	0.31
22	32°39′20"N.	107°06′46"W.	180	180	68	1.1	24	629	0.06	9.60	0.02
23	32°35′27"N.	107°00′07"W.	240	330	150	0.50	26	1,000	<0.01	<0.05	0.25
24	32°36′01"N.	107°01′00"W.	210	310	120	0.50	19	868	<0.01	0.38	0.08
25	32°37′22"N.	107°00′28"W.	560	1,700	450	2.9	27	3,630	0.05	0.57	0.16
26	32°37′33"N.	107°01′10"W.	140	820	170	1.1	26	1,680	<0.01	<0.05	0.05
27	32°38′02"N.	107°02′41"W.	520	980	290	0.60	29	2,420	<0.01	<0.05	0.23
28	32°38′52"N.	107°03′38"W.	220	210	100	0.70	24	702	<0.01	0.05	0.13
29	32°39′17"N.	107°03′16"W.	310	410	130	0.80	27	1,360	0.04	31.0	0.04
30	32°39′30"N.	107°04′14"W.	270	270	83	1.0	20	854	0.08	5.60	0.03

Appendix B. Shallow ground-water-quality data for selected sites in the Rincon Valley study area--Continued

Well number (fig. 8)	Latitude	Longitude	Ammonia + organic, dissolved (mg/L as N)	Phos-phorus, dissolved (mg/L as P)	Ortho-phosphate, dissolved (mg/L as P)	Dissolved organic carbon (mg/L as C)	Aluminum, dissolved (∞g/L as Al)	Antimony, dissolved (∞g/L as Sb)	Arsenic, dissolved (∞g/L as As)	Barium, dissolved (∞g/L as Ba)	Beryllium, dissolved (∞g/L as Be)	Bromide, dissolved (mg/L as Br)
1	32°47′14"N.	107°18′02"W.	<0.2	0.02	<0.01	2.1	1	<1	<1	66	<1	0.14
2	32°48′55"N.	107°18′46"W.	0.3	0.04	0.05	3.6	<1	<1	3	43	<1	0.50
3	32°49′55"N.	107°18′09"W.	0.2	<0.01	0.01	3.3	1	<1	1	52	<1	0.26
4	32°50′02"N.	107°18′12"W.	0.2	<0.01	0.01	2.8	2	<1	2	69	<1	0.15
5	32°51′23"N.	107°17′57"W.	<0.2	<0.01	0.01	2.4	<1	<1	<1	100	<1	0.40
6	32°51′21"N.	107°17′26"W.	0.2	<0.01	0.01	1.4	3	<1	2	78	<1	0.31
7	32°47′38"N.	107°16′52"W.	0.3	<0.01	0.01	3.7	<1	<1	1	33	<1	0.27
8	32°46′28"N.	107°16′34"W.	0.2	0.05	0.06	2.2	<1	<1	3	83	<1	0.24
9	32°46′12"N.	107°16′38"W.	0.3	<0.01	0.02	2.2	<1	<1	<1	56	<1	0.23
10	32°45′10"N.	107°16′26"W.	<0.2	0.07	0.05	2.2	2	<1	4	81	<1	0.17
11	32°44′19"N.	107°16′08"W.	<0.2	0.02	0.02	2.6	5	<1	2	51	<1	0.21
12	32°40′59"N.	107°12′23"W.	0.5	0.05	0.06	3.1	<1	<1	2	55	<1	0.27
13	32°41′22"N.	107°12′08"W.	0.2	<0.01	<0.01	3.0	2	<1	<1	94	<1	0.30
14	32°42′02"N.	107°14′31"W.	0.3	<0.01	<0.01	2.9	2	<1	<1	52	<1	0.13
15	32°42′36"N.	107°13′37"W.	0.4	0.05	0.05	3.7	<1	<1	3	49	<1	0.36
16	32°42′57"N.	107°14′26"W.	<0.2	0.06	0.05	2.4	2	<1	2	59	<1	0.26
17	32°44′22"N.	107°15′22"W.	<0.2	0.03	0.03	1.6	1	<1	2	61	<1	0.36
18	32°40′41"N.	107°10′00"W.	0.3	<0.01	0.01	3.8	2	<1	<1	110	<1	0.43
19	32°40′21"N.	107°11′43"W.	0.8	0.03	0.02	2.5	<1	<1	2	70	<1	0.39
20	32°39′59"N.	107°07′54"W.	<0.2	0.02	0.02	1.9	6	<1	2	85	<1	0.13
21	32°39′26"N.	107°07′51"W.	1.2	0.13	0.05	3.4	<1	<1	<1	69	<1	0.36
22	32°39′20"N.	107°06′46"W.	0.5	0.01	0.02	4.1	2	<1	1	44	<1	0.13
23	32°35′27"N.	107°00′07"W.	1.2	0.01	<0.01	2.8	1	<1	<1	96	<1	0.25
24	32°36′01"N.	107°01′00"W.	0.3	0.04	0.05	2.6	2	<1	3	110	<1	0.22
25	32°37′22"N.	107°00′28"W.	0.3	0.03	0.04	4.1	<3	<3	2	35	<3	0.97
26	32°37′33"N.	107°01′10"W.	1.5	0.08	0.02	1.1	<1	<1	2	29	<1	0.53
27	32°38′02"N.	107°02′41"W.	0.7	0.07	0.05	5.3	<2	<2	3	49	<2	0.63
28	32°38′52"N.	107°03′38"W.	0.3	0.05	0.06	2.6	2	<1	2	99	<1	0.15
29	32°39′17"N.	107°03′16"W.	0.3	0.02	0.01	3.4	<1	<1	2	41	<1	0.31
30	32°39′30"N.	107°04′14"W.	0.3	<0.01	0.01	2.7	<1	<1	1	82	<1	0.16

