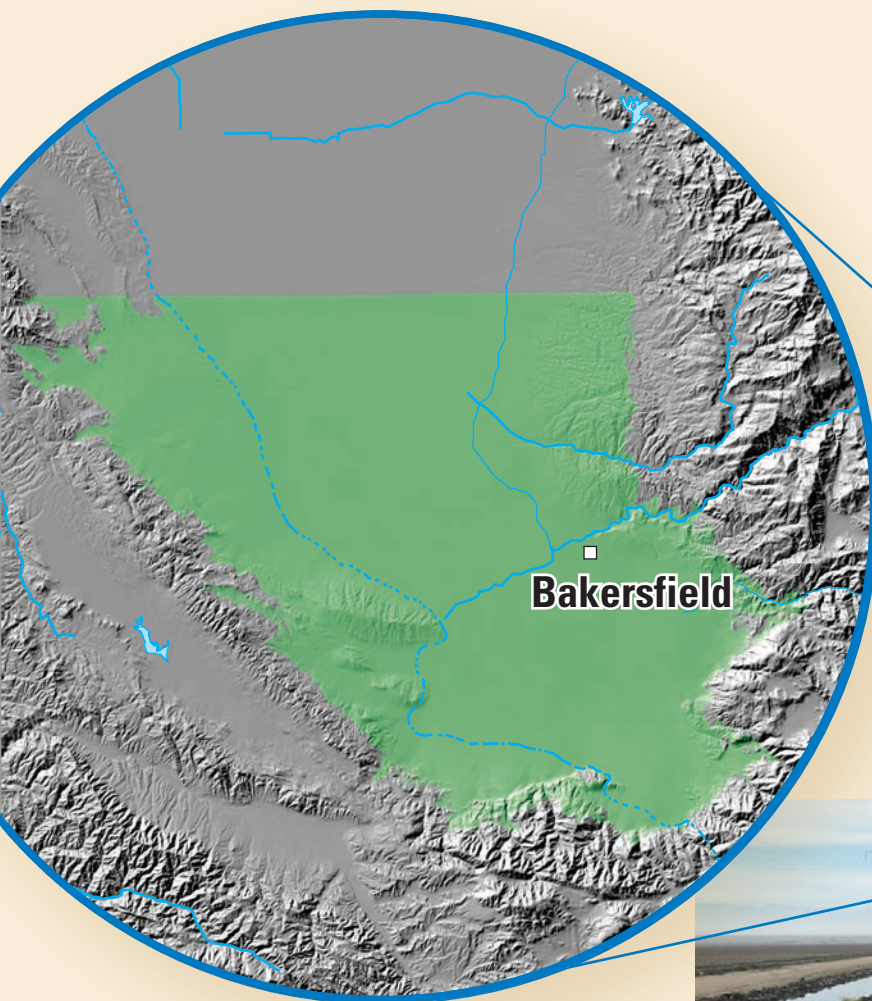


In cooperation with the California State Water Resources Control Board

A product of the California Groundwater Ambient Monitoring and Assessment (GAMA) Program

Ground-Water Quality Data in the Kern County Subbasin Study Unit, 2006—Results from the California GAMA Program



Data Series 337

Top photo: Almond orchards in bloom in Kern County, California. (Photo credit: Stephen T. Schmitt, USGS)

Bottom photo: Irrigation well in Kern County, California. (Photo credit: Michael T. Wright, USGS)

Ground-Water Quality Data in the Kern County Subbasin Study Unit, 2006—Results from the California GAMA Program

By Jennifer L. Shelton, Isabel Pimentel, Miranda S. Fram, and Kenneth Belitz

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Abbreviations and Acronyms

(Additional information or clarification given in parentheses)

AB	Assembly Bill (through the California State Assembly)
AL-US	action level (USEPA)
CAS	Chemical Abstracts Service (American Chemical Society)
CSU	combined standard uncertainty
CV	critical value
CVP	Central Valley Project
E	estimated or having a higher degree of uncertainty
GAMA	Groundwater Ambient Monitoring and Assessment Program
GPS	global positioning system
HAL-US	Lifetime Health Advisory Level (USEPA)
HPLC	high-performance liquid chromatography
KERN	Kern County Subbasin study unit
KERNFP	KERN flow-path well
LRL	laboratory reporting level
LSD	land-surface datum
LT-MDL	long-term method detection level
LUFT	leaking underground fuel tank
MCL	maximum contaminant level
MCL-CA	maximum contaminant level (CDPH)
MCL-US	maximum contaminant level (USEPA)
MDL	method detection limit
MRL	minimum reporting level
MU	method uncertainty
N	Normal (1-gram-equivalent per liter of solution)
na	not available
nc	constituent not analyzed
nd	not detected
NELAP	National Environmental Laboratory Accreditation Program
NL-CA	notification level (CDPH)
NWIS	National Water Information System (USGS)
PCFF-GAMA	Personal Computer Field Forms program designed for GAMA sampling
QC	quality control
RPD	relative percent difference
RSD	relative standard deviation
RSD5-US	risk-specific dose at a risk factor of 10^{-5} (USEPA)
SMCL	secondary maximum contaminant level
SMCL-CA	secondary maximum contaminant level (CDPH)
SMCL-US	secondary maximum contaminant level (USEPA)
SSMDC	sample-specific minimum detectable concentration
SWP	State Water Project
TT	treatment technique
TT-US	treatment technique (USEPA)
US	United States
V	constituent detected in sample and an associated blank; thus, data are censored from the ground-water quality assessment
VPDB	Vienna Peedee Belemnite
VSMOW	Vienna Standard Mean Ocean Water

Organizations

CDPH	California Department of Public Health
LLNL	Lawrence Livermore National Laboratory
MWH	Montgomery Watson Harza (Laboratory)
NAWQA	National Water Quality Assessment (USGS)
NWQL	National Water Quality Laboratory (USGS)
SWRCB	State Water Resources Control Board (California)
TML	Trace Metal Laboratory (USGS)
USEPA	U.S. Environmental Protection Agency
USGS	U. S. Geological Survey

Selected Chemical Names

CaCO_3	calcium carbonate
CO_3^{-2}	carbonate
DBCP	1,2-dibromo-3-chloropropane
1,1-DCA	1,1-dichloroethane
1,2-DCA	1,2-dichloroethane
1,1-DCE	1,1-dichloroethene
<i>cis</i> -1,2-DCE	<i>cis</i> -1,2-dichloroethene
1,2-DCP	1,2-dichloropropane
DO	dissolved oxygen
DOC	dissolved organic carbon
EDB	1,2-dibromoethane
EPTC	<i>S</i> -ethyl dipropylthiocarbamate
HCO_3^-	bicarbonate
PCE	tetrachloroethene
TCE	trichloroethene
1,2,3-TCP	1,2,3- trichloropropane
TDS	total dissolved solids
THM	trihalomethane
VOC	volatile organic compound

Note: Although there are numerous chemicals and chemical abbreviations mentioned throughout the text and tables, for brevity, only the more frequently used abbreviations are listed here.

Units of Measurement

cm^3 STP	cubic centimeters at standard temperature and pressure (0 degrees Celsius and 1 atmosphere of pressure)
ft	foot (feet)
g	gram
in.	inch
L	liter
mg	milligram
mg/L	milligrams per liter (parts per million)
mi	mile
mL	milliliter
NTU	nephelometric turbidity unit
$\mu\text{g/L}$	micrograms per liter (parts per billion)
μL	microliter
μm	micrometer
pCi/L	picocurie per liter

Notes

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

$$^{\circ}\text{F} = (1.8 \times ^{\circ}\text{C}) + 32$$

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

Elevation, as used in this report, refers to distance above the vertical datum.

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

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius ($\mu\text{S}/\text{cm}$ at 25°C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter ($\mu\text{g}/\text{L}$). Milligrams per liter is equivalent to parts per million (ppm) and micrograms per liter is equivalent to parts per billion (ppb).

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Ground-Water Quality Data in the Kern County Subbasin Study Unit, 2006—Results from the California GAMA Program

By Jennifer L. Shelton, Isabel Pimentel, Miranda S. Fram, and Kenneth Belitz

Abstract

Ground-water quality in the approximately 3,000 square-mile Kern County Subbasin study unit (KERN) was investigated from January to March, 2006, as part of the Priority Basin Assessment Project of the Groundwater Ambient Monitoring and Assessment (GAMA) Program. The GAMA Priority Basin Assessment project was developed in response to the Groundwater Quality Monitoring Act of 2001, and is being conducted by the California State Water Resources Control Board (SWRCB) in collaboration with the U.S. Geological Survey (USGS) and the Lawrence Livermore National Laboratory (LLNL).

The Kern County Subbasin study was designed to provide a spatially unbiased assessment of raw (untreated) ground-water quality within KERN, as well as a statistically consistent basis for comparing water quality throughout California. Samples were collected from 50 wells within the San Joaquin Valley portion of Kern County. Forty-seven of the wells were selected using a randomized grid-based method to provide a statistical representation of the ground-water resources within the study unit. Three additional wells were sampled to aid in the evaluation of changes in water chemistry along regional ground-water flow paths.

The ground-water samples were analyzed for a large number of man-made organic constituents (volatile organic compounds [VOCs], pesticides, and pesticide degradates), constituents of special interest (perchlorate, *N*-nitrosodimethylamine [NDMA], and 1,2,3-trichloropropane [1,2,3-TCP]), naturally occurring inorganic constituents (nutrients, major and minor ions, and trace elements), radioactive constituents, and microbial indicators. Naturally occurring isotopes (tritium, carbon-14, and stable isotopes of hydrogen, oxygen, nitrogen, and carbon) and dissolved noble gases also were measured to help identify the source and age of the sampled ground water.

Quality-control samples (blanks, replicates, and laboratory matrix spikes) were collected and analyzed at approximately 10 percent of the wells, and the results for these samples were used to evaluate the quality of the data from the ground-water samples. Assessment of the quality-control information resulted in censoring of less than 0.4 percent of the data collected for ground-water samples.

This study did not attempt to evaluate the quality of water delivered to consumers; after withdrawal from the ground, raw ground water typically is treated, disinfected, or blended with other waters to maintain acceptable water quality. Regulatory thresholds apply, not to the raw ground water, but to treated water that is served to the consumer. However, to provide some context for the results, concentrations of constituents measured in the raw ground water were compared with health-based thresholds established by the U.S. Environmental Protection Agency (USEPA) and the California Department of Public Health (CDPH), and as well as with thresholds established for aesthetic concerns (secondary maximum contaminant levels, SMCL-CA) by CDPH.

VOCs and pesticides each were detected in approximately 60 percent of the grid wells, and detections of all compounds but one were below health-based thresholds. The fumigant, 1,2-dibromo-3-chloropropane (DBCP), was detected above the USEPA maximum contaminant level (MCL-US) in one sample. Detections of most inorganic constituents were also below health-based thresholds. Constituents detected above health-based thresholds include: nitrate, (MCL-US, 2 samples), arsenic (MCL-US, 2 samples), and vanadium (California notification level, NL-CA, 1 sample). All detections of radioactive constituents were below health-based thresholds, although nine samples had activities of radon-222 above the lower proposed MCL-US. Most of the samples from KERN wells had concentrations of major elements, total dissolved solids, and trace elements below the non-enforceable thresholds set for aesthetic concerns.

Introduction

California relies on ground water for nearly half of the water used for public supply, and will likely be more dependent on ground water as the population continues to grow (Solley and others, 1998; Hutson and others, 2004). The State Water Resources Control Board (SWRCB), in collaboration with the U.S. Geological Survey (USGS) and Lawrence Livermore National Laboratory (LLNL), implemented a statewide ground-water-quality monitoring and assessment program to assess the quality of ground water in aquifers used for public supply, and to establish a program for monitoring trends in ground-water quality (<http://www.waterboards.ca.gov/gama>). The Groundwater Ambient Monitoring and Assessment (GAMA) Program consists of three projects: Priority Basin Assessment, conducted by the USGS, (<http://ca.water.usgs.gov/gama/>); Voluntary Domestic Well Assessment, conducted by the SWRCB; and Special Studies, conducted by LLNL.

The GAMA Priority Basin Assessment project was developed in response to the Ground-Water Quality Monitoring Act of 2001 (Sections 10780–10782.3 of the California Water Code, Assembly Bill 599, or “AB 599”). AB 599 is a public mandate to assess and monitor the quality of ground water used as public supply for municipalities in California and to increase the availability of information about ground-water quality to the public. The project is a comprehensive assessment of statewide ground-water quality, designed to help better understand and identify risks to ground-water resources. As part of the AB 599 process, the USGS, in collaboration with the SWRCB, developed the monitoring plan for the project (Belitz and others, 2003; State Water Resources Control Board, 2003). Key aspects of the project are interagency collaboration and cooperation with local water agencies and well owners. Local participation in the project is entirely voluntary.

The GAMA Priority Basin Assessment project is unique because the data collected during the study included analyses for an extensive number of chemical constituents at very low concentrations—analyses that are not normally available. A broader understanding of ground-water composition will be especially useful for providing an early indication of changes in water quality and for identifying the natural and human factors that affect water quality. Additionally, the GAMA Priority Basin Assessment project will analyze a broader suite of constituents than required by the California Department of Public Health (CDPH) (formerly known as the California Department of Health Services until July 1, 2007). An understanding of the occurrence and distribution of these constituents is important for the long-term management and protection of ground-water resources.

The range of hydrologic, geologic, and climatic conditions that exist in California must be considered in an assessment of ground-water quality. Belitz and others, (2003) divided the state into ten hydrogeologic provinces, each with distinctive hydrologic, geologic, and climatic characteristics ([fig. 1](#)), and representative regions in all ten provinces were included in the project design. Eighty percent of California’s approximately 16,000 public-supply wells are located in ground-water basins within these hydrologic provinces. These ground-water basins, defined by the California Department of Water Resources, generally consist of relatively permeable, unconsolidated deposits of alluvial or volcanic origin (California Department of Water Resources, 2003). Ground-water basins were prioritized for sampling on the basis of the number of public-supply wells in the basin, with secondary consideration given to municipal ground-water use, agricultural pumping, the number of leaking underground fuel tanks (LUFTS), and pesticide applications within a basin (Belitz, and others, 2003). In addition, some ground-water basins or groups of adjacent similar basins with relatively few public-supply wells were assigned a high priority so that all hydrogeologic provinces would be represented in the subset of basins sampled. The 116 priority basins were grouped into 35 defined study units. Some areas not in the defined ground-water basins were included in several of the study units to achieve representation of the 20 percent of public-supply wells not located in the ground-water basins.

Three types of water-quality assessments are being conducted using the data collected in each study unit: (1) Status: assessment of the current quality of the ground-water resource, (2) Trends: detection of changes in ground-water quality, and (3) Understanding: identification of the natural and human factors affecting ground-water quality (Kulongoski and Belitz, 2004). This report is one of a series of reports presenting the status of current water-quality conditions in each study unit (Wright and others, 2005; Bennett and others, 2006; Kulongoski and others, 2006; Fram and Belitz, 2007; Kulongoski and Belitz, 2007; and Dawson and others, 2008). Subsequent assessment reports will address the results of the trends and understanding aspects of the water-quality assessments.

The Kern County Subbasin study unit, hereafter referred to as “KERN,” occupies the largest area of any ground-water basin in California. KERN is the eighth study unit sampled by the GAMA Priority Basin Assessment Project, and was considered a high priority for sampling on the basis of the number of public-supply wells, the reliance on ground water for drinking-water resources, the amount of agricultural pumpage, the number of LUFTS, and the extent of pesticide applications (Belitz and others, 2003).



Figure 1. The hydrogeologic provinces of California and the location of the Kern County subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study unit (black area), modified from Belitz and others (2003).

Purpose and Scope

The purposes of this report are to: (1) present the analytical results for ground-water samples collected in KERN, (2) briefly describe the hydrogeologic setting of KERN, (3) detail the sampling and analytical methods, and the quality assurance, used during the study, and (4) present the results of quality-control tests. Ground-water samples were analyzed for organic, inorganic, and microbial constituents, field parameters, and chemical tracers. The chemical and microbial data presented in this report were evaluated by comparison with state and federal drinking-water regulatory thresholds and other health-based standards that are applied to treated drinking water. Regulatory thresholds are established by the U.S. Environmental Protection Agency (USEPA) and the California Department of Public Health (CDPH). The data presented in this report are intended to characterize the quality of untreated ground-water resources within the study unit, not the treated drinking water delivered to consumers by water purveyors.

Discussion of the factors that influence the distribution and occurrence of constituents in ground-water samples will be the subject of subsequent GAMA publications. In addition, pharmaceutical results from the analysis of quality-control tests and from ground-water samples collected in KERN are beyond the scope of this report, and will be included in a subsequent GAMA report.

Acknowledgments

The authors thank the cooperating well owners and water purveyors for their generosity in allowing the USGS to collect samples from their wells. We also thank the following cooperators for their support: State Water Resources Control Board (SWRCB), California Department of Public Health, California Department of Water Resources, and Lawrence Livermore National Laboratory. Three peer reviewers provided comments that helped improve this work: Thomas Haslebacher (Kern County Water Agency), Jan Stepek (SWRCB), and Patricia von Phul (USGS). Funding for this work was provided by California State bonds authorized by Proposition 50 and administered by the SWRCB.

Hydrogeologic Setting

KERN is at the southern end of the Central Valley hydrogeologic province, and covers about 3,000 mi² in Kern County ([fig. 1](#)). KERN is defined by the California Department of Water Resources (California Department of Water Resources, 2003) as the Kern County subbasin of the San Joaquin Valley Groundwater Basin. KERN is bounded

by the Kern County line to the north, the granitic bedrock of the Sierra Nevada foothills and the Tehachapi mountains to the east and southeast, and the marine sediments of the San Emigdio Mountains and Coast Ranges to the southwest and west ([fig. 2](#)) (California Department of Water Resources, 2006).

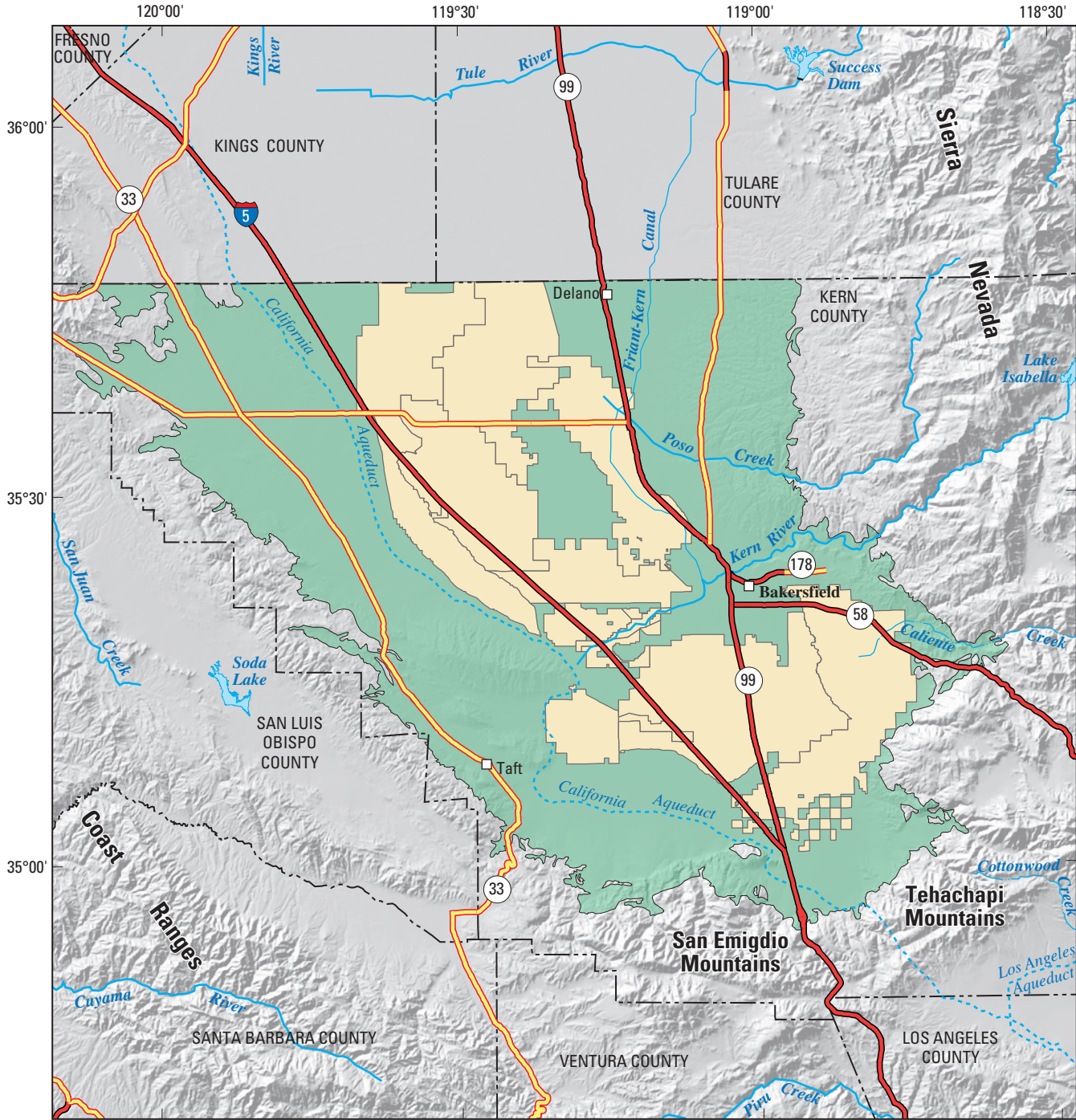
The northwest-trending, asymmetrical structural trough of the San Joaquin Valley occupies the southern two-thirds of the Central Valley and is filled with marine and continental sediments of Tertiary and Quaternary age. The sediment thickness increases from the valley margins toward the axis of the trough, and from the north toward the south, up to a total thickness of about 30,000 ft in the south-central portion of Kern County (Page, 1986). Freshwater occurs in the uppermost 3,000 ft, with brackish water beneath (Page, 1973).

The primary geologic formations that comprise the aquifer system are the Plio-Pleistocene age Tulare and Kern River Formations and overlying alluvium and terrace deposits (California Department of Water Resources, 2006). The aquifer system is unconfined in the eastern portion and above the Corcoran Clay, where it is present, in the central and western portions of KERN. Confined conditions exist below the Corcoran Clay (Dale and others, 1966). The aquifer is thickest along the eastern margin of the study unit and ranges from about 175 to 2,900 ft with an average thickness of about 600 ft, according to estimates from the California Department of Water Resources (California Department of Water Resources, 2006).

The primary sources of recharge are from artificial recharge from ground-water banking programs ([fig. 2](#)) (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.

Most of the land use within KERN is agricultural, with most of the irrigated acreage dedicated to field crops and fruit and nut orchards (California Department of Water Resources, 1998). However, the rate of increase in population in Bakersfield from 1990 to 2000, the largest city in Kern County, is one of the highest in the San Joaquin Valley and within the state (U.S. Census Statistics, 2000).

The hot Mediterranean climate of KERN is well suited to farming, with long, hot summer days and cool nights, and with mild, damp winters where frostless days and nights caused by dense tule fog prepare fruit and nut trees for springtime bloom. The average annual temperature is 67 °F. The average annual precipitation, on the basis of a 56-year record at the California Irrigation Management Information System stations in Bakersfield and Shafter (California Irrigation Management Information System, 2006), is 6 in., which occurs as rain primarily between November and February.



Shaded relief derived from U.S. Geological Survey National Elevation Dataset, 2006
Albers Equal Area Conic Projection

0 5 10 20 MILES
0 4.5 9 18 KILOMETERS

EXPLANATION

- Kern County Subbasin Study Unit (KERN)
- Ground-water banking programs

Figure 2. The Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study unit showing the California Department of Water Resources defined ground-water subbasin and major hydrologic features.

Methods

Methods used for the GAMA Program were selected to achieve the following objectives: (1) design a sampling plan suitable for statistical analysis; (2) collect samples in a consistent manner; (3) analyze samples using proven and reliable laboratory methods; (4) assure the quality of the ground-water data; and, (5) maintain data securely and with relevant documentation.

Study Design

The wells selected for sampling reflect the combination of two well-selection strategies. Forty-seven wells were selected to provide a statistically unbiased, spatially distributed assessment of ground-water quality in the aquifer system, and three additional wells were selected to provide greater sampling density in a few areas to address specific ground-water-quality issues in the study unit.

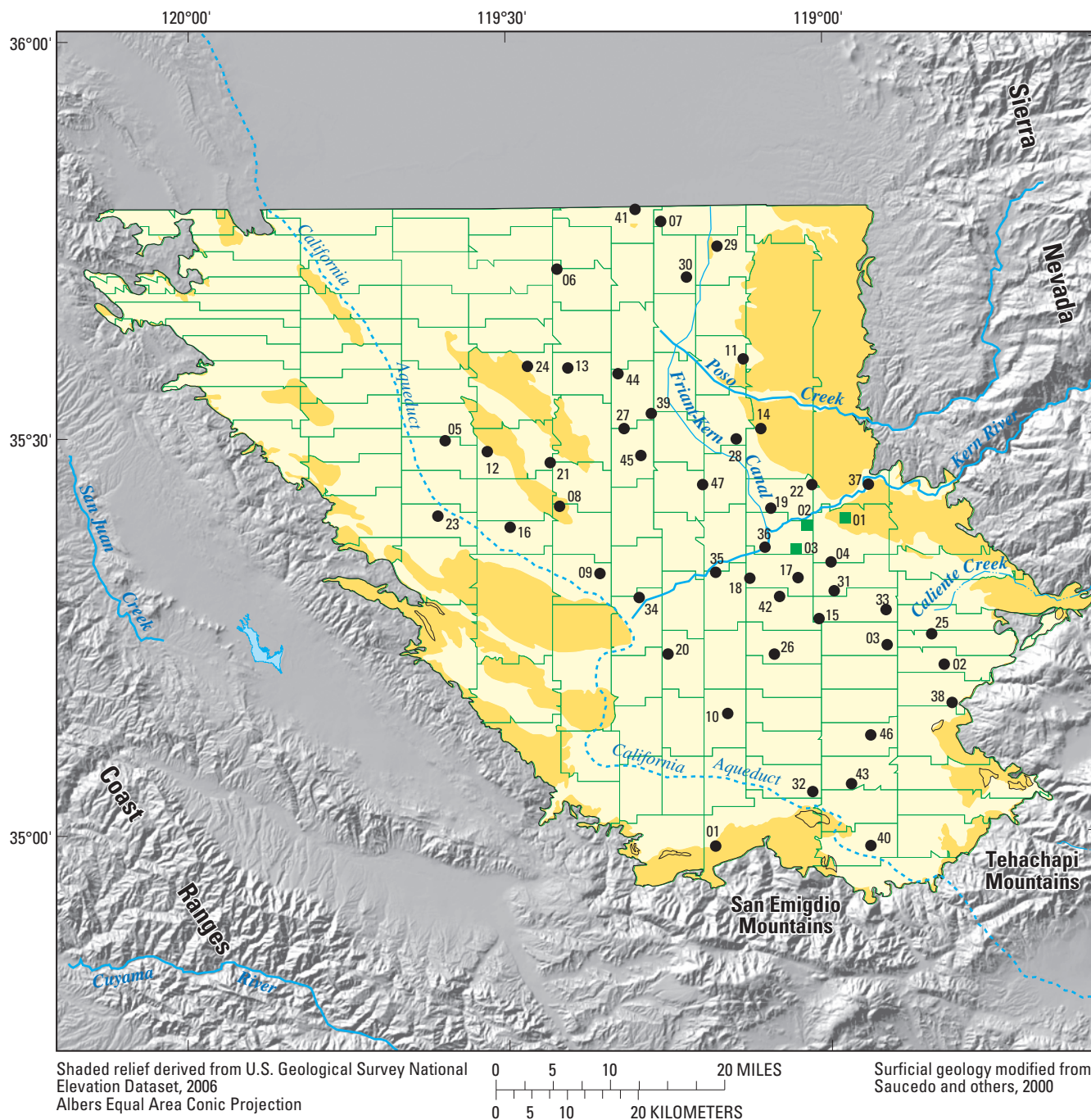
The spatially distributed wells were selected using a randomized grid-based method (Scott, 1990). This design minimizes spatial bias in the dataset (Gilliom and others, 1995). Public-supply wells were not evenly distributed in KERN with very few located along the margins, particularly the western margin or in areas where the surficial geology was mapped as Plio-Pleistocene and older. To minimize the number of cells without any wells, only the areas where the surficial geology was mapped as alluvium were included in the gridded area. The area was divided into 122 equal area (20 mi²) grid cells. Only 68 of the 122 grid cells contained at least one well in the CDPH database.

