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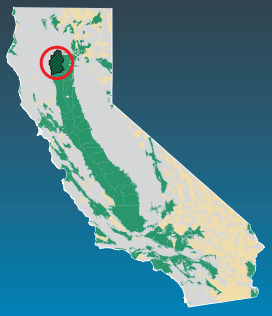
Water Boards

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

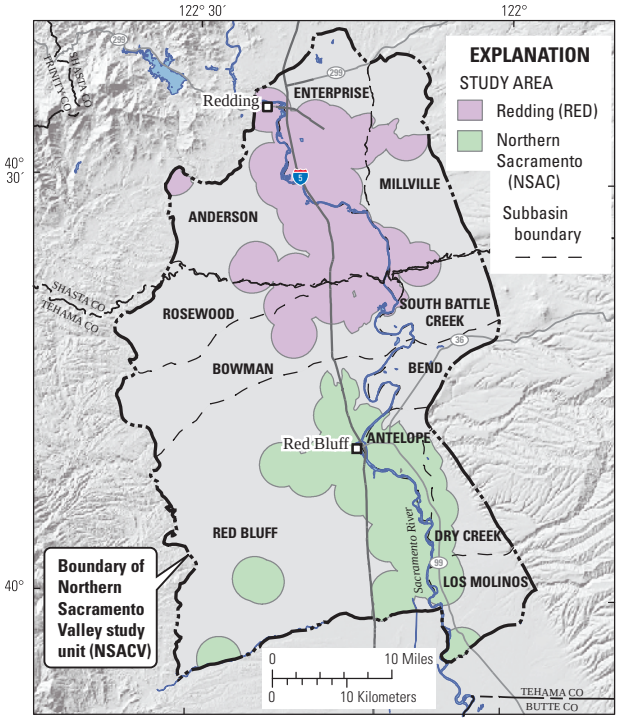
Groundwater Quality in the Northern Sacramento Valley, California



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 groundwater quality and increases public access to groundwater-quality information. The Northern Sacramento Valley is one of the study units being evaluated.

The Northern Sacramento Valley Study Unit

The Northern Sacramento Valley (NSACV) study unit is located in California's Sacramento Valley. The approximately 1,200-square-mile study unit includes 2 study areas and 11 groundwater subbasins (subbasins listed clockwise beginning in the north): Enterprise, Millville, South Battle Creek, Bend, Antelope, Dye Creek, Los Molinos, Red Bluff, Bowman, Rosewood, and Anderson (California Department of Water Resources, 2003). In the NSACV study unit, summers are hot and dry and winters are cool and moist. Average annual rainfall ranges from 21 to 33 inches. Most rivers and streams flowing across the study unit drain into the Sacramento River.

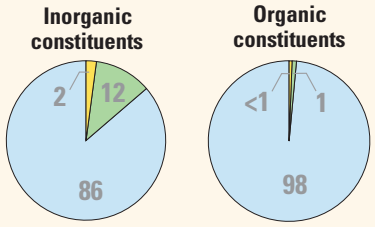


Aquifers in the NSACV study unit consist of discontinuous lenses of gravel, sand, silt, and clay, which primarily are derived from the Klamath Mountains and Cascade Range to the north and east, respectively, but also from the Coast Ranges to the west. The primary aquifers in the NSACV study unit are defined as those parts of the aquifers corresponding to the perforated intervals of wells listed in the California Department of Public Health (CDPH) database. The public-supply wells monitored by CDPH typically are completed within the primary aquifers to depths of 200–400 feet below land surface (bls). The wells are constructed with solid casing from land surface to a depth of about 100–200 feet bls, and are perforated below the solid casing to allow water into the well. Water quality in the primary aquifers may differ from water quality in the shallow or deep parts of the aquifer system.

Land use in the study unit is about 61 percent (%) natural (primarily grassland), 30% agricultural, and 9% urban. The City of Redding is the largest urban area in the study unit.

Recharge to the groundwater flow system primarily is from rivers and streams draining the Sierra Nevada and the Coast Ranges, and from infiltration of precipitation and of surface water applied for irrigation (California Department of Water Resources, 2003). The primary sources of groundwater discharge (water leaving the flow system) are from pumping for irrigation and municipal water supply, evaporation from areas with a shallow depth to water, and discharge to streams.