Appendix B. Shallow ground-water-quality data for selected sites in the Rincon Valley study area--Continued

Well number (fig. 8)	Latitude	Longitude	Cadmium, dissolved (∝g/L as Cd)	Chromium, dissolved (∝g/L as Cr)	Cobalt, dissolved (∝g/L as Co)	Copper, dissolved (∝g/L as Cu)	Iron, dissolved (∝g/L as Fe)	Lead, dissolved (∝g/L as Pb)	Manga-nese, dissolved (∝g/L as Mn)	Molyb-denum, dissolved (∝g/L as Mo)	Nickel, dissolved (∝g/L as Ni)	Selenium, dissolved (∝g/L as Se)
1	32°47′14"N.	107°18′02"W.	<1	3	<1	2	5	<1	1	6	2	<1
2	32°48′55"N.	107°18′46"W.	<1	7	<1	5	<3	<1	110	10	3	7
3	32°49′55"N.	107°18′09"W.	<1	3	<1	3	8	<1	250	11	2	<1
4	32°50′02"N.	107°18′12"W.	<1	4	<1	1	3	<1	28	9	2	<1
5	32°51′23"N.	107°17′57"W.	<1	5	<1	4	1,200	<1	1,650	7	2	<1
6	32°51′21"N.	107°17′26"W.	<1	1	<1	4	<3	<1	470	12	1	<1
7	32°47′38"N.	107°16′52"W.	<1	5	<1	3	7	<1	230	38	2	1
8	32°46′28"N.	107°16′34"W.	<1	4	<1	2	6	<1	220	15	2	<1
9	32°46′12"N.	107°16′38"W.	<1	3	<1	2	1,100	<1	>1,360	9	<1	<1
10	32°45′10"N.	107°16′26"W.	<1	5	<1	5	<3	<1	1,370	8	2	<1
11	32°44′19"N.	107°16′08"W.	<1	4	<1	5	<3	<1	170	13	2	<1
12	32°40′59"N.	107°12′23"W.	<1	6	<1	3	26	<1	1,350	11	2	<1
13	32°41′22"N.	107°12′08"W.	2	7	<1	5	100	<1	230	9	3	<1
14	32°42′02"N.	107°14′31"W.	<1	5	<1	3	9	<1	710	11	2	<1
15	32°42′36"N.	107°13′37"W.	<1	4	<1	6	<3	<1	77	17	3	<1
16	32°42′57"N.	107°14′26"W.	<1	5	<1	3	83	<1	1,210	8	1	<1
17	32°44′22"N.	107°15′22"W.	<1	2	<1	2	7	<1	<1	7	1	<1
18	32°40′41"N.	107°10′00"W.	<1	4	<1	6	140	<1	920	17	3	<1
19	32°40′21"N.	107°11′43"W.	<1	6	<1	4	<3	<1	17	10	2	1
20	32°39′59"N.	107°07′54"W.	<1	3	<1	1	<3	<1	<1	5	1	<1
21	32°39′26"N.	107°07′51"W.	<1	5	<1	6	1,900	<1	2,130	12	1	<1
22	32°39′20"N.	107°06′46"W.	<1	<1	<1	2	<3	<1	210	16	2	<1
23	32°35′27"N.	107°00′07"W.	<1	4	<1	3	980	<1	1,550	6	1	<1
24	32°36′01"N.	107°01′00"W.	<1	3	<1	4	3	<1	950	4	2	<1
25	32°37′22"N.	107°00′28"W.	<3	6	4	18	32	<3	>1,000	18	8	<1
26	32°37′33"N.	107°01′10"W.	<1	3	<1	11	19	<1	300	18	3	<1
27	32°38′02"N.	107°02′41"W.	4	10	<2	21	1,000	<2	>1,000	9	4	<1
28	32°38′52"N.	107°03′38"W.	<1	<1	<1	4	<3	<1	220	7	2	<1
29	32°39′17"N.	107°03′16"W.	<1	5	<1	4	3	<1	440	12	3	<1
30	32°39′30"N.	107°04′14"W.	<1	4	<1	3	5	<1	740	12	2	<1

