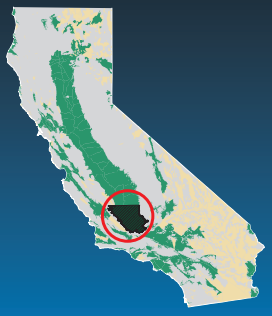
U.S. Geological Survey and the California State Water Resources Control Board

Groundwater Quality in the Kern County Subbasin, California

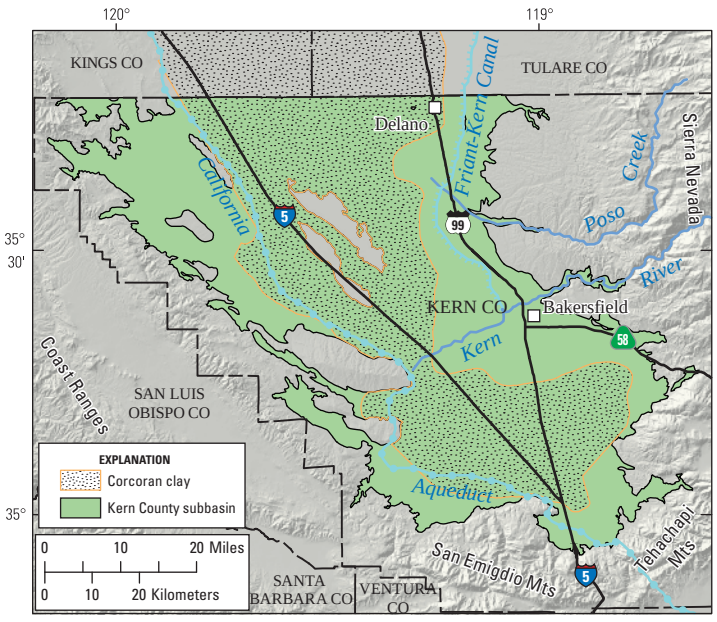


Groundwater provides more than 40 percent of California's drinking water. To protect this vital resource, the State of California created the Groundwater Ambient Monitoring and Assessment (GAMA) Program. The Priority Basin Project of the GAMA Program provides a comprehensive assessment of the State's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

The Kern County Subbasin Study Unit

The Kern County Subbasin (KERN) study unit is located at the southern end of California's San Joaquin Valley and consists of the Kern County groundwater subbasin (California Department of Water Resources, 2003; Shelton and others, 2008). The study unit covers about 3,000 square miles in Kern County. It is bounded by the Kern, Kings, and Tulare County lines to the north, the granitic bedrock of the Sierra Nevada and Tehachapi Mountains to the east and southeast, and the marine sediments of the San Emigdio Mountains and Coast Ranges to the southwest and west. The KERN study unit has long, hot summer days and cool nights, and mild, damp winters with dense fog. Average annual rainfall is about 6 inches. The Kern River, which originates in the Sierra Nevada, is the primary stream flowing through the study unit.

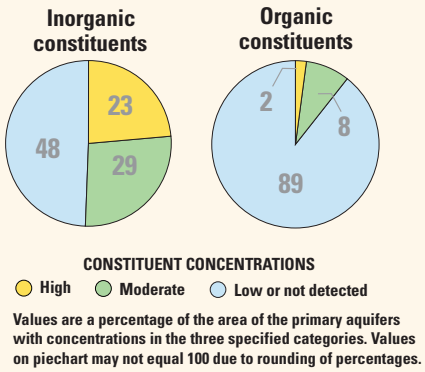
The primary aquifers consist of alluvial sediments (mixtures of sand, silt, clay, cobbles, and boulders), and marine and continental deposits in the deeper portion of the aquifers. Downward flow of groundwater is impeded by a subsurface clay layer, known as the Corcoran clay, in the central part of the KERN study unit. The primary aquifers are defined as those parts of the aquifers corresponding to the perforated intervals of wells listed in the California Department of Public Health database. Public-supply wells typically are drilled to depths between 600 and 800 feet below land surface, consist of solid casing from the land surface to a depth of about 275–450 feet, and are perforated or screened below the solid casing. Water quality in the primary aquifers may differ from that in the shallower and deeper parts of the aquifer system.



