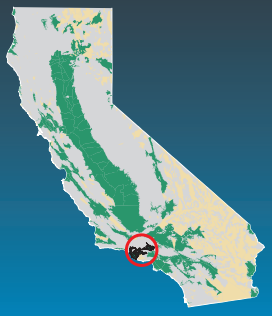
U.S. Geological Survey and the California State Water Resources Control Board

Groundwater Quality in the Santa Clara River Valley, California

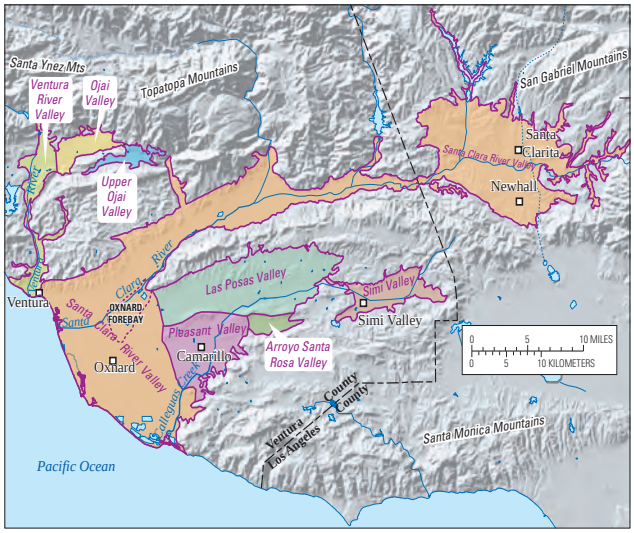


Groundwater provides more than 40 percent of California's drinking water. To protect this vital resource, the State of California has created the Groundwater Ambient Monitoring and Assessment (GAMA) Program. The Priority Basin Project of the GAMA Program provides a comprehensive assessment of the State's groundwater quality and increases public access to groundwater-quality information. The Santa Clara River Valley is one of the study units being evaluated.

The Santa Clara River Valley Study Unit

The Santa Clara River Valley (SCRV) study unit is located in Los Angeles and Ventura Counties, California, and is bounded by the Santa Monica, San Gabriel, Topatopa, and Santa Ynez Mountains, and the Pacific Ocean. The 460-square-mile study unit includes eight groundwater basins: Ojai Valley, Upper Ojai Valley, Ventura River Valley, Santa Clara River Valley, Pleasant Valley, Arroyo Santa Rosa Valley, Las Posas Valley, and Simi Valley (California Department of Water Resources, 2003; Montrella and Belitz, 2009). The SCRV study unit has hot, dry summers and cool, moist winters. Average annual rainfall ranges from 12 to 28 inches. The study unit is drained by the Ventura and Santa Clara Rivers, and Calleguas Creek.

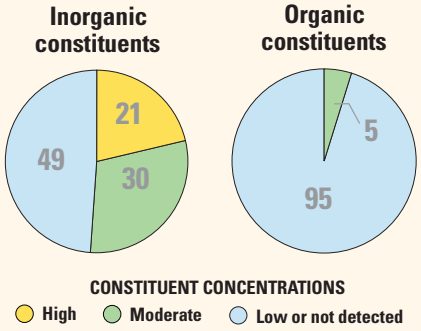
The primary aquifer system in the Ventura River Valley, Ojai Valley, Upper Ojai Valley, and Simi Valley basins is largely unconfined alluvium. The primary aquifer system in the remaining groundwater basins mainly consists of unconfined sands and gravels in the upper portion and partially confined marine and nonmarine deposits in the lower portion. The primary aquifer system in the SCRV study unit is defined as those parts of the aquifers corresponding to the perforated intervals of wells listed in the California Department of Public Health (CDPH) database. Public-supply wells typically are completed in the primary aquifer system to depths of 200 to 1,100 feet below land surface (bls). The wells contain solid casing reaching from the land surface to a depth of about 60–700 feet, and are perforated below the solid casing to allow water into the well. Water quality in the primary aquifer system may differ from the water in the shallower and deeper parts of the aquifer.