Appendix B. Shallow ground-water-quality data for selected sites in the Rincon Valley study area--Continued

Well number (fig. 8)	Latitude	Longitude	Silver, dissolved (∝g/L as Ag)	Uranium, dissolved (∝g/L as U)	Zinc, dissolved (∝g/L as Zn)	Gross alpha, dissolved (∝g/L as U)	Alpha, count, 2 sigma, dissolved (∝g/L as U)	Gross beta, dissolved (pCi/L as Sr-90/Y-90)	Beta count, 2 sigma, dissolved (pCi/L as Sr-90/Y-90)	Radon-222, total (pCi/L)	Radon-222, count, 2 sigma (pCi/L)
1	32°47′14″N.	107°18′02"W.	<1	4	2	5.0	1.7	5.7	1.5	260	25
2	32°48′55"N.	107°18′46"W.	<1	26	5	34	7.9	14	3.6	260	22
3	32°49′55"N.	107°18′09"W.	<1	10	2	13	3.7	9.3	2.4	250	19
4	32°50′02"N.	107°18′12"W.	<1	6	2	8.3	2.5	5.8	1.7	250	19
5	32°51′23"N.	107°17′57"W.	<1	16	3	20	5.2	12	3.1	440	23
6	32°51′21"N.	107°17′26"W.	<1	34	2	33	5.6	17	3.1	--	--
7	32°47′38"N.	107°16′52"W.	<1	62	2	67	10	29	5.0	290	23
8	32°46′28"N.	107°16′34"W.	<1	13	2	15	3.8	6.8	2.0	--	--
9	32°46′12"N.	107°16′38"W.	<1	<1	1	1.9	1.2	5.9	1.6	--	--
10	32°45′10"N.	107°16′26"W.	<1	8	3	11	2.9	11	2.4	--	--
11	32°44′19"N.	107°16′08"W.	<1	10	5	11	3.1	9.4	2.3	240	20
12	32°40′59"N.	107°12′23"W.	<1	17	3	21	5.7	12	3.0	280	23
13	32°41′22"N.	107°12′08"W.	<1	13	3	21	5.0	10	2.5	--	--
14	32°42′02"N.	107°14′31"W.	<1	14	3	18	4.6	14	3.2	--	--
15	32°42′36"N.	107°13′37"W.	<1	15	4	18	4.6	13	3.1	240	22
16	32°42′57"N.	107°14′26"W.	<1	7	2	8.5	2.8	9.0	2.3	--	--
17	32°44′22"N.	107°15′22"W.	<1	2	2	3.8	1.4	7.2	1.5	390	24
18	32°40′41"N.	107°10′00"W.	<1	41	4	34	7.8	22	4.6	250	29
19	32°40′21"N.	107°11′43"W.	<1	14	5	14	4.5	15	3.5	260	22
20	32°39′59"N.	107°07′54"W.	<1	3	<1	3.8	1.4	6.2	1.4	310	22
21	32°39′26"N.	107°07′51"W.	<1	<1	4	0.8	1.2	7.9	2.5	--	--
22	32°39′20"N.	107°06′46"W.	<1	3	2	3.9	1.4	4.7	1.3	--	--
23	32°35′27"N.	107°00′07"W.	<1	<1	4	2.0	1.5	6.3	1.9	210	18
24	32°36′01"N.	107°01′00"W.	<1	2	4	2.2	1.3	9.0	2.2	250	18
25	32°37′22"N.	107°00′28"W.	<3	6	14	7.9	8.4	23	7.0	260	18
26	32°37′33"N.	107°01′10"W.	<1	6	6	4.8	2.5	17	3.8	--	--
27	32°38′02"N.	107°02′41"W.	<2	9	8	13	5.6	12	4.3	--	--
28	32°38′52"N.	107°03′38"W.	<1	1	2	2.0	1.1	20	3.3	--	--
29	32°39′17"N.	107°03′16"W.	<1	12	3	13	3.9	11	2.9	260	19
30	32°39′30"N.	107°04′14"W.	<1	7	3	8.6	2.6	10	2.4	240	18