Land use in the study unit is approximately 66 percent (%) agricultural, 3% urban, and 31% natural. The primary agricultural uses are for field crops (such as vegetables and hay) and fruit and nut orchards. The largest urban area is the City of Bakersfield.

The primary sources of recharge are from the Kern River and artificial recharge at groundwater banking facilities that exist throughout most of the study unit (Tom Haslebacher, Kern County Water Agency, written commun., June 15, 2007). Secondary sources of recharge include return flows from agricultural and municipal irrigation and infiltration of flows from intermittent streams along the edge of the subbasin. The primary sources of groundwater discharge are water pumped for irrigation and municipal supply (California Department of Water Resources, 2003).

Overview of Water Quality



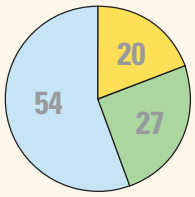
GAMA's Priority Basin Project evaluates the quality of untreated groundwater. However, for context, benchmarks established for drinking-water quality are used for comparison. Benchmarks and definitions of *high*, *moderate*, and *low* concentrations are discussed in the inset box on page 3.

Many inorganic constituents occur naturally in groundwater. The concentrations of inorganic constituents can be affected by natural processes as well as by human activities. In the KERN study unit, one or more inorganic constituents were present at high concentrations in 23% of the primary aquifers and at moderate concentrations in 29%.

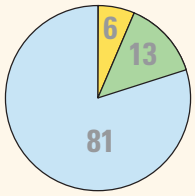
Organic constituents are in products used in the home, business, industry, and agriculture. Organic constituents can enter the environment through normal usage, spills, or improper disposal. In this study unit, one or more organic constituents were present at high concentrations in 2% of the primary aquifers and at moderate concentrations in 8%.

RESULTS: Groundwater Quality in the Kern County Subbasin Study Unit

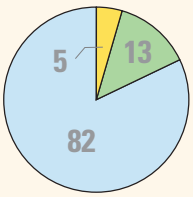
INORGANIC CONSTITUENTS



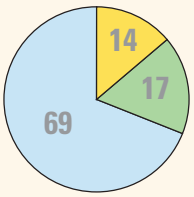
Trace and minor elements



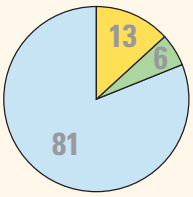
Uranium and radioactive constituents



Nutrients

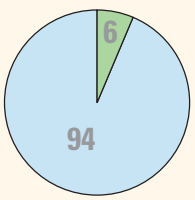


Total dissolved solids



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 KERN study unit, trace elements were present at high concentrations in 20% of the primary aquifers, and at moderate concentrations in 27%. Arsenic, antimony, boron, and vanadium were the trace elements that occurred at high concentrations in more than 2% of the primary aquifers. Lead, thallium, and selenium were detected at high concentrations, but in less than (<) 2% of the primary aquifers. Fluoride is a minor element that was present at high concentrations in 4% of the primary aquifers and at moderate concentrations in 2% of the primary aquifers.

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 in minerals in the aquifer sediments. In the KERN study unit, radioactive constituents were present at high concentrations in 6% of the primary aquifers, and at moderate concentrations in 13% of the primary aquifers. Radium and uranium were detected at high concentrations.

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, 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 the nutrient present at high concentrations in 5% of the primary aquifers and at moderate concentrations in 13% of the primary aquifers.

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), sulfate, and chloride, affect the aesthetic properties of water, such as taste, color, and odor. Other constituents, such as iron and manganese, can create nuisance problems, such as scaling and staining.

The State of California has recommended and upper limits for TDS, sulfate, and chloride in drinking water. In the KERN study unit, TDS was present at high concentrations (greater than the upper limit) in about 14% of the primary aquifers, and at moderate concentrations (between the recommended and upper limit) in 17% of the primary aquifers. Sulfate was present at high concentrations in about 8% of the primary aquifers, and at moderate concentrations in 6% of the primary aquifers. Chloride was present at high concentrations in 2% of the primary aquifers, and at moderate concentrations in 4% of the primary aquifers.

Iron and manganese are naturally occurring elements, and were present at high concentrations in 13% of the primary aquifers. Iron, or manganese, or both were present at moderate concentrations in 6% of the primary aquifers.