The wells in each cell were assigned a random number and a ranking that is based on information available for the well (for example, availability of previous water-quality data and well-construction information). Public-supply wells with the lowest random number and the highest ranking within a cell were picked, and owners were contacted to determine if basic sampling criteria could be met (for example, sampling point prior to treatment, and capability to pump for several hours). An attempt was made to select one public-supply well per grid cell; however, some grid cells either did not contain wells or did not contain wells accessible for sampling. If a grid cell contained no accessible public-supply wells, domestic and irrigation wells were considered for sampling. An attempt was made to select domestic and irrigation wells with depths and screened intervals similar to those in public-supply wells in the area. In a few cases, public-supply wells in adjacent areas close to the cell border were chosen. Forty-seven of the 68 grid cells that contained at least one well from the CDPH database were sampled in KERN; the other 21 grid cells did not contain accessible wells at the time of sampling (fig. 3). Wells sampled as part of the grid-cell network are hereinafter referred to as “grid wells.” Grid wells sampled in KERN were numbered with the “KERN” prefix.

Three additional wells were selected to provide greater sampling density along the Kern River (fig. 3). These wells were sampled to assess movement of water and dissolved constituents along a regional ground-water flow path. These three additional wells are hereafter referred to as “flow-path wells,” and results from these wells were not included in the statistical characterization of water quality in the study unit. Flow-path wells were numbered with the “KERNFP” prefix.

Ground-water samples were collected from 40 public-supply wells, 5 irrigation wells, 4 domestic wells, and 1 fire-protection-use well from January to March of 2006. Table 1 provides the GAMA-id (alphanumeric identification number) for each well, along with the sampling schedule, date and time sampled, and well-construction information. Well locations and identifications were verified using a global positioning system (GPS), 1:24,000 scale USGS topographic maps, comparison with existing well information in USGS and CDPH databases, and information provided by well owners. Drillers’ logs for wells were obtained when available. Well information was recorded by hand on field sheets and electronically using specialized software on field laptop computers. All information was verified and then uploaded into the USGS’s National Water Information System (NWIS). To maintain confidentiality of well owners and well locations, all well information and chemical data are currently inaccessible from the NWIS’s public website.

The wells in KERN were sampled using a tiered analytical approach. All wells were sampled for a standard set of constituents, including volatile organic compounds (VOCs), low-level 1,2-dibromo-3-chloropropane (DBCP) and 1,2-dibromoethane (EDB), pesticides and pesticide degradates, perchlorate, pharmaceutical compounds, stable isotopes of water, and dissolved noble gases and tritium—helium age dates. This standard set of constituents was termed the “fast” schedule (table 2). Wells on the “intermediate” schedule were sampled for all the constituents on the fast schedule, plus gasoline oxygenates and degradates, polar pesticides and metabolites, *N*-nitrosodimethylamine (NDMA), 1,2,3-trichloropropane (1,2,3-TCP), nutrients and dissolved organic carbon, major and minor ions and trace elements, and species of inorganic arsenic, chromium, and iron, stable isotopes of nitrate, and uranium isotopes (table 2). Wells on the “slow” schedule were sampled for all the constituents on the intermediate schedule, plus stable isotopes of carbon and carbon-14 abundance, additional radioactive constituents, tritium, and microbial constituents (table 2). Fast, intermediate, and slow refer to the time required to sample the well for all the analytes on the schedule. Generally, one slow or two intermediate or four fast wells could be sampled in one day. In KERN, 33 wells were sampled on the fast schedule, 6 on the intermediate schedule, and 11 on the slow schedule.



EXPLANATION

- Grid cell
 - Surficial geology
 - Quaternary alluvium
 - Plio-Pleistocene and older
- Sampled wells—Alphanumeric identification numbers for grid wells have the prefix “KERN,” and numbers for flow-path wells have the prefix “KERNFP” as defined in the text; only the numeric portions are shown on the map
- 01 Grid well
 - 03 Flow-path well

Figure 3. The Kern County subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study unit overlain on top of the map of the surficial geology of California showing the distribution of study unit grid cells and the locations of sampled grid wells and flow-path wells. The surficial geology map is modified from Saucedo and others, 2000.

Sample Collection and Analysis

Samples were collected in accordance with the protocols established by the USGS's National Water-Quality Assessment (NAWQA) program (Koterba and others, 1995) and the USGS National Field Manual (U.S. Geological Survey, variously dated). These sampling protocols ensure that a representative sample of ground water is collected at each site, and that the samples are collected and handled in a way that minimizes the potential for contamination of samples or cross-contamination between samples collected at different wells. The methods used for sample collection are described in the Appendix.

Tables 3A–L list the compounds analyzed in each constituent class. Ground-water samples were analyzed for 85 VOCs (table 3A), low-level DBCP and EDB (table 3B), and 8 gasoline oxygenates and degradates (table 3C), 83 pesticides and pesticide degradates (table 3D), 63 polar pesticides and metabolites (table 3E), 3 constituents of special interest (table 3F), 5 nutrients and dissolved organic carbon (table 3G), 10 major and minor ions and total dissolved solids and 25 trace elements (table 3H), species of inorganic arsenic, chromium, and iron (table 3I), 5 stable isotope constituents, 10 radioactive constituents (table 3J), 5 dissolved noble gases and helium isotope ratios (table 3K), and 4 microbial constituents (table 3L). The methods used for sample analysis are described in the Appendix.

Data Reporting

The methods and conventions used for reporting the data are described in the Appendix. Thirteen constituents analyzed in this study were measured by more than one method at the USGS's National Water Quality Laboratory (NWQL), but only the results from the preferred method are reported. Arsenic, iron, chromium, and 1,2,3-TCP concentrations, and tritium activities were measured by more than one laboratory, and both sets of results are reported.

Quality Assurance

The quality assurance used in this study follows the protocols used by the NAWQA program (Koterba and others, 1995) and described in the USGS National Field Manual (U.S. Geological Survey, variously dated). The primary laboratory used in this study, NWQL, follows stringent quality-assurance procedures (Maloney, 2005; Pirkey and Glodt, 1998). Quality-control (QC) samples collected in the KERN study include source-solution blanks, field blanks, replicates, laboratory matrix spikes, and surrogates. QC samples were collected to evaluate contamination, as well as bias and variability of

the water chemistry data that may have resulted from sample collection, processing, storage, transportation, and laboratory analysis. The quality-assurance results are described in the Appendix.

Water-Quality Results

Results from analyses of raw (untreated) ground-water samples from KERN are summarized in tables 4–14. Ground-water samples collected in KERN were analyzed for up to 300 constituents, and about 200 were not detected (tables 3A–L). Result tables present only the constituents that were detected, and list only samples that had at least one constituent detected. For constituent classes that were analyzed at all 47 grid wells, the tables also include the number of wells at which the constituent was detected, the frequency at which it was detected (in relation to the total number of grid wells), and the total number of constituents detected at each well. Results from the flow-path wells are presented in the tables, but these results were not included in the statistical compilations.

Table 4 includes water-quality indicators measured in the field and at NWQL, while tables 5 through 14 present the results of ground-water analyses organized by compound classes:

- Organic constituents
 - VOCs, low-level DBCP and EDB, and gasoline oxygenates and degradates (table 5)
 - Pesticides and pesticide degradates (table 6A), and polar pesticides and metabolites (table 6B)
- Constituents of special interest (table 7)
- Inorganic constituents
 - Nutrients and dissolved organic carbon (table 8)
 - Major and minor ions and total dissolved solids (table 9)
 - Trace elements (table 10)
 - Species of inorganic arsenic, iron, and chromium (table 11)
- Isotopic tracer constituents
 - Stable isotope ratios and tritium and carbon activities (table 12)
 - Noble gases, helium isotope ratios, and tritium (table 13)
 - Radioactive constituents (table 14)

No summary table is presented for microbial indicators because none were detected. Results from the analysis of pharmaceutical compounds will be presented in a subsequent GAMA report.

Quality-Control-Sample Results

Results of QC analyses (blanks, replicates, laboratory matrix spikes, and surrogates) were used to evaluate the quality of the data resulting from analysis of the ground-water samples. Assessment of the blanks resulted in censoring 0.4 percent of the data for the ground-water samples. Laboratory matrix-spike recoveries for a number of organic constituents were lower than the acceptable limits, which may indicate that these constituents might not have been detected in some samples if they were present at very low concentrations. The QC results are described in the Appendix.

Comparison Thresholds

Concentrations of constituents in ground-water samples were compared with CDPH and USEPA drinking-water health-based thresholds and thresholds established for aesthetic purposes (California Department of Health Services, 2007a; U.S. Environmental Protection Agency, 2006). The chemical and microbial data presented in this report are meant to characterize the quality of the untreated ground-water resources within KERN and are not intended to represent the treated drinking water delivered to consumers by water purveyors. The chemical and microbial composition of treated drinking water may differ from untreated ground water because treated drinking water may be subjected to disinfection, filtration, mixing with other waters, and exposure to the atmosphere prior to its delivery to consumers.

The following thresholds were used for comparisons:

- **MCL—Maximum Contaminant Level.** Legally enforceable standards that apply to public-water systems and are designed to protect public health by limiting the levels of contaminants in drinking water. MCLs established by USEPA are the minimum standards with which states are required to comply, and individual states may choose to set more stringent standards. CDPH has established MCLs for additional constituents not regulated by the USEPA and has lowered the threshold concentration for a number of constituents with MCLs established by USEPA. In this report, a threshold set by USEPA is labeled “MCL-US,” and one set by CDPH that is more stringent than the MCL-US is labeled “MCL-CA.” CDPH is notified when constituents are detected at concentrations that exceed MCL-US or MCL-CA thresholds in samples collected for the GAMA Priority Basin Assessment project.
- **AL—Action Level.** Legally enforceable standards that apply to public-water systems and are designed to protect public health by limiting the levels of copper and lead in drinking water. Detections of copper or lead above thresholds trigger requirements for mandatory water treatment to reduce the corrosiveness of water to water pipes. The action levels established by USEPA and CDHS are the same; thus, the thresholds are labeled “AL-US” in this report.
- **TT—Treatment Technique.** Legally enforceable standards that apply to public-water systems and are designed to protect public health by limiting the levels of microbial constituents in drinking water. Detections of microbial constituents above thresholds trigger requirements for mandatory additional disinfection during water treatment. The treatment technique threshold values established by USEPA and CDPH are the same; thus, the thresholds are labeled “TT-US” in this report.
- **SMCL—Secondary Maximum Contaminant Level.** Non-enforceable standards applied to constituents that affect the aesthetic qualities of drinking water, such as taste, odor, and color, or technical qualities of drinking water, such as scaling and staining. Both USEPA and CDPH define SMCLs, but unlike MCLs, SMCLs established by CDPH are not required to be at least as stringent as those established by USEPA. SMCLs established by CDPH (SMCL-CA) are used in this report for all constituents that have SMCL-CA values. The SMCL-US is used for pH because no SMCL-CA has been defined.
- **NL—Notification Level.** Health-based notification levels established by CDPH (NL-CA) for some of the constituents in drinking water that lack MCLs. If a constituent is detected above its NL-CA, state law requires timely notification of local governing bodies and recommends consumer notification.
- **HAL—Lifetime Health Advisory Level.** The concentration of a constituent in drinking water that is not expected to cause any adverse carcinogenic effects for a lifetime of exposure. HALs are established by the USEPA (HAL-US) and are calculated assuming consumption of 2 liters of water per day over a 70-year lifetime by a 70-kilogram adult and that 20 percent of a person’s exposure comes from drinking water.
- **RSD5—Risk-Specific Dose.** The concentration of a constituent in drinking water corresponding to an excess estimated lifetime cancer risk of 1 in 100,000. RSD5 is an acronym for risk-specific dose at 10^{-5} . RSD5s are calculated by dividing the 10^{-4} Cancer Risk concentrations established by the USEPA by 10 (RSD5-US).

For constituents with MCLs, detections in ground-water samples were compared with the MCL-US or MCL-CA. Constituents with SMCLs were compared with the SMCL-CA. For chloride, sulfate, specific conductance, and total dissolved solids, CDPH defines a “recommended” and an “upper” SMCL-CA; detections of these constituents in ground-water samples were compared with both levels. The SMCL-US for these constituents corresponds to the recommended SMCL-CA. Detected concentrations of constituents that lack MCLs and SMCLs were compared with the NL-CA. For constituents that lack an MCL, SMCL, or NL-CA, detected concentrations were compared with the HAL-US. For constituents that lack an MCL, SMCL, NL-CA, or HAL-US, detected concentrations were compared with the RSD5-US. Note that this hierarchy of selection of comparison thresholds means that for constituents that have multiple types of established thresholds, the threshold used for comparison purposes may not be the one with the lowest concentration. The comparison thresholds used in this report are listed in [tables 3A–L](#) for all constituents and in [tables 4–14](#) for constituents detected in ground-water samples from KERN. Not all of the constituents that were analyzed for this study have established thresholds available. Detections of constituents at concentrations greater than the selected comparison threshold are marked with asterisks in [tables 4–14](#).

Water-Quality Data

Field Parameters

Field measurements of dissolved oxygen, pH, specific conductance, alkalinity, and associated parameters (turbidity and water temperature) are presented in [table 4](#). Laboratory measurements of pH, specific conductance, and alkalinity are also presented in [table 4](#) when available, but field measurements take precedence when both are available. Dissolved oxygen and alkalinity are used as indicators of natural processes that control water chemistry. Specific conductance is the unit of electrical conductivity of the water and is proportional to the amount of dissolved salts in the water. Four wells had specific conductance values above the recommended SMCL-CA, and nine wells were above the upper threshold value. The pH value indicates the acidity or basicity of the water relative to a neutral pH of 7. Two grid wells had pH values greater than 8.5 and were above the SMCL-US for pH.

Organic Constituents

VOCs are widely used and can be found in adhesives, dry-cleaning products, exhaust fumes, fuels and fuel additives, fumigants, paints, refrigerants, solvents, and disinfected water, and are characterized by their tendency to evaporate. VOCs generally persist longer in ground water than in surface water because ground water is isolated from the atmosphere.

Of the 88 VOCs analyzed, 17 were detected; nearly all detections were below health-based thresholds, and most were less than one one-hundredth of the threshold values ([table 5](#)). DBCP was detected above the MCL-US in one sample. Two VOCs were detected in more than 10 percent of the samples from grid wells: 1,2-dichloropropane (1,2-DCP), historically used as a fumigant; and trichloromethane (chloroform), a by-product of drinking-water disinfection. Chloroform, one of the most frequently detected VOCs in KERN, is the most frequently detected VOC in the United States (Squillace and others, 1999). One or more VOCs were detected in samples from 30 of the 47 grid wells.

Pesticides are used on agricultural crops, roadsides, canals or ditch edges, rights-of-way, and open land, and frequently on lawns and gardens, and can be categorized on the basis of how they are used. Herbicides are used to control weeds; insecticides are used to control insects; fumigants can be used to control soil-borne nematodes; and fungicides are used to control fungi.

Of the 83 pesticides and pesticide degradates analyzed in all KERN samples, 12 were detected; all detections were below health-based thresholds, and most were less than one one-thousandth of the threshold values ([table 6A](#)). An additional 63 pesticides and metabolites were analyzed in a subset of the samples, 6 were detected; all detections were below health-based thresholds, and most were less than one one-thousandth of the threshold values ([table 6B](#)). Five pesticide constituents were detected in more than 10 percent of the grid wells: deethylatrazine (a degradate of atrazine), simazine, atrazine, EPTC, and 3,4-dichloroaniline (a degradate of diuron). The three most frequently detected pesticide constituents in this study—deethylatrazine, simazine, and atrazine—are also the most commonly detected pesticide constituents in ground water nationally (Gilliom and others, 2006). One or more pesticide constituents were detected in samples from 29 of the 47 grid wells.

Constituents of Special Interest

Perchlorate, 1,2,3-TCP, and NDMA are constituents of special interest in California, because they recently have been found in water supplies as analytical methods have improved and detection limits have been lowered (California Department of Health Services, 2007b). NDMA was not detected in any samples. Perchlorate was detected in 6 percent of the grid wells, and all concentrations of perchlorate measured in KERN wells were less than one-fifth of the NL-CA ([table 7](#)). 1,2,3-TCP was detected in 8 grid well samples at concentrations of one one-hundredth or less than the HAL-US.

Inorganic Constituents

Unlike the organic constituents and the constituents of special interest, most of the inorganic constituents are naturally present in ground water, although their concentrations may be affected by human activities.

The nutrients (nitrogen and phosphorus) and the dissolved organic carbon (DOC) present in ground water can affect biological activity in aquifers and in surface-water bodies that receive ground-water discharge. Nutrients may be present in an aquifer because of natural and human factors. Human derived sources include nitrogen fertilizers, dairies, and septic systems. Nitrogen may be present in the form of ammonia, nitrite, or nitrate, depending on the oxidation–reduction state of the ground water. Nitrate is the dominant form of nitrogen in oxygenated ground water. High nitrate can adversely affect human health, particularly the health of infants because nitrate is a factor in the development of infant methoglobinemia or blue baby syndrome (Comly, 1945). All concentrations of nitrite and ammonia measured in samples from KERN wells were below health-based thresholds ([table 8](#)). Concentrations of phosphorus and dissolved organic carbon were also low. Samples from two wells contained nitrate at concentrations above the MCL-US.

The major-ion composition, total dissolved solids (TDS) content, and levels of certain trace elements in ground water affect the aesthetic properties of water, such as taste, color, and odor, and the technical properties, such as scaling and staining. Although there are no adverse health effects associated with these properties, they may reduce consumer satisfaction with the water or may have economic impacts. CDPH has established non-enforceable thresholds (SMCL-CAs) that are based on aesthetic or technical properties rather than on health-based guidelines for the major ions chloride and sulfate, TDS, and several trace elements.

Almost all concentrations of chloride, sulfate, and TDS measured in samples from KERN wells were below the recommended SMCL-CAs ([table 9](#)). One sample contained chloride, two samples contained sulfate, and three samples contained TDS above the recommended SMCL-CA, and two samples contained TDS and sulfate above the upper SMCL-CA.

Eighteen of the 25 trace elements analyzed in this study have health-based thresholds. Detections of all trace elements in samples from KERN wells were below health-based thresholds, with the exception of arsenic and vanadium ([table 10](#)). Arsenic and vanadium are trace elements that can be found in the Earth's crust and in rocks. Arsenic can also occur as a component of pesticides (Hem, 1985). Arsenic was detected above the MCL-US in two samples. Vanadium can also be found in crude petroleum deposits and can enter the environment from the burning of fuel oils. Vanadium was detected in one sample at a concentration above the NL-CA.

Manganese is a trace element whose concentration is affected by the oxidation–reduction state of the ground water. Precipitation of minerals containing manganese may cause orange or black staining of surfaces. Concentrations of manganese in KERN wells were typically low, but one grid well and one flow-path well had concentrations above the SMCL-CA ([table 10](#)).

Arsenic, iron, and chromium occur in different species depending on the oxidation–reduction state of the ground water. The oxidized and reduced species have different solubilities in ground water and may have different effects on human health. The relative proportions of the oxidized and reduced species of each element also are used to aid in interpretation of the oxidation–reduction state of the aquifer. [Table 11](#) reports measured concentrations of total arsenic, iron, and chromium, and the concentrations of the oxidized or the reduced species of each element. The concentration of the other species can be calculated by difference.

Isotopic Tracer Constituents

Stable isotope ratios, tritium and carbon-14 activities, and noble gas concentrations are used as tracers of natural processes that affect ground-water composition. Hydrogen and oxygen stable isotope ratios of water ([table 12](#)) are used to aid in interpretation of ground-water recharge sources. The stable isotope ratios of water depend on the elevation, latitude, and temperature of precipitation and on the extent of evaporation of surface water or soil water (Kendall and Caldwell, 1998). The nitrogen and oxygen stable isotope ratios of nitrate ([table 12](#)) are used to aid in interpretation of processes that affect nitrate concentrations in ground water. Nitrate derived from natural, agricultural, and wastewater sources may have distinct stable isotope ratios. Noble gas concentrations ([table 13](#)) are used to aid in interpretation of ground-water recharge sources because the concentrations of the different noble gases depend on water temperature. The noble gases record the temperature of the water at the time it was recharged into the ground water, and water temperature is a function of elevation and season of recharge.

Tritium activities (tables 12 and 13), carbon-14 activities (table 12), and helium isotope ratios (table 13) provide information about the age of the ground water. Tritium is a radioactive isotope of hydrogen that is incorporated into the water molecule. Low levels of tritium are continuously produced by cosmic ray bombardment of water in the atmosphere and are considered to be background levels normally found in ground water; in contrast, a large amount of tritium was produced between 1952 and 1963 by atmospheric testing of nuclear weapons. Thus, concentrations of tritium above background levels generally indicate the presence of water recharged since the early 1950s. Helium isotope ratios (table 13) are used in conjunction with tritium concentrations to estimate more exact ages for young ground water. Carbon-14 (table 12) is a radioactive isotope of carbon that is incorporated into dissolved carbonate species in water. Low levels of carbon-14 are continuously produced by cosmic ray bombardment of nitrogen in the atmosphere. Because carbon-14 decays with a half-life of approximately 5,700 years, low activities of carbon-14 relative to modern values generally indicate presence of ground water that is several thousand years old.

The only isotopic tracer constituent with a health-based threshold analyzed in this study is tritium. All measured tritium activities in samples from KERN wells were less than one one-thousandth of the MCL-CA (tables 12 and 13).

Radioactive Constituents

Radioactivity is the release of energy or energetic particles during changes in the structure of the nucleus of an atom. Most of the radioactivity in ground water comes from decay of naturally occurring isotopes of uranium and thorium that are present in minerals in the sediments or fractured rocks of an aquifer. Both uranium and thorium decay in a series of steps, eventually forming stable isotopes of lead. Radium-226, radium-228, and radon-222 are radioactive isotopes formed during the uranium and thorium decay series. In each step of the decay series, one radioactive element turns into a different radioactive element by emitting an alpha or a beta particle from its nucleus. For example, radium-226 emits an alpha particle, and therefore, turns into radon-222, and radium-228 decays to form actinium-228 by emission of a beta particle. The alpha and beta particles emitted during radioactive decay are hazardous to human health because these energetic particles may damage cells. Radiation damage to cell DNA may increase the cancer risk in humans.

The equivalent to concentration for radioactive constituents is activity. Activity of radioactive constituents in ground water is measured in units of picocuries per liter (pCi/L), and one picocurie is approximately equal to two atoms decaying per minute. The number of atoms decaying is equal to the number of alpha or beta particles emitted.

Radon was the only radioactive constituent detected above a health-based threshold. Two health-based thresholds have been proposed by USEPA to address radon levels in air (U.S. Environmental Protection Agency, 2007). In communities with programs to mitigate radon in air, the proposed MCL-US for radon is 4,000 pCi/L. In communities without these programs, the proposed MCL-US is 300 pCi/L. Activities of radon-222 were detected above the proposed MCL-US of 300 pCi/L in nine grid wells and one flow-path well, but all detections were below the proposed alternative MCL-US of 4,000 pCi/L.

Microbial Indicators

Water is disinfected during drinking-water treatment to prevent diseases that may be spread by water-borne microbial constituents derived from human or animal wastes. The specific viruses and bacteria responsible for diseases generally are not measured because routine analytical methods are not available. Measurements are made of the more easily analyzed microbial constituents that serve as indicators of the presence of human or animal waste in water. Drinking-water purveyors respond to detections of microbial indicators by applying additional disinfection to the water.

Samples from eleven KERN wells were analyzed for microbial indicators. None were detected.

Future Work

Future work will include analysis of the data presented in this report using a variety of statistical, qualitative, and quantitative approaches to assess the natural and human factors affecting ground-water quality. Water-quality data stored in the CDPH and NWIS databases, and water-quality and well construction data available from other state and local agencies, will be compiled, evaluated, and used in combination with the data presented in this report.

Summary

Ground-water quality in the approximately 3,000 mi² Kern County Subbasin study unit (KERN) was investigated from January to March 2006 as part of the Priority Basin Assessment Project of the Groundwater Ambient Monitoring and Assessment (GAMA) Program. The California State Water Resources Control Board (SWRCB), in collaboration with the U.S. Geological Survey (USGS) and the Lawrence Livermore National Laboratory (LLNL), is implementing the GAMA Program (<http://www.waterboards.ca.gov/gama/>). The Priority Basin Assessment Project was designed by the SWRCB and the USGS in response to the Ground-Water Quality Monitoring Act of 2001 (Belitz and others, 2003; State Water Resources Control Board, 2003). The project is a comprehensive assessment of statewide ground-water quality designed to help better understand and identify risks to ground-water resources and to increase the availability of information about ground-water quality to the public. KERN was the eighth study unit sampled as part of the project.

KERN is in the southern portion of the Central Valley hydrogeologic province and is defined as the Kern County subbasin of the San Joaquin Valley Basin (California Department of Water Resources, 2003). Assessment of the ground-water quality from 50 wells in Kern County was completed in this study. Forty-seven of the wells were selected using a randomized grid approach to achieve statistically unbiased representation of ground water used for public drinking-water supplies. Three wells were selected to provide additional sampling density to aid in understanding processes that affect ground-water quality. Ground-water samples were analyzed for VOCs, pesticides and pesticide degradates, pharmaceutical compounds, nutrients, major and minor ions, trace elements, radioactivity, and microbial indicators. Naturally occurring isotopes (stable isotopes of hydrogen, oxygen, nitrogen, and carbon, and activities of tritium and carbon-14) and dissolved noble gases also were measured to provide a dataset that will be used to help interpret the source and age of the sampled ground water. This report briefly describes the hydrogeologic setting of the KERN region, details the sampling, analytical, and quality-assurance methods used in the study, and presents the results of the chemical and microbial analyses made of the ground-water samples collected from January to March 2006.

Quality-control samples (blanks, replicates, laboratory matrix spikes) were collected at approximately 10 percent of the wells, and the results for these samples were used to evaluate the quality of the data from the ground-water samples. Assessment of the quality-control data resulted in censoring of less than 0.4 percent of the ground-water quality data.

This study did not attempt to evaluate the quality of water delivered to consumers; after withdrawal from the ground, water typically is treated, disinfected, or blended with other waters to maintain acceptable water quality. Regulatory

thresholds apply, not to raw ground water, but to treated water that is served to the consumer. However, to provide some context for the results, concentrations of constituents measured in the raw ground water were compared with health-based thresholds established by the U.S. Environmental Protection Agency and the California Department of Public Health.

Most detections of organic constituents sampled for this study were below health-based thresholds and most were less than one one-hundredth of the threshold values. DBCP was detected above the MCL-US in one sample. Most detections of trace elements, nutrients, and radioactive constituents were below health-based thresholds. Constituents detected above health-based thresholds include: arsenic (MCL-US, two samples), nitrate (MCL-US, two samples), vanadium (NL-CA, one sample), and radon-222 (lower proposed MCL-US, nine samples). Specific conductance, pH, total dissolved solids, chloride, manganese, and sulfate were detected at concentrations above thresholds set for aesthetic concerns (SMCL-CAs) in samples from up to 15 of the wells. Future work will include subsequent reports that will interpret the data presented in this report using a variety of statistical, qualitative, and quantitative approaches to assess the natural and human factors that affect ground-water quality.

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Table 1. Identification, sampling, and construction information for wells sampled for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March 2006.