Appendix B. Shallow ground-water-quality data for selected sites in the Rincon Valley study area--Continued

Well number (fig. 8)	Latitude	Longtitude	Alpha count, 2 sigma, dissolved (pCi/L as Th-230)	Gross beta, dissolved (pCi/L as Cs-137)	Beta count, 2 sigma, dissolved (pCi/L as Cs-137)	Radon-222, total (pCi/L)	Meto-lachlor, dissolved (∝g/L)	Diazinon, dissolved (∝g/L)
1	32°47′14"N.	107°18′02"W.	1.2	7.6	2.1	260	<0.002	<0.002
2	32°48′55"N.	107°18′46"W.	5.7	19	4.7	260	<0.002	<0.002
3	32°49′55"N.	107°18′09"W.	2.6	13	3.2	250	<0.002	<0.002
4	32°50′02"N.	107°18′12′"W.	1.8	7.6	2.3	250	0.26	<0.002
5	32°51′23"N.	107°17′57"W.	3.8	16	4.2	440	<0.002	<0.002
6	32°51′21"N.	107°17′26"W.	4.0	22	4.1	--	<0.002	<0.002
7	32°47′38"N.	107°16′52"W.	7.6	39	6.7	290	<0.002	<0.002
8	32°46′28"N.	107°16′34"W.	2.7	9.1	2.7	--	<0.002	<0.002
9	32°46′12′"N.	107°16′38"W.	0.73	8.0	2.2	--	<0.002	<0.002
10	32°45′10"N.	107°16′26"W.	2.0	14	3.1	--	E0.005	<0.002
11	32°44′19"N.	107°16′08"W.	2.1	13	3.0	240	<0.002	<0.002
12	32°40′59"N.	107°12′23"W.	4.0	16	4.0	280	<0.002	<0.002
13	32°41′22"N.	107°12′08"W.	3.4	14	3.3	--	<0.002	<0.002
14	32°42′02"N.	107°14′31"W.	3.2	19	4.2	--	0.010	<0.002
15	32°42′36"N.	107°13′37"W.	3.2	17	4.2	240	0.13	<0.002
16	32°42′57"N.	107°14′26"W.	1.9	12	3.1	--	<0.002	<0.002
17	32°44′22"N.	107°15′22"W.	0.95	9.5	2.0	390	<0.002	<0.002
18	32°40′41"N.	107°10′00"W.	5.6	29	6.1	250	0.018	<0.002
19	32°40′21"N.	107°11′43"W.	3.2	19	4.6	260	0.38	<0.002
20	32°39′59"N.	107°07′54"W.	0.96	8.3	1.9	310	<0.002	<0.002
21	32°39′26"N.	107°07′51"W.	0.86	11	3.4	--	<0.002	<0.002
22	32°39′20"N.	107°06′46"W.	0.92	6.3	1.8	--	5.4	<0.002
23	32°35′27"N.	107°00′07"W.	1.0	8.4	2.6	210	<0.002	<0.002
24	32°36′01"N.	107°01′00"W.	0.91	12	2.9	250	<0.002	<0.002
25	32°37′22"N.	107°00′28"W.	5.9	30	9.2	260	<0.002	<0.002
26	32°37′33"N.	107°01′10"W.	1.7	23	5.1	--	<0.002	<0.002
27	32°38′02"N.	107°02′41"W.	4.0	16	5.7	--	<0.002	<0.002
28	32°38′52"N.	107°03′38"W.	0.79	27	4.3	--	E0.005	0.077
29	32°39′17"N.	107°03′16"W.	2.8	14	3.8	260	<0.002	<0.002
30	32°39′30"N.	107°04′14"W.	1.8	13	3.1	240	E0.005	<0.002

Appendix B. Shallow ground-water-quality data for selected sites in the Rincon Valley study area--Concluded