Overview of Water Quality



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

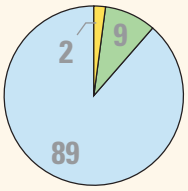
GAMA's Priority Basin Project evaluates the quality of untreated groundwater. However, for context, benchmarks established for drinking-water quality are used for comparison. Benchmarks, and definitions of *high*, *moderate*, and *low* concentrations, are discussed in the inset box, "Benchmarks for Evaluating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

Many inorganic constituents occur naturally in groundwater. The concentrations of the inorganic constituents can be affected by natural processes as well as by human activity. In the NSACV study unit, one or more inorganic constituents were detected at high concentrations in about 2% of the primary aquifers and at moderate concentrations in about 12%.

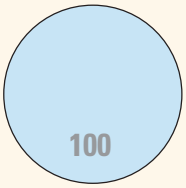
Organic constituents are present in products used in the home, business, industry, and agriculture. Organic constituents can enter the environment through normal usage, spills, or improper disposal. In the NSACV study unit, one or more organic constituents were detected at high concentrations in less than (<) 1% of the primary aquifers, and at moderate concentrations in about 1%.

RESULTS: Groundwater Quality in the Northern Sacramento Valley Study Unit

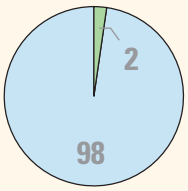
INORGANIC CONSTITUENTS



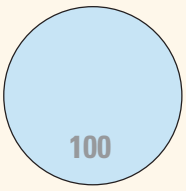
Trace and minor elements



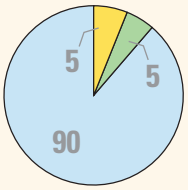
Radioactive constituents



Nutrients



Total dissolved solids



Iron or manganese

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 NSACV study unit, one or more trace elements were detected at high concentrations in about 2% of the primary aquifers and at moderate concentrations in about 9%. Arsenic was the only trace element that was detected at high concentrations in one or more wells.

Radioactivity is the release of energy or energetic particles during structural changes in the nucleus of an atom. Most radioactivity in groundwater comes from decay of naturally occurring isotopes of uranium and thorium in minerals in the sediments of the aquifer. In the NSACV study unit, radioactive constituents were not detected at high or moderate concentrations in the primary aquifers.

Nutrients, such as nitrate and nitrite, are naturally present at low concentrations in groundwater. High and moderate concentrations generally occur as a result of human activities, and can come from fertilizer applied to crops and landscaping, seepage from septic systems, and human and animal waste. In the NSACV study unit, nutrients were not detected at high concentrations in the primary aquifers, but were detected at moderate concentrations in about 2% of the primary aquifers.

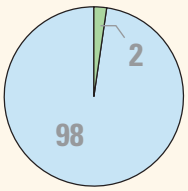
Inorganic Constituents with Non-Health Benchmarks

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

Some constituents affect the aesthetic properties of water, such as taste, color, or odor, or may create nuisance problems, such as staining and scaling. The State of California has a recommended and an upper limit for total dissolved solids (TDS) in drinking water. In the NSACV study unit, TDS concentrations were low (less than the recommended and upper limits) throughout the primary aquifers.

Iron and manganese are naturally occurring elements that often co-occur. Iron or manganese concentrations (or both) were present at high concentrations in about 5% of the primary aquifers and at moderate concentrations in about 5%.

SPECIAL-INTEREST CONSTITUENTS



Perchlorate

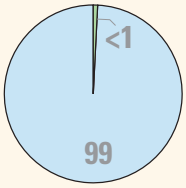
Perchlorate

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

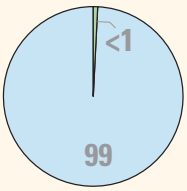
Perchlorate is an inorganic constituent that has been regulated in California drinking water since 2007. It is an ingredient in rocket fuel, fireworks, safety flares, and other products, may be present in some fertilizers, and also occurs naturally at low concentrations in groundwater. In the NSACV study unit, perchlorate was detected at moderate concentrations in about 2% of the primary aquifers.