[GAMA well identification no.: KERN, Kern County Subbasin study unit; KERNFP, KERN flow-path well. Elevation of LSD is a datum plane that is approximately at land surface at each well. The elevation of the LSD is described in feet above the North American Vertical Datum of 1988. Abbreviations: ft, feet; LSD, land surface datum; NAVD 88, North American Vertical Datum of 1988; na, not available]

GAMA identification no.	Sampling information			Elevation of LSD (ft above NAVD 88)	Construction information (ft below LSD)		
	Date	Time	Schedule		Top perforation	Bottom perforation	Well depth
Grid wells							
KERN-01	01-09-06	1220	Fast	1,472	220	560	560
KERN-02	01-10-06	0910	Fast	453	402	702	702
KERN-03	01-10-06	1200	Fast	385	400	na	750
KERN-04	01-10-06	1410	Fast	400	na	na	¹ 637
KERN-05	01-11-06	0850	Fast	246	396	522	522
KERN-06	01-11-06	1110	Fast	238	400	700	700
KERN-07	01-11-06	1410	Fast	295	400	1,000	1,000
KERN-08	01-12-06	1150	Fast	295	290	410	430
KERN-09	01-23-06	0940	Fast	287	150	400	400
KERN-10	01-23-06	1210	Fast	295	119	1,007	1,007
KERN-11	01-23-06	1520	Fast	610	440	785	785
KERN-12	01-24-06	0930	Fast	252	200	500	500
KERN-13	01-24-06	1240	Fast	287	380	780	790
KERN-14	01-25-06	1300	Fast	555	630	1,008	1,020
KERN-15	02-06-06	0900	Fast	349	340	724	724
KERN-16	02-06-06	1220	Fast	264	160	460	460
KERN-17	02-09-06	0910	Fast	342	na	na	627
KERN-18	02-09-06	1140	Fast	360	na	na	740
KERN-19	02-09-06	1350	Fast	402	260	680	700
KERN-20	02-13-06	1100	Fast	293	350	1,000	1,000
KERN-21	02-13-06	1300	Fast	264	125	455	455
KERN-22	02-13-06	1530	Fast	600	502	970	970
KERN-23	02-16-06	0920	Fast	380	na	na	na
KERN-24	02-16-06	1200	Fast	263	400	500	500
KERN-25	02-27-06	0940	Fast	495	639	900	900
KERN-26	02-27-06	1300	Fast	325	320	400	400
KERN-27	02-27-06	1430	Fast	330	na	na	600
KERN-28	02-27-06	1640	Fast	430	482	763	763
KERN-29	02-28-06	0920	Fast	400	320	500	500
KERN-30	02-28-06	1140	Fast	330	294	1,008	1,008
KERN-31	03-01-06	0900	Fast	367	300	590	590
KERN-32	03-01-06	1130	Fast	417	590	730	730
KERN-33	03-01-06	1240	Fast	395	395	793	793
KERN-34	01-10-06	1210	Slow	305	106	762	765
KERN-35	01-25-06	1130	Slow	340	240	na	680
KERN-36	01-26-06	1000	Slow	378	400	720	720
KERN-37	02-15-06	1040	Slow	524	na	na	500
KERN-38	01-11-06	0940	Slow	413	na	na	na
KERN-39	² 01-12-06	0930	Slow	364	494	694	694
KERN-40	01-30-06	0930	Intermediate	1,100	1,048	1,400	1,496
KERN-41	01-31-06	0830	Slow	262	955	1,370	1,390
KERN-42	02-01-06	0930	Slow	352	na	na	718
KERN-43	02-02-06	0830	Intermediate	530	730	870	880
KERN-44	02-07-06	1200	Slow	335	300	709	709
KERN-45	02-08-06	1210	Slow	325	na	na	600
KERN-46	02-28-06	1020	Intermediate	370	483	1,028	1,028
KERN-47	03-02-06	0930	Intermediate	342	na	na	810
Flow-path wells							
KERNFP-01	01-26-06	0920	Intermediate	590	400	740	750
KERNFP-02	01-24-06	1130	Slow	377	420	720	720
KERNFP-03	01-25-06	0940	Intermediate	390	220	457	477

¹ Hole depth used as an estimate for well depth.

² Also sampled 02-14-06 at 1000.

20 Ground-Water Quality Data in the Kern County Subbasin Study Unit, 2006—Results from the California GAMA Program

Table 2. Classes of chemical and microbial constituents and water-quality indicators collected for the “slow,” “intermediate,” and “fast” well sampling schedules in the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March 2006.

[Abbreviations: na, not available]

Analyte classes	Schedule			Table	
	Slow (11 wells)	Intermediate (6 wells)	Fast (33 wells)	Constituent list	Result
Water-quality indicators					
Dissolved oxygen, temperature, specific conductance, hardness ¹	X	X	X		4
pH, alkalinity, turbidity	X				4
Organic constituents					
Volatile organic compounds	X	X	X	3A	5
Low-level 1,2-dibromo-3-chloropropane (DBCP) and 1,2-dibromoethane (EDB)	X	X	X	3B	5
Gasoline oxygenates and degradates	X	X		3C	5
Pesticides and pesticide degradates	X	X	X	3D	6A
Polar pesticides and metabolites	X	X		3E	6B
Pharmaceutical compounds	X	X	X	na ²	na ²
Constituents of special interest					
Perchlorate	X	X	X	3F	7
N-Nitrosodimethylamine (NDMA)	X	X		3F	7
1,2,3-Trichloropropane (1,2,3-TCP)	X	X		3F	7
Inorganic constituents					
Nutrients	X	X		3G	8
Dissolved organic carbon	X			3G	8
Major and minor ions	X	X		3H	9
Trace elements	X	X		3H	10
Arsenic, chromium, and iron abundances and speciation	X	X		3I	11
Stable isotopes					
Stable isotopes of hydrogen and oxygen in water	X	X	X	3J	12
Stable isotopes of nitrogen and oxygen in nitrate	X	X		3J	12
Stable isotopes of carbon and carbon-14 abundance	X			3J	12
Radioactivity and noble gases					
Tritium	X	X		3J	12
Tritium and noble gases	X	X	X	3K	13
Gross alpha and beta radiation	X			3J	14
Radium isotopes	X			3J	14
Radon-222	X			3J	14
Uranium isotopes	X	X		3J	14
Microbial constituents					
Bacterial and viral indicators	X			3L	None detected

¹ Data to calculate hardness was collected in *slow* and *intermediate* wells only.

² Pharmaceutical data will be presented in a subsequent report.

Table 3A. Volatile organic compounds, primary uses or sources, comparison thresholds, and reporting information for the U.S. Geological Survey National Water Quality Laboratory Schedule 2020.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007. **Detection:** D, detected in ground-water samples (table 5); —, not detected. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists. HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL-CA, California Department of Public Health notification level; RSD5-US, U.S. Environmental Protection Agency risk specific dose at a risk factor of 10⁻⁵. **Primary use or source:** THM, trihalomethane. **Abbreviations:** CAS, Chemical Abstracts Service; LRL, laboratory reporting level; USGS, U.S. Geological Survey; µg/L, micrograms per liter; na, not available]

Constituent	Detection	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type	Threshold value (µg/L)
Acetone	—	Solvent	81552	67-64-1	6	na	na
Acrylonitrile	—	Organic synthesis	34215	107-13-1	0.8	RSD5-US	0.6
Benzene	D	Gasoline hydrocarbon	34030	71-43-2	.021	MCL-CA	1
Bromobenzene	—	Solvent	81555	108-86-1	.028	na	na
Bromochloromethane	—	Fire retardant	77297	74-97-5	.12	HAL-US	90
Bromodichloromethane	D	Disinfection by-product (THM)	32101	75-27-4	.028	MCL-US	180
Bromoform (Tribromomethane)	—	Disinfection by-product (THM)	32104	75-25-2	.10	MCL-US	180
2-Butanone (MEK, Methyl ethyl ketone)	—	Solvent	81595	78-93-3	2	HAL-US	4,000
<i>n</i> -Butylbenzene	—	Gasoline hydrocarbon	77342	104-51-8	.12	NL-CA	260
<i>sec</i> -Butylbenzene	—	Gasoline hydrocarbon	77350	135-98-8	.06	NL-CA	260
<i>tert</i> -Butylbenzene	—	Gasoline hydrocarbon	77353	98-06-6	.06	NL-CA	260
Carbon disulfide	D	Organic synthesis	77041	75-15-0	.038	NL-CA	160
Carbon tetrachloride (Tetrachloromethane)	—	Solvent	32102	56-23-5	.06	MCL-CA	0.5
Chlorobenzene	—	Solvent	34301	108-90-7	.028	MCL-CA	70
Chloroethane	—	Solvent	34311	75-00-3	.12	na	na
Chloroform (Trichloromethane)	D	Disinfection by-product (THM)	32106	67-66-3	.024	MCL-US	180
Chloromethane	—	Refrigerant, organic synthesis	34418	74-87-3	.17	HAL-US	30
3-Chloro-1-propene (3-Chloropropene)	—	Organic synthesis	78109	107-05-1	.5	na	na
2-Chlorotoluene	—	Solvent	77275	95-49-8	.04	NL-CA	140
4-Chlorotoluene	—	Solvent	77277	106-43-4	.05	NL-CA	140
Dibromochloromethane	—	Disinfection by-product (THM)	32105	124-48-1	.10	MCL-US	180
1,2-Dibromo-3-chloropropane (DBCP)	D	Fumigant	82625	96-12-8	.51	MCL-US	0.2
1,2-Dibromoethane (EDB)	D	Fumigant	77651	106-93-4	.036	MCL-US	0.05
Dibromomethane	—	Solvent	30217	74-95-3	.050	na	na
1,2-Dichlorobenzene (o-Dichlorobenzene)	—	Solvent	34536	95-50-1	.048	MCL-CA	600
1,3-Dichlorobenzene	—	Solvent	34566	541-73-1	.03	HAL-US	600
1,4-Dichlorobenzene (p-Dichlorobenzene)	—	Fumigant	34571	106-46-7	.034	MCL-CA	5
<i>trans</i> -1,4-Dichloro-2-butene	—	Organic synthesis	73547	110-57-6	.70	na	na
Dichlorodifluoromethane (CFC-12)	—	Refrigerant	34668	75-71-8	.18	NL-CA	1,000
1,1-Dichloroethane (1,1-DCA)	D	Solvent	34496	75-34-3	.035	MCL-CA	5
1,2-Dichloroethane (1,2-DCA)	D	Solvent	32103	107-06-2	.13	MCL-CA	0.5
1,1-Dichloroethene (1,1-DCE)	D	Organic synthesis	34501	75-35-4	.024	MCL-CA	6
<i>cis</i> -1,2-Dichloroethene (<i>cis</i> -1,2-DCE)	D	Solvent	77093	156-59-2	.024	MCL-CA	6
<i>trans</i> -1,2-Dichloroethene (<i>trans</i> -1,2-DCE)	—	Solvent	34546	156-60-5	.032	MCL-CA	10
Dichloromethane (Methylene chloride)	—	Solvent	34423	75-09-2	.06	MCL-US	5
1,2-Dichloropropane (1,2-DCP)	D	Fumigant	34541	78-87-5	.029	MCL-US	5

Table 3A. Volatile organic compounds, primary uses or sources, comparison thresholds, and reporting information for the U.S. Geological Survey National Water Quality Laboratory Schedule 2020.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007. **Detection:** D, detected in ground-water samples (table 5); —, not detected. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists. HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL-CA, California Department of Public Health notification level; RSD5-US, U.S. Environmental Protection Agency risk specific dose at a risk factor of 10⁻⁵. **Primary use or source:** THM, trihalomethane. **Abbreviations:** CAS, Chemical Abstracts Service; LRL, laboratory reporting level; USGS, U.S. Geological Survey; µg/L, micrograms per liter; na, not available]

Constituent	Detection	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type	Threshold value (µg/L)
1,3-Dichloropropane	—	Fumigant	77173	142-28-9	0.06	na	na
2,2-Dichloropropane	—	Fumigant	77170	594-20-7	.05	na	na
1,1-Dichloropropene	—	Organic synthesis	77168	563-58-6	.026	na	na
<i>cis</i> -1,3-Dichloropropene	—	Fumigant	34704	10061-01-5	.05	RSD5-US	²⁴
<i>trans</i> -1,3-Dichloropropene	—	Fumigant	34699	10061-02-6	.09	RSD5-US	²⁴
Diethyl ether	—	Solvent	81576	60-29-7	.08	na	na
Diisopropyl ether (DIPE)	—	Gasoline oxygenate	81577	108-20-3	.10	na	na
Ethylbenzene	D	Gasoline hydrocarbon	34371	100-41-4	.030	MCL-CA	300
Ethyl <i>tert</i> -butyl ether (ETBE)	—	Gasoline oxygenate	50004	637-92-3	.030	na	na
Ethyl methacrylate	—	Organic synthesis	73570	97-63-2	.18	na	na
1-Ethyl-2-methylbenzene (o-Ethyl toluene, 2-Ethyltoluene)	—	Gasoline hydrocarbon	77220	611-14-3	.06	na	na
Hexachlorobutadiene	—	Organic synthesis	39702	87-68-3	.14	RSD5-US	9
Hexachloroethane	—	Solvent	34396	67-72-1	.14	HAL-US	1
2-Hexanone (<i>n</i> -Butyl methyl ketone)	—	Solvent	77103	591-78-6	.4	na	na
Isopropylbenzene (Cumene)	D	Gasoline hydrocarbon	77223	98-82-8	.038	NL-CA	770
4-Isopropyl-1-methylbenzene (4-Isopropyltoluene, p-Isopropyltoluene)	—	Gasoline hydrocarbon	77356	99-87-6	.08	na	na
Methyl acrylate	—	Organic synthesis	49991	96-33-3	1.0	na	na
Methyl acrylonitrile	—	Organic synthesis	81593	126-98-7	.40	na	na
Methyl bromide (Bromomethane)	—	Fumigant	34413	74-83-9	.33	HAL-US	10
Methyl <i>tert</i> -butyl ether (MTBE)	—	Gasoline oxygenate	78032	1634-04-4	.10	MCL-CA	13
Methyl iodide (Iodomethane)	—	Organic synthesis	77424	74-88-4	.50	na	na
Methyl isobutyl ketone (MIBK)	—	Solvent	78133	108-10-1	.37	NL-CA	120
Methyl methacrylate	—	Organic synthesis	81597	80-62-6	.20	na	na
Methyl <i>tert</i> -pentyl ether (<i>tert</i> -Amyl methyl ether, TAME)	—	Gasoline oxygenate	50005	994-05-8	.04	na	na
Naphthalene	—	Gasoline hydrocarbon	34696	91-20-3	.52	NL-CA	17
<i>n</i> -Propylbenzene	—	Solvent	77224	103-65-1	.042	NL-CA	260
Styrene	—	Gasoline hydrocarbon	77128	100-42-5	.042	MCL-US	100
1,1,1,2-Tetrachloroethane	—	Solvent	77562	630-20-6	.03	HAL-US	70
1,1,2,2-Tetrachloroethane	—	Solvent	34516	79-34-5	.08	MCL-CA	1
Tetrachloroethene (PCE)	D	Solvent	34475	127-18-4	.030	MCL-US	5
Tetrahydrofuran	—	Solvent	81607	109-99-9	1.2	na	na
1,2,3,4-Tetramethylbenzene	—	Gasoline hydrocarbon	49999	488-23-3	.14	na	na
1,2,3,5-Tetramethylbenzene (Isodurene)	—	Gasoline hydrocarbon	50000	527-53-7	.14	na	na
Toluene	D	Gasoline hydrocarbon	34010	108-88-3	.02	MCL-CA	150
1,2,3-Trichlorobenzene	—	Organic synthesis	77613	87-61-6	.18	na	na
1,2,4-Trichlorobenzene	—	Solvent	34551	120-82-1	.12	MCL-CA	5
1,1,1-Trichloroethane (TCA)	—	Solvent	34506	71-55-6	.032	MCL-CA	200
1,1,2-Trichloroethane	—	Solvent	34511	79-00-5	.04	MCL-CA	5
Trichloroethene (TCE)	D	Solvent	39180	79-01-6	.038	MCL-US	5
Trichlorofluoromethane (CFC-11)	—	Refrigerant	34488	75-69-4	.08	MCL-CA	150
1,2,3-Trichloropropane (1,2,3-TCP)	D	Fumigant, solvent	77443	96-18-4	.18	HAL-US ³	40

Table 3A. Volatile organic compounds, primary uses or sources, comparison thresholds, and reporting information for the U.S. Geological Survey National Water Quality Laboratory Schedule 2020.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007. **Detection:** D, detected in ground-water samples (table 5); —, not detected. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists. HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL-CA, California Department of Public Health notification level; RSD5-US, U.S. Environmental Protection Agency risk specific dose at a risk factor of 10⁻⁵. **Primary use or source:** THM, trihalomethane. **Abbreviations:** CAS, Chemical Abstracts Service; LRL, laboratory reporting level; USGS, U.S. Geological Survey; µg/L, micrograms per liter; na, not available]

Constituent	Detection	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type	Threshold value (µg/L)
1,1,2-Trichlorotrifluoroethane (CFC-113)	—	Refrigerant	77652	76-13-1	0.038	MCL-CA	1,200
1,2,3-Trimethylbenzene	—	Gasoline hydrocarbon	77221	526-73-8	.06	na	na
1,2,4-Trimethylbenzene	D	Gasoline hydrocarbon	77222	95-63-6	.056	NL-CA	330
1,3,5-Trimethylbenzene	—	Organic synthesis	77226	108-67-8	.044	NL-CA	330
Vinyl bromide (Bromoethene)	—	Fire retardant	50002	593-60-2	.10	na	na
Vinyl chloride (Chloroethene)	—	Organic synthesis	39175	75-01-4	.08	MCL-CA	0.5
<i>m</i> - and <i>p</i> -Xylene	—	Gasoline hydrocarbon	85795	108-38-3, 106-42-3	.06	MCL-CA	⁴ 1,750
<i>o</i> -Xylene	—	Gasoline hydrocarbon	77135	95-47-6	.038	MCL-CA	⁴ 1,750

¹ The MCL-US thresholds for trihalomethanes are the sum of chloroform, bromoform, bromodichloromethane, and dibromochloromethane.

² The RSD5 threshold for 1,3-dichloropropene is the sum of its isomers (*cis* and *trans*).

³ In earlier reports in this series, the NL-CA (0.005 µg/L) was used as the comparison threshold for 1,2,3-TCP.

⁴ The MCL-CA threshold for xylenes is the sum of all xylenes.

Table 3B. Low-level 1,2-dibromo-3-chloropropane (DBCP) and 1,2-dibromoethane (EDB), primary uses or sources, comparison thresholds, and reporting information for the U.S. Geological Survey National Water Quality Laboratory Schedule 1306.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007. **Detection:** D, detected in ground-water samples ([table 5](#)). **Threshold type and value:** Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; MCL-US, U.S. Environmental Protection Agency maximum contaminant level. **Abbreviations:** CAS, Chemical Abstracts Service; LRL, laboratory reporting level; USGS, U.S. Geological Survey; µg/L, micrograms per liter]

Constituent	Detection	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold	
						Type	Value (µg/L)
1,2-Dibromo-3-chloropropane (DBCP)	D	Fumigant	82625	96-12-8	0.03	MCL-US	0.2
1,2-Dibromoethane (EDB)	D	Fumigant	77651	106-93-4	.04	MCL-US	.05

Table 3C. Gasoline oxygenates and selected degradates, primary uses or sources, comparison thresholds, and reporting information for the U.S. Geological Survey National Water Quality Laboratory Schedule 4024.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists. MCL-US, U.S. Environmental Protection Agency maximum contaminant level. **Abbreviations:** CAS, Chemical Abstracts Service; LRL, laboratory reporting level; USGS, U.S. Geological Survey; µg/L, micrograms per liter; na, not available; —, not detected in ground-water samples]

Constituent	Detection	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold	
						Type	Value (µg/L)
Acetone	—	Degradate	81552	67-64-1	1.2	na	na
<i>tert</i> -Amyl alcohol	—	Oxygenate	77073	75-85-4	1.0	na	na
<i>tert</i> -Butyl alcohol (TBA)	—	Degradate	77035	75-65-0	1	NL-CA	12
Diisopropyl ether (DIPE)	—	Oxygenate	81577	108-20-3	0.06	na	na
Ethyl <i>tert</i> -butyl ether (ETBE)	—	Oxygenate	50004	637-92-3	.06	na	na
Methyl acetate	—	Degradate	77032	79-20-9	.43	na	na
Methyl <i>tert</i> -butyl ether (MTBE)	—	Oxygenate	78032	1634-04-4	.05	MCL-US	13
Methyl <i>tert</i> -pentyl ether (<i>tert</i> -Amyl methyl ether, TAME)	—	Oxygenate	50005	994-05-8	.05	na	na

Table 3D. Pesticides and pesticide degradates, primary uses or sources, comparison thresholds, and reporting information for the U.S. Geological Survey National Water Quality Laboratory Schedule 2033.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007.

Detection: D, detected in ground-water samples (table 6A); —, not detected. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; RSD5-US, U.S. Environmental Protection Agency risk specific dose at a risk factor of 10⁻⁵.

Abbreviations: CAS, Chemical Abstracts Service; LRL, laboratory reporting level; µg/L, micrograms per liter; na, not available]

Constituent	Detection	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type	Threshold value (µg/L)
Acetochlor	—	Herbicide	49260	34256-82-1	0.006	na	na
Alachlor	—	Herbicide	46342	15972-60-8	.005	MCL-US	2
Atrazine	D	Herbicide	39632	1912-24-9	.007	MCL-CA	1
Azinphos-methyl	—	Insecticide	82686	86-50-0	.05	na	na
Azinphos-methyl oxygen analog	— ¹	Insecticide degradate	61635	961-22-8	.07	na	na
Benfluralin	— ¹	Herbicide	82673	1861-40-1	.01	na	na
Carbaryl	—	Insecticide	82680	63-25-2	.041	RSD5-US	400
Carbofuran	—	Insecticide	82674	1563-66-2	.016	MCL-CA	18
2-Chloro-2,6-diethylacetanilide	—	Herbicide degradate	61618	6967-29-9	.005	na	na
4-Chloro-2-methylphenol	— ¹	Herbicide degradate	61633	1570-64-5	.0056	na	na
Chlorpyrifos	D	Insecticide	38933	2921-88-2	.005	HAL-US	2
Chlorpyrifos, oxygen analog	— ¹	Insecticide degradate	61636	5598-15-2	.0562	na	na
Cyanazine	—	Herbicide	04041	21725-46-2	.018	HAL-US	1
Cyfluthrin	— ¹	Insecticide	61585	68359-37-5	.0267	na	na
λ-Cyhalothrin	— ¹	Insecticide	61595	91465-08-6	.0089	na	na
Cypermethrin	— ¹	Insecticide	61586	52315-07-8	.0086	na	na
DCPA (Dacthal)	—	Herbicide	82682	1861-32-1	.003	HAL-US	70
Deethylatrazine (2-Chloro-4-isopropylamino-6-amino-s-triazine)	D ¹	Herbicide degradate	04040	6190-65-4	.028	na	na
Desulfnylfipronil	—	Insecticide degradate	62170	na	.012	na	na
Desulfnylfipronil amide	—	Insecticide degradate	62169	na	.029	na	na
Diazinon	—	Insecticide	39572	333-41-5	.005	HAL-US	1
Diazinon, oxygen analog	—	Insecticide degradate	61638	962-58-3	.01	na	na
3,4-Dichloroaniline	D	Herbicide degradate	61625	95-76-1	.0045	na	na
3,5-Dichloroaniline	—	Herbicide degradate	61627	626-43-7	.0043	na	na
Dichlorvos	— ¹	Insecticide	38775	62-73-7	.0118	na	na
Dicrotophos	— ¹	Insecticide	38454	141-66-2	.0843	na	na
Dieldrin	D	Insecticide	39381	60-57-1	.009	RSD5-US	.02
2,6-Diethylaniline	—	Herbicide degradate	82660	579-66-8	.006	na	na
Dimethoate	— ¹	Insecticide	82662	60-51-5	.0061	na	na
Disulfoton	— ¹	Insecticide	82677	298-04-4	.021	HAL-US	.7
Disulfoton sulfone	—	Insecticide degradate	61640	2497-06-5	.0059	na	na
α-Endosulfan	—	Insecticide	34362	959-98-8	.0047	na	na
Endosulfan sulfate	—	Insecticide degradate	61590	1031-07-8	.0138	na	na
EPTC (S-Ethyl dipropylthiocarbamate)	D	Herbicide	82668	759-94-4	.004	na	na

Table 3D. Pesticides and pesticide degradates, primary uses or sources, comparison thresholds, and reporting information for the U.S. Geological Survey National Water Quality Laboratory Schedule 2033.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007. **Detection:** D, detected in ground-water samples (table 6A); —, not detected. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; RSD5-US, U.S. Environmental Protection Agency risk specific dose at a risk factor of 10⁻⁵. **Abbreviations:** CAS, Chemical Abstracts Service; LRL, laboratory reporting level; µg/L, micrograms per liter; na, not available]

Constituent	Detection	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type	Threshold value (µg/L)
Ethion	—	Insecticide	82346	563-12-2	0.004	na	na
Ethion monoxon	—	Insecticide degradate	61644	17356-42-2	.002	na	na
Ethoprop	—	Herbicide	82672	13194-48-4	.005	na	na
2-Ethyl-6-methylaniline	—	Herbicide degradate	61620	24549-06-2	.0045	na	na
Fenamiphos	—	Insecticide	61591	22224-92-6	.029	HAL-US	0.7
Fenamiphos sulfone	—	Insecticide degradate	61645	31972-44-8	.0491	na	na
Fenamiphos sulfoxide	— ¹	Insecticide degradate	61646	31972-43-7	.0387	na	na
Fipronil	—	Insecticide	62166	120068-37-3	.016	na	na
Fipronil sulfide	—	Insecticide degradate	62167	120067-83-6	.013	na	na
Fipronil sulfone	—	Insecticide degradate	62168	120068-36-2	.024	na	na
Fonofos	—	Insecticide	04095	944-22-9	.003	HAL-US	10
Hexazinone	D	Herbicide	04025	51235-04-2	.0129	HAL-US	400
Iprodione	— ¹	Fungicide	61593	36734-19-7	.538	na	na
Isofenphos	—	Insecticide	61594	25311-71-1	.0034	na	na
Malaoxon	—	Insecticide degradate	61652	1634-78-2	.0298	na	na
Malathion	—	Insecticide	39532	121-75-5	.027	HAL-US	100
Metalaxyl	—	Fungicide	61596	57837-19-1	.0051	na	na
Methodathion	—	Insecticide	61598	950-37-8	.0058	na	na
Metolachlor	D	Herbicide	39415	51218-45-2	.006	HAL-US	700
Metribuzin	D	Herbicide	82630	21087-64-9	.006	HAL-US	70
Molinate	—	Herbicide	82671	2212-67-1	.0016	MCL-CA	20
Myclobutanil	—	Fungicide	61599	88671-89-0	.008	na	na
1-Naphthol	— ¹	Insecticide degradate	49295	90-15-3	.0882	na	na
Oxyfluorfen	— ¹	Herbicide	61600	42874-03-3	.0073	na	na
Paraoxon-methyl	— ¹	Insecticide degradate	61664	950-35-6	.0299	na	na
Parathion-methyl	—	Insecticide	82667	298-00-0	.015	HAL-US	1
Pendimethalin	—	Herbicide	82683	40487-42-1	.022	na	na
cis-Permethrin	— ¹	Insecticide	82687	54774-45-7	.006	na	na
Phorate	— ¹	Insecticide	82664	298-02-2	.011	na	na
Phorate oxygen analog	—	Insecticide degradate	61666	2600-69-3	.1048	na	na
Phosmet	— ¹	Insecticide	61601	732-11-6	.0079	na	na
Phosmet oxon	—	Insecticide degradate	61668	3735-33-9	.0511	na	na
Prometon	D	Herbicide	04037	1610-18-0	.01	HAL-US	100
Prometryn	D	Herbicide	04036	7287-19-6	.0054	na	na
Pronamide	—	Herbicide	82676	23950-58-5	.004	RSD5-US	20

Table 3D. Pesticides and pesticide degradates, primary uses or sources, comparison thresholds, and reporting information for the U.S. Geological Survey National Water Quality Laboratory Schedule 2033.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007.

Detection: D, detected in ground-water samples (table 6A); —, not detected. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; RSD5-US, U.S. Environmental Protection Agency risk specific dose at a risk factor of 10⁻⁵.