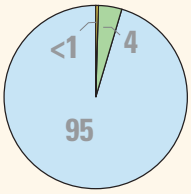
Perchlorate and *N*-Nitrosodimethylamine (NDMA)

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

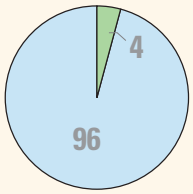
Perchlorate, an inorganic constituent, and NDMA, a semi-volatile organic compound, are of special interest in California because these constituents have recently been found in or are considered to have the potential to affect drinking-water supplies. Their presence in groundwater is monitored by the California Department of Public Health (http://www.cdph.ca.gov). In the KERN study unit, perchlorate was not present at high concentrations in the primary aquifers, but was present at moderate concentrations in 6%. NDMA was not present at high or moderate concentrations in the primary aquifers.

RESULTS: Groundwater Quality in the Kern County Subbasin Study Unit

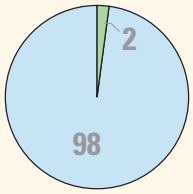
ORGANIC CONSTITUENTS



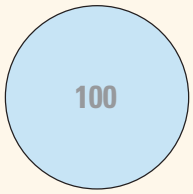
Solvents



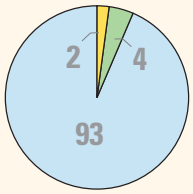
Trihalomethanes



Other volatile organic compounds



Pesticides



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 low concentrations can be used to help trace water from the landscape into the aquifer system.

Volatile Organic Compounds with Human-Health Benchmarks

VOCs are 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 KERN study unit, solvents were present at high concentrations in <1% of the primary aquifers. The solvents found at high concentrations were carbon tetrachloride and trichloroethene. Solvents were present at moderate concentrations in 4% of the primary aquifers.

Trihalomethanes may form during municipal water purification and can enter groundwater by the infiltration of landscape irrigation water. Trihalomethanes were present at moderate concentrations in 4% of the primary aquifers.

Other VOCs include organic synthesis reagents and gasoline hydrocarbons. Other VOCs were not present at high concentrations but were present in moderate concentrations in about 2% of the primary aquifers. The VOC found at moderate concentrations was benzene, which is a gasoline hydrocarbon.

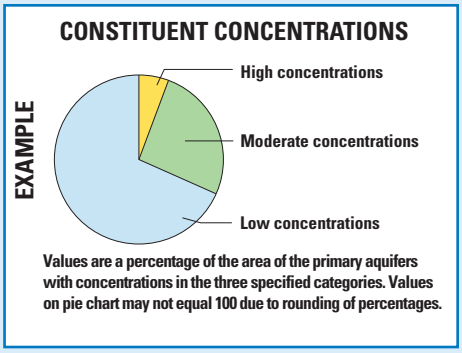
Pesticides with Human-Health Benchmarks

Pesticides are applied to crops, gardens, lawns, around buildings, and along roads to help control unwanted vegetation (weeds), insects, fungi, and other pests. In the KERN study unit, pesticides (not including fumigants) were not detected at high or moderate concentrations in the primary aquifers.

The fumigant 1,2-dibromo-3-chloropropane (DBCP) was present at high concentrations in 2% of the primary aquifers. DBCP and other fumigants were present at moderate concentrations in 4% of the primary aquifers. Use of DBCP as a soil fumigant was discontinued in California in 1977.

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 when available. Nonregulatory benchmarks for protecting aesthetic properties, such as taste and odor (Secondary Maximum Contaminant Level, SMCL), and nonregulatory benchmarks for protecting human health (Notification Level, NL, and Lifetime Health Advisory, HAL) were used when Federal or California regulatory benchmarks were not available.

