

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

Groundwater Quality in the South Coast Interior Basins, California

Groundwater provides more than 40 percent of California's drinking water. To protect this vital resource, the State of California 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 untreated groundwater quality and increases public access to groundwater-quality information. The South Coast Interior Basins constitute one of the study units being evaluated.



The South Coast Interior Basins Study Unit

The South Coast Interior Basins (SCI) study unit covers approximately 653 square miles and consists of the Livermore, Gilroy-Hollister, Cuyama Valley, Castac Lake Valley, Cuddy Canyon Valley, Cuddy Ranch Area, Cuddy Valley, and Mil Potero groundwater basins (California Department of Water Resources, 2003). These basins were grouped into three study areas based on geography: Livermore (LIV), Gilroy (GIL), and Cuyama (CUY) (Mathany and others, 2009).



Average annual precipitation across the study unit varies among the three study areas—from more than 20 inches (in.) along the northwest margin of the LIV study area to less than 8 in. in the northern parts of the CUY study area. The study areas are drained by the Arroyo de la Laguna canal in LIV, the Pájaro River and the San Benito River in GIL, and the Cuyama River in CUY. The primary aquifer system consists of Plio-Pleistocene sedimentary formations, Tertiary to Holocene-age alluvial sedimentary sequences, and unconfined Holocene-age and Pleistocene-age alluvium. The primary aquifer system is defined as those parts

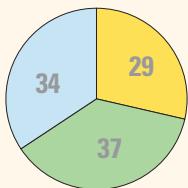
of the aquifers corresponding to the perforated intervals of the public-supply wells listed in the California Department of Public Health (CDPH) database. Public-supply wells in the study unit are typically drilled to depths between 200 and 600 feet, consist of solid casing from the land surface to a depth of about 50 to 350 feet, and are perforated below the solid casing. Water quality in the primary aquifer system may differ from that in the shallower and deeper parts of the aquifer system.

Land use within 500-meter buffer areas around the wells in the study unit is approximately 44 percent (%) agricultural, 29% urban, and 27% natural. Agricultural lands are mostly orchards, row crops, vineyards, or pastures. The largest urban areas are the cities of Livermore and Gilroy.

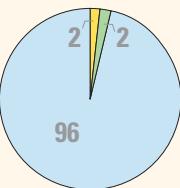
Recharge to groundwater basins occurs as infiltration of spring and streamflow, direct infiltration of precipitation and irrigation, subsurface inflow, and engineered recharge (percolation ponds and river regulation). The primary sources of groundwater discharge are water pumped for irrigation and municipal supply, discharge to rivers and streams, and evaporation.

Overview of Water Quality

Inorganic constituents



Organic constituents



CONSTITUENT CONCENTRATIONS

Values are a percentage of the area of the primary aquifer system with concentrations in the three specified categories. Values on piechart may not equal 100 due to rounding of percentages.

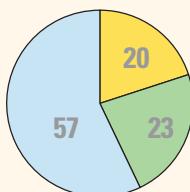
GAMA's Priority Basin Project evaluates the quality of untreated groundwater. However, for context, benchmarks established for drinking-water quality are used for comparison. Benchmarks and definitions of *high*, *moderate*, and *low* concentrations are discussed in the inset box on page 3.

Many inorganic constituents occur naturally in groundwater. The concentrations of the inorganic constituents in groundwater can be affected by natural processes as well as by human activities. In the SCI study unit, one or more inorganic constituents with human-health benchmarks were present at high concentrations in about 29% of the primary aquifer system and at moderate concentrations in about 37%.

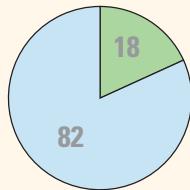
Human-made organic constituents can be found in products used in the home, business, industry, and agriculture, and can enter the environment through normal usage, spills, or improper disposal. In the SCI study unit, one or more organic constituents were present at high concentrations in about 2% of the primary aquifer system and at moderate concentrations in about 2%.