Abbreviations: CAS, Chemical Abstracts Service; LRL, laboratory reporting level; µg/L, micrograms per liter; na, not available]

Constituent (common name)	Detection	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type	Threshold value (µg/L)
Propanil	—	Herbicide	82679	709-98-8	0.011	na	na
Propargite	—	Insecticide	82685	2312-35-8	.023	na	na
<i>cis</i> -Propiconazole	—	Fungicide	79846	60207-90-1	.008	na	na
<i>trans</i> -Propiconazole	—	Fungicide	79847	60207-90-1	.0133	na	na
Simazine	D	Herbicide	04035	122-34-9	.005	MCL-US	4
Tebuconazole	— ¹	Fungicide	62852	107534-96-3	.0136	na	na
Tebuthiuron	—	Herbicide	82670	34014-18-1	.016	HAL-US	500
Tefluthrin	— ¹	Insecticide	61606	79538-32-2	.0077	na	na
Terbufos	—	Insecticide	82675	13071-79-9	.017	HAL-US	0.4
Terbufos oxygen analog sulfone	—	Insecticide degradate	61674	56070-15-6	.0676	na	na
Terbutylazine	—	Herbicide	04022	5915-41-3	.0102	na	na
Thiobencarb	—	Herbicide	82681	28249-77-6	.01	MCL-CA	70
Tribufos	—	Herbicide	61610	78-48-8	.0044	na	na
Trifluralin	—	Herbicide	82661	1582-09-8	.009	HAL-US	10

¹ The median laboratory matrix-spike recovery was less than 70 percent. Low recoveries may indicate that the compound might not have been detected in some samples if it was present at very low concentrations

Table 3E. Polar pesticides and metabolites, primary uses or sources, comparison thresholds, and reporting information for the U.S. Geological Survey National Water Quality Laboratory Schedule 2060.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007. **Detection:** D, detected in ground-water samples (table 6B); —, not detected. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; RSD5-US, U.S. Environmental Protection Agency risk specific dose at a risk factor of 10^{-5} . **Abbreviations:** CAS, Chemical Abstracts Service; LRL, laboratory reporting level; USGS, U.S. Geological Survey; $\mu\text{g/L}$, micrograms per liter; na, not available]

Constituent	Detection	Primary use or source	USGS parameter code	CAS number	LRL ($\mu\text{g/L}$)	Threshold type	Threshold value ($\mu\text{g/L}$)
Acifluorfen	—	Herbicide	49315	50594-66-6	0.028	na	na
Aldicarb	—	Insecticide	49312	116-06-3	¹ .04	MCL-US	3
Aldicarb sulfone	—	Degradate	49313	1646-88-4	.018	MCL-US	3
Aldicarb sulfoxide	—	Degradate	49314	1646-87-3	.022	MCL-US	4
Atrazine	D	Herbicide	39632	1912-24-9	.008	MCL-CA	1
Bendiocarb	—	Insecticide	50299	22781-23-3	.020	na	na
Benomyl	—	Fungicide	50300	17804-35-2	.022	na	na
Bensulfuron-methyl	—	Herbicide	61693	83055-99-6	.018	na	na
Bentazon	—	Herbicide	38711	25057-89-0	.012	MCL-CA	18
Bromacil	D	Herbicide	04029	314-40-9	.018	HAL-US	70
Bromoxynil	—	Herbicide	49311	1689-84-5	.028	na	na
Caffeine	D	Beverages	50305	58-08-2	.018	na	na
Carbaryl	—	Herbicide	49310	63-25-2	.018	RSD5-US	400
Carbofuran	—	Herbicide	49309	1563-66-2	.016	MCL-CA	18
Chloramben, methyl ester	—	Herbicide	61188	7286-84-2	.024	na	na
Chlorimuron-ethyl	—	Herbicide	50306	90982-32-4	.032	na	na
3-(4-Chlorophenyl)-1-methyl urea	—	Degradate	61692	5352-88-5	.036	na	na
Clopyralid	—	Herbicide	49305	1702-17-6	.024	na	na
Cycloate	—	Herbicide	04031	1134-23-2	.014	na	na
2,4-D (2,4-Dichlorophenoxyacetic acid), 2,4-D methyl ester (2,4-Dichlorophenoxyacetic acid methyl ester) ²	—	Herbicides	39732, 50470	94-75-7, 1928-38-7	.038	MCL-US	70
2,4-DB (4-(2,4-Dichlorophenoxy)butyric acid)	—	Herbicide	38746	94-82-6	.020	na	na
DCPA (Dacthal) monoacid	—	Degradate	49304	887-54-7	.028	na	na
Deethylatrazine (2-Chloro-4-isopropylamino-6-amino- <i>s</i> -triazine)	D	Degradate	04040	6190-65-4	.028	na	na
Deisopropyl atrazine (2-Chloro-6-ethylamino-4-amino- <i>s</i> -triazine)	D	Degradate	04038	1007-28-9	.08	na	na
Dicamba	—	Herbicide	38442	1918-00-9	.036	HAL-US	4,000
Dichlorprop	—	Herbicide	49302	120-36-5	.028	na	na
Dinoseb (Dinitrobutyl phenol)	D	Herbicide	49301	88-85-7	.038	MCL-CA	7
Diphenamid	D	Herbicide	04033	957-51-7	.010	HAL-US	200
Diuron	D	Herbicide	49300	330-54-1	.015	HAL-US	10
Fenuron	—	Herbicide	49297	101-42-8	.019	na	na
Flumetsulam	—	Herbicide	61694	98967-40-9	.040	na	na
Fluometuron	—	Herbicide	38811	2164-17-2	.016	HAL-US	90
Hydroxyatrazine (2-Hydroxy-4-isopropylamino-6-ethylamino- <i>s</i> -triazine)	—	Degradate	50355	2163-68-0	.032	na	na
3-Hydroxycarbofuran	—	Degradate	49308	16655-82-6	.008	na	na
Imazaquin	—	Herbicide	50356	81335-37-7	.036	na	na
Imazethapyr	D ³	Herbicide	50407	81335-77-5	.038	na	na
Imidacloprid	—	Insecticide	61695	138261-41-3	.020	na	na
Linuron	—	Herbicide	38478	330-55-2	.014	na	na

Table 3E. Polar pesticides and metabolites, primary uses or sources, comparison thresholds, and reporting information for the U.S. Geological Survey National Water Quality Laboratory Schedule 2060.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007. **Detection:** D, detected in ground-water samples (table 6B); —, not detected. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; RSD5-US, U.S. Environmental Protection Agency risk specific dose at a risk factor of 10⁻⁵. **Abbreviations:** CAS, Chemical Abstracts Service; LRL, laboratory reporting level; USGS, U.S. Geological Survey; µg/L, micrograms per liter; na, not available]

Constituent	Detection	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type	Threshold value (µg/L)
MCPA (2-Methyl-4-chlorophenoxyacetic acid)	—	Herbicide	38482	94-74-6	0.030	HAL-US	30
MCPB (4-(2-Methyl-4-chlorophenoxy) butyric acid)	—	Herbicide	38487	94-81-5	.010	na	na
Metalaxyl	—	Fungicide	50359	57837-19-1	.012	na	na
Methiocarb	—	Insecticide	38501	2032-65-7	.010	na	na
Methomyl	—	Insecticide	49296	16752-77-5	.020	HAL-US	200
Metsulfuron methyl	—	Herbicide	61697	74223-64-6	¹ .025	na	na
Neburon	—	Herbicide	49294	555-37-3	.012	na	na
Nicosulfuron	—	Herbicide	50364	111991-09-4	.04	na	na
Norflurazon	—	Herbicide	49293	27314-13-2	.020	na	na
Oryzalin	—	Herbicide	49292	19044-88-3	.012	na	na
Oxamyl	—	Insecticide	38866	23135-22-0	.030	MCL-CA	50
Picloram	—	Herbicide	49291	1918-02-01	.032	MCL-US	500
Propham	—	Herbicide	49236	122-42-9	.030	HAL-US	100
Propiconazole	—	Fungicide	50471	60207-90-1	.010	na	na
Propoxur	—	Insecticide	38538	114-26-1	.008	na	na
Siduron	—	Herbicide	38548	1982-49-6	.020	na	na
Sulfometuron-methyl	—	Herbicide	50337	74222-97-2	.038	na	na
Tebuthiuron	—	Herbicide	82670	34014-18-1	.026	HAL-US	500
Terbacil	—	Herbicide	04032	5902-51-2	.016	HAL-US	90
Triclopyr	—	Herbicide	49235	55335-06-3	.026	na	na

¹ Although listed as LRLs, these constituents were reported using method reporting levels (MRLs) during the period of this study.

² These two constituents (2,4-D and 2,4-D methyl ester) were summed on a molar basis and reported as 2,4-D.

³ The median laboratory matrix-spike recovery was greater than 130 percent. High recoveries may indicate that reported values could be higher than what is in the sample.

Table 3F. Constituents of special interest, primary uses or sources, comparison thresholds, and reporting information for the Montgomery Watson Harza Laboratory.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Thresholds and threshold values as of October 18, 2007.

Detection: D, detected in ground-water samples (table 7); —, not detected. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; HAL-US, U.S.

Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; NL-CA, California Department of Public Health notification level. **Abbreviations:** CAS, Chemical Abstracts Service; LRL, laboratory reporting level; µg/L, micrograms per liter]

Constituent	Detection	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold	
						Type	Value (µg/L)
Perchlorate	D	Rocket fuel, fireworks, flares, fertilizer	61209	14797-73-0	0.5	MCL-CA	6
1,2,3-Trichloropropane (1,2,3-TCP)	D	Fumigant, solvent	77443	96-18-4	.005	HAL-US	¹ 40
N-Nitrosodimethylamine (NDMA)	—	Rocket fuel, plasticizer	64176	62-75-9	.002	NL-CA	.010

¹ In earlier reports in this series, the NL-CA (0.005 µg/L) was used as the comparison threshold for 1,2,3-TCP.

Table 3G. Nutrients and dissolved organic carbon, primary uses or sources, comparison thresholds, and reporting information for the U.S. Geological Survey National Water Quality Laboratory Schedule 2755 and Laboratory code 2613.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007.

Detection: D, detected in ground-water samples (table 8). **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level. **Abbreviations:** CAS, Chemical Abstracts Service; LRL, laboratory reporting level; U.S. Geological Survey; µg/L, micrograms per liter; na, not available]

Constituent	Detection	USGS parameter code	CAS number	LRL (µg/L)	Threshold	
					Type	Value (µg/L)
Ammonia (as nitrogen)	D	00608	7664-41-7	0.04	HAL-US	30
Nitrite (as nitrogen)	D	00613	14797-65-0	.008	MCL-US	1
Nitrate plus nitrite (as nitrogen)	D	00631	na	.060	MCL-US	10
Total nitrogen (ammonia, nitrite, nitrate, organic nitrogen) (as nitrogen)	D	62854	17778-88-0	.06	na	na
Phosphorus, phosphate, orthophosphate (as phosphorus)	D	00671	14265-44-2	.006	na	na
Dissolved organic carbon (DOC)	D	00681	na	.33	na	na

Table 3H. Major and minor ions and trace elements, comparison thresholds, and reporting information for the U.S. Geological Survey National Water Quality Laboratory Schedule 1948.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007.

Detection: D, detected in ground-water samples (tables 9 and 10); —, not detected. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; AL-US, U.S. Environmental Protection Agency action level; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL-CA, California Department of Public Health notification level; SMCL-CA, California Department of Public Health secondary maximum contaminant level. **Abbreviations:** CAS, Chemical Abstracts Service; LRL, laboratory reporting level; mg/L, milligrams per liter; µg/L, micrograms per liter; na, not available]

Constituent	Detection	USGS parameter code	CAS number	LRL (µg/L)	Threshold	
					Type	Value (µg/L)
Major and minor ions (mg/L)						
Bromide	D	71870	24959-67-9	0.02	na	na
Calcium	D	00915	7440-70-2	.02	na	na
Chloride	D	00940	16887-00-6	.20	SMCL-CA	¹ 250 (500)
Fluoride	D	00950	16984-48-8	.10	MCL-CA	2
Iodide	D	78165	7553-56-2	.002	na	na
Magnesium	D	00925	7439-95-4	.008	na	na
Potassium	D	00935	7440-09-7	.16	na	na
Silica	D	00955	7631-86-9	.04	na	na
Sodium	D	00930	7440-23-5	.20	na	na
Sulfate	D	00945	14808-79-8	.18	SMCL-CA	¹ 250 (500)
Total dissolved solids (TDS)	D	70300	na	10	SMCL-CA	¹ 500 (1,000)
Trace elements (µg/L)						
Aluminum	D	01106	7429-90-5	1.6	MCL-CA	1,000
Antimony	D	01095	7440-36-0	.20	MCL-US	6
Arsenic	D	01000	7440-38-2	.12	MCL-US	10
Barium	D	01005	7440-39-3	.2	MCL-CA	1,000
Beryllium	D	01010	7440-41-7	.06	MCL-US	4
Boron	D	01020	7440-42-8	8	NL-CA	1,000
Cadmium	D	01025	7440-43-9	.04	MCL-US	5
Chromium	D	01030	7440-47-3	.04	MCL-CA	50
Cobalt	D	01035	7440-48-4	.04	na	na
Copper	D	01040	7440-50-8	.4	AL-US	1,300
Iron	D	01046	7439-89-6	6	SMCL-CA	300
Lead	D	01049	7439-92-1	.08	AL-US	15
Lithium	D	01130	7439-93-2	.6	na	na
Manganese	D	01056	7439-96-5	.2	SMCL-CA	50
Mercury	D	71890	7439-97-6	.010	MCL-US	2
Molybdenum	D	01060	7439-98-7	.4	HAL-US	40
Nickel	D	01065	7440-02-0	.06	MCL-CA	100
Selenium	D	01145	7782-49-2	.08	MCL-US	50
Silver	—	01075	7440-22-4	.20	SMCL-CA	100
Strontium	D	01080	7440-24-6	.4	HAL-US	4,000
Thallium	—	01057	7440-28-0	.04	MCL-US	2
Tungsten	D	01155	7440-33-7	.06	na	na
Uranium	D	22703	7440-61-1	.04	MCL-US	30
Vanadium	D	01085	7440-62-2	.10	NL-CA	50
Zinc	D	01090	7440-66-6	.6	HAL-US	2,000

¹ The recommended SMCL-CA thresholds for chloride, sulfate, and TDS are listed with the upper SMCL-CA thresholds in parentheses.

Table 3I. Arsenic, iron, and chromium species, comparative thresholds, and reporting information for the U.S. Geological Survey Trace Metal Laboratory, Boulder, Colorado.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007. **Detection:** D, detected in ground-water samples ([table 11](#)); —, not detected. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level. **Abbreviations:** CAS, Chemical Abstracts Service; MDL, method detection limit; USGS, U.S. Geological Survey; µg/L, micrograms per liter; na, not available]

Constituent (valence state)	Detection	USGS parameter code	CAS number	MDL (µg/L)	Threshold	
					Type	Value (µg/L)
Arsenic(III)	—	99034	22569-72-8	1	na	na
Arsenic(Total)	D	99033	7440-38-2	0.5	MCL-US	10
Iron(II)	D	01047	7439-89-6	2	na	na
Iron(Total)	D	01046	7439-89-6	2	HAL-US	300
Chromium(VI), hexavalent	D	01032	18540-29-9	1	na	1
Chromium(Total)	D	01030	7440-47-3	1	MCL-CA	50

Table 3J. Isotopic and radioactive constituents, comparison thresholds, and reporting information for laboratories.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007. Stable isotope ratios are reported in the standard delta notation (δ), the ratio of a heavier isotope to more common lighter isotope of that element, relative to a standard reference material. **Detection:** D, detected in ground-water samples (tables 12 and 14). **Reporting level type:** MU, method uncertainty; SSMDC, sample-specific minimum detectable concentration; MRL, minimum reporting level. **Reporting level or uncertainty:** CSU, combined standard uncertainty; CV, critical value. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level. **Abbreviations:** CAS, Chemical Abstracts Service; USGS, U.S. Geological Survey; pCi/L, picocurie per liter; $\mu\text{g/L}$, micrograms per liter; na, not available]

Constituent	Detection	USGS parameter code	CAS number	Reporting level type ($\mu\text{g/L}$)	Reporting level or uncertainty	Threshold	
						Type	Value ($\mu\text{g/L}$)
Stable isotope ratios (per mil)							
$\delta^2\text{H}$ of water ¹	D	82082	na	MU	2	na	na
$\delta^{18}\text{O}$ of water ¹	D	82085	na	MU	0.20	na	na
$\delta^{15}\text{N}$ of nitrate ¹	D	82690	na	MU	.25	na	na
$\delta^{18}\text{O}$ of nitrate ¹	D	63041	na	MU	.50	na	na
$\delta^{13}\text{C}$ of dissolved carbonates ²	D	82081	na	1 sigma	.05	na	na
Radioactive constituents (percent modern)							
Carbon-14 ³	D	49933	14762-75-5	1 sigma	0.0015	na	na
Radioactive constituents (pCi/L)							
Gross-alpha radioactivity, 72-hour and 30-day counts ⁴	D	62636, 62639	12587-46-1	SSMDC	CSU and CV	MCL-US	15
Gross-beta radioactivity, 72-hour and 30-day counts ⁴	D	62642, 62645	12587-47-2	SSMDC	CSU and CV	MCL-CA	50
Radium-226 ⁴	D	09511	13982-63-3	SSMDC	CSU and CV	MCL-US ⁵	5
Radium-228 ⁴	D	81366	15262-20-1	SSMDC	CSU and CV	MCL-US ⁵	5
Radon-222 ⁶	D	82303	14859-67-7	SSMDC	CSU and CV	Proposed MCL-US ⁷	300, (4,000)
Tritium ⁸	D	07000	10028-17-8	MRL	1	MCL-CA	20,000
Uranium-234 ⁴	D	22610	13966-29-5	SSMDC	CSU and CV	MCL-CA ⁹	20
Uranium-235 ⁴	D	22620	15117-96-1	SSMDC	CSU and CV	MCL-CA ⁹	20
Uranium-238 ⁴	D	22603	7440-61-1	SSMDC	CSU and CV	MCL-CA ⁹	20

¹ U.S. Geological Survey Stable Isotope Laboratory, Reston, Virginia.

² University of Waterloo (contract laboratory).

³ University of Arizona, Accelerator Mass Spectrometry Laboratory (contract laboratory).

⁴ Eberline Analytical Services (contract laboratory).

⁵ The MCL-US threshold for radium is the sum of radium-226 and radium-228.

⁶ U.S. Geological Survey National Water Quality Laboratory.

⁷ Two MCLs have been proposed for radon-222. The proposed Alternative MCL is in parentheses.

⁸ U.S. Geological Survey Stable Isotope and Tritium Laboratory, Menlo Park, California.

⁹ The MCL-CA threshold for uranium is the sum of all uranium isotopes.

Table 3K. Noble gases and tritium, comparison thresholds, and reporting information for the Lawrence Livermore National Laboratory.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007.

Detection: D, detected in ground-water samples (table 13). **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; MCL-CA, California Department of Public Health maximum contaminant level. **Abbreviations:** CAS: Chemical Abstracts Service; cm³STP/g, cubic centimeters of gas at standard temperature and pressure per gram of water; pCi/L, picocurie per liter; µg/L, micrograms per liter; na, not available]

Constituent	Detection	USGS parameter code	CAS number	Method uncertainty (percent)	Reporting units	Threshold	
						Type	Value (µg/L)
Argon	D	85563	7440-37-1	2	cm ³ STP/g	na	na
Helium-3/Helium-4	D	61040	na / 7440-59-7	0.75	Ratio	na	na
Helium-4	D	85561	7440-59-7	2	cm ³ STP/g	na	na
Krypton	D	85565	7439-90-9	2	cm ³ STP/g	na	na
Neon	D	61046	7440-01-09	2	cm ³ STP/g	na	na
Tritium	D	07000	10028-17-8	1	pCi/L	MCL-CA	20,000
Xenon	D	85567	7440-63-3	2	cm ³ STP/g	na	na

Table 3L. Microbial constituents, comparison thresholds, and reporting information for the U.S. Geological Survey Ohio Microbiology Laboratory.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007. **Detection:** —, not detected in ground-water samples. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; TT-US, U.S. Environmental Protection Agency treatment technique—a required process intended to reduce the level of contamination in drinking water. **Abbreviations:** USGS, U.S. Geological Survey; mL, milliliter; na, not available]

Constituent	Detection	USGS parameter code	Primary source	Method detection limit	Threshold	
					Type	Threshold value
<i>Escherichia coliform (E. coli)</i> ¹	—	90901	Sewage and animal waste indicator	1 colony/100 mL	TT-US	0
Total coliform including fecal coliform and <i>E. coli</i> ¹	—	90900	Sewage and animal waste indicator	1 colony/100 mL	MCL-US	5 percent samples positives per month
F-specific coliphage	—	99335	Sewage and animal waste indicator	na	TT-US	99.99 percent killed / inactivated
Somatic coliphage	—	99332	Sewage and animal waste indicator	na	TT-US	99.99 percent killed / inactivated

¹ Analyzed in the field.

Table 4. Water-quality indicators in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March, 2006.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007. **Hardness** is calculated using an algorithm in the USGS NWIS database from calcium (parameter code 00915) and magnesium (parameter code 00925) values measured in the USGS NWQL Schedule 1948. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; SMCL-CA, California Department of Public Health secondary maximum contaminant level. The SMCL-CA for specific conductance has recommended and upper threshold values. The upper threshold value is shown in parentheses. **GAMA identification no.:** KERN, Kern County Subbasin study unit; KERNFP, KERN flow-path well. **Abbreviations:** °C, degrees celsius; cm, centimeter; mg/L, milligrams per liter; mm, millimeter; NTU, nephelometric turbidity unit; USGS, U.S. Geological Survey; µS/cm, microsiemens per centimeter; CaCO₃, calcium carbonate; na, not available; nc, constituent not analyzed; <, less than; >, greater than; * Indicates sample value above threshold value; ** Indicates sample value above upper threshold value]

GAMA identification no.	Turbidity, field (NTU) (63676)	Dissolved oxygen, field (mg/L) (00300)	Water temperature, field (°C) (00010)	pH, field (standard units) (00400)	pH, lab (standard units) (00403)	Specific conductance, field (µS/cm at 25°C) (00095)	Specific conductance, lab (µS/cm at 25°C) (00095)	Alkalinity, field (mg/L as CaCO ₃) (29802)	Alkalinity, lab (mg/L as CaCO ₃) (29801)	Hardness (mg/L as CaCO ₃) (00900)
Reporting limit or range	0.1	0.2	0.0–38.5	0–14	0–14	5	5	1	1	na ⁴
Threshold type	na	na	na	SMCL-US	SMCL-US	SMCL-CA	SMCL-CA	na	na	na
Threshold value	na	na	na	<6.5, >8.5	<6.5, >8.5	900 (1,600)	900 (1,600)	na	na	na
Grid wells										
KERN-01	nc	7.5	nc	nc	nc	**1,950	nc	nc	nc	nc
KERN-02	nc	3.9	22.5	nc	nc	423	nc	nc	nc	nc
KERN-03	nc	1.9	23.0	nc	nc	721	nc	nc	nc	nc
KERN-04	nc	1.1	20.5	nc	nc	204	nc	nc	nc	nc
KERN-05	nc	1.8	19.5	nc	nc	*1,130	nc	nc	nc	nc
KERN-06	nc	3.9	23.0	nc	nc	830	nc	nc	nc	nc
KERN-07	nc	1.4	25.0	nc	nc	510	nc	nc	nc	nc
KERN-08	nc	<0.2	24.0	nc	nc	670	nc	nc	nc	nc
KERN-09	nc	2.1	21.0	nc	nc	749	nc	nc	nc	nc
KERN-10	nc	<.2	30.0	nc	nc	*1,200	nc	nc	nc	nc
KERN-11	nc	5.6	25.0	nc	nc	538	nc	nc	nc	nc
KERN-12	nc	1.8	20.5	nc	nc	**4,310	nc	nc	nc	nc
KERN-13	nc	7.7	23.0	nc	nc	585	nc	nc	nc	nc
KERN-14	nc	<.2	28.0	nc	nc	415	nc	nc	nc	nc
KERN-15	nc	1.7	20.0	nc	nc	422	nc	nc	nc	nc
KERN-16	nc	.3	18.5	nc	nc	**1,830	nc	nc	nc	nc
KERN-17	nc	5.4	18.5	nc	nc	244	nc	nc	nc	nc
KERN-18	nc	6.6	20.0	nc	nc	202	nc	nc	nc	nc
KERN-19	nc	<.2	24.0	nc	nc	354	nc	nc	nc	nc
KERN-20	nc	6.4	31.0	nc	nc	534	nc	nc	nc	nc
KERN-21	nc	5.7	20.0	nc	nc	*1,300	nc	nc	nc	nc
KERN-22	nc	1.1	26.0	nc	nc	738	nc	nc	nc	nc
KERN-23	nc	.5	24.0	nc	nc	**3,830	nc	nc	nc	nc
KERN-24	nc	3.6	20.0	nc	nc	**1,960	nc	nc	nc	nc
KERN-25	nc	1.9	20.5	nc	nc	700	nc	nc	nc	nc
KERN-26	nc	.8	20.5	nc	nc	380	nc	nc	nc	nc
KERN-27	nc	6.9	23.5	nc	nc	752	nc	nc	nc	nc
KERN-28	nc	.2	25.5	nc	nc	**2,440	nc	nc	nc	nc
KERN-29	nc	5.0	20.0	nc	nc	209	nc	nc	nc	nc
KERN-30	nc	8.4	23.0	nc	nc	711	nc	nc	nc	nc
KERN-31	nc	4.9	20.5	nc	nc	565	nc	nc	nc	nc
KERN-32	nc	<.2	24.5	nc	nc	*1,060	nc	nc	nc	nc

Table 4. Water-quality indicators in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March, 2006.—Continued

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007. **Hardness** is calculated using an algorithm in the USGS NWIS database from calcium (parameter code 00915) and magnesium (parameter code 00925) values measured in the USGS NWQL Schedule 1948. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; SMCL-CA, California Department of Public Health secondary maximum contaminant level. The SMCL-CA for specific conductance has recommended and upper threshold values. The upper threshold value is shown in parentheses. **GAMA identification no.:** KERN, Kern County Subbasin study unit; KERNFP, KERN flow-path well. **Abbreviations:** °C, degrees celsius; cm, centimeter; mg/L, milligrams per liter; mm, millimeter; NTU, nephelometric turbidity unit; USGS, U.S. Geological Survey; µS/cm, microsiemens per centimeter; CaCO₃, calcium carbonate; na, not available; nc, constituent not analyzed; <, less than; >, greater than; * Indicates sample value above threshold value; ** Indicates sample value above upper threshold value]

GAMA identification no.	Turbidity, field (NTU) (63676)	Dissolved oxygen, field (mg/L) (00300)	Water temperature, field (°C) (00010)	pH, field (standard units) (00400)	pH, lab (standard units) (00403)	Specific conductance, field (µS/cm at 25°C) (00095)	Specific conductance, lab (µS/cm at 25°C) (00095)	Alkalinity, field (mg/L as CaCO ₃) (29802)	Alkalinity, lab (mg/L as CaCO ₃) (29801)	Hardness (mg/L as CaCO ₃) (00900)
Grid wells—Continued										
KERN-33	nc	1.1	22.5	nc	nc	461	nc	nc	nc	nc
KERN-34	1.4	7.8	22.0	8.0	8.3	320	336	83.9	80.0	66
KERN-35	0.1	5.8	19.0	8.1	8.0	324	327	88.2	90.0	91
KERN-36	.1	3.0	19.5	8.5	8.3	342	354	58.8	62.0	77
KERN-37	.5	2.4	19.0	7.7	7.9	301	301	101	105	100
KERN-38	.5	4.0	22.0	7.7	7.7	**1,630	**1,630	104	108	390
KERN-39 ¹	nc, .1	7.8, 7.8	21.5, 21.5	nc, 7.9	nc, 7.9	630; 661	nc, 660	nc, 99.0	nc, 103	nc, 230
KERN-40	nc	.2	29.0	nc	7.8	**1,930	**1,740	nc	86.0	560
KERN-41	.2	.5	27.5	*9.6	*9.7	375	372	36.3	42.0	10
KERN-42	.8	1.5	18.0	8.4	8.3	209	208	77	81.0	56
KERN-43	nc	< .2	24.0	nc	7.7	471	474	nc	172	140
KERN-44	.2	9.0	22.0	8.0	8.0	334	332	74.5	79.0	91
KERN-45	.1	3.0	25.0	*9.1	*9.1	467	462	30.2	35.0	57
KERN-46	nc	< .2	22.0	7.6	7.8	**1,610	*1,580	nc	129	460
KERN-47	nc	5.4	24.5	nc	*8.7	574	563	nc	26.0	70
Flow-path wells										
KERNFP-01	nc	< 0.2	22.5	nc	8.0	677	697	nc	81.0	250
KERNFP-02	.2	.2	19.0	7.9	8.2	267	273	90.6	94.0	88
KERNFP-03	nc	4.0	18.0	nc	7.1	283	275	nc	76.0	85

¹ Same well sampled twice.