Land use in the study unit is approximately 40 percent (%) natural (primarily shrubs, grassland, and wetlands), 37% agricultural, and 23% urban. The primary crops are citrus, avocados, alfalfa, pasture, strawberries, and dry beans. The largest urban areas in the study unit are the cities of Ventura, Oxnard, Camarillo, Simi Valley, Newhall, and Santa Clarita.

Currently, groundwater pumping for agricultural use accounts for the greatest amount of discharge from the aquifer system in the SCRV study unit, followed by municipal use. Recharge to the groundwater system is through stream-channel infiltration from the three main river systems and by direct infiltration of precipitation and irrigation. Recharge facilities in the Oxnard forebay play an important role in recharging the local aquifer systems.

Overview of Water Quality



Values are a percentage of the area of the primary aquifer system with concentrations in the three specified categories.

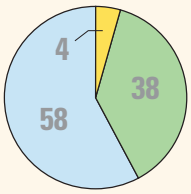
GAMA's Priority Basin Project evaluates the quality of untreated groundwater; however, for context, benchmarks established for drinking-water quality are used for comparison. Benchmarks and definitions of *high*, *moderate*, and *low* concentrations are discussed in the inset box on page 3.

Many inorganic constituents are naturally present in groundwater. The concentrations of inorganic constituents can be affected by natural processes, as well as by human activities. In the SCRV study unit, one or more inorganic constituents were present at high concentrations in about 21% of the primary aquifers, and at moderate concentrations in about 30%.

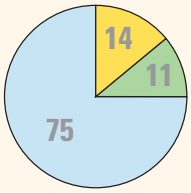
Organic constituents are present in products used in the home, business, industry, and agriculture. In the SCRV study unit, organic constituents can enter the environment through normal usage, spills, or improper disposal. Organic constituents were not present at high concentrations in the primary aquifer system, but one or more organic constituents were present at moderate concentrations in about 5% of the primary aquifer system.

RESULTS: Groundwater Quality in the Santa Clara River Valley Study Unit

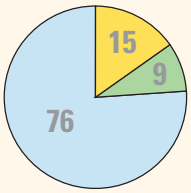
INORGANIC CONSTITUENTS



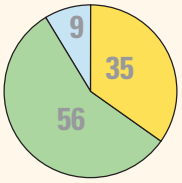
Trace and minor elements



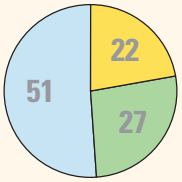
Radioactive constituents



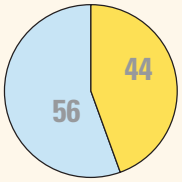
Nutrients



Total dissolved solids

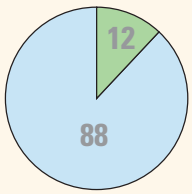


Sulfate



Iron or manganese

SPECIAL INTEREST CONSTITUENTS



Perchlorate

Inorganic Constituents with Human-Health Benchmarks

Trace and minor elements are naturally present in the minerals in rocks and soils, and in the water that comes into contact with those materials. In the SCRV study unit, one or more trace elements were present at high concentrations in about 4% of the primary aquifer system. Arsenic, boron, and vanadium were the trace elements that occurred at high concentrations in 2, 3, and 3% of the primary aquifer system, respectively.

Radioactivity is the release of energy or energetic particles during structural changes in the nucleus of an atom. Most of the radioactivity in groundwater comes from decay of naturally occurring isotopes of uranium and thorium present in minerals in the aquifer sediments. In the SCRV study unit, radioactive constituents were present at high concentrations in 14% of the primary aquifer system, and 11% at moderate concentrations.