Well number (fig. 8)	Latitude	Longitude	Naprop-amide, dissolved (∝g/L)	p,p′-DDE, dissolved (∝g/L)	Prometon, dissolved (∝g/L)	Methyl-chloride, total (∝g/L)	Xylene water unfltrd rec (∝g/L)	Group A pesticide surrogates			Group B pesticide surrogate
								Diazinon (percent recovery)	HCH alpha (percent recovery)	Terbuth-ylazine, (percent recovery)	BDMC (percent recovery)
1	32°47′14"N.	107°18′02"W.	<0.01	<0.006	<0.018	<0.2	<0.20	89	93	114	--
2	32°48′55"N.	107°18′46"W.	<0.01	<0.006	<0.018	<0.2	<0.20	91	70	100	110
3	32°49′55"N.	107°18′09"W.	<0.01	<0.006	<0.018	<0.2	<0.20	101	89	109	24
4	32°50′02"N.	107°18′12"W.	<0.01	<0.006	E0.009	<0.2	<0.20	102	90	110	6.0
5	32°51′23"N.	107°17′57"W.	<0.01	<0.006	<0.018	0.3	<0.20	83	84	76	32
6	32°51′21"N.	107°17′26"W.	<0.01	<0.006	<0.018	0.5	<0.20	84	88	94	28
7	32°47′38"N.	107°16′52"W.	<0.01	<0.006	<0.018	<0.2	<0.20	90	68	93	100
8	32°46′28"N.	107°16′34"W.	<0.01	<0.006	<0.018	<0.2	<0.20	86	80	100	80
9	32°46′12"N.	107°16′38"W.	<0.01	<0.006	<0.018	--	--	95	83	105	--
10	32°45′10"N.	107°16′26"W.	0.014	<0.006	<0.018	<0.2	<0.20	90	82	102	70
11	32°44′19"N.	107°16′08"W.	<0.01	<0.006	<0.018	<0.2	<0.20	88	80	99	68
12	32°40′59"N.	107°12′23"W.	<0.01	<0.006	<0.018	--	--	90	87	89	8.0
13	32°41′22"N.	107°12′08"W.	<0.01	<0.006	<0.018	--	--	91	89	89	56
14	32°42′02"N.	107°14′31"W.	<0.01	<0.006	<0.018	--	--	92	87	91	32
15	32°42′36"N.	107°13′37"W.	<0.01	<0.006	<0.018	0.2	<0.20	92	79	90	26
16	32°42′57"N.	107°14′26″W.	<0.01	<0.006	<0.018	<0.2	2.8	91	78	104	62
17	32°44′22"N.	107°15′22"W.	<0.01	<0.006	E0.005	0.2	<0.20	87	76	89	26
18	32°40′41"N.	107°10′00"W.	<0.01	<0.006	<0.018	--	--	92	89	108	16
19	32°40′21"N.	107°11′43"W.	<0.01	<0.006	<0.018	<0.2	<0.20	90	79	89	8.0
20	32°39′59"N.	107°07′54"W.	<0.01	<0.006	<0.018	<0.2	<0.20	100	90	109	12
21	32°39′26"N.	107°07′51"W.	<0.01	<0.006	<0.018	0.4	0.70	90	89	87	56
22	32°39′20"N.	107°06′46"W.	<0.01	<0.006	E0.012	--	--	90	88	90	50
23	32°35′27"N.	107°00′07"W.	<0.01	<0.006	<0.018	--	--	84	71	89	34
24	32°36′01"N.	107°01′00"W.	<0.01	<0.006	<0.018	0.3	<0.20	100	83	96	12
25	32°37′22"N.	107°00′28"W.	<0.01	<0.006	0.32	0.4	--	96	76	98	26
26	32°37′33"N.	107°01′10"W.	<0.01	<0.006	<0.018	--	0.30	90	91	95	46
27	32°38′02"N.	107°02′41"W.	<0.01	<0.006	<0.018	--	<0.20	79	84	81	48
28	32°38′52"N.	107°03′38"W.	<0.01	<0.006	E0.010	--	--	90	84	99	44
29	32°39′17"N.	107°03′16"W.	<0.01	E0.002	<0.018	--	--	87	84	87	28
30	32°39′30"N.	107°04′14"W.	<0.01	<0.006	<0.018	0.3	<0.20	87	80	85	34

Appendix C. Concentrations of pesticides and pesticide metabolites detected in bed-material samples from selected sites in the Rincon Valley study area

[∝g/kg, micrograms per kilogram]

Site name	Date	DDT (∝g/kg)	DDD (∝g/kg)	p,p'-DDE (∝g/kg)
Rincon Drain at Rio Grande, near Rincon	01-03-95	0.4	1.4	44.0
Hatch Drain at Rio Grande, near Hatch	01-04-95	0.3	0.6	4.8
Garfield Drain at Road 390 near Salem	01-05-95	0.5	0.2	1.5