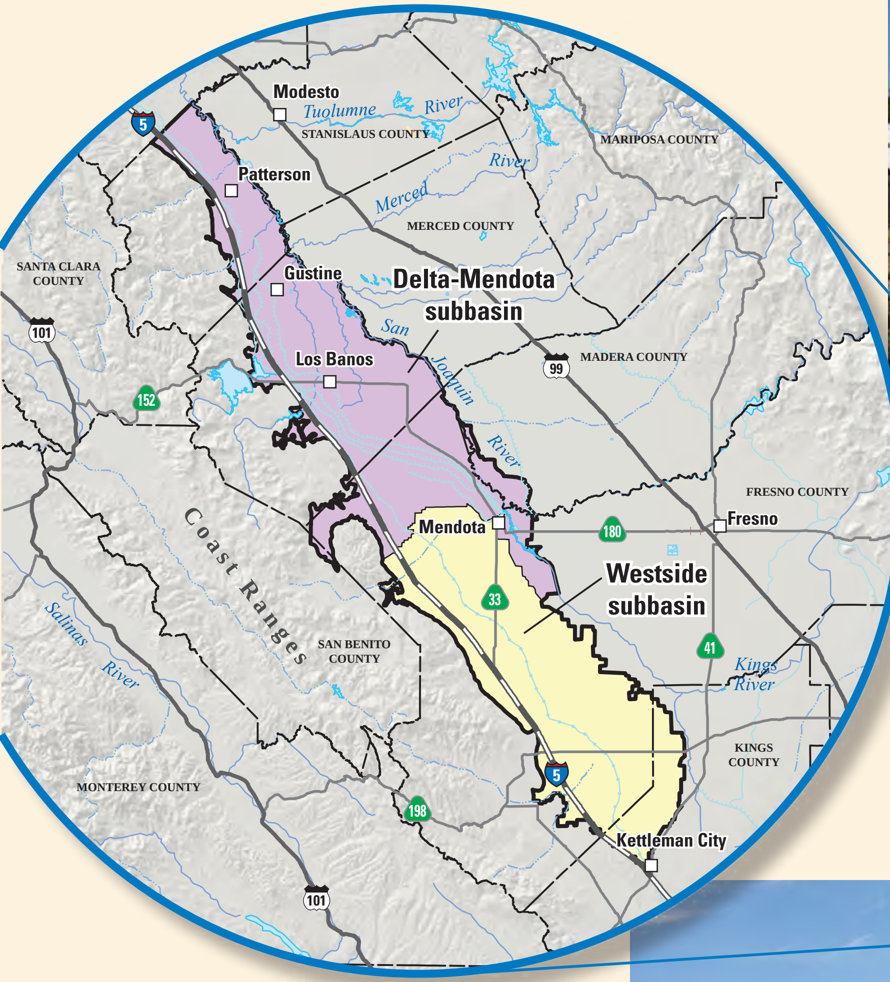
Prepared in cooperation with the California State Water Resources Control Board

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

Groundwater-Quality Data in the Western San Joaquin Valley Study Unit, 2010: Results from the California GAMA Program



Data Series 706

U.S. Department of the Interior
U.S. Geological Survey

Cover photographs:

Top right: Irrigation well, Gustine, California. (Photograph taken by Gregory Brewster, U.S. Geological Survey).

Bottom right: Alfalfa field, Five Points, California. (Photograph taken by Tyler Johnson, U.S. Geological Survey).

Groundwater-Quality Data in the Western San Joaquin Valley Study Unit, 2010: Results from the California GAMA Program

By Timothy M. Mathany, Matthew K. Landon, Jennifer L. Shelton, and Kenneth Belitz

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Data Series 706

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
KEN SALAZAR, Secretary

U.S. Geological Survey
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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
quart (qt)	0.9464	liter (L)
	Mass	
pound, avoirdupois (lb)	0.4536	kilogram (kg)

SI to Inch/Pound

Multiply	By	To obtain
	Length	
micrometer (µm)	3.3×10^{-6}	foot (ft)
centimeter (cm)	0.3937	inch (in.)
kilometer (km)	0.6214	mile (mi)
	Area	
square kilometer (km^2)	0.3861	square mile (mi^2)
	Volume	
liter (L)	1.057	quart (qt)
	Mass	
gram (g)	0.03527	ounce, avoirdupois (oz)
kilogram (kg)	2.205	pound, avoirdupois (lb)

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

$$°F=(1.8\times°C)+32.$$

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

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

Land-surface altitude, as used in this report, refers to distance above the vertical datum and is reported as feet above mean sea level (ft above msl).