RESULTS: Groundwater Quality in the Northern Sacramento Valley Study Unit

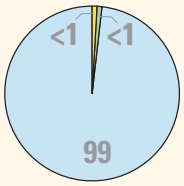
ORGANIC CONSTITUENTS



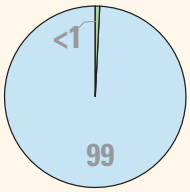
Solvents



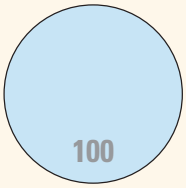
Trihalomethanes



Gasoline additives



Fumigants



Herbicides and insecticides

Organic Constituents

The Priority Basin Project uses laboratory methods that can detect the presence of volatile organic compounds (VOC) and pesticides at low concentrations, far below human-health benchmarks. VOCs and pesticides detected at these low concentrations can be used to trace the pathways of water from the landscape 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 NSACV study unit, solvents were not detected at high concentrations, and were detected at moderate concentrations in <1% of the primary aquifers, and at low concentrations (or not detected) in almost 100%.

Trihalomethanes form during disinfection of water supplies, and may enter groundwater by the infiltration of landscape irrigation water or leakage from water-distribution lines. In the NSACV study unit, trihalomethanes were not detected at high concentrations, and were detected at moderate concentrations in <1% of the primary aquifers, and at low concentrations (or not detected) in almost 100%.

Gasoline additives are added to gasoline to make it burn more efficiently. In the NSACV study unit, the gasoline additive *tert*-butyl alcohol was detected at high concentrations in <1% of the primary aquifers, at moderate concentrations in <1%, and at low concentrations (or not detected) in about 99%.

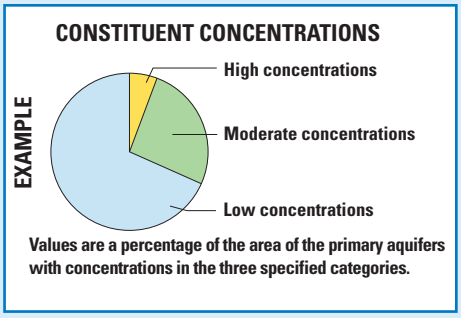
Other VOCs include organic synthesis reagents. Organic synthesis reagents are used in the manufacture of complex organic molecules. In the NSACV study unit, other VOCs were not detected at high or moderate concentrations in the primary aquifers.

Pesticides with Human-Health Benchmarks

Pesticides (fumigants, herbicides, and insecticides) are applied to crops, lawns, gardens, around buildings, and along roads to help control weeds, insects, fungi, and other pests. In the NSACV study unit, pesticides were not detected at high concentrations in the primary aquifers. One agricultural fumigant, bromomethane (methyl bromide), was detected at moderate concentrations in <1% of the primary aquifers. Herbicides and insecticides were detected at low concentrations (or not detected) in 100% of the primary aquifers.

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 the evaluation when available. Otherwise, non-regulatory benchmarks for protecting aesthetic properties (Secondary Maximum Contaminant Level, SMCL) such as taste and odor, and non-regulatory benchmarks for protecting human health (Notification Level, NL, and Lifetime Health Advisory, HAL), are used.