Table 5. Volatile organic compounds (VOCs), low-level 1,2-dibromo-3-chloropropane (DBCP) and 1,2-dibromoethane (EDB), and gasoline oxygenates and degradates detected in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March 2006.—Continued

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property. Thresholds and threshold values as of February 10, 2007. Samples from all 50 wells were analyzed, but only samples with detections are listed. Analytes are listed in order of decreasing detection frequency in the 47 grid wells. All analytes are listed in tables 3A, 3B, and 3C. **GAMA identification no.:** KERN, Kern County Subbasin study unit; KERNFP, KERN flow-path well. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL-CA, California Department of Public Health notification level. **Abbreviations:** E, estimated value; V, constituent detected in sample and an associated blank; thus, data are censored from the ground-water quality assessment; µg/L, micrograms per liter; —, not detected; *, Indicates sample value above threshold value]

GAMA identification no.	Bromo-dichloro-methane (µg/L) (32101)	1,2-Di-bromo-ethane (EDB) (µg/L) (77651)	1,1-Di-chloro-ethane (1,1-DCA) (µg/L) (34496)	1,2-Dichloro-ethane (1,2-DCA) (µg/L) (32103)	1,1-Di-chloro-ethene (1,1-DCE) (µg/L) (34501)	cis-1,2-Dichloro-ethene (cis-1,2-DCE) (µg/L) (77093)	Ethyl-benzene (µg/L) (34371)	Tri-chloro-ethene (TCE) (µg/L) (39180)	Toluene (µg/L) (34010)	VOC detections per well
LRL	0.03	0.04	0.04	0.1	0.02	0.02	0.03	0.04	0.02	
Threshold type	MCL-US	MCL-US	MCL-CA	MCL-CA	MCL-CA	MCL-CA	MCL-CA	MCL-US	MCL-CA	
Threshold value	'80	0.05	5	0.5	6	6	300	5	150	
Grid wells										
KERN-02	—	—	—	—	—	—	—	—	—	3
KERN-03	E0.03	—	—	—	—	—	—	—	—	4
KERN-04	—	—	—	—	—	—	—	—	—	1
KERN-05	—	—	—	—	—	—	—	—	—	1
KERN-06	—	—	—	—	—	—	—	—	—	1
KERN-07	—	—	—	—	—	—	—	—	—	2
KERN-08	—	—	—	—	—	—	—	—	VE0.03	1
KERN-10	—	—	—	—	—	—	E0.05	—	—	3
KERN-12	—	—	—	—	—	—	—	—	—	3
KERN-13	—	—	E0.07	—	0.35	—	—	—	—	4
KERN-14	—	—	—	—	—	—	—	—	—	1
KERN-16 ²	—	—	—	0.4	—	—	—	—	—	1
KERN-19 ²	—	—	—	—	—	—	—	—	—	1
KERN-21	—	—	—	—	—	—	—	—	—	2
KERN-22	—	—	—	—	—	—	—	—	—	1
KERN-23	—	—	—	—	—	—	—	—	—	1
KERN-24	—	—	—	—	—	—	—	—	—	2
KERN-25	—	—	—	—	—	—	—	—	—	2
KERN-27	—	—	—	—	—	—	—	—	VE0.02	3
KERN-28	—	—	—	—	—	—	—	—	—	1
KERN-31	—	—	—	—	—	—	—	E0.04	—	4
KERN-36	—	—	—	—	—	E0.02	—	—	—	3
KERN-38	—	—	—	—	—	—	—	—	—	3
KERN-39	—	—	—	—	—	—	—	—	—	4
KERN-42	—	—	—	—	—	—	—	—	—	1
KERN-43	—	—	—	—	—	—	—	—	—	1
KERN-44	—	—	—	—	—	—	—	—	—	1
KERN-45	—	—	—	—	—	—	—	—	—	1
KERN-46	—	E0.02	—	—	—	—	—	—	—	2
KERN-47	—	—	—	—	—	—	—	—	—	1
Number of detections	1	1	1	1	1	1	1	1	0	
Detection frequency (percent)	2	2	2	2	2	2	2	2	0	³ 64
Flow-path wells										
KERNFP-01	—	—	—	—	—	—	—	—	—	1

The MCL-US threshold for trihalomethanes is the sum of chloroform, bromoform, bromodichloroform, and dibromochloromethane.

² Samples analyzed with raised laboratory reporting levels: KERN-16 (LRLs doubled for all analytes); KERN-19 (LRLs doubled for all analytes).

³ Frequency of detection of at least one VOC in the grid wells. Detections with V remark codes are not included.

Table 6A. Pesticides and pesticide degradates detected in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March 2006.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property. Samples from 49 wells were analyzed, but only samples with detections are listed. No data for KERN-11. Analytes are listed in order of decreasing detection frequency in the 46 grid wells. All analytes are listed in [table 3D](#). Thresholds and threshold values as of February 10, 2007. **GAMA identification no.:** KERN, Kern County Subbasin study unit; KERNFP, KERN flow-path well. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level; RSD5-US, U.S. Environmental Protection Agency risk specific dose at a risk factor of 10⁻⁵. **Abbreviations:** E, estimated value; LRL, laboratory reporting level; na, not available; µg/L, micrograms per liter; —, not detected]

GAMA identification no.	Deethylatrazine (2-chloro-4-isopropylamino-6-amino-s-triazine) (µg/L) (04040)	Simazine (µg/L) (04035)	Atrazine (µg/L) (39632)	EPTC (S-Ethyl dipropylthio-carbamate) (µg/L) (82668)	3,4-Dichloro-aniline (µg/L) (61625)	Prometryn (µg/L) (04036)	Hexazinone (µg/L) (04025)
LRL	0.006	0.005	0.007	0.004	0.004	0.005	0.013
Threshold type	na	MCL-US	MCL-CA	na	na	na	HAL-US
Threshold value	na	4	1	na	na	na	400
Grid wells							
KERN-03	E0.006	E0.007	E0.006	—	—	—	—
KERN-04	E.005	—	E.006	—	—	—	—
KERN-06	E.005	.008	—	E0.002	E0.003	0.006	—
KERN-07	—	—	—	E.003	—	.006	—
KERN-08	—	—	—	E.002	—	—	—
KERN-09	E.007	E.005	E.007	—	E.005	—	—
KERN-10	—	—	—	.009	—	—	—
KERN-12	E.008	E.006	E.004	—	—	—	—
KERN-15	E.006	E.007	.009	—	—	—	—
KERN-16	—	—	—	.032	—	—	—
KERN-17	E.004	—	—	—	—	—	—
KERN-18	E.005	.033	E.007	—	—	—	—
KERN-19	E.004	—	E.005	—	—	—	—
KERN-24	E.011	.010	.020	—	E.004	—	0.017
KERN-26	E.007	—	E.005	—	—	—	—
KERN-27	—	E.005	—	—	—	.009	—
KERN-28	—	.008	—	—	E.005	—	—
KERN-29	E.007	.017	.009	—	E.005	—	—
KERN-30	—	E.004	—	—	—	—	—
KERN-31	E.016	—	.009	—	—	—	—
KERN-33	E.007	—	E.004	—	—	—	—
KERN-34	E.007	E.007	E.007	E.002	—	—	—
KERN-35	E.005	.031	E.006	—	—	—	E.011
KERN-37	—	E.004	—	—	—	—	—
KERN-38	—	.008	—	—	—	—	—
KERN-39	E.005	.015	E.007	—	—	—	—
KERN-44	E.004	E.007	E.005	E.003	—	—	—
Number of detections	18	17	16	7	5	3	2
Detection frequency (in percent)	39	37	35	15	11	7	4
Flow-path wells							
KERNFP-01	—	—	—	—	—	—	—
KERNFP-02	—	1	0.010	—	—	—	—
KERNFP-03	E0.006	E0.007	.009	—	E0.006	—	—

Table 6A. Pesticides and pesticide degradates detected in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March 2006.—Continued

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code is used to uniquely identify a specific constituent or property. Samples from 49 wells were analyzed, but only samples with detections are listed. No data for KERN-11. Analytes are listed in order of decreasing detection frequency in the 46 grid wells. All analytes are listed in [table 3D](#). Thresholds and threshold values as of February 10, 2007. **GAMA identification no.:** KERN, Kern County Subbasin study unit; KERNFP, KERN flow-path well. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level; RSD5-US, U.S. Environmental Protection Agency risk specific dose at a risk factor of 10⁻⁵. **Abbreviations:** E, estimated value; LRL, laboratory reporting level; na, not available; µg/L, micrograms per liter; —, not detected]

GAMA identification no.	Metolachlor (µg/L) (39415)	Prometon (µg/L) (04037)	Chlorpyrifos (µg/L) (38933)	Dieldrin (µg/L) (39381)	Metribuzin (µg/L) (82630)	Pesticide and pesticide degradate detections per well
LRL	0.006	0.01	0.005	0.01	0.006	
Threshold type	HAL-US	HAL-US	HAL-US	RSD5-US	HAL-US	
Threshold value	700	100	2	0.02	70	
Grid wells						
KERN-03	—	—	—	—	—	3
KERN-04	0.014	—	—	—	—	3
KERN-06	—	—	—	—	—	5
KERN-07	—	—	—	—	—	2
KERN-08	—	—	—	—	—	1
KERN-09	—	—	—	—	—	4
KERN-10	—	—	—	—	—	1
KERN-12	—	—	—	—	—	3
KERN-15	—	—	—	—	—	3
KERN-16	—	—	—	—	—	1
KERN-17	—	—	—	—	—	1
KERN-18	—	—	—	—	—	3
KERN-19	—	—	—	—	—	2
KERN-24	—	E0.01	—	—	—	6
KERN-26	—	—	—	—	—	2
KERN-27	—	—	—	—	—	2
KERN-28	—	—	0.006	—	—	3
KERN-29	—	—	—	—	—	4
KERN-30	—	—	—	—	—	1
KERN-31	—	—	—	—	—	2
KERN-33	—	—	—	—	—	2
KERN-34	¹ —	E.01	—	—	0.010	6
KERN-35	—	—	—	—	—	4
KERN-37	—	—	—	—	—	1
KERN-38	—	—	—	—	—	1
KERN-39	.013	—	—	E0.007	—	5
KERN-44	—	—	—	—	—	4
Number of detections	2	2	1	1	1	
Detection frequency (in percent)	4	4	2	2	2	² 59
Flow-path wells						
KERNFP-01	—	—	—	E0.004	—	1
KERNFP-02	—	—	—	—	—	1
KERNFP-03	—	—	—	—	—	4

¹ Samples analyzed with raised laboratory reporting levels: KERN-34 (Metolachlor <0.013 µg/L); KERNFP-02 (Simazine < 0.011 µg/L).

² Frequency of detection of at least one pesticide or pesticide degradate in the grid wells.

Table 6B. Polar pesticides and metabolites detected in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March 2006.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property. Samples from the 17 slow and intermediate wells were analyzed, but only samples with detections are listed. Analytes are listed in order of decreasing detection frequency in the 14 grid wells. All analytes are listed in [table 3E](#). Thresholds and threshold values as of February 10, 2007. **GAMA identification no.:** KERN, Kern County Subbasin study unit; KERNFP, KERN flow-path well. **Threshold type:** The maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level. **Abbreviations:** E, estimated value; LRL, laboratory reporting level; na, not available; V, constituent detected in sample and an associated blank; thus, data are censored from the ground-water quality assessment; µg/L, micrograms per liter; —, not detected]

GAMA identification no.	Deisopropyl atrazine (2-Chloro-6-ethylamino-4-amino-s-triazine) (04038)	Dinoseb (Dinitrobutyl phenol) (µg/L) (49301)	Bromacil (µg/L) (04029)	Diphenamid (µg/L) (04033)	Diuron (µg/L) (49300)	Imazethapyr (µg/L) (50407)	Caffeine (µg/L) (50305)	Pesticide and metabolite detections per well
LRL	0.08	0.04	0.02	0.01	0.02	0.04	0.018	
Threshold type	na	MCL-US	HAL-US	HAL-US	HAL-US	na	na	
Threshold value	na	7	90	200	10	na	na	
Grid wells								
KERN-34	E0.01	—	—	—	—	—	VE0.007	1
KERN-35	E.04	—	—	—	—	—	—	1
KERN-36	E.01	—	—	E0.01	—	—	—	2
KERN-38	—	E0.01	—	—	—	—	—	1
KERN-39	E.004	E.03	E0.01	—	0.02	—	—	4
KERN-40	—	—	—	—	—	—	VE.007	0
KERN-43	—	—	—	—	—	—	V.030	0
KERN-44	—	E.02	—	—	—	—	—	1
KERN-45	—	—	—	—	—	—	V.035	0
KERN-47	—	E.02	—	—	—	—	—	1
Number of detections	4	4	1	1	1	0	0	
Detection frequency (in percent)	29	29	7	7	7	0	0	150
Flow-path wells								
KERNFP-01	—	—	—	0.03	—	—	VE0.013	1
KERNFP-02	—	—	—	—	—	² E0.01	—	1
KERNFP-03	E0.005	—	—	—	0.07	—	VE0.018	2

¹ Frequency of detection of at least one pesticide or pesticide metabolite in the grid wells. Detections with V remark codes are not included.

² The median laboratory matrix-spike recovery was greater than 130 percent for this compound. High recoveries may indicate that reported value could be higher than what is in the sample.

Table 7. Constituents of special interest (perchlorate, *N*-nitrosodimethylamine [NDMA], and 1,2,3-trichloropropane [1,2,3-TCP]) detected in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March, 2006.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property. Samples from all 50 wells were analyzed for perchlorate and samples from the 17 slow and intermediate wells were analyzed for NDMA and 1,2,3-TCP, but only wells with at least one detection are listed. Thresholds and threshold values as of October 18, 2007. Information about the analytes given in [table 3F](#). **GAMA identification no.:** KERN, Kern County Subbasin study unit; KERNFP, KERN flow-path well. **Threshold type:** Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level; NL-CA, California Department of Public Health notification level. **Abbreviations:** MRL, method reporting limit; nc, constituent not analyzed; µg/L, micrograms per liter; —, not detected]

GAMA identification no.	Perchlorate (µg/L) (61209)	<i>N</i>-Nitroso- dimethylamine (NMDA) (µg/L) (64176)	1,2,3- Trichloro- propane (µg/L) (77443)
MRL	0.5	0.002	0.005
Threshold type	MCL-CA	NL-CA	HAL-US
Threshold value	6	0.010	40
Grid wells			
KERN-27	1.1	nc	nc
KERN-30	0.74	nc	nc
KERN-36	—	—	0.02
KERN-38	¹ —	—	.4
KERN-39	—	—	.3
KERN-42	—	—	.03
KERN-44	.62	—	.08
KERN-45	—	—	.04
KERN-46	¹ —	—	.03
KERN-47	—	—	.1
Number of detections	3		
Detection frequency (in percent)	² 6		

¹ Samples analyzed with raised method reporting levels: KERN-23 (perchlorate < 2 µg/L); KERN-38 (perchlorate < 1 µg/L); KERN-46 (perchlorate < 1 µg/L).

² Frequency of detection of perchlorate in the 50 grid wells and of NDMA.

Table 8. Nutrients and dissolved organic carbon detected in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March 2006.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property. Samples from the 17 slow and intermediate wells were analyzed. Thresholds and threshold values as of February 10, 2007. **GAMA identification no.:** KERN, Kern County Subbasin study unit; KERNFP, KERN flow-path well. **Threshold type:** Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level. **Abbreviations:** E, estimated value; LRL, laboratory reporting level; mg/L, milligrams per liter; na, not available; nc, constituent not analyzed; V, analyte detected in sample and an associated blank; thus, data are not included in ground-water quality assessment; *, indicates value above threshold value; —, not detected]

GAMA identification no.	Ammonia, dissolved as nitrogen (mg/L) (00608)	Dissolved organic carbon (mg/L) (00681)	Nitrite, dissolved as nitrogen (mg/L) (00613)	Nitrite plus nitrate, dissolved as nitrogen (mg/L) (00631)	Total nitrogen (nitrate + nitrite + ammonia + organic-nitrogen) dissolved as nitrogen (mg/L) (62854)	Orthophosphate, dissolved as phosphorous (mg/L) (00671)
LRL	0.04	0.33	0.008	0.06	0.06	0.006
Threshold type	HAL-US	na	MCL-US	MCL-US	na	na
Threshold value	24.7	na	1	10	na	na
Grid wells						
KERN-34	—	V0.4	—	1.92	¹ 1.87	0.006
KERN-35	—	V.4	—	1.04	1.08	—
KERN-36	—	.6	—	1.12	¹ 1.11	E.003
KERN-37	—	1.0	—	0.36	0.39	.008
KERN-38	—	V.4	—	*13.4	² 13.1	E.004
KERN-39	—	V.4	—	*12.4	12.4	.007
KERN-40	—	nc	0.027	2.78	2.85	E.004
KERN-41	0.06	VE.3	.668	3.38	² 3.65	E.004
KERN-42	—	V.4	—	.55	.56	.012
KERN-43	—	nc	—	.54	.57	E.004
KERN-44	—	V.4	—	8.50	² 8.38	E.004
KERN-45	—	V.4	—	2.04	2.06	.009
KERN-46	—	nc	.054	7.45	² 7.38	.008
KERN-47	—	nc	—	4.48	² 4.23	—
Flow-path wells						
KERNFP-01	0.04	nc	—	—	E0.06	E0.003
KERNFP-02	—	0.6	—	0.07	0.11	.012
KERNFP-03	—	nc	—	.46	² 0.45	.007

¹ The HAL-US is 30 mg/L “as ammonia.” To facilitate comparison to the analytical results, we have converted and reported this HAL-US as 24.7 mg/L “as nitrogen.”

² Total nitrogen in these samples is less than the sum of the filtered nitrogen analytes, but falls within the U.S. Geological Survey National Water Quality Laboratory acceptance criteria of a 10 percent relative percent difference.

Table 9. Major and minor ions and total dissolved solids detected in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March 2006.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property. Samples from the 17 slow and intermediate wells were analyzed. Thresholds and threshold values as of February 10, 2007. Information about analytes given in [table 3H](#). **GAMA identification no.:** KERN, Kern County Subbasin study unit; KERNFP, KERN flow-path well. **Threshold type:** Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; SMCL-CA, California Department of Public Health secondary maximum contaminant level. The SMCL-CA for chloride, sulfate, and total dissolved solids have recommended and upper threshold values. The upper value is shown in parentheses. **Abbreviations:** E, estimated value; LRL, laboratory reporting level; mg/L, milligrams per liter; *, indicates sample value above threshold value; **, indicates sample value above upper threshold value; —, not detected]

GAMA identification no.	Calcium (mg/L) (00915)	Magnesium (mg/L) (00925)	Potassium (mg/L) (00935)	Sodium (mg/L) (00930)	Bromide (mg/L) (71870)	Chloride (mg/L) (00940)	Fluoride (mg/L) (00950)	Iodide (mg/L) (71865)	Silica (mg/L) (00955)	Sulfate (mg/L) (00945)	Total dissolved solids (residue on evaporation) (mg/L) (70300)
LRL	0.02	0.008	0.16	0.20	0.02	0.20	0.10	0.002	0.04	0.18	10
Threshold type	na	na	na	na	na	SMCL-CA	MCL-CA	na	na	SMCL-CA	SMCL-CA
Threshold value	na	na	na	na	na	250 (500)	2	na	na	250 (500)	500 (1,000)
Grid wells											
KERN-34	24.3	1.14	0.61	42.0	0.13	28.1	0.16	0.002	20.1	34.0	204
KERN-35	34.6	1.09	1.38	28.3	.10	26.2	E.08	E.002	18.6	23.7	204
KERN-36	29.5	.654	1.76	39.9	.15	37.0	.10	.014	16.3	38.8	215
KERN-37	39.8	.488	1.77	21.6	.04	9.79	.17	.014	20.3	28.3	195
KERN-38	134	14.4	3.42	156	1.45	*339	.29	—	20.1	131	*974
KERN-39	83.3	6.08	3.07	36.9	.23	34.9	E.08	—	23.2	120	435
KERN-40	141	50.6	10.6	178	.22	45.6	.69	.040	19.3	**779	**1,400
KERN-41	4.00	.010	.26	67.2	.22	44.1	.85	.029	20.0	39.7	218
KERN-42	19.7	1.54	1.80	21.0	E.02	6.88	.15	—	14.3	12.1	126
KERN-43	38.1	10.9	6.73	41.6	.07	16.1	.80	E.002	22.6	43.4	281
KERN-44	34.4	1.24	1.70	27.5	.07	13.9	E.09	—	23.2	30.3	213
KERN-45	22.4	.075	1.01	65.7	.14	47.0	.16	E.001	14.5	95.5	281
KERN-46	132	31.8	7.03	183	.36	60.4	.80	.033	18.2	**579	**1,150
KERN-47	27.9	0.064	1.35	84.9	.10	30.9	E.07	E.001	13.7	161	369
Flow-path wells											
KERNFP-01	85.7	7.48	2.26	42.4	0.20	65.5	0.10	.050	21.5	147	436
KERNFP-02	30.0	3.06	2.02	21.4	.04	11.9	E.08	.018	25.2	21.1	180
KERNFP-03	29.8	2.61	2.01	22.6	.07	21.1	.10	E.001	20.5	20.3	172

Table 10. Trace elements detected in ground-water samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March 2006.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property. Samples from the 17 slow and intermediate wells were analyzed. Thresholds and threshold values as of February 10, 2007. All analytes are listed in [table 3H](#) (silver and thallium analyzed but not detected). **GAMA identification no.:** KERN, Kern County Subbasin study unit; KERNFP, KERN flow-path well. **Threshold type:** Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; AL-US, U.S. Environmental Protection Agency action level; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; AL-US, U.S. Environmental Protection Agency action level; NL-CA, California Department of Public Health notification level; SMCL-CA, California Department of Public Health secondary maximum contaminant level. **Abbreviations:** E, estimated value; LRL, laboratory reporting level; V, constituent detected in sample and an associated blank; thus, data are censored from the ground-water quality assessment; µg/L, micrograms per liter; *, indicates value above threshold value; —, not detected]

GAMA identification no.	Aluminum (µg/L) (01106)	Antimony (µg/L) (01095)	Arsenic (µg/L) (01000)	Barium (µg/L) (01005)	Beryllium, (µg/L) (01010)	Boron (µg/L) (01020)	Cadmium (µg/L) (01025)	Chromium (µg/L) (01030)	Cobalt (µg/L) (01035)	Copper (µg/L) (01040)	Iron (µg/L) (01046)	Lead, (µg/L) (01049)
LRL	1.6	0.20	0.12	0.2	0.06	8	0.04	0.04	0.040	0.4	6	0.08
Threshold type	MCL-CA	MCL-US	MCL-US	MCL-CA	MCL-US	NL-CA	MCL-US	MCL-CA	na	AL-US	SMCL-CA	AL-US
Threshold value	1,000	6	10	1,000	4	1,000	5	50	na	1,300	300	15
Grid wells												
KERN-34	3.4	E0.19	6.2	23	0.17	143	E0.04	1.7	0.044	V0.5	—	0.22
KERN-35	E1.5	E.13	1.3	49	—	116	—	0.58	.052	VE.3	—	—
KERN-36	3.2	.29	5.1	46	—	137	—	.32	E.036	VE.3	—	.22
KERN-37	E1.0	.73	2.0	59	—	140	E.03	—	.069	.6	8	.29
KERN-38	1.6	E.11	2.3	100	E.07	523	.06	2.1	.152	2.9	— ¹	1.95
KERN-39	E0.9	E.10	1.9	119	—	22	—	1.7	.147	1.7	—	.34
KERN-40	E1.3	—	1.3	23	E.14	446	E.08	V.05	.103	2.5	22	.94
KERN-41	33.5	.86	*31.4	2	—	113	.07	V.05	—	VE.2	13	VE.04
KERN-42	2.4	E.18	6.6	42	—	140	—	1.2	E.023	V.5	—	.21
KERN-43	1.8	E.16	3.1	70	—	357	—	.71	—	.6	VE4	.49
KERN-44	E1.5	E.10	1.5	63	.07	23	E.02	3.5	.067	1.1	—	1.40
KERN-45	10.9	.29	*10.4	38	—	83	—	3.0	.049	1.6	13	.22
KERN-46	2.2	—	1.6	51	— ¹	817	— ¹	.53	.169	4.5	VE4	—
KERN-47	6.7	E.15	2.2	35	—	61	—	1.4	.04	.9	10	.21
Flow-path wells												
KERNFP-01	2.2	—	0.26	100	—	157	—	0.06	0.085	0.7	31	0.21
KERNFP-02	E1.0	—	.37	57	E0.04	123	—	.06	.044	—	7	.33
KERNFP-03	E0.9	—	.62	56	—	130	—	.14	.046	1.4	—	.88

Table 10. Trace elements detected in ground-water samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March 2006.—Continued

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property. Samples from the 17 slow and intermediate wells were analyzed. Thresholds and threshold values as of February 10, 2007. All analytes are listed in [table 3H](#) (silver and thallium analyzed but not detected). **GAMA identification no.:** KERN, Kern County Subbasin study unit; KERNFP, KERN flow-path well. **Threshold type:** Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; AL-US; U.S. Environmental Protection Agency action level; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; AL-US, U.S. Environmental Protection Agency action level; NL-CA, California Department of Public Health notification level; SMCL-CA, California Department of Public Health secondary maximum contaminant level. **Abbreviations:** E, estimated value; LRL, laboratory reporting level; V, constituent detected in sample and an associated blank; thus, data are censored from the ground-water quality assessment; µg/L, micrograms per liter; *, indicates sample value above threshold value; —, not detected]

GAMA identification no.	Lithium (µg/L) (01130)	Manganese (µg/L) (01056)	Mercury (µg/L) (71890)	Molybdenum (µg/L) (01060)	Nickel (µg/L) (01065)	Selenium (µg/L) (01145)	Strontium (µg/L) (01080)	Tungsten (µg/L) (01155)	Uranium (µg/L) (22703)	Vanadium (µg/L) (01085)	Zinc (µg/L) (01090)
LRL	0.6	0.2	0.010	0.4	0.06	0.08	0.4	0.06	0.04	0.10	0.6
Threshold type	na	SMCL-CA	MCL-US	HAL-US	MCL-CA	MCL-US	HAL-US	na	MCL-US	NL-CA	HAL-US
Threshold value	na	50	2	40	100	50	4,000	na	30	50	2,000
Grid wells											
KERN-34	5.0	—	—	1.7	0.31	0.63	243	0.44	11.9	12.5	9.7
KERN-35	4.9	—	—	1.1	0.72	0.11	400	0.09	7.79	4.2	V1.7
KERN-36	2.7	E0.2	—	0.9	0.78	—	365	0.30	1.08	1.9	16.2
KERN-37	14.8	2.6	—	8.0	0.96	—	831	—	7.66	0.20	14.0
KERN-38	11.3	0.7	—	8.7	1.29	6.7	571	0.20	3.46	19.1	18.9
KERN-39	7.2	0.3	—	3.3	1.90	1.1	629	0.08	10.8	7.8	V1.9
KERN-40	45.9	6.3	—	14.6	0.81	0.20	2,360	0.20	7.46	3.5	18.9
KERN-41	3.0	0.5	—	24.5	V0.09	0.41	11.3	6.2	0.14	*53.4	V0.9
KERN-42	4.0	0.5	—	2.2	0.17	E0.06	232	0.40	1.45	15.6	V0.9
KERN-43	20.5	1.2	—	10.5	0.24	0.82	451	0.21	10.3	3.3	14.1
KERN-44	3.8	—	—	2.6	0.81	0.48	319	0.12	1.72	10.4	10.7
KERN-45	3.6	—	—	1.4	0.58	0.73	320	1.1	0.88	23.0	V2.1
KERN-46	19.3	*69.3	—	17.5	1.42	6.6	1,270	0.18	14.5	5.2	5.2
KERN-47	2.0	0.4	—	0.6	0.35	1.3	381	0.24	0.47	5.0	V1.7
Flow-path wells											
KERNFP-01	E0.6	*80.3	—	9.0	0.46	—	1,080	—	0.30	—	13.4
KERNFP-02	.6	1.3	0.025	2.5	0.60	—	278	—	1.41	2.3	V0.9
KERNFP-03	3.5	6.9	—	1.7	0.60	E0.04	279	—	1.46	1.9	V3.9

¹ Samples analyzed with raised laboratory reporting levels: KERN-46 (beryllium <0.24 µg/L and cadmium <0.16 µg/L); KERN-38 (iron <60 µg/L).