RESULTS: Groundwater Quality in the South Coast Interior Basins Study Unit

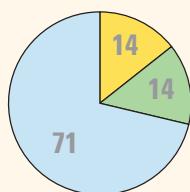
INORGANIC CONSTITUENTS



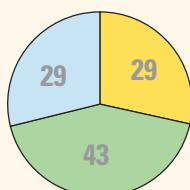
Trace and minor elements



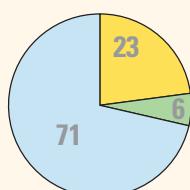
Uranium and radioactive constituents



Nutrients

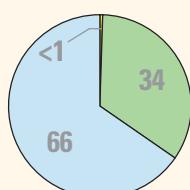


Total dissolved solids



Iron or manganese

SPECIAL-INTEREST CONSTITUENT



Perchlorate

Inorganic Constituents with Health-Based 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 SCI study unit, trace and minor elements were detected at high concentrations in about 20% of the primary aquifer system and at moderate concentrations in about 23%. Arsenic, boron, and molybdenum were the trace elements that were most frequently detected at high concentrations.

Radioactivity is the release of energy or energetic particles during spontaneous decay of unstable atoms. Most of the radioactivity in groundwater comes from the decay of naturally occurring isotopes of uranium and thorium in minerals in the sediments of the aquifer. Radioactive constituents were not present at high concentrations in the primary aquifer system and were present at moderate concentrations in about 18%.

Nutrients, such as nitrate and nitrite, can be naturally present at low concentrations in groundwater. High and moderate concentrations generally occur as a result of human activities, such as applying fertilizer to crops. Livestock, when in concentrated numbers, and septic systems also produce nitrogenous waste that can leach into groundwater. Nitrate was present at high concentrations in about 14% of the primary aquifer system and at moderate concentrations in about 14%.

Inorganic Constituents with Non-Health Benchmarks

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

Some constituents, such as total dissolved solids (TDS), can affect the aesthetic properties of water, such as taste, color, and odor, or may create nuisance problems, such as staining and scaling. All water naturally contains TDS as a result of the weathering and dissolution of minerals in soils. The State of California has a recommended and an upper limit for TDS in drinking water. In the SCI study unit, TDS was present at high concentrations (greater than the upper limit) in 29% of the primary aquifer system and at moderate concentrations (between the upper and recommended limits) in 43%. Most of the sites with high concentrations of TDS also had high concentrations of sulfate.

Anoxic conditions (low amounts of dissolved oxygen) in groundwater may result in release of naturally occurring elements such as iron and manganese from minerals into groundwater. Iron, or manganese, or both were present at high concentrations in 23% of the primary aquifer system.

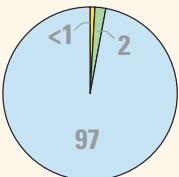
Constituent of Special Interest: Perchlorate

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

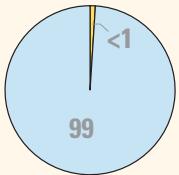
Perchlorate is an inorganic constituent that has been regulated in California drinking water since 2007. It is an ingredient in rocket fuel, fireworks, safety flares and other products, may be present in some fertilizers, and also occurs at low concentrations under natural conditions in groundwater. Perchlorate was detected at high concentrations in <1% of the primary aquifer system and at moderate concentrations in about 34%.

RESULTS: Groundwater Quality in the South Coast Interior Basins Study Unit

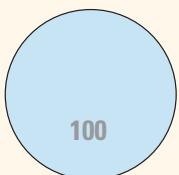
ORGANIC CONSTITUENTS



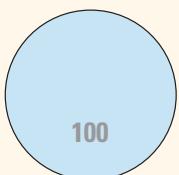
Solvents



Trihalomethanes



Other VOCs



Herbicides and insecticides (including fumigants)

Organic Constituents

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

Volatile Organic Compounds with Human-Health Benchmarks

VOCs, which include solvents and trihalomethanes, are in many household, commercial, industrial, and agricultural products and are characterized by their tendency to volatilize (evaporate) into the air.