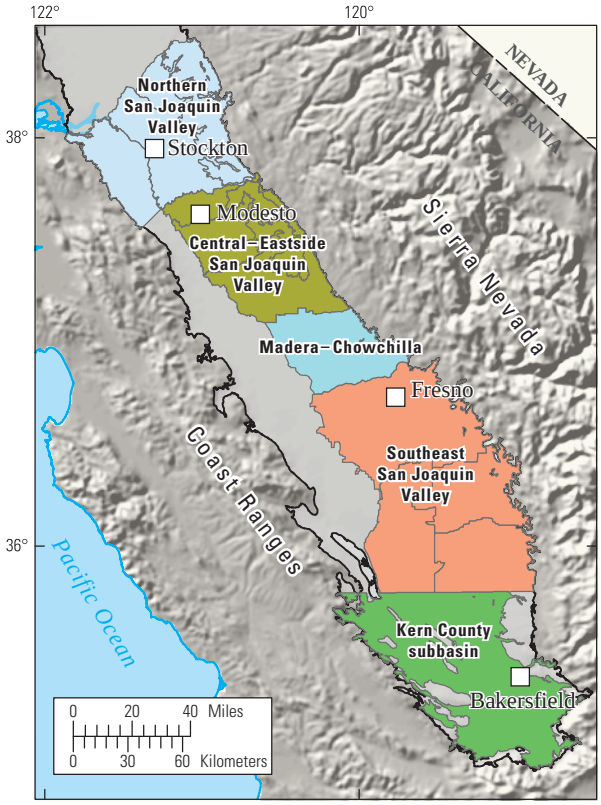


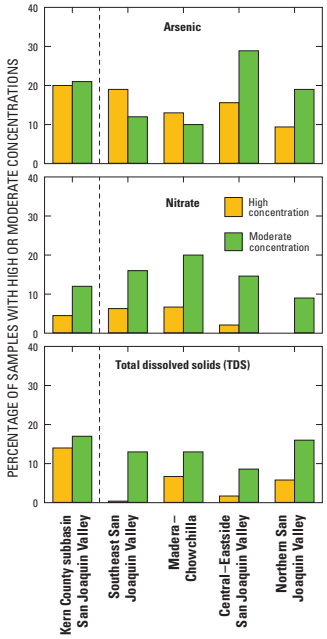
High, moderate, and low concentrations are defined relative to benchmarks

Concentrations are considered *high* if they are greater than a benchmark. For inorganic constituents, 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 are generally 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 (2012).

Inorganic Constituent Concentrations in the Eastern San Joaquin Valley

Arsenic, nitrate, and TDS were inorganic constituents that were present at high concentrations in KERN and four other study units in the eastern San Joaquin Valley (ESJV) (Bennett and others, 2010; Landon and others, 2010; Burton and others, 2012; J. Shelton, USGS, written commun., 2011). Arsenic was the trace element most frequently present at high concentrations in KERN (20%) and other ESJV study units (9% to 20%). High concentrations of arsenic result from the interaction of groundwater with naturally occurring minerals. Nitrate was present at high concentrations in 5% of the primary aquifers in KERN, and ranged from 0% to 9% in other study units in the ESJV. High concentrations of nitrate can result from human activities such as applicaton of fertilizer, animal waste, and septic systems. TDS, a constituent with a non-health-based benchmark, was present at high concentrations in 14% of the primary aquifers in KERN, the largest proportion in the ESJV. High concentrations of TDS result from natural and human sources.





By Carmen A. Burton and Kenneth Belitz

SELECTED REFERENCES

Bennett, G.L.,V, Fram, M.S., Belitz, Kenneth, and Jurgens, B.C., 2010, Status and understanding of groundwater quality in the Northern San Joaquin Basin, 2005—California GAMA Priority Basin Project: U.S. Geological Survey Scientific Investigations Report 2010-5175, 82 p. Available at http://pubs.usgs.gov/sir/2010/5175.

Burton, C.A., Shelton, J.L., and Belitz, Kenneth, 2012, Status and understanding of groundwater quality in the two Southern San Joaquin Valley study units, 2005–2006—California GAMA Priority Basin Project: U.S. Geological Survey Scientific Investigations Report 2011-5218, 150 p. Available at http://pubs.usgs.gov/sir/2011/5218.

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

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Shelton, J.L., Pimentel, Isabel, Fram, M.S., and Belitz, Kenneth, 2008, Ground-water quality data in the Kern County subbasin study unit, 2006—Results from the California GAMA Program: U.S. Geological Survey Data Series Report 337, 75 p. Available at http://pubs.usgs.gov/ds/337.

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 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 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 KERN study unit, data were collected by the PBP in 2006 and from the CDPH database for 2003–2005. 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

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Division of Water Quality
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