Table 11. Species of inorganic arsenic, iron, and chromium in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March 2006.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property. Samples from the 17 slow and intermediate wells were analyzed. Thresholds and threshold values as of February 10, 2007. Information about analytes given in [table 31](#). **GAMA identification no.:** KERNFP, KERN flow-path well. **Threshold type:** Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; SMCL-CA, California Department of Public Health secondary maximum contaminant level. **Abbreviations:** MDL, method detection limit; na, not available; µg/L, micrograms per liter; *, indicates sample above threshold value; —, not detected]

GAMA identification no.	Arsenic (µg/L) (99033)	Arsenic(III) (µg/L) (99034)	Iron (µg/L) (01046)	Iron(II) (µg/L) (01047)	Chromium (µg/L) (01030)	Chromium(VI) (µg/L) (01032)
MDL	0.5	1	1	1	0.1	0.1
Threshold type	MCL-US	na	SMCL-CA	na	MCL-CA	na
Threshold value	10	na	300	na	50	na
Grid wells						
KERN-34	4.8	—	—	—	6	6
KERN-35	0.98	—	—	—	4	4
KERN-36	5.2	—	—	—	4	4
KERN-37	1.8	—	13	7	—	—
KERN-38	3.3	—	11	8	7	7
KERN-39	1.2	—	2	—	3	2
KERN-40	1.1	—	21	18	—	—
KERN-41	*23	—	3	2	—	—
KERN-42	6.1	—	—	—	2	1
KERN-43	3.3	—	4	—	—	—
KERN-44	1.3	—	—	—	5	4
KERN-45	9.7	—	4	—	4	4
KERN-46	2.4	—	4	—	1	—
KERN-47	2.1	—	10	—	2	1
Flow-path wells						
KERNFP-01	—	—	25	15	—	—
KERNFP-02	—	—	5	3	5	3
KERNFP-03	0.68	—	—	—	—	—

Table 12. Stable isotope ratios and tritium and carbon-14 activities in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March 2006.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property. Samples from all 50 wells were analyzed for stable isotopes of water; samples from the 17 slow and intermediate wells were analyzed for stable isotopes of nitrate and carbon and activities of tritium and carbon-14. Thresholds and threshold values as of February 10, 2007. Information about analytes given in [table 3J](#). Stable isotope ratios are reported in the standard delta notation (δ), the ratio of a heavier isotope to the more common lighter isotope of that element, relative to a standard reference material. **Tritium:** Results from U.S. Geological Survey Stable Isotope and Tritium Laboratory, Menlo Park, California. **GAMA identification no.:** KERN, Kern County Subbasin study unit; KERNFP, KERN flow-path well. **Abbreviations:** pCi/L, picocurie per liter; na, not available; nc, constituent not analyzed; <, less than; —, not detected]

GAMA identification no.	$\delta^2\text{H}$ of water (per mil) (82082)	$\delta^{18}\text{O}$ of water (per mil) (82085)	$\delta^{15}\text{N}$ of nitrate (per mil) (82690)	$\delta^{18}\text{O}$ of nitrate (per mil) (63041)	Tritium (pCi/L) (07000)	$\delta^{13}\text{C}$ of dissolved carbonates (per mil) (82081)	Carbon-14 (percent modern) (49933)
Threshold type	na	na	na	na	MCL-CA	na	na
Threshold value	na	na	na	na	20,000	na	na
Grid wells							
KERN-01	-71.4	-9.64	nc	nc	nc	nc	nc
KERN-02	-60.4	-8.68	nc	nc	nc	nc	nc
KERN-03	-69.2	-9.61	nc	nc	nc	nc	nc
KERN-04	-103	-13.96	nc	nc	nc	nc	nc
KERN-05	-79.3	-10.91	nc	nc	nc	nc	nc
KERN-06	-67.8	-9.64	nc	nc	nc	nc	nc
KERN-07	-66.7	-8.93	nc	nc	nc	nc	nc
KERN-08	-94.9	-13.07	nc	nc	nc	nc	nc
KERN-09	-93.2	-12.49	nc	nc	nc	nc	nc
KERN-10	-80.9	-11.52	nc	nc	nc	nc	nc
KERN-11	-63.9	-9.25	nc	nc	nc	nc	nc
KERN-12	-76.8	-10.19	nc	nc	nc	nc	nc
KERN-13	-66.4	-9.38	nc	nc	nc	nc	nc
KERN-14	-85.6	-11.51	nc	nc	nc	nc	nc
KERN-15	-95.2	-12.77	nc	nc	nc	nc	nc
KERN-16	-81.0	-10.01	nc	nc	nc	nc	nc
KERN-17	-98.0	-13.21	nc	nc	nc	nc	nc
KERN-18	-96.6	-12.86	nc	nc	nc	nc	nc
KERN-19	-102	-13.71	nc	nc	nc	nc	nc
KERN-20	-79.6	-10.95	nc	nc	nc	nc	nc
KERN-21	-88.0	-11.63	nc	nc	nc	nc	nc
KERN-22	-96.2	-12.88	nc	nc	nc	nc	nc
KERN-23	-68.1	-8.83	nc	nc	nc	nc	nc
KERN-24	-68.0	-9.16	nc	nc	nc	nc	nc
KERN-25	-66.7	-9.06	nc	nc	nc	nc	nc
KERN-26	-86.1	-11.74	nc	nc	nc	nc	nc
KERN-27	-83.0	-11.24	nc	nc	nc	nc	nc
KERN-28	-74.5	-9.79	nc	nc	nc	nc	nc
KERN-29	-92.9	-12.23	nc	nc	nc	nc	nc
KERN-30	-66.9	-9.28	nc	nc	nc	nc	nc
KERN-31	-94.6	-12.55	nc	nc	nc	nc	nc
KERN-32	-67.3	-9.14	nc	nc	nc	nc	nc
KERN-33	-67.1	-9.36	nc	nc	nc	nc	nc
KERN-34	-96.4	-12.86	4.58	-0.06	8.6	-12.40	90.3
KERN-35	-88.0	-11.64	6.84	-1.14	10.9	-13.80	103.8
KERN-36	-97.1	-13.03	6.52	-1.28	21.4	-9.70	62.9
KERN-37	-94.3	-12.43	12.28	7.12	10.9	-12.50	90.0
KERN-38	-63.2	-8.50	4.93	2.59	3.2	-13.50	71.3

Table 12. Stable isotope ratios and tritium and carbon-14 activities in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March 2006.—Continued

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property. Samples from all 50 wells were analyzed for stable isotopes of water; samples from the 17 slow and intermediate wells were analyzed for stable isotopes of nitrate and carbon and activities of tritium and carbon-14. Thresholds and threshold values as of February 10, 2007. Information about analytes given in [table 3J](#). Stable isotope ratios are reported in the standard delta notation (δ), the ratio of a heavier isotope to the more common lighter isotope of that element, relative to a standard reference material. **Tritium:** Results from U.S. Geological Survey Stable Isotope and Tritium Laboratory, Menlo Park, California. **GAMA identification no.:** KERN, Kern County Subbasin study unit; KERNFP, KERN flow-path well. **Abbreviations:** pCi/L, picocurie per liter; na, not available; nc, constituent not analyzed; <, less than; —, not detected]

GAMA identification no.	$\delta^2\text{H}$ of water (per mil) (82082)	$\delta^{18}\text{O}$ of water (per mil) (82085)	$\delta^{15}\text{N}$ of nitrate (per mil) (82690)	$\delta^{18}\text{O}$ of nitrate (per mil) (63041)	Tritium (pCi/L) (07000)	$\delta^{13}\text{C}$ of dissolved carbonates (per mil) (82081)	Carbon-14 (percent modern) (49933)
Threshold type	na	na	na	na	MCL-CA	na	na
Threshold value	na	na	na	na	20,000	na	na
Grid wells—Continued							
KERN-39	-83.0	-11.24	5.32	1.78	11.8	-13.10	98.5
KERN-40	-69.0	-9.35	8.98	8.93	<1	nc	nc
KERN-41	-76.6	-9.82	24.82	8.55	<1	-13.30	1.8
KERN-42	-103	-13.90	nc	nc	<1	-8.70	83.2
KERN-43	-60.9	-8.67	6.24	4.75	<1	nc	nc
KERN-44	-79.6	-11.06	3.76	-0.29	4.8	-13.30	89.4
KERN-45	-101	-13.76	3.13	-3.27	1.3	-9.53	64.0
KERN-46	-61.1	-8.79	7.73	8.64	<1	nc	nc
KERN-47	-100	-13.38	2.99	-2.46	15.7	nc	nc
Flow-path wells							
KERNFP-01	-99.4	-13.04	nc	nc	24.6	nc	nc
KERNFP-02	-95.2	-12.54	24.86	19.32	29.4	-8.40	90.5
KERNFP-03	-89.8	-11.88	7.16	-1.50	15.4	nc	nc

Table 13. Noble gases, tritium, and helium isotope ratios in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March 2006.

[The five-digit code below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property. Samples from all 50 wells were analyzed. Thresholds and threshold levels as of February 10, 2007. Information about analytes given in [table 3K](#). **GAMA identification no:** KERN, Kern County Subbasin study unit; KERNFP, Kern flow-path well. **Threshold type:** maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level. **Abbreviations:** cm³ STP g⁻¹ H₂O, cubic centimeters at standard temperature and pressure per gram of water; na, not available; nc, constituent not analyzed; pCi/L, picocurie per liter]

GAMA Identification no.	Collection date	Tritium (pCi/L) (07000)	Dissolved gas analysis date	Helium-3-Helium-4 (atom ratio) (61040)	Helium-4 (85561)	Neon (61046)	Argon (85563)	Krypton (85565)	Xenon (85567)						
										(cm ³ STP g ⁻¹ H ₂ O)					
										(× 10 ⁻⁶)	(× 10 ⁻⁷)	(× 10 ⁻⁷)	(× 10 ⁻⁴)	(× 10 ⁻⁸)	(× 10 ⁻⁸)
Threshold type	na	MCL-CA	na	na	na	na	na	na	na						
Threshold	na	20,000	na	na	na	na	na	na	na						
Grid wells															
KERN-01	01-09-06	8.27	03-29-06	1.37	0.43	1.89	3.01	6.91	0.94						
KERN-02	01-10-06	1.11	nc	nc	nc	nc	nc	nc	nc						
KERN-03	01-10-06	4.15	04-15-06	0.55	2.09	2.72	3.73	8.12	1.03						
KERN-04	01-10-06	1.60	03-29-06	1.42	.50	2.33	3.51	7.69	1.09						
KERN-05	01-11-06	1.01	03-29-06	.16	6.28	3.34	4.35	8.76	1.21						
KERN-06	01-11-06	1.69	03-30-06	1.04	.96	3.15	4.07	8.22	1.09						
KERN-07	01-11-06	2.86	03-30-06	1.01	1.02	3.88	3.84	7.75	1.03						
KERN-08	01-12-06	1.09	04-04-06	.17	4.06	1.60	8.76	6.98	.95						
KERN-09	01-23-06	12.8	03-31-06	1.68	1.01	4.27	5.54	10.70	1.31						
KERN-10	01-23-06	<1	04-04-06	.34	3.88	3.88	8.83	7.04	1.29						
KERN-11	01-23-06	<1	03-31-06	1.31	.93	3.54	4.19	8.35	1.04						
KERN-12	01-24-06	2.83	03-31-06	.91	.98	2.45	3.52	7.72	.99						
KERN-13	01-24-06	2.26	03-31-06	1.35	.82	3.34	4.36	8.75	1.14						
KERN-14	01-25-06	1.1	04-12-06	.34	2.60	2.51	8.68	7.94	1.13						
KERN-15	02-06-06	9.29	05-05-06	1.79	.57	2.38	3.53	7.84	1.06						
KERN-16	02-06-06	11.7	06-21-06	1.45	.82	2.50	3.80	8.13	1.05						
KERN-17	02-09-06	20.8	05-05-06	2.92	.82	4.04	4.64	9.26	1.17						
KERN-18	02-09-06	22.5	05-05-06	2.68	.90	3.69	4.57	9.09	1.21						
KERN-19	02-09-06	3.30	05-05-06	1.21	.73	3.31	4.66	7.39	1.07						
KERN-20	02-13-06	<1	nc	nc	nc	nc	nc	nc	nc						
KERN-21	02-13-06	1.50	05-05-06	1.36	.74	2.93	3.82	8.13	1.06						
KERN-22	02-13-06	1.10	05-05-06	1.02	1.35	4.27	4.58	8.61	1.15						
KERN-23	02-16-06	4.64	05-06-06	.40	1.82	3.82	3.60	7.33	1.02						
KERN-24	02-16-06	9.32	05-06-06	1.44	.82	5.22	4.69	7.87	1.06						
KERN-25	02-27-06	10.4	05-06-06	.68	1.69	5.57	4.32	8.26	1.10						
KERN-26	02-27-06	4.59	05-06-06	1.38	.82	3.11	3.89	8.14	1.11						
KERN-27	02-27-06	2.51	nc	nc	nc	nc	nc	nc	nc						
KERN-28	02-27-06	1.78	05-16-06	1.05	.72	2.10	3.18	7.18	.94						
KERN-29	02-28-06	25.4	05-16-06	2.05	1.25	4.70	4.54	8.81	1.05						
KERN-30	02-28-06	2.60	05-16-06	1.29	1.19	4.38	4.75	9.22	1.10						
KERN-31	03-01-06	15.89	05-16-06	2.06	.53	2.15	3.37	7.43	.96						
KERN-32	03-01-06	<1	05-16-06	.98	1.01	2.90	3.73	8.03	1.07						
KERN-33	03-01-06	1.24	05-17-06	.84	1.32	2.84	4.17	9.12	1.14						
KERN-34	01-10-06	na ²	04-12-06	1.71	1.27	4.94	5.36	10.00	1.25						
KERN-35	01-25-06	12.8	04-04-06	1.48	2.50	9.40	6.95	11.70	1.30						
KERN-36	01-26-06	19.7	04-04-06	1.48	1.87	5.45	5.71	10.40	1.28						
KERN-37	02-15-06	12.2	05-06-06	1.71	.47	7.41	4.69	7.24	.96						
KERN-38	01-11-06	4.37	03-30-06	1.34	.62	3.90	4.00	7.63	.99						
KERN-39 ¹	01-12-06, 02-14-06	14.8, nc	nc, 05-05-06	nc, 2.21	nc, 0.64	nc, 2.85	nc, 3.83	nc, 8.00	nc, 1.03						

Table 13. Noble gases, tritium, and helium isotope ratios in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March 2006.—Continued

[The five-digit code below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property. Samples from all 50 wells were analyzed. Thresholds and threshold levels as of February 10, 2007. Information about analytes given in [table 3K](#). **GAMA identification no:** KERN, Kern County Subbasin study unit; KERNFP, Kern flow-path well. **Threshold type:** maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level. **Abbreviations:** cm³ STP g⁻¹ H₂O, cubic centimeters at standard temperature and pressure per gram of water. na, not available; nc, constituent not analyzed; pCi/L, picocurie per liter]

GAMA Identification no.	Collection date	Tritium (pCi/L) (07000)	Dissolved gas analysis date	Helium-3- Helium-4 (atom ratio) (61040)	Helium-4 (85561)	Neon (61046)	Argon (85563)	Krypton (85565)	Xenon (85567)
Threshold type	na	MCL-CA	na	(× 10 ⁻⁶) na	(× 10 ⁻⁷) na	(× 10 ⁻⁷) na	(× 10 ⁻⁴) na	(× 10 ⁻⁸) na	(× 10 ⁻⁸) na
Threshold	na	20,000	na	na	na	na	na	na	na
Grid wells—Continued									
KERN-40	01-30-06	<1	04-04-06	0.82	1.30	3.24	3.90	7.86	1.06
KERN-41	01-31-06	1.12	04-14-06	.41	1.78	2.41	3.60	7.86	1.08
KERN-42	02-01-06	1.94	04-05-06	1.47	.53	2.28	3.55	7.99	1.08
KERN-43	02-02-06	1.01	04-05-06	.80	1.67	3.25	3.99	8.24	1.05
KERN-44	02-07-06	5.72	08-30-06	1.63	0.69	2.80	3.94	8.20	1.05
KERN-45	02-08-06	2.48	08-30-06	1.18	.64	2.11	3.36	7.41	0.98
KERN-46	02-28-06	<1	05-16-06	1.34	.71	2.74	3.78	7.88	1.06
KERN-47	03-02-06	16.5	nc	nc	nc	nc	nc	nc	nc
Flow-path wells									
KERNFP-01	01-26-06	na ²	04-12-06	4.32	0.60	3.17	3.87	7.80	1.07
KERNFP-02	01-24-06	29.6	03-31-06	2.86	.85	3.57	4.56	8.80	1.17
KERNFP-03	01-25-06	15.6	04-12-06	1.54	1.27	4.88	5.09	9.49	1.20

¹ Same well sampled twice.² Laboratory error, values not reported.

Table 14. Radioactive constituents detected in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March 2006.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property. Samples from the 11 slow wells were analyzed for alpha and beta radioactivity, radium, and radon. Samples from the 17 slow and intermediate wells were analyzed for uranium isotopes. Thresholds and threshold values as of February 10, 2007. Information about analytes given in [table 3J](#). **GAMA well identification no.:** KERN, Kern County Subbasin study unit; KERNFP, KERN flow-path well. **Threshold type:** Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level. The MCL-US threshold for radium is the sum of radium-226 plus radium-228. Two MCLs have been proposed for radon-222. The second MCL-US listed (4,000) is the proposed Alternative MCL. The MCL-CA threshold for uranium is the sum of all uranium isotopes. **Abbreviations:** E, estimated value; na, not available; nc, constituent not analyzed; pCi/L, picocurie per liter; V, constituent detected in sample and an associated blank; thus, data are censored from the ground-water quality assessment; *, indicates sample value above threshold value; <, less than]

GAMA well identification no.	Alpha radioactivity (pCi/L)		Beta radioactivity (pCi/L)		Radium-226 (pCi/L) (09511)	Radium-228 (pCi/L) (81366)	Radon-222 (pCi/L) (82303)	Uranium-234 (pCi/L) (22610)	Uranium-235 (pCi/L) (22620)	Uranium-238 (pCi/L) (22620)
	72-hour count (62636)	30-day count (62639)	72-hour count (62642)	30-day count (62645)						
Threshold type	MCL-US	MCL-US	MCL-CA	MCL-CA	MCL-US	MCL-US	Proposed MCL-US	MCL-CA	MCL-CA	MCL-CA
Threshold value	15	15	50	50	5	5	300, (4,000)	20	20	20
Grid wells										
KERN-34	11.5	9.3	E1.0	4.7	0.062	VE0.19	*748	4.21	0.19	3.60
KERN-35	E6.4	6.2	<2.3	3.2	.10	VE.40	*822	3.03	.11	2.42
KERN-36	E2.0	<1.2	E1.8	2.7	E.066	VE.23	*584	.79	E0.30	0.30
KERN-37	11.5	3.3	E3.6	5.5	.14	VE.30	*1,660	2.60	.12	2.22
KERN-38	E1.9	<4.6	12.9	10.4	E0.50	VE.32	236	1.29	E.051	1.06
KERN-39	10.3	E3.8	4.0	7.0	.17	.60	*1,144	4.16	.21	2.91
KERN-40	nc	nc	nc	nc	nc	nc	nc	2.84	.14	2.60
KERN-41	<2.1	<1.2	<2.6	E0.8	VE.024	VE.45	*596	.091	<.026	E.044
KERN-42	E2.2	E0.5	E2.8	2.5	.076	E.55	*546	.78	E.015	.42
KERN-43	nc	nc	nc	nc	nc	nc	nc	3.22	.17	2.88
KERN-44	E4	E1.5	E2.4	2.5	.062	E.51	*446	.97	E.026	.54
KERN-45	E0.7	<1.4	E1.2	E1.9	.095	<.43	*823	.27	<.027	.20
KERN-46	nc	nc	nc	nc	nc	nc	nc	4.80	.18	4.44
KERN-47	nc	nc	nc	nc	nc	nc	nc	.10	<.028	.15
Flow-path wells										
KERNFP-01	nc	nc	nc	nc	nc	nc	nc	0.18	<0.026	0.11
KERNFP-02	E1.4	1.0	E2.3	2.6	0.068	VE0.26	*1,042	1.14	E.018	.43
KERNFP-03	nc	nc	nc	nc	nc	nc	nc	.87	E.020	.45

Appendix

This appendix discusses the methods used to collect and analyze ground-water samples and report the data for the Kern County Subbasin study unit (KERN). These methods were selected to obtain representative samples of the ground water used for drinking-water supplies in the study area, and to minimize potential bias to the data. Procedures to analyze and interpret quality-control data collected as part of the ground-water sampling are also discussed.

Sample Collection and Analysis

Samples were collected using standard and modified USGS protocols (Koterba and others, 1995; U.S. Geological Survey, variously dated) and protocols described by Weiss (1968); Shelton and others (2001); Ball and McClesky (2003a,b); and Wright and others (2005). These sampling protocols ensure that a representative sample of ground water is collected at each site and that the samples are collected and handled in a way that minimizes the potential for contamination of samples and cross contamination between samples collected at wells.

Prior to sampling, each well was pumped continuously to purge at least three casing-volumes of water from the well (Wilde and others, 1999). Wells were sampled using Teflon tubing with brass and stainless-steel fittings attached to a sampling point on the well discharge pipe as close to the well as possible and upstream of any well-head treatment system or water storage tank. Samples were collected before filtration or chemical treatment, such as chlorination. If a chlorinating system was attached to the well, the chlorinator was shut off at least 24 hours prior to purging and sampling the well to clear all chlorine out of the system. For the *fast* and *intermediate* schedules, samples were collected at the well head using a foot-long length of Teflon tubing. For the *slow* schedule, the samples were collected inside an enclosed chamber located inside a mobile laboratory and connected to the well head by a 10- to 50-ft length of the Teflon tubing (Lane and others, 2003). Fittings and tubing were cleaned between sampling each well (Wilde, 2004).

For the field measurements, ground water was pumped through a flow-through chamber fitted with a multi-probe meter that simultaneously measures the water-quality indicators dissolved oxygen, temperature, pH, and specific conductance. Field measurements were made in accordance with protocols in the USGS National Field Manual (Wilde and Radtke, 2005; Wilde, 2006; Lewis, 2006; Radtke and others, 2005; Wilde and others, 2006). All sensors on the multi-probe meter were calibrated daily. Turbidity was measured in the field inside a mobile laboratory with a calibrated turbidity meter (Wilde and Gibbs, 1998). Measured temperature,

dissolved oxygen, pH, and specific conductance values were recorded at 5-minute intervals for at least 30 minutes, and when these values remained stable for 20 minutes, samples for laboratory analyses were then collected. Field measurements and instrument calibrations were recorded by hand on field record sheets and electronically in the Personal Computer Field Forms program designed for GAMA sampling (PCFF-GAMA), a software package designed by the USGS with support from the GAMA Program. Analytical service requests and chain of custody documentation were also managed by PCFF-GAMA. Information from PCFF-GAMA was uploaded directly into NWIS at the end of every week of sample collection.

For analyses requiring filtered water, ground-water was diverted through a 0.45- μm pore size vented capsule filter, a disk filter, or a baked glass-fiber filter depending on the protocol for the analysis (Wilde and others, 1999; Wilde and others, 2004). Prior to sample collection, polyethylene sample bottles were pre-rinsed using native water three times before sample collection. Samples requiring acidification were acidified to a pH of 2 or less with the appropriate acids using ampoules of certified, traceable concentrated acids obtained from the USGS's National Water Quality Laboratory (NWQL).

Temperature-sensitive samples were stored on ice prior to daily shipping to the various laboratories. The non-temperature sensitive samples for tritium, noble gases, chromium speciation, and stable isotopes were shipped monthly, whereas VOCs, pesticides, compounds of special interest, DOC, radium isotopes, gross alpha and beta radioactivity, and radon-222 samples were shipped daily.

Detailed sampling protocols for individual analyses and groups of analytes are described in Koterba and others (2005) and the USGS National Field Manual (Wilde and others, 1999; Wilde and others, 2004) and in the references for analytical methods listed in [table A1](#); only brief descriptions are given here. VOCs, low-level 1,2-dibromo-3-chloropropane (DBCP) and 1,2-dibromoethane (EDB), gasoline oxygenates and degradates, 1,2,3-trichloropropane (1,2,3-TCP), and dissolved nitrogen samples were collected in 40-mL sample vials that were purged with three vial volumes of sample water before bottom filling to eliminate atmospheric contamination. Six-normal (6 N) hydrochloric acid (HCl) was added as a preservative to the VOC samples, but not to the DBCP and EDB, gasoline oxygenates and degradates, or the 1,2,3-TCP samples. The perchlorate sample was collected in a 125-mL polyethylene bottle. Tritium samples were collected by bottom filling two 1-L polyethylene bottles with unfiltered ground water, after first overfilling the bottle with three volumes of water. Stable isotopes of water were collected in 60-mL clear glass bottles filled with unfiltered water, sealed with a conical

cap, and secured with electrical tape to prevent leakage and evaporation.

Pesticides, polar pesticides and their corresponding degradation products, pharmaceutical compounds, and *N*-nitrosodimethylamine (NDMA) samples were collected in 1-L baked amber bottles. Pesticide and pharmaceutical samples were filtered with a glass fiber filter, whereas the NDMA samples were filtered at the Montgomery Watson Harza Laboratory prior to analysis.

Ground-water samples for major and minor ions, trace elements, alkalinity, and total dissolved solids analyses required filling one 250-mL polyethylene bottle with raw ground water, and one 500-mL and one 250-mL polyethylene bottles with filtered ground water (Wilde and others, 2004). Filtration was done using a Whatman capsule filter. The 250-mL filtered sample was then preserved with 7.5 N nitric acid. Mercury samples were collected by filtering ground water into a 250-mL glass bottle and preserving with 6 N hydrochloric acid. Arsenic and iron speciation samples were filtered into a 250-mL polyethylene bottle that was covered with tape to prevent light exposure and preserved with 6 N hydrochloric acid. The nutrient sample was filtered into 125-mL brown polyethylene bottle. The nitrate isotope was filtered into a 1-L polyethylene bottle. Radium isotopes and gross alpha and beta radiation samples were filtered into 1-L polyethylene bottles and acidified with nitric acid. Carbon isotope samples were filtered and bottom filled into two 500-mL glass bottles that were first overfilled with three bottle volumes of ground water. These samples had no headspace and were sealed with a conical cap to avoid atmospheric contamination. Samples for alkalinity titrations were collected by filtering ground water into a 500-mL polyethylene bottle.

DOC, chromium, radon-222, dissolved gases, and microbial constituents were collected from the hose bib at the well head, regardless of the sampling schedule (*fast*, *intermediate* or *slow*). DOC was collected after rinsing the sampling equipment with universal blank water (Wilde and others, 2004). Using a 50-mL syringe and 0.45- μ m disk filter, the ground water sample then was filtered into a 125-mL baked glass bottle and preserved with 4.5 N sulfuric acid. Chromium speciation samples were collected using a 10-mL syringe with an attached 0.45- μ m disk filter. After the syringe was thoroughly rinsed and filled with ground water, 4 mL was forced through the disk filter; the next 2 mL of the ground water was slowly filtered into a small centrifuge vial for analysis of total chromium. Hexavalent chromium, Cr(VI) was then collected by attaching a small cation exchange column to the syringe filter, and after conditioning the column with 2 mL of sample water, 2 mL was collected in a second centrifuge vial. Both vials were preserved with 10 μ L of 7.5 N nitric acid (Ball and McClesky, 2003a,b).

For the collection of radon-222, a stainless steel and Teflon valve assembly was attached to the sampling port at the well head (Wilde and others, 2004). The valve was partially closed to create back pressure, and a 10-mL sample was taken through a Teflon septum on the valve assembly

using a glass syringe affixed with a stainless-steel needle. The sample was then injected into a 25-mL vial partially filled with scintillation mixture (mineral oil) and shaken. The vial was then placed in a cardboard tube to shield it from light during shipping.

Noble gases were collected in 3/8-in. copper tubes using reinforced nylon tubing connected to the hose bib at the wellhead. Ground water was flushed through the tubing to dislodge bubbles before flow was restricted with a back pressure valve. Clamps on either side of the copper tube were then tightened, trapping a sample of ground water for analyses of noble gases (Weiss, 1968).

Samples for analysis of microbial constituents also were collected at the well head (Myers, 2004; Bushon, 2003). Prior to the collection of samples, the sampling port was sterilized using isopropyl alcohol, and ground water was run through the sampling port for at least 3 minutes to remove any traces of the sterilizing agent. Two sterilized 250-mL bottles were then filled with ground water for coliform analyses (total and *Escherichia coli* coliform determinations), and one sterilized 3-L carboy was filled for coliphage analyses (F-specific and somatic coliphage determinations).

Alkalinity and total coliforms and *Escherichia coli* coliform (*E. coli*) were measured in the mobile laboratory at the well site. Alkalinity was measured on filtered samples by Gran's titration method, and concentrations of bicarbonate and carbonate were calculated from the titration data using the advanced-speciation method (Rounds, 2006). Total coliforms and *E. coli* plates were prepared using sterilized equipment and reagents (Meyers, 2004). Plates were counted under an ultraviolet light, following a 22–24 hour incubation time.

Ten laboratories performed chemical and microbial analyses for this study (see [table A1](#)), although most of the analyses were performed at NWQL or by laboratories contracted by NWQL. NWQL maintains a rigorous quality-assurance program (Maloney, 2005; Pirkey and Glodt, 1998). Laboratory quality-control samples, including method blanks, continuing calibration verification standards, standard reference samples, reagent spikes, external certified reference materials, and external blind proficiency samples, are analyzed regularly. Method detection limits are continually tested and laboratory reporting levels updated accordingly. NWQL maintains National Environmental Laboratory Accreditation Program (NELAP) and other certifications (<http://nwql.usgs.gov/Public/Performance/publiclabcertcoverpage.html>). In addition, the Branch of Quality Systems within the USGS Office of Water Quality maintains independent oversight of quality assurance at NWQL and laboratories contracted by NWQL. The Branch of Quality Systems also runs a National Field Quality Assurance program that includes annual testing of all USGS field personal for proficiency in making field water-quality measurements. Results for analyses made at NWQL or by laboratories contracted by NWQL are uploaded directly into NWIS by NWQL. Laboratory quality-control data are also stored in NWIS.