Solvents are used for a number of purposes, including manufacturing and cleaning. In the SCI study unit, solvents were present at high concentrations in <1% of the primary aquifer system. The solvent detected at high concentrations was tetrachloroethene (PCE). Solvents were present at moderate concentrations in about 2% of the primary aquifer system and were low or not detected in about 97%.

Trihalomethanes may form during municipal water purification and can enter groundwater by the infiltration of landscape irrigation water. One trihalomethane, bromoform, was detected at high concentrations in <1% of the primary aquifer system. Trihalomethanes were present at low concentrations, or were not detected, in about 99% of the primary aquifer system.

Other volatile organic compounds, including organic synthesis reagents, refrigerants, and gasoline additives, were not detected at either high or moderate concentrations.

Pesticides with Human-Health Benchmarks

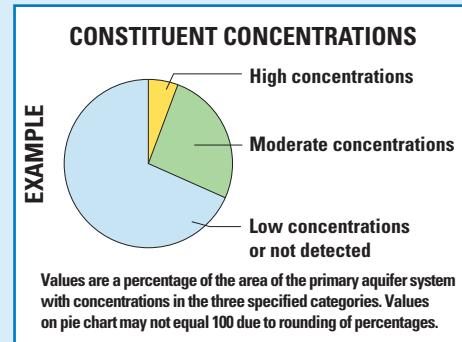
Pesticides, which include herbicides, insecticides, and fumigants, are applied to crops, gardens, lawns, around buildings, and along roads to help control unwanted vegetation (weeds), insects, fungi, and other pests. In the SCI study unit, herbicides and insecticides (including fumigants) were not detected at either high or moderate concentrations in the primary aquifer system.

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) were used for the evaluation when available. Otherwise, non-regulatory benchmarks for protecting aesthetic properties, such as taste and odor (Secondary Maximum Contaminant Level, SMCL), and non-regulatory benchmarks for protecting human health (Notification Level, NL, and lifetime Health Advisory Level, HAL) were used when Federal and California regulatory benchmarks were not available.

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

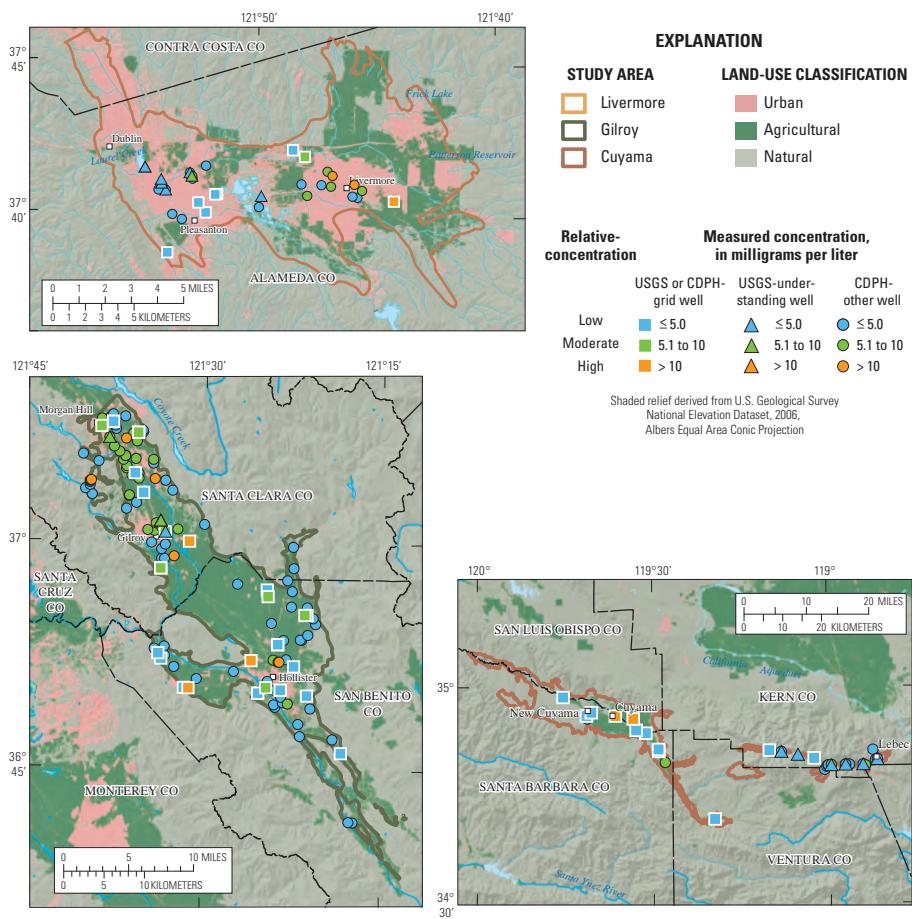
Concentrations are considered *high* if they are greater than a benchmark. For inorganic constituents (except perchlorate), concentrations are *moderate* if they are greater than one-half of a benchmark. For organic and special-interest constituents (including perchlorate), concentrations are *moderate* 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* includes nondetections and values less than moderate concentrations. Methods for evaluating water quality are discussed in Parsons and others (2014).