Nutrients, such as nitrate, are naturally present at low concentrations in groundwater. High and moderate concentrations generally occur as a result of human activities such as the application of fertilizer for agriculture. Livestock, when in concentrated numbers, and septic systems also can affect nitrate concentrations in groundwater. In the SCRV study unit, nitrate was present at high and moderate concentrations in 15% and 9%, respectively, of the primary aquifer system.

Inorganic Constituents with Non-Health Benchmarks

(Not included in overview of water-quality charts shown on the front page)

Some constituents affect the aesthetic properties of water, such as taste, color, and odor, or may create nuisance problems, such as scaling and staining.

Total dissolved solids (TDS, an indicator of salinity) and sulfate are naturally occurring constituents. The State of California has a recommended and an upper limit for both TDS and sulfate in drinking water. In the SCRV study unit, TDS and sulfate were present at high concentrations (greater than the upper limit) in 35 and 22% of the primary aquifer system, respectively. Moderate concentrations (between the recommended and upper limit) for TDS and sulfate were 56 and 27%, respectively.

Iron and manganese are naturally occurring elements, and either or both were present at high concentrations in about 44% of the primary aquifer system. Iron and (or) manganese were not present at moderate concentrations but were present at low cencentrations or not detected in 56% of the primary aquifer system.

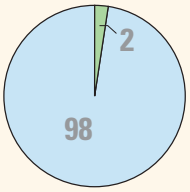
Perchlorate

(Not included in overview of water-quality charts shown on the front page)

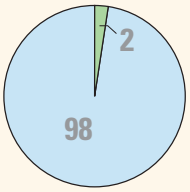
Perchlorate, an inorganic constituent, is of special interest in California because this constituent has recently been found in groundwater and is considered to have the potential to affect drinking-water supplies. Its presence in groundwater has been regulated by the California Department of Public Health since 2007. Perchlorate is an ingredient in rocket fuel, fireworks, safety flares, and other products, may be present in some fertilizers, and also occurs naturally at low concentrations in groundwater. In the SCRV study unit, perchlorate was present at moderate concentrations in 12% of the primary aquifer system and was low or not detected in 88% of the primary aquifer system.

RESULTS: Groundwater Quality in the Santa Clara River Valley Study Unit

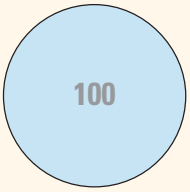
ORGANIC CONSTITUENTS



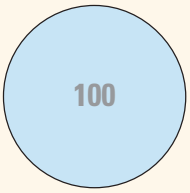
Solvents



Trihalomethanes



Other volatile organic compounds



Herbicides and insecticides (including fumigants)

Organic Constituents

The Priority Basin Project uses laboratory methods that can detect low concentrations of volatile organic compounds (VOCs) and pesticides far below human-health benchmarks. VOCs and pesticides detected at these very low concentrations can be used to trace the pathway of water from the land surface into the aquifer system.

Volatile Organic Compounds with Human-Health Benchmarks

VOCs are present in many household, commercial, industrial, and agricultural products, and are characterized by their tendency to volatilize into the air.

Solvents are used for a number of purposes, including manufacturing and cleaning. In the SCRV study unit, solvents were not present at high concentrations but were present at moderate concentrations in about 2% of the primary aquifer system. Solvents were present at low concentrations or not detected in about 98% of the primary aquifer system.

Trihalomethanes may form during municipal disinfection of water supplies, and may enter groundwater by infiltration of landscape irrigation water. Trihalomethanes were not detected at high concentrations in the primary aquifer system, but were present at moderate concentrations in 2% of the primary aquifer system. The trihalomethane, chloroform, was detected at low concentrations in 17% of the primary aquifer system.