Data Reporting

Laboratory Reporting Conventions

The USGS's NWQL uses the laboratory reporting level (LRL) as a threshold for reporting analytical results. The LRL is set to minimize the reporting of false negatives (not detecting a compound when it is actually present in a sample) to less than 1 percent (Childress, and others, 1999). The LRL is set at two-times the long-term method detection level (LT-MDL). The LT-MDL is derived from the standard deviation of at least 24 method detection limit (MDL) determinations made over an extended period of time. LT-MDLs are continually monitored and updated. The MDL is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the concentration is greater than zero (at the MDL, there is less than 1 percent chance of a false positive) (U.S. Environmental Protection Agency, 2002a). NWQL updates LRL values regularly, and the values listed in this report were in effect during the period that analyses were made for ground-water samples from the KERN study (January to March, 2006).

Detections between the LRL and the LT-MDL are reported as estimated concentrations (designated with an "E" before the value in the tables and text). For information-rich methods, detections below the LRL have a high certainty of detection, but the precise concentration is uncertain. Information-rich methods are those that utilize gas chromatography or high-performance liquid chromatography (HPLC) with mass spectrometry detection (VOCs, low-level DBCP and EDB, gasoline oxygenates and degradates, pesticides, polar pesticides, and pharmaceuticals). Compounds are identified by the presence of characteristic fragmentation patterns in their mass spectra in addition to being quantified by measurement of peak areas at their associated chromatographic retention times. E-values also may result from detections outside the range of calibration standards for detections that did not meet all laboratory quality-control criteria and for samples that were diluted prior to analysis. For example, the pesticide degradate, deethylatrazine, is always reported as estimated because of poor analytical recovery (Furlong and others, 2001).

Some compound concentrations in this study are reported using minimum reporting levels (MRLs) or method uncertainties (MU). The MRL is the smallest measurable concentration of a constituent that may be reliably reported using a given analytical method (Timme, 1995). The MU generally indicates the precision of a particular analytical measurement; it gives a range of values wherein the true value will be found.

Detections that could have resulted from inadvertent sample contamination are reported with a "V" code in front of

the values in the tables indicating the detection was censored and not included in the ground-water quality assessment. The potential for sample contamination was assessed using results from the field, source-solution, and laboratory blanks.

The reporting levels for radiochemical constituents (gross-alpha radioactivity, gross-beta radioactivity, radium-226, and radium-228, and uranium isotopes) are based on a sample-specific minimum detectable concentration (SSMDC), a critical value (CV), and the combined standard uncertainty (CSU) (U.S. Environmental Protection Agency, 2004; Bennett and others, 2006). A result above the critical value represents a greater-than-95-percent certainty that the result is greater than zero (significantly different from the instrument's background response to a blank sample), and a result above the SSMDC represents a greater-than-95-percent certainty that the result is greater than the critical value. Using these reporting level elements, three unique cases were possible when screening the raw analytical data. If the analytical result was less than the CV (case 1), then the analyte was considered not detected, and the concentration was reported as less than the SSMDC. If the analytical result was greater than the CV, the ratio of the CSU to the analytical result was calculated as a percent (percent relative CSU). For those samples with percent relative CSU greater than 20 percent, concentrations were reported as estimated values (designated by an "E" preceding the value) (case 2). For those samples with percent relative CSU less than 20 percent, concentrations were reported unqualified (case 3). For table clarity, only the screened results are reported.

Stable isotopic compositions of oxygen, hydrogen, carbon, and nitrogen are reported as relative isotope ratios in units of per mil using the standard delta notation (Coplen and others, 2002):

$$\delta^i E = \left[\frac{R_{\text{sample}}}{R_{\text{reference}}} - 1 \right] \times 1,000 \text{ per mil}$$

where

- $^i E$ is the heavier isotope (oxygen-18, hydrogen-2, carbon-13, or nitrogen-15)
- R_{sample} is the ratio of the abundance of the heavier isotope to the lighter isotope (oxygen-16, hydrogen-1, carbon-12, or nitrogen-14) in the sample, and
- $R_{\text{reference}}$ is the ratio of the abundance of the heavier isotope to the lighter isotope (oxygen-16, carbon-12, or hydrogen-1) in the reference material

The reference material for oxygen and hydrogen is Vienna Standard Mean Ocean Water (VSMOW), which is assigned $\delta^{18}\text{O}$ and $\delta^2\text{H}$ values of 0 per mil (note that $\delta^2\text{H}$ is also written as δD because the common name of the heavier isotope of hydrogen, hydrogen-2, is deuterium). The reference material for carbon is Vienna Pee Dee Belemnite (VPDB), which is assigned a $\delta^{13}\text{C}$ value of 0 per mil. The reference material for nitrogen is atmospheric nitrogen gas, which is assigned a $\delta^{15}\text{N}$ value of 0 per mil. Positive values indicate enrichment of the heavier isotope, and negative values indicate depletion of the heavier isotope, compared with the ratios observed in the standard reference material.

Constituents on Multiple Analytical Schedules

Eighteen constituents targeted in the KERN study were determined by more than one analytical schedule or more than one laboratory (table A2). The preferred method for constituents analyzed under multiple analytical schedules at NWQL was selected on the basis of the procedure recommended by NWQL (http://www.nwql.cr.usgs.gov/USGS/Preferred_method_selection_procedure.html). The primary reasons that results from certain analytical schedules may be preferred over others are: full method approval rather than provisional approval; greater accuracy or precision; lower LRL; detection instrumentation with greater specificity; or method consistency among the GAMA study units. If a VOC, low-level DBCP and EDB, gasoline oxygenate and degradate, pesticide, or polar pesticide appears on multiple NWQL analytical schedules, then only the measurement determined by the preferred method is reported.

For arsenic, chromium, and iron concentrations, the standard method used by NWQL is preferred over the research method used by the USGS's Trace Metal Laboratory (TML), although both are reported. The concentrations measured by TML are used only to calculate ratios of redox species for the elements. Tritium results from both the USGS's Stable Isotope and Tritium Laboratory and LLNL are reported.

The water quality indicators—pH, SC, and alkalinity—were measured in the field and at NWQL. The field measurements are the preferred method; however, both are reported because the laboratory measurements of pH and alkalinity were made on a greater number of samples.

Quality Assurance

The quality assurance used in this study follows the protocols used by the USGS's NAWQA program (Koterba and others, 1995) and described in the USGS National Field

Manual (U.S. Geological Survey, variously dated). The primary laboratory used in this study, the NWQL, follows stringent quality-assurance procedures (Maloney, 2005; Pirkey and Glodt, 1998). Quality-control (QC) samples collected in the KERN study include source-solution blanks, field blanks, replicates, and laboratory matrix and surrogate spikes. QC samples were collected to evaluate bias and variability of the data that may have resulted from sample collection, processing, storage, transportation, and laboratory analysis.

Blanks

Blank samples (blanks) were collected using “blank” water (nitrogen-purged universal blank water) certified by NWQL to contain less than the LRL or MRL of the analytes investigated in the study. Certification is documented by the blank water lot number. Two types of blanks were collected: source-solution blanks and field blanks. Source-solution blanks were collected to verify that the blank water used for the field blanks was free of analytes of interest. Field blanks were collected to determine if equipment or procedures used in the field or laboratory introduced contamination. Field blanks were collected at about 10 percent of the wells sampled and source-solution blanks were collected at about 8 percent of the wells sampled. Field blanks were analyzed for VOCs, low-level DBCP and EDB, gasoline oxygenates and degradates, pesticides, polar pesticides, pharmaceuticals, perchlorate, NDMA, 1,2,3-TCP, nutrients, dissolved organic carbon, major and minor ions, trace elements, iron, arsenic, and chromium speciation, and radioactive constituents. Source-solution blanks were analyzed for VOCs, low-level DBCP and EDB, gasoline additives, pharmaceuticals, perchlorate, NDMA, and 1,2,3-TCP. Universal blank water is not available for tritium or noble gases; thus, blanks were not collected for these constituents.

Source-solution blanks were collected at the sampling site by pouring blank water directly into sample containers that were preserved, stored, shipped, and analyzed in the same manner as the ground-water samples. For field blanks, blank water was either pumped or poured through the sampling equipment (fittings and tubing) used to collect ground water, then processed and transported using the same protocols for the ground-water samples.

If a constituent was detected in a field blank, the associated source-solution blank results and the corresponding

blank water certificate of analysis results were examined for similar constituent detections. If the field blank, the source-solution blank, and the certificate of analysis contained the constituent, then the blank water was interpreted as the origin of the contamination in the blanks, and the field blank detections using the same blank water were disregarded (in other words, field blank detections were not considered to introduce contamination). If no source-solution blank was collected, but the certificate of analysis contained the constituent at a similar or higher concentration than what was detected in the field blank, then the field blank detections using the same blank water lot number were disregarded. If the certificate of analysis contained the constituent at a lower concentration than what was detected in the field blank, then this was noted in the tables because the blank water may be a source of contamination to the field blank, but it cannot explain the detection so the field blank detection was not disregarded. If an analyte was detected in multiple blanks or in a field blank and in a ground-water sample and the blank water was not determined to be the source of contamination, then ground-water values for the analyte were censored. The ground-water value was censored if the concentration was less than the concentration in the field blank plus one-half the LRL (table A3). This approach to censoring is conservative in that all ground-water samples were compared with field blank results to minimize as much potential positive bias as possible as opposed to only comparing results of ground water samples collected immediately prior to, or after field blank samples. Censored values are tabulated with a “V” preceding the value, and are not considered in the summary statistics.

Replicates

Sequential replicate samples assess variability that may result from the processing and analyses of inorganic and organic constituents. Relative standard deviation (RSD) of the measured values was used to assess the variability between replicate pairs for each compound. The RSD is defined as the standard deviation divided by the mean concentration for each replicate pair of samples, multiplied by 100 percent. If one value in a sample pair was reported as a nondetection, and the other value was reported as an estimate below the LRL or MRL, the RSD was set to zero because the values are analytically identical. If one value in a sample pair was reported as a nondetection, and the other value was greater than the LRL or MRL, then the nondetection value was set equal to one-quarter of the LRL, and the RSD was calculated (Childress, and others, 1999). Values of RSD less than 20 percent are considered acceptable in this study. An RSD value of 20 percent corresponds to a relative percent difference (RPD) value of 29 percent. High RSD values for a compound

may indicate analytical uncertainty at low concentrations, particularly for concentrations within an order of magnitude of LT-MDL or MDL. Sequential replicate samples were collected at about 10 percent of the wells sampled. Table A4 lists the number of replicates collected by analyte class or constituent and the values for replicate pairs with an RSD greater than 20 percent.

Laboratory Matrix Spikes

Addition of a known concentration of a constituent (“spike”) to a replicate ground-water sample enables the analyzing laboratory to determine the effect of the matrix, in this case ground water, on the analytical technique used to measure the constituent. The known compounds added in laboratory matrix spikes are the same as those being analyzed in the method. This enables an analysis of matrix interferences on a compound-by-compound basis. Matrix spikes were added at the laboratory performing the analysis. Low matrix spike recoveries may indicate that the compound might not be detected in some samples if it were present at very low concentrations.

Acceptable ranges for laboratory matrix-spike recoveries are based on the acceptable ranges established for laboratory “set” spike recoveries. Laboratory set spikes are aliquots of laboratory blank water to which the same spike solution used for the laboratory matrix spikes has been added. One set spike is analyzed with each set of samples. Acceptable ranges for set spike recoveries are between 70 to 130 percent for NWQL Schedules 2020, 1306, and 4024 (Connor and others, 1998; Eichelberger, 1993; Rose and Sandstrom, 2003), 60 to 120 percent for NWQL Schedules 2033 and 2060 (Zaugg and others, 1995; Lindley and others, 1996; Madsen and others, 2003; Sandstrom and others, 2001; Furlong and others, 2001). Based on these ranges, 70 to 130 percent was defined as the acceptable range for laboratory matrix-spike recoveries for organic constituents.

Laboratory matrix spikes were done for VOCs, low level DBCP and EDB, gasoline oxygenates and degradates, pesticides and degradates, polar pesticides and metabolites, perchlorate, NDMA, and 1,2,3-TCP because the analytical methods for these constituents are chromatographic methods, which may be susceptible to matrix interferences. Replicate samples for the addition of matrix spikes were collected at 10 percent of the wells sampled, although not all analyte classes were tested at every well (tables A5A, A5B, and A5C).

Surrogates

Surrogate compounds are added to environmental samples in the laboratory prior to analysis to evaluate the recovery of similar constituents. Surrogate compounds were added to all ground-water and quality-control samples that were analyzed for VOCs, gasoline oxygenates and degradates, pesticides and degradates, polar pesticides and metabolites, NDMA, and 1,2,3-TCP (table A6). Most of the surrogate compounds are deuterated analogs of compounds being analyzed. For example, the surrogate toluene-d8 used for the VOC analytical method has the same chemical structure as toluene, except that the eight hydrogen-1 atoms on the molecule have been replaced by deuterium (hydrogen-2). Toluene-d8 and toluene behave very similarly in the analytical procedure, but the small mass difference between the two results in slightly different chromatographic retention times; thus, the use of a toluene-d8 surrogate does not interfere with the analysis of toluene (Grob, 1995). Only 0.0156 percent of hydrogen atoms are deuterium (Firestone and others, 1996); thus, deuterated compounds such as toluene-d8 do not occur naturally and are not found in environmental samples. Surrogates are used to identify general problems that may arise during sample analysis that could affect the analysis results for all compounds in that sample. Potential problems include matrix interferences (such as high levels of dissolved organic carbon) that produce a positive bias, or incomplete laboratory recovery (possibly attributed to improper maintenance and calibration of analytical equipment) that produces a negative bias. A 70 to 130 percent recovery of surrogates is generally considered acceptable; values outside this range indicate possible problems with the processing and analysis of samples (Connor and others, 1998; Sandstrom and others, 2001).

Quality-Control-Sample Results

Detections in Field and Source-Solution Blanks

Field blanks were collected at approximately 10 percent of the wells, and the results for these samples were used to evaluate the quality of the data from ground-water samples. Table A3 presents a summary of detections in field blanks.

Of the 88 different VOCs analyzed, only toluene was censored from the ground-water samples. Toluene was detected in all five field blanks and in two source solution blanks at concentrations ranging from E0.01 $\mu\text{g/L}$ to 0.12 $\mu\text{g/L}$. Therefore, both detections of toluene in ground-water samples (0.02 $\mu\text{g/L}$ to 0.03 $\mu\text{g/L}$) were censored (tables 5 and A3). The only detections of acetone, 2-butanone (MEK), dichloromethane, ethylbenzene, and xylenes, and the highest detection of toluene occurred in the same field

blank. None of these compounds were detected in the ground-water sample collected at the same site, and acetone, MEK, dichloromethane, and xylenes were not detected in any KERN samples. The site at which the contaminated field blank was collected had a very large diesel generator running inside the pump house during sampling and the exhaust fan for the pump house was directly above the well head where the field blank was being collected. Because a plausible source of contamination specific to this site was identified, the detections in the field blank collected at this site were not used to censor detections in other ground-water samples. Therefore, the detection of ethylbenzene in a ground-water sample (E0.05 $\mu\text{g/L}$) was not censored even though the concentration in the blank (E0.05 $\mu\text{g/L}$) plus one-half the LRL (0.03 $\mu\text{g/L}$) was greater.

Of the 140 different pesticides and degradates, and polar pesticides and metabolites analyzed, none were detected in field blanks or censored from the ground-water samples. Five field blanks were collected for the analysis of pesticides and pesticide degradates using the NWQL analytical Schedule 2033. Two field blanks were collected for the analysis of polar pesticides and pesticide metabolites using the NWQL analytical Schedule 2060. Caffeine, a pharmaceutical compound on the NWQL analytical Schedule 2060, was detected in one out of two field blanks at a concentration of 0.029 $\mu\text{g/L}$. Concentrations of caffeine in all six ground-water samples were less than the censor value of 0.038 $\mu\text{g/L}$ (0.029 $\mu\text{g/L}$ plus one-half the LRL of 0.018 $\mu\text{g/L}$), and were, therefore, censored (tables 6B and A3).

No constituents of special interest were detected in field blanks or censored from ground-water samples. Five field blanks were collected for perchlorate, three field blanks were collected for NDMA, and two field blanks were collected for 1,2,3-TCP.

No nutrients were detected in field blanks or censored from ground-water samples. Two field blanks were collected for the analysis of DOC and nutrients. DOC was detected in both field blanks. Eight of the 11 DOC detections in ground-water samples were censored because they were lower than the censoring value of 0.55 mg/L (0.4 mg/L, the maximum concentration in the field blank, plus one-half the LRL of 0.3 mg/L) (tables 8 and A3).

No major or minor ions were censored from ground-water samples. Two field blanks were collected for the analysis of major and minor ions. Out of the 10 major and minor ions analyzed, 5 were detected in field blanks. The maximum concentration of the detections in field blanks was 10 times less than the minimum concentrations in ground-water samples (tables 9 and A3).

Of the 25 trace elements analyzed, 9 were detected in field blanks. Aluminum, strontium, and barium were detected at unusually high concentrations (table A3). NWQL determined that high concentrations of aluminum, strontium, and barium in field blanks and source solution blanks collected in late 2005 through early 2006 were the result of systematic contamination of the blank water by leaching from the glass bottles (<http://www.nwql.cr.usgs.gov/USGS/rapi-note/06-008.html>). All bottles with the same lot numbers as the affected bottles were discarded. No other field blanks were collected for trace element analyses in KERN; thus, it was not possible to assess potential contamination of the ground-water samples. Copper, lead, nickel, and zinc were detected in both field blanks and chromium and iron in one of the two field blanks. These detections resulted censoring of some data for all six elements. Copper was detected in two field blanks, both at concentrations of $E0.4 \mu\text{g/L}$. Five detections of copper in ground-water samples with concentrations less than $0.6 \mu\text{g/L}$ ($0.4 \mu\text{g/L}$ plus one-half the LRL of $0.4 \mu\text{g/L}$) were, therefore, censored (tables 10 and A3). Lead was detected in two field blanks at concentrations of $E0.06 \mu\text{g/L}$ and $0.16 \mu\text{g/L}$. One detection of lead in a ground-water sample with a concentration less than $0.2 \mu\text{g/L}$ ($0.16 \mu\text{g/L}$ plus one-half the LRL of $0.08 \mu\text{g/L}$) was, therefore, censored (tables 10 and A3). Nickel was detected in two field blanks at concentrations of $0.07 \mu\text{g/L}$ and $0.10 \mu\text{g/L}$. One detection of nickel in a ground-water sample with a concentration less than $0.13 \mu\text{g/L}$ ($0.10 \mu\text{g/L}$ plus one-half the LRL of $0.06 \mu\text{g/L}$) was, therefore, censored (tables 10 and A3). Zinc was detected in two field blanks at concentrations of $0.6 \mu\text{g/L}$ and $4.8 \mu\text{g/L}$. Eight detections of zinc in ground-water samples with concentrations less than $4.82 \mu\text{g/L}$ ($4.8 \mu\text{g/L}$ plus one-half the LRL of $0.04 \mu\text{g/L}$) were, therefore, censored (tables 10 and A3). Chromium was detected in one field blank at a concentration of $0.04 \mu\text{g/L}$. Two detections of chromium in ground-water samples with concentrations less than $0.06 \mu\text{g/L}$ ($0.04 \mu\text{g/L}$ plus one-half the LRL of $0.04 \mu\text{g/L}$) were, therefore, censored (tables 10 and A3). Iron was detected in one field blank at a concentration of $E4 \mu\text{g/L}$. Two detections of iron in ground-water samples with concentrations less than $7 \mu\text{g/L}$ ($4 \mu\text{g/L}$ plus one-half the LRL of $6 \mu\text{g/L}$) were, therefore, censored (tables 10 and A3). The trace elements censored can be products of the corrosion of stainless steel or in the case of zinc, from corroded electroplating. It could be possible that the field blank contamination originated from corroded metal components that were touched and then brought into contact with the sampling equipment or perhaps from corroded metal fittings used to connect sampling lines.

Concentrations of arsenic, iron, or chromium speciation were not detected in field blanks or censored from ground-water samples. Two field blanks were collected for these analyses.

Two field blanks were collected for the analysis of radium-226, radium-228, alpha radioactivity-72 hour count, alpha radioactivity-30 day count, beta radioactivity-72 hour count, and beta radioactivity-30 day count. Radium-226 and radium-228 were detected in both field blanks. One detection of radium-226 and seven detections of radium-228 in ground-water samples were censored.

Variability in Replicate Samples

Table A4 summarizes the results of replicate sample pairs in ground-water samples collected for the KERN study. More than 300 replicate analyses were made for constituents detected in at least one ground-water sample, and more than 700 replicate analyses were made in total when replicate analyses for all constituents are counted. Five replicate samples were collected for VOCs, low-level DBCP and EDB, and pesticides and pesticide degradates (NWQL Schedules 2020, 1306, and 2033), and all replicate analyses had RSD values less than 20 percent. Two replicate samples were collected for gasoline oxygenates and degradates, polar pesticides and metabolites, nutrients, major and minor ions, chromium(VI), stable isotopes of water, stable isotopes of nitrate, and tritium (NWQL Schedules 4024, 2060, 2755, 1948, chromium(VI) analyzed by the USGS's TML, NWQL Schedule 1142, USGS NWQL Laboratory codes 2900 and 1565, respectively), and all replicate analyses had RSD values less than 20 percent. All replicate analyses for the following analytes also had RSD values less than 20 percent: DOC, stable isotopes of carbon, radon-222, uranium-235 (one replicate); helium-3/helium-4, krypton, xenon, and tritium analyzed by LLNL (five replicates). Most replicate sample pairs had RSD values less than 5 percent. Thirteen constituents had RSD values greater than the acceptable limit of 20 percent (table A4). Constituents with replicate sample pairs with RSD values greater than 20 percent include aluminum, cadmium, copper, iron, and zinc analyzed at NWQL; arsenic(Total), chromium(Total), and iron(II) analyzed by the TML; uranium-234 and uranium-238 analyzed by Eberline Laboratory; and argon, helium-4, and neon analyzed by LLNL. However, the magnitudes of the concentrations of aluminum, cadmium, copper, and iron were within a factor of two of the LRLs for the respective analytes (tables 10 and A4), and the magnitudes of the activities of uranium-234 and uranium-238 were within the lowest 20 percent of the samples analyzed. At these low concentrations, small deviations in measured values result in large RSDs. Replicate analyses with RSD values greater than 20 percent for zinc and the constituents analyzed at the TML have been observed in the data from other GAMA study units (Wright and others, 2005; Bennett and others, 2006; Kulongoski and Belitz, 2007). No data were censored as a result of variability in replicate sample pairs.

Laboratory Matrix Spike Recoveries

Tables [A5A–A5C](#) present a summary of laboratory matrix-spike recoveries for the KERN study. Addition of a spike or known concentration of a constituent to an environmental sample enables the laboratory to determine the effect of the matrix, in this case ground water, on the analytical technique used to measure the constituent. Acceptable spike recovery values range between 70 and 130 percent. Five environmental samples were spiked with VOCs to calculate matrix spike recoveries ([table A5A](#)). Seventy-seven of the 88 VOC compounds had spike recoveries between the acceptable range. Twelve VOCs had at least one matrix spike recovery greater than 130 percent. However, only three of these VOCs (bromodichloromethane, 1,1-dichloroethane, and tetrachloroethene) were detected in ground-water samples, and the median recoveries were within acceptable limits for these compounds; thus, no positive bias was expected and no ground-water data were censored. One VOC (methyl iodide or iodomethane) had one matrix spike recovery below 70 percent and one matrix spike recovery above 130 percent, indicating variable laboratory performance. This VOC was not detected in ground-water samples.

Four ground-water samples were spiked with pesticides and degradates, and three ground-water samples were spiked with polar pesticides and metabolites to calculate laboratory matrix-spike recoveries ([table A5B](#)). Twenty-three compounds had at least one laboratory matrix-spike recovery greater than 130 percent; however, only one of these compounds (imazethapyr) was detected in a ground-water sample. Two of the three matrix spike recoveries for imazethapyr were greater than 130 percent (median 134 percent), suggesting that a measured concentration in an environmental sample may be disproportionately high. The concentration of imazethapyr was reported by NWQL with an “E” code ([table 6B](#)) indicating that the magnitude of the concentration is uncertain. Forty compounds had at least one laboratory matrix-spike recovery less than 70 percent. Two (3,4-dichloroaniline and hexazinone) were detected in ground-water samples, and the median recoveries were within acceptable limits for these compounds;

thus, no positive bias was expected and no ground-water data were censored. Three compounds (azinphos-methyl, fenamiphos sulfone, and metsulfuron methyl) had at least one matrix spike recovery below 70 percent and one matrix spike recovery above 130 percent, indicating variable laboratory performance. These compounds were not detected in ground-water samples. None of the pesticides and degradates, and polar pesticides and metabolites with laboratory matrix-spike recoveries of less than 70 or greater than 130 percent are regulated compounds. No ground-water data were censored on the basis of matrix spike recoveries. (NOTE: low recoveries may indicate that the compound might not have been detected in some samples if it was present at very low concentrations).

Two ground-water samples were spiked with NDMA and 1,2,3-TCP, and one ground-water sample was spiked with perchlorate. All spike recoveries were within the acceptable range of 70 to 130 percent ([table A5C](#)).

One laboratory matrix spike was collected for total coliphage analyses. F-specific and somatic coliphage results were reported as positive by the laboratory, indicating successful matrix spike recovery. Results are not tabled.

Surrogate Compound Recoveries

Surrogate compounds were added to environmental samples in the laboratory and analyzed to evaluate the recovery of similar constituents. [Table A6](#) lists the surrogate, analytical schedule on which it was applied, the number of analyses for blank and nonblank samples, the number of surrogate recoveries below 70 percent, and the number of surrogate recoveries above 130 percent for the blank and nonblank samples. Blank and nonblank samples were considered separately to assess whether the matrices present in nonblank samples affect surrogate recoveries. No systematic differences between surrogate recoveries in blank and nonblank samples were observed. Ninety-five percent of all surrogate recoveries in the analyses were in the acceptable range of 70 to 130 percent recovery.

Table A1. Analytical methods used for the determination of organic, inorganic, and microbial constituents by the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) and additional contract laboratories.