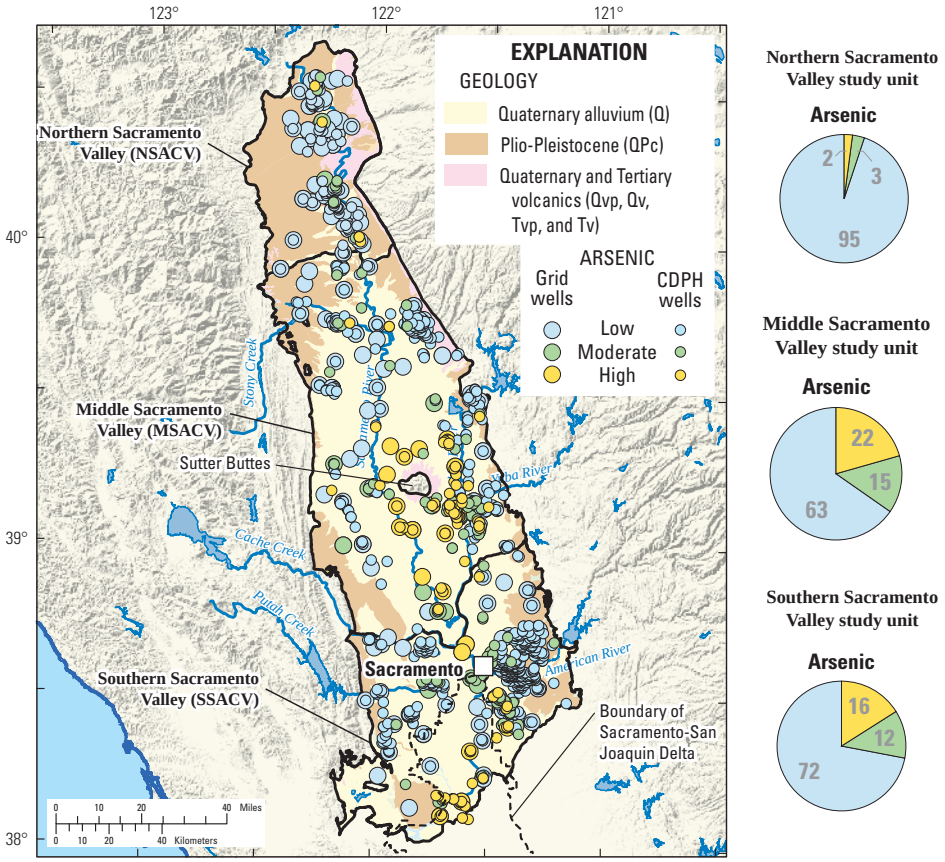


High, moderate, and low concentrations are defined relative to benchmarks

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* includes nondetections and values less than moderate concentrations. Methods for evaluating water quality are discussed in Bennett and others (2010).

Comparison of Arsenic Concentrations to Other Sacramento Valley Study Units

Arsenic was detected at concentrations greater than the regulatory MCL benchmark of 10 micrograms per liter in 2% of the primary aquifers in the NSACV study unit, a lower proportion than what was observed in the Southern of Middle Sacramento Valley study units. High concentrations of arsenic were found in wells located along the Sacramento River, likely because geochemical conditions in the sediments favor arsenic solubility. Groundwater in the Quaternary alluvium sediments along the River and in the Delta commonly has low dissolved oxygen content (reducing conditions), and reducing conditions are correlated with elevated arsenic concentrations in Sacramento Valley groundwater (Dawson, 2001). These conditions are less prevalent in NSACV because Quaternary alluvium is less abundant and is geographically limited to areas near the Sacramento River.



By George L. Bennett, V, Miranda S. Fram, and Kenneth Belitz

SELECTED REFERENCES

Bennett, G.L., V, Fram, M.S., and Belitz, Kenneth, 2011, Status of groundwater quality in the Southern, Middle, and Northern Sacramento Valley study units, 2005–08—California GAMA Program Priority Basin Project: U.S. Geological Survey Scientific Investigations Report 2011-5002, 120 p. (Also available at *http://pubs.usgs.gov/sir/2011/5002*.)

Bennett, P.A., Bennett, G.L., V, Belitz, Kenneth, 2009, Groundwater quality data for the Northern Sacramento Valley, 2007—Results from the California GAMA program: U.S. Geological Survey Data Series 452, 90 p. (Also available at *http://pubs.usgs.gov/ds/452*.)

California Department of Water Resources, 2003, California's groundwater: California Department of Water Resources Bulletin 118, 246 p., accessed October 26, 2010, at *http://www.water.ca.gov/groundwater/bulletin118/update2003.cfm*.

Dawson, B.J., 2001, Ground-water quality in the Southeastern Sacramento Valley Aquifer, California, 1996: U.S. Geological Survey Water-Resources Investigations Report 01-4125, 24 p. (Also available at *http://pubs.usgs.gov/wri/wri014125*.)

Priority Basin Assessments

GAMA's Priority Basin Project (PBP) assesses water quality areally in that part of the aquifer system used for drinking water, primarily public supply. Water quality in the primary aquifers may differ from water quality in shallower and deeper parts of the 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 between constituent concentrations in untreated groundwater and drinking-water benchmarks established for 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 combines water-quality, hydrologic, geographic, and other data to assess the factors that affect water quality. In the NSACV study unit, data were collected by the PBP in 2007–08, and from the CDPH database for 2005–08. 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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WEB: http://ca.water.usgs.gov/gama

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