Nitrate in the South Coast Interior Basins Study Unit

In the SCI study unit, nitrate was the constituent with a health-based benchmark that was most commonly present at high concentrations. About 14% of the primary aquifer system had nitrate concentrations greater than the Federal MCL of 10 milligrams per liter as nitrogen. High and moderate concentrations of nitrate in groundwater generally indicate that anthropogenic sources of nitrate are present. Potential anthropogenic sources include fertilizer applied to crops and landscaping, animal waste, seepage from septic systems, and wastewater discharge.

High and moderate concentrations of nitrate were detected in all three study areas of the SCI study unit. Groundwater with high and moderate concentrations of nitrate was predominantly classified as oxic and as modern age (Parsons and others, 2013), which indicates the groundwater was recharged since 1952. Nitrate concentrations were greater in areas with agricultural or urban land use than in areas with natural land use. Elevated nitrate concentrations have previously been observed in the Cuyama Valley (Everett and others, 2011) and were attributed to irrigation return flows.



By Mary C. Parsons and Kenneth Belitz

SELECTED REFERENCES

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- Everett, R.R., Hanson, R.T., and Sweetkind, D.S., 2011, Kirschenmann Road multi-well monitoring site, Cuyama Valley, Santa Barbara County, California: U.S. Geological Survey Open-File Report 2011-1292, 4 p. Available at <http://pubs.usgs.gov/of/2011/1292/>.
- Mathany, T.M., Kulongoski, J.T., Ray, M.C., and Belitz, Kenneth, 2009, Groundwater-quality data in the South Coast Interior Basins study unit, 2008—Results from the California GAMA Program: U.S. Geological Survey Data Series Report 463, 82 p. Available at <http://pubs.usgs.gov/ds/463/>.
- Parsons, M.C., Kulongoski, J.T., and Belitz, K., 2014, Status and understanding of groundwater quality in the South Coast Interior groundwater basins, 2008—California GAMA Priority Basin Project: U.S. Geological Survey Scientific Investigations Report 2014-5023, 68 p. Available at <http://dx.doi.org/10.3133/sir20145023>.

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 that in the primary aquifer system. GAMA's Domestic Well Project assesses water quality in the shallower parts of the aquifer system. Ongoing PBP 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 with benchmarks established for the protection of human health and for aesthetic concerns for drinking water. 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 combines water-quality, hydrologic, geographic, and other data to help assess the factors that affect water quality. In the South Coast Interior Basins study unit, data were collected by the PBP in 2008 and compiled from the CDPH database for 2005–2008. The PBP includes chemical analyses not generally required 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

GAMA Project Chief

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