[Laboratory entity codes in the USGS's National Water Information System (NWIS) for laboratories other than the USGS's National Water Quality Laboratory (NWQL) are given in parentheses after the laboratory names. **Analytical method:** MI agar, supplemental nutrient agar in which coliforms (total and *Escherichia*) produce distinctly different fluorescence under ultraviolet lighting. **Abbreviations:** UV, ultraviolet]

Analyte classes	Analytical method	Laboratory and analytical schedule	Citation(s)
Water-quality indicators			
Field parameters		USGS field measurement	U.S. Geological Survey, variously dated
Organic constituents			
Volatile organic compounds (VOCs)	Purge and trap capillary gas chromatography/mass spectrometry	NWQL, Schedule 2020	Connor and others, 1998
Low level 1,2-dibromo-3-chloropropane (DBCP) and 1,2-dibromoethane (EDB)	Microextraction and gas chromatography	NWQL, Schedule 1306	Eichelberger, 1993 (USEPA method 504.1)
Gasoline oxygenates and degradates	Heated purge and trap/gas chromatography/mass spectrometry	NWQL, Schedule 4024	Rose and Sandstrom, 2003
Pesticides and degradates	Solid-phase extraction and capillary-column gas chromatography/mass spectrometry	NWQL, Schedule 2033	Zaugg and others, 1995; Lindley and others, 1996; Madsen and others, 2003; Sandstrom and others, 2001
Polar pesticides and metabolites	Solid-phase extraction and high-performance liquid chromatography/mass spectrometry	NWQL, Schedule 2060	Furlong and others, 2001
Constituents of special interest			
Perchlorate	Chromatography and mass spectrometry	Montgomery Watson Harza Laboratory (CA-MWHL)	Hautman and others, 1999
N-Nitrosodimethylamine (NDMA)	Chromatography and mass spectrometry	Montgomery Watson Harza Laboratory (CA-MWHL)	U.S. Environmental Protection Agency, 1996, 1999
1,2,3-Trichloropropane (1,2,3-TCP)	Gas chromatography/electron capture detector	Montgomery Watson Harza Laboratory (CA-MWHL)	U.S. Environmental Protection Agency, 1995
Inorganic constituents			
Nutrients	Alkaline persulfate digestion, Kjeldahl digestion	NWQL, Schedule 2755	Fishman, 1993; Patton and Kryskalla, 2003
Dissolved organic carbon	UV-promoted persulfate oxidation and infrared spectrometry	NWQL, Laboratory code 2613	Brenton and Arnett, 1993
Major and minor ions, and trace elements	Atomic absorption spectrometry, colorimetry, ion-exchange chromatography, inductively-coupled plasma atomic emission spectrometry and mass spectrometry	NWQL, Schedule 1948	Fishman and Friedman, 1989; Fishman, 1993; Faires, 1993; Garbarino, 1999; Garbarino and Damrau, 2001; Patton and Kryskalla, 2003; McLain, 1993; American Public Health Association, 1998; Garbarino and others, 2006

Table A1. Analytical methods used for the determination of organic, inorganic, and microbial constituents by the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) and additional contract laboratories.—Continued

[Laboratory entity codes in the USGS's National Water Information System (NWIS) for laboratories other than the USGS's National Water Quality Laboratory (NWQL) are given in parentheses after the laboratory names. **Analytical method:** MI agar, supplemental nutrient agar in which coliforms (total and *Escherichia*) produce distinctly different fluorescence under ultraviolet lighting. **Abbreviations:** UV, ultraviolet]

Analyte classes	Analytical method	Laboratory and analytical schedule	Citation(s)
Inorganic constituents—Continued			
Arsenic, iron, and chromium speciation	Various techniques of ultraviolet visible (UV-VIS) spectrophotometry and atomic absorbance spectroscopy	USGS Trace Metal Laboratory, Boulder, Colorado (USGSTMCO)	Stookey, 1970; To and others, 1998; Ball and McCleskey, 2003a,b; McCleskey and others, 2003
Chromium, arsenic and iron species	Various techniques of ultraviolet visible (UV-VIS) spectrophotometry and atomic absorbance spectroscopy	USGS Trace Metal Laboratory, Boulder, Colorado	Stookey, 1970; To and others, 1998; Ball and McCleskey, 2003a and 2003b; McCleskey and others, 2003
Stable isotopes			
Stable isotopes of water	Gaseous hydrogen and carbon dioxide-water equilibration and stable-isotope mass spectrometry	USGS Stable Isotope Laboratory, Reston, Virginia (USGSSIVA), NWQL Schedule 1142	Epstein and Mayeda, 1953; Coplen and others, 1991; Coplen, 1994
Nitrogen and oxygen isotopes of nitrate in water	Bacterial conversion of nitrate to nitrous oxide and nitrogen isotopic analysis by continuous flow isotope ratio mass spectrometry and stable-isotope mass spectrometry	USGS Stable Isotope Laboratory, Reston, Virginia (USGSSIVA), NWQL Laboratory code 2900	Revesz and Casciotti, 2007
Carbon isotopes	Accelerator mass spectrometry	University of Waterloo, Environmental Isotope Laboratory (CAN-UWIL); University of Arizona Accelerator Mass Spectrometry Laboratory (AZ-UAMSL), NWQL Schedule 2015	Donahue and others, 1990; Jull and others, 2004
Radioactivity and gases			
Tritium	Electrolytic enrichment-liquid scintillation	USGS Stable Isotope and Tritium Laboratory, Menlo Park, California (USGSH3CA), NWQL Laboratory code 1565	Thatcher and others, 1977
Noble gases and tritium	Helium-3 in-growth and mass spectrometry	Lawrence Livermore National Laboratory (CA-LLNL)	Moran and others, 2002; Eaton and others, 2004
Radon-222	Liquid scintillation counting	NWQL, Schedule 1369	American Society for Testing and Materials, 1998a,b
Radium isotopes	Alpha activity counting	Eberline Analytical Services (CA-EBERL), NWQL Schedule 1262	U.S. Environmental Protection Agency, 1980 (USEPA methods 903 and 904)
Uranium isotopes	Chemical separations and alpha-particle spectrometry	Eberline Analytical Services (CA-EBERL), NWQL Schedule 1130	American Society for Testing and Materials, 2002
Gross alpha and beta radioactivity	Alpha and beta activity counting	Eberline Analytical Services (CA-EBERL), NWQL Schedule 1792	U.S. Environmental Protection Agency, 1980 (USEPA method 900.0)
Microbial constituents			
F-specific and somatic coliphage	Single-agar layer (SAL) and two-step enrichment methods	USGS Ohio Water Microbiology Laboratory	U.S. Environmental Protection Agency, 2001
Total and <i>Escherichia</i> coliform	Membrane filter technique with "MI agar"	USGS field measurement	U.S. Environmental Protection Agency, 2002b

Table A2. Preferred analytical schedules for constituents appearing on multiple schedules for samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March, 2006.

[Preferred analytical schedules are the methods of analysis with the greatest accuracy and precision out of the ones used for the compound in question. LLNL, Lawrence Livermore National Laboratory; MWH, Montgomery Watson Harza Laboratory; SITL, U.S. Geological Survey's Stable Isotope and Tritium Laboratory; TML, U.S. Geological Survey's Trace Metal Laboratory. Abbreviations: VOC, volatile organic compound; —, no preference]

Constituent	Primary constituent classification	Analytical schedules	Preferred analytical schedule
Results from preferred method reported			
Acetone	VOC, gasoline degradate	2020, 4024	2020
Methyl <i>tert</i> -pentyl ether (<i>tert</i> -Amyl methyl ether, TAME)	VOC, gasoline oxygenate	2020, 4024	2020
Atrazine	Pesticide	2033, 2060	2033
Carbaryl	Pesticide	2033, 2060	2033
Carbofuran	Pesticide	2033, 2060	2060
Deethylatrazine (2-Chloro-4-isopropylamino-6-amino- <i>s</i> -triazine)	Pesticide degradate	2033, 2060	2033
1,2-Dibromo-3-chloropropane (DBCP)	VOC, fumigant	2020, 1306	1306
1,2-Dibromoethane (EDB)	VOC, fumigant	2020, 1306	1306
Diisopropyl ether (DIPE)	VOC, gasoline oxygenate	2020, 4024	2020
Ethyl <i>tert</i> -butyl ether (ETBE)	VOC, gasoline oxygenate	2020, 4024	2020
Metalaxyl	Pesticide	2033, 2060	2060
Methyl <i>tert</i> -butyl ether (MTBE)	VOC, gasoline oxygenate	2020, 4024	2020
Tebuthiuron	Pesticide	2033, 2060	2033
Results from both methods reported			
Alkalinity	Water-quality indicator	1948, field	field
Arsenic(Total)	Trace element	1948, TML	1948
Chromium(Total)	Trace element	1948, TML	1948
Iron(Total)	Trace element	1948, TML	1948
pH	Water-quality indicator	1948, field	field
Specific conductance	Water-quality indicator	1948, field	field
1,2,3-Trichloropropane (1,2,3-TCP)	VOC, fumigant	2020, MWH	MWH
Tritium	Inorganic tracer	LLNL, SITL	—

Table A3. Constituents detected in field blanks collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March 2006.

[Censored data are reported but not used in summary statistics. **Abbreviations:** E, estimated value; mg/L, milligrams per liter; pCi/L, picocurie per liter; µg/L, micrograms per liter; —, not detected]

Constituent	Number of field blank detections/ number of field blanks	Concentration detected in field blanks	Minimum concentration detected in ground-water samples	Number of ground-water samples censored
Organic constituents (µg/L)				
Acetone ¹	1/5	11	—	0
2-Butanone (methyl ethyl ketone, MEK)	1/5	3.5	—	0
Caffeine ^{1,2}	1/2	0.029	E0.007	6
Dichloromethane	1/5	E.03	—	0
Dissolved organic carbon (DOC) ^{2,3}	2/2	E.2, 0.4	E.3	8
Ethylbenzene ¹	1/5	E.05	E.05	0
Toluene ^{1,2,4}	5/5	E.01, E.02, E.02, E.03, 0.12	E.02	2
Trichloroethene (TCE) ¹	1/5	E.01	E.04	0
<i>m</i> - and <i>p</i> -Xylene ¹	1/5	0.24	—	0
<i>o</i> -Xylene ¹	1/5	0.10	—	0
Inorganic constituents (µg/L)				
Aluminum ^{3,5}	2/2	8.0, 3.0	E.9	0
Barium ^{3,5}	2/2	.2, 1	2	0
Calcium ^{1,2}	2/2	.080, .19	4.00	0
Chromium ^{2,3}	1/2	.04	.05	2
Copper ³	2/2	E.4, E.4	E.2	5
Fluoride ²	1/2	E.10	E.07	0
Iron ^{2,3}	1/2	E 4	E 4	2
Lead ^{2,3}	2/2	E.06, .16	E.04	1
Magnesium ³	2/2	E.006, E.006	.010	0
Nickel ¹	2/2	.07, .10	.09	1
Silica ^{2,3}	2/2	2.1, 2.7	13.7	0
Sodium ^{2,3}	2/2	.39, .46	21.0	0
Strontium ^{1,5}	2/2	E.29, E.36	11.3	0
Zinc ³	2/2	.6, 4.8	.9	8
Radioactive constituents (pCi/L)				
Radium-226	2/2	E.02, E.02	E.02	1
Radium-228	2/2	E.22, E.29	E.19	7

¹ The only detections or the highest detection of these constituents were reported in the field blank collected at KERN-34. VOCs detected in the field blank sample were not detected in the ground-water sample collected at the same site. A plausible source of VOC contamination specific to this site was identified. VOC detections in the field blank collected at this site were not used to censor detections in other ground-water samples. Therefore, the detection of ethylbenzene in a ground-water sample was not censored even though the concentration in the blank plus one-half the LRL was greater.

² Detections of these constituents were reported in the U.S. Geological Survey National Water Quality Laboratory Certificate of Analyses for universal blank water at concentrations below the maximum concentration detected in field blank samples. The blank water may be a source of contamination to the field blank, but it cannot explain the detection; so, the field blank was not disregarded as a source of contamination to the ground-water samples.

³ The only detection or the highest detection of these constituents was reported in the field blank collected at KERN-45.

⁴ Toluene was detected in two out of five source-solution blanks at concentrations of E0.01 and E0.04 mg/L.

⁵ Detections of these constituents were reported in the U.S. Geological Survey's National Water Quality Laboratory Certificate of Analysis for universal blank water lot number 44328 at concentrations above the maximum concentration detected in field blank samples. The blank water was considered to be the source of contamination to the field blank. Therefore, detections of aluminum in ground-water samples were not censored even though the concentration in the blank plus one-half the LRL was greater.

Table A4. Quality-control summary for replicate analyses for constituents with relative standard deviations greater than 20 percent detected in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March 2006.

[**Abbreviations:** RSD, relative standard deviation in percent; cm³ STP/g H₂O, cubic centimeters of gas at standard temperature and pressure per gram of water; nd, not detected; pCi/L, picocurie per liter; µg/L, micrograms per liter]

Constituent	Number of RSDs greater than 20 percent/number of replicate pairs	RSD values	Concentrations for replicates with RSD greater than 20 percent (environmental/replicate)
Trace elements (µg/L)			
Aluminum	1/2	1, 47	(E0.9, 1.9)
Cadmium	1/2	0, 106	(nd, .07)
Copper	1/2	7, 85	(nd, 0.4)
Iron	1/2	0, 57	(7, E3)
Zinc	1/2	7, 87	(1.7, 7.1)
Arsenic(Total) ¹	1/2	0, 24	(2.1, 1.5)
Chromium(Total) ¹	1/2	0, 33	(5, 8)
Iron(II) ¹	1/2	20, 101	(nd, 3)
Radioactivity (pCi/L)			
Uranium-234 (pCi/L)	1/1	103	(.10, .66)
Uranium-238 (pCi/L)	1/1	83	(.15, .56)
Noble gases (cm ³ STP/g H ₂ O)			
Argon (× 10 ⁻⁴)	1/5	1, 1, 6, 10, 24	(5.04, 3.55)
Helium-4 (× 10 ⁻⁷)	2/5	0, .2, 4, 24, 67	(.85, 1.20), (1.50, .53)
Neon (× 10 ⁻⁷)	1/5	3, 3, 8, 14, 40	(4.08, 2.28)

¹Analyses made by the U.S. Geological Survey's Trace Metal Laboratory.

Table A5A. Quality-control summary for laboratory matrix-spike recoveries of volatile organic compounds (VOCs), low-level 1,2-dibromo-3-chloropropane (DBCP) and 1,2-dibromoethane (EDB), and gasoline oxygenates and degradates in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March, 2006.

[Acceptable recovery range is between 70 and 130 percent]

Constituent	Number of spiked samples	Recovery (percent)		
		Minimum	Maximum	Median
Acetone ¹	5	103	119	113
Acrylonitrile	5	97	122	115
<i>tert</i> -Amyl alcohol	2	108	112	110
Benzene ²	5	109	130	129
Bromobenzene	5	100	116	106
Bromochloromethane	5	104	118	117
Bromodichloromethane ²	5	109	131	119
Bromoform (Tribromomethane)	5	100	114	112
2-Butanone (MEK, Methyl ethyl ketone)	5	109	116	116
<i>tert</i> -Butyl alcohol (TBA)	2	106	108	107
<i>n</i> -Butylbenzene	5	83	95	85
<i>sec</i> -Butylbenzene	5	96	111	109
<i>tert</i> -Butylbenzene	5	105	124	123
Carbon disulfide ²	5	89	105	101
Carbon tetrachloride (Tetrachloromethane)	5	100	130	120
Chlorobenzene	5	98	116	113
Chloroethane	5	97	135	129
Chloroform (Trichloromethane) ²	5	108	130	126
Chloromethane	5	125	153	138
3-Chloro-1-propene (3-Chloropropene)	5	110	141	133
2-Chlorotoluene	5	102	115	106
4-Chlorotoluene	5	98	105	100
Dibromochloromethane	5	101	117	113
1,2-Dibromo-3-chloropropane (DBCP) ^{2,3}	4	86	100	93
1,2-Dibromoethane (EDB) ^{2,3}	4	86	100	86
Dibromomethane	5	104	123	119
1,2-Dichlorobenzene (o-Dichlorobenzene)	5	102	115	104
1,3-Dichlorobenzene	5	96	110	100
1,4-Dichlorobenzene (p-Dichlorobenzene)	5	91	104	98
<i>trans</i> -1,4-Dichloro-2-butene	5	86	103	99
Dichlorodifluoromethane (CFC-12)	5	98	104	102
1,1-Dichloroethane (1,1-DCA) ²	5	106	132	130
1,2-Dichloroethane (1,2-DCA) ²	5	107	126	123
1,1-Dichloroethene (1,1-DCE) ²	5	98	128	118
<i>cis</i> -1,2-Dichloroethene (<i>cis</i> -1,2-DCE) ²	5	109	127	120
<i>trans</i> -1,2-Dichloroethene (<i>trans</i> -1,2-DCE)	5	102	124	119
Dichloromethane (Methylene chloride)	5	107	121	120
1,2-Dichloropropane (1,2-DCP) ²	5	106	125	124
1,3-Dichloropropane	5	107	124	119
2,2-Dichloropropane	5	80	114	99
1,1-Dichloropropene	5	102	122	121
<i>cis</i> -1,3-Dichloropropene	5	92	106	105
<i>trans</i> -1,3-Dichloropropene	5	97	111	108
Diethyl ether	5	113	128	119
Diisopropyl ether (DIPE)	5	101	126	114
Ethylbenzene ²	5	100	122	117
Ethyl <i>tert</i> -butyl ether (ETBE)	5	102	119	111
Ethyl methacrylate	5	102	118	113
1-Ethyl-2-methylbenzene (o-Ethyl toluene, 2-Ethyltoluene)	5	96	114	104
Hexachlorobutadiene	5	84	93	89
Hexachloroethane	5	95	120	113

Table A5A. Quality-control summary for laboratory matrix-spike recoveries of volatile organic compounds (VOCs), low-level 1,2-dibromo-3-chloropropane (DBCP) and 1,2-dibromoethane (EDB), and gasoline oxygenates and degradates in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March, 2006.—Continued

[Acceptable recovery range is between 70 and 130 percent]

Constituent	Number of spiked samples	Recovery (percent)		
		Minimum	Maximum	Median
2-Hexanone (<i>n</i> -Butyl methyl ketone)	5	106	127	110
Isopropylbenzene (Cumene) ²	5	100	121	117
4-Isopropyl-1-methylbenzene (4-Isopropyltoluene, <i>p</i> -Isopropyltoluene)	5	93	109	99
Methyl acetate	2	106	118	112
Methyl acrylate	5	102	116	111
Methyl acrylonitrile	5	103	118	112
Methyl bromide (Bromomethane)	5	102	143	129
Methyl <i>tert</i> -butyl ether (MTBE)	5	105	125	116
Methyl iodide (Iodomethane)	5	64	131	82
Methyl isobutyl ketone (MIBK)	5	98	122	109
Methyl methacrylate	5	96	111	106
Methyl <i>tert</i> -pentyl ether (<i>tert</i> -Amyl methyl ether, TAME)	5	103	119	111
Naphthalene	5	96	116	102
<i>n</i> -Propylbenzene	5	94	107	100
Styrene	5	98	113	102
1,1,1,2-Tetrachloroethane	5	100	124	117
1,1,2,2-Tetrachloroethane	5	107	127	116
Tetrachloroethene (PCE) ²	5	92	160	108
Tetrahydrofuran	5	107	119	117
1,2,3,4-Tetramethylbenzene	5	97	121	116
1,2,3,5-Tetramethylbenzene	5	115	134	120
Toluene ²	5	102	123	123
1,2,3-Trichlorobenzene	5	93	112	94
1,2,4-Trichlorobenzene	5	80	101	88
1,1,1-Trichloroethane (TCA)	5	104	135	130
1,1,2-Trichloroethane	5	105	124	118
Trichloroethene (TCE) ²	5	100	121	120
Trichlorofluoromethane (CFC-11)	5	106	134	128
1,2,3-Trichloropropane (1,2,3-TCP) ²	5	101	123	112
1,1,2-Trichlorotrifluoroethane (CFC-113)	5	96	115	105
1,2,3-Trimethylbenzene ²	5	97	117	101
1,2,4-Trimethylbenzene	5	90	114	101
1,3,5-Trimethylbenzene	5	96	111	98
Vinyl bromide (Bromoethene)	5	117	144	139
Vinyl chloride (Chloroethene)	5	106	129	125
<i>m</i> - and <i>p</i> -Xylene	5	102	118	111
<i>o</i> -Xylene	5	104	120	112

¹ Constituents on Schedules 2020 and 4024; only values from Schedule 2020 are reported because it is the preferred analytical schedule.² Constituents detected in ground-water samples.³ Constituents on Schedules 1306 and 2020; only values from Schedule 1306 are reported because it is the preferred analytical schedule.

Table A5B. Quality-control summary for laboratory matrix-spike recoveries of pesticides and degradates, and polar pesticides and metabolites in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March, 2006.

[Acceptable recovery range is between 70 and 130 percent. **Abbreviations:** —, not detected]

Constituent	Number of spiked samples	Recovery (percent)		
		Minimum	Maximum	Median
Acetochlor	4	88	118	98
Acifluorfen	3	112	136	134
Alachlor	4	94	112	97
Aldicarb	3	60	83	76
Aldicarb sulfone	3	96	104	99
Aldicarb sulfoxide	3	110	117	118
Atrazine ^{1,2}	4	89	107	93
Azinphos-methyl	4	63	133	86
Azinphos-methyl oxygen analog	4	40	96	54
Bendiocarb	3	92	104	99
Benfluralin	4	57	89	66
Benomyl	3	88	109	104
Bensulfuron-methyl	3	116	158	151
Bentazon	3	95	104	100
Bromacil ¹	3	91	100	96
Bromoxynil	3	87	116	92
Caffeine ¹	3	74	93	81
Carbaryl ²	4	89	218	137
Carbofuran ²	4	84	139	103
Chloramben methyl ester	3	96	104	99
Chlorimuron-ethyl	3	113	154	141
2-Chloro-2,6-diethylacetanilide	4	88	114	94
3-(4-Chlorophenyl)-1-methyl urea	3	111	116	112
4-Chloro-2-methylphenol	4	49	73	66
Chlorothalonil	0	—	—	—
Chlorpyrifos ¹	4	82	97	90
Chlorpyrifos oxygen analog	4	25	55	39
Clopyralid	3	87	100	96
Cyanazine	4	88	118	108
Cycloate	3	107	116	112
λ-Cyhalothrin	4	33	54	35
Cyfluthrin	4	49	74	57
Cypermethrin	4	48	73	55
Dacthal monoacid	3	72	182	171
Dacthal (DCPA)	4	97	109	102
Deethylatrazine (2-Chloro-4-isopropylamino-6-amino- <i>s</i> -triazine) ²	4	38	54	42
Deisopropyl atrazine (2-Chloro-6-ethylamino-4-amino- <i>s</i> -triazine)	3	92	93	92
Desulfinyl fipronil	4	44	110	93
Desulfinyl fipronil amide	4	34	116	84
Diazinon	4	82	97	88
Diazinon oxygen analog	4	65	113	88
Dicamba	3	107	124	108
3,4-Dichloroaniline ¹	4	69	81	74
3,5-Dichloroaniline	4	80	93	82
2,4-D (2,4-Dichlorophenoxyacetic acid)	3	142	144	143
2,4-DB (4-(2,4-dichlorophenoxy) butanoic acid)	3	127	130	128
2,4-D Methyl ester	3	95	107	103
Dichlorprop	3	108	292	263
Dichlorvos	4	20	38	29

Table A5B. Quality-control summary for laboratory matrix-spike recoveries of pesticides and degradates, and polar pesticides and metabolites in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March, 2006.—Continued[Acceptable recovery range is between 70 and 130 percent. **Abbreviations:** —, not detected]

Constituent	Number of spiked samples	Recovery (percent)		
		Minimum	Maximum	Median
Dicrotophos	4	25	45	32
Dieldrin ¹	4	76	90	78
2,6-Diethylaniline	4	87	98	91
Dimethoate	4	24	40	30
Dinoseb ¹	3	72	124	122
Diphenamid ¹	3	108	118	116
Disulfoton sulfone	4	84	117	95
Disulfoton	4	40	62	48
Diuron ¹	3	108	112	111
α -Endosulfan	4	74	85	78
Endosulfan sulfate	4	66	112	93
EPTC ¹	4	84	96	88
Ethion	4	72	103	80
Ethion monoxon	4	71	122	90
Ethoprop	4	91	125	100
2-Ethyl-6-methylaniline	4	80	92	85
Fenamiphos	4	68	122	81
Fenamiphos sulfone	4	60	132	76
Fenamiphos sulfoxide	4	35	81	55
Fenuron	3	104	108	107
Fipronil	4	89	141	94
Fipronil sulfide	4	40	109	90
Fipronil sulfone	4	27	94	81
Flumetsulam	3	136	166	159
Fluometuron	3	108	118	116
Fonofos	4	84	96	89
Hexazinone ¹	4	64	97	74
3-Hydroxy carbofuran	3	102	114	112
2-Hydroxy-4-isopropylamino-6-ethylamino-s-triazine	0	—	—	—
Imazaquin	3	138	159	140
Imazethapyr ¹	3	124	139	134
Imidacloprid	3	112	132	131
Iprodione	4	37	62	43
Isofenphos	4	94	120	105
3-Ketocarbofuran	0	—	—	—
Linuron	3	104	112	111
Malaoxon	4	64	116	85
Malathion	4	94	119	100
MCPA	3	124	127	126
MCPB	3	124	131	130
Metalaxy ¹²	4	87	108	94
Methidathion	4	94	120	100
Methiocarb	3	91	114	113
Methomyl	3	110	125	110
Metolachlor ¹	4	78	122	106
Metribuzin ¹	4	76	107	87
Metsulfuron methyl	3	64	174	139
Molinate	4	87	103	93
Myclobutanil	4	81	104	92
1-Naphthol	4	13	32	24
Neburon	3	108	120	118

Table A5B. Quality-control summary for laboratory matrix-spike recoveries of pesticides and degradates, and polar pesticides and metabolites in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March, 2006.—Continued

[Acceptable recovery range is between 70 and 130 percent. **Abbreviations:** —, not detected]

Constituent	Number of spiked samples	Recovery (percent)		
		Minimum	Maximum	Median
Nicosulfuron	3	148	195	162
Norflurazon	3	120	124	122
Oryzalin	3	100	120	118
Oxamyl	3	88	111	104
Oxyfluorfen	4	57	89	61
Paraoxon-methyl	4	47	89	58
Parathion-methyl	4	70	113	80
Pendimethalin	4	83	139	98
<i>cis</i> -Permethrin	4	42	69	54
Phorate	4	52	72	56
Phorate oxygen analog	4	71	118	95
Phosmet	4	7	10	8
Phosmet oxygen analog	0	—	—	—
Picloram	3	99	120	108
Prometon ¹	4	83	111	94
Prometryn ¹	4	92	115	99
Propanil	4	86	133	100
Propargite	4	65	105	75
Propham	3	106	113	110
Propiconazole	3	104	108	107
<i>cis</i> -Propiconazole	4	32	127	85
<i>trans</i> -Propiconazole	4	74	115	86
Propoxur	3	97	113	108
Propyzamide (Pronamide)	4	86	109	94
Siduron	3	112	122	120
Simazine ¹	4	87	109	101
Sulfometuron-methyl	3	118	163	155
Tebuconazole	4	49	89	69
Tebuthiuron ²	4	93	138	121
Tefluthrin	4	36	49	43
Terbacil	3	105	121	110
Terbufos	4	72	88	81
Terbufos oxygen analog sulfone	4	76	137	100
Terbutylazine	4	96	112	99
Thiobencarb	4	107	125	109
Tribuphos	4	49	77	60
Triclopyr	3	100	124	103
Trifluralin	4	61	99	72

¹ Constituents detected in ground-water samples.

² Constituents on both Schedules 2033 and 2060; most values reported are from Schedule 2033 because it is the preferred analytical schedule. Values reported for carbofuran and metalaxyl are from Schedule 2060 because it is the preferred analytical schedule for these constituents.

Table A5C. Quality-control summary for laboratory matrix-spike recoveries for constituents of special interest in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March, 2006.

[Acceptable recovery range is between 70 and 130 percent]

Constituent	Number of spike samples	Recovery (percent)		
		Minimum	Maximum	Median
<i>N</i> -Nitrosodimethylamine (NDMA)	2	75	91	83
Perchlorate ¹	1	118	118	118
1,2,3-Trichloropropane (1,2,3-TCP) ¹	2	110	127	119

¹ Constituents detected in ground-water samples.

Table A6. Quality-control summary for surrogate recoveries of volatile organic compounds, low-level 1,2-dibromo-3-chloropropane (DBCP) and 1,2-dibromoethane (EDB), gasoline oxygenates and degradates, pesticides and degradates, polar pesticides and metabolites, and constituents of special interest in samples collected for the Kern County Subbasin Groundwater Ambient Monitoring and Assessment (GAMA) study, California, January to March, 2006.

[Abbreviations: MWH, Montgomery Watson Harza Laboratory; VOC, volatile organic compound]

Surrogate	Analytical schedule	Constituent class	Number of analyses		Total number of sample analyses	Median recovery		Number of surrogate recoveries		
			Blank	Sample		Blanks (percent)	Samples (percent)	Below 70 percent	Between 70 and 130 percent	Above 130 percent
1-Bromo-4-fluorobenzene	2020	VOCs, Gasoline oxygenates	10	56	66	107	95	0	66	0
1,2-Dichloroethane-d4	2020, 4024	VOCs, Gasoline oxygenates	10	56	66	100	105	0	66	0
Isobutyl alcohol-d6	2020, 4024	VOCs, Gasoline oxygenates	3	12	15	107	106	0	15	0
Toluene-d8	2020	VOCs, Gasoline oxygenates	10	56	66	102	99	0	66	0
alpha-HCH-d6	2033	Pesticides and degradates	5	55	60	91	89	2	58	0
Diazinon-d10	2033	Pesticides and degradates	5	55	60	101	93	1	59	0
Barban	2060	Polar pesticides and metabolites	2	18	20	113	108	1	19	0
Caffeine-13C	2060	Polar pesticides and metabolites	2	18	20	119	114	0	20	0
2,4,5-T	2060	Polar pesticides and metabolites	2	18	20	166	134	0	5	15
NDMA-d6	MWH	Constituents of special interest	4	2	6	97	79	3	3	0
Toluene-d8	MWH	Constituents of special interest	4	2	6	94	85	0	6	0