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

Milligrams per liter is equivalent to parts per million (ppm), and micrograms per liter is equivalent to parts per billion (ppb).

Activities of radioactive constituents in water (except uranium) are given in picocuries per liter (pCi/L).

Selected Terms and Symbols

α	confidence level
cm^3 STP/g	cubic centimeters of gas at standard temperature and pressure (0 degrees Celsius and 1 atmosphere of pressure) per gram of water
$\delta^{i}E$	delta notation, the ratio of a heavier isotope of an element (^{i}E) to the more common lighter isotope of that element, relative to a standard reference material, expressed as per mil
=	equal to
>	greater than
≥	greater than or equal to
<	less than
≤	less than or equal to
N	Normal (1-gram-equivalent per liter of solution)
—	not detected
p	significant level
pH	a measure of the acidity or basicity of a solution
$pK_{1,2}$	negative logarithms of the acid dissociation constants for carbonic acid
pK_w	negative logarithm of the acid dissociation constant of water
R	result
z	test statistic
±	plus or minus
*	value is at a concentration greater than benchmark level
**	value is at a concentration greater than upper benchmark level

Abbreviations and Acronyms

AL	action level
AL-US	action level (USEPA)
APE	Alternate Place Entry program designed for USGS sampling
CAS	Chemical Abstract Service (American Chemical Society)
CASRN	Chemical Abstract Service (American Chemical Society) Registry Number®
CSU	combined standard uncertainty
DM	Delta-Mendota subbasin study area
E	estimated or having a higher degree of uncertainty
GAMA	Groundwater Ambient Monitoring and Assessment Program
GPS	Global Positioning System
HAL	lifetime health advisory level
HAL-US	lifetime health advisory level (USEPA)
HPLC	high-performance liquid chromatography
IBSP	Inorganic Blind Sample Project (USGS)
LRL	laboratory reporting level
LSD	land surface datum
LT-MDL	long-term method detection level
MCL	maximum contaminant level
MCL-CA	maximum contaminant level (CDPH)

Abbreviations and Acronyms—Continued

MCL-US	maximum contaminant level (USEPA)
MDL	method detection limit
MRL	minimum reporting level
MU	method uncertainty
na	not available
nc	not collected
NELAP	National Environmental Laboratory Accreditation Program
NFM	National Field Manual (USGS)
NFQA	National Field Quality Assurance Program (USGS)
NL	notification level
NL-CA	notification level (CDPH)
np	no preference
nv	no measured value or no value in category
NWIS	National Water Information System (USGS)
PBP	Priority Basin Project
PCFF	Personal Computer Field Form program designed for USGS sampling
QA	quality assurance
QC	quality control
RL	reporting level
RPD	relative percent difference
RSD	relative standard deviation
RSD5-US	risk-specific dose at 10^{-5} (USEPA)
SD	standard deviation
SMCL	secondary maximum contaminant level
SMCL-CA	secondary maximum contaminant level (CDPH)
SMCL-US	secondary maximum contaminant level (USEPA)
SRL	study reporting level (concentration cutoff for applying the ≤ symbol)
ssL_C	sample-specific critical level
U.S.	United States
UV	ultraviolet
VCDT	Vienna Canon Diablo Troilite (the international reference standard for sulfur isotopes)
VPDB	Vienna Pee Dee Belemnite (the international reference standard for carbon isotopes)
VSMOW	Vienna Standard Mean Ocean Water (an isotopic water standard defined in 1968 by the International Atomic Energy Agency)
WS	Westside subbasin study area
WSJV	Western San Joaquin Valley study unit

Organizations

BQS	Branch of Quality Systems (USGS)
CDPH	California Department of Public Health
CDPR	California Department of Pesticide Regulation
CDWR	California Department of Water Resources
LLNL	Lawrence Livermore National Laboratory
NAWQA	National Water-Quality Assessment Program (USGS)

Abbreviations and Acronyms—Continued

NIST	National Institute of Standards and Technology
NRP	National Research Program (USGS)
NWQL	National Water Quality Laboratory (USGS)
SITL	Stable Isotope and Tritium Laboratory, Menlo Park, California (USGS)
SWRCB	California State Water Resources Control Board
TML	Trace Metal Laboratory, Boulder, Colorado (USGS)
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
Weck	Weck Laboratories Inc., City of Industry, California

Selected Chemical Names

$CaCO_3$	calcium carbonate
CO_3^{2-}	carbonate
CFC	chlorofluorocarbon
DBCP	1,2-dibromo-3-chloropropane
DOC	dissolved organic carbon
EDB	1,2-dibromoethane
EPTC	*S*-ethyl-dipropylthiocarbamate
H_2O	water
HCl	hydrochloric