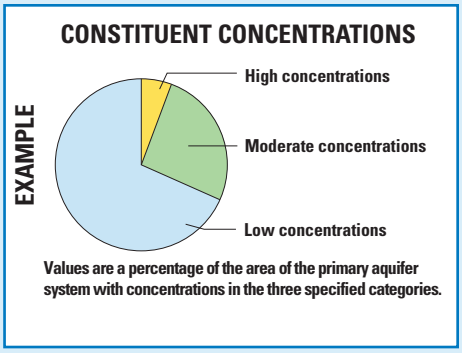
Other VOCs include organic synthesis reagents and gasoline additives. Other VOCs were not detected at high or moderate concentrations in the primary aquifer system.

Pesticides with Human-Health Benchmarks

Pesticides (herbicides, insecticides, and fumigants) are applied to crops, gardens, lawns, around buildings, and along roads to help control weeds, insects, fungi, and other pests. In the SCRV study unit, herbicides and insecticides (including fumigants) were not detected at high or moderate concentrations in the primary aquifer system. The pesticides atrazine and simazine were detected at low concentrations in 17 and 26% of the primary aquifer system, respectively.

BENCHMARKS FOR EVALUATING GROUNDWATER QUALITY

GAMA's Priority Basin Project uses benchmarks established for drinking water to provide context for evaluating the quality of untreated groundwater. After withdrawal, groundwater may be disinfected, filtered, mixed, and exposed to the atmosphere before being delivered to consumers. Federal and California regulatory benchmarks for protecting human health (Maximum Contaminant Level, MCL) are used for this evaluation when available. Otherwise, nonregulatory benchmarks for protecting aesthetic properties (Secondary Maximum Contaminant Level, SMCL), such as taste and odor, and nonregulatory benchmarks for protecting human health (Notification Level, NL, and Lifetime Health Advisory, HAL) are used.

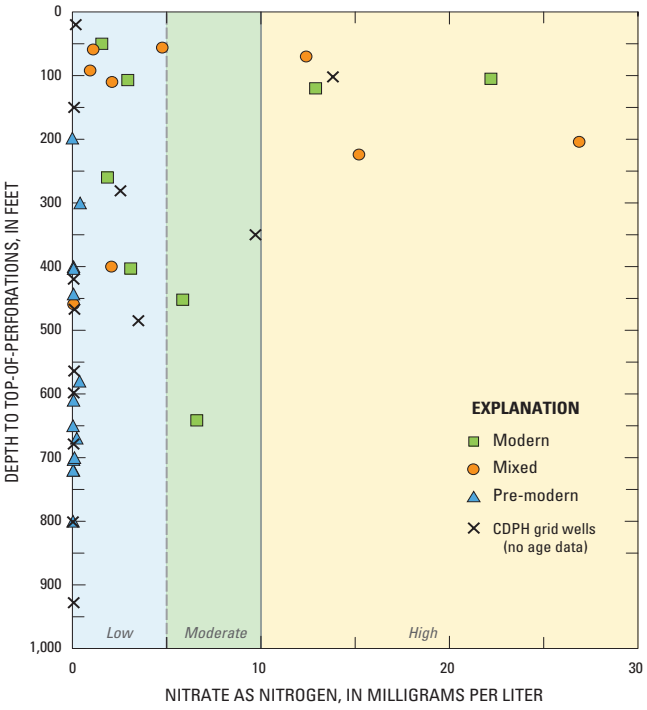


High, moderate, and low concentrations are defined relative to benchmarks

Concentrations are considered *high* if they are greater than a benchmark. For inorganic constituents, concentrations are *moderate* if they are greater than one-half of a benchmark. For organic and special-interest constituents, concentrations are *moderate* if they are greater than one-tenth of a benchmark; this lower threshold was used because organic constituents generally are less prevalent and have smaller concentrations relative to benchmarks than inorganic constituents. *Low* concentrations include non-detections and values less than moderate concentrations. Methods for evaluating water quality are discussed by Burton and others (2011).

Factors That Affect Groundwater Quality

In the SCRV study unit, nitrate is the constituent with a human-health benchmark that was most frequently present at high concentrations. High concentrations of nitrate were detected in about 15% of the primary aquifer system. Nitrate concentrations in groundwater can be affected by both natural and human factors. Certain bacteria and algae naturally convert nitrogen from the atmosphere to nitrate, which is an important nutrient for plants. Anthropogenic sources of nitrate include its application as a fertilizer for agriculture and landscape maintenance, livestock, and septic systems (Hem, 1985). The human-health regulatory benchmark for nitrate (as nitrogen) is 10 milligrams per liter.



In the SCRV study unit, nitrate was present at high concentrations only in the upper part of the primary aquifer system. Water from wells with high concentrations of nitrate occurred in the upper 300 feet. At depths below 300 feet, nitrate is detected only at moderate or low concentrations. Nitrate also was associated with young groundwater. High and moderate nitrate concentrations were found only in modern (entered the aquifer since about 1953) or mixed-age groundwater. In pre-modern-age groundwater (entered the aquifer before 1953), nitrate is only detected at low concentrations. Nitrate concentrations generally were low in groundwater that has low dissolved oxygen (Burton and others, 2011). Previous groundwater studies within the SCRV study unit have confirmed that degradation of nitrate occurs in some parts of the aquifer that have low dissolved oxygen (Izbicki and others, 2005).

By Carmen A. Burton, Matthew K. Landon, and Kenneth Belitz

Priority Basin Assessments

GAMA's Priority Basin Project (PBP) assesses water quality in that part of the aquifer system used for drinking water, primarily public supply. Water quality in shallower and deeper parts may differ from water quality in these primary aquifers. GAMA's Domestic Well Project assesses water quality in the shallower parts of the aquifer system. Ongoing assessments are being conducted in more than 120 basins throughout California.

The PBP assessments are based on a comparison of constituent concentrations in untreated groundwater to benchmarks established for the protection of human health and for aesthetic concerns. The PBP does not evaluate the quality of drinking water delivered to consumers.

The PBP uses two scientific approaches for assessing groundwater quality. The first approach uses a network of wells to statistically assess the status of groundwater quality. The second approach uses additional wells to help assess the factors that affect water quality. Both approaches use data routinely collected for regulatory compliance, as well as data collected by the PBP. Data were collected by the PBP in 2007, and were compiled from the CDPH database for 2003–2006. The PBP includes chemical analyses generally not available as part of regulatory compliance monitoring, including measurements at concentrations much lower than human-health benchmarks, and measurement of constituents that can be used to trace the sources and movement of groundwater.

For more information

Technical reports and hydrologic data collected for the GAMA Program may be obtained from

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U.S. Geological Survey
California Water Science Center
4165 Spruance Road, Suite 200
San Diego, CA 92101
Telephone number: (619) 225-6100
WEB: http://ca.water.usgs.gov/gama

GAMA Program Unit
State Water Resources Control Board
Division of Water Quality
PO Box 2231, Sacramento, CA 95812
Telephone number: (916) 341-5779
WEB: http://www.waterboards.ca.gov/gama

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Burton, C.A., Montrella, Joseph, Landon, M.K., and Belitz, Kenneth, 2011, Status and understanding of groundwater quality in the Santa Clara River Valley, 2007—California GAMA Priority Basin Project: U.S. Geological Survey Scientific Investigations Report 2011-5052, 86 p. Available at *http://pubs.usgs.gov/sir/2011/5052/*

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Hem, J.D., 1985, Study and interpretation of the chemical characteristics of natural water (3d ed.): U.S. Geological Survey Water-Supply Paper 2254, 263 p.

Izbicki, J.A., Christensen, A.H., Newhouse, M.N., and Aiken, G.R., 2005, Inorganic, isotopic, and organic composition of high-chloride water from wells in a coastal southern California aquifer: Applied Geochemistry, v. 20, p. 1496–1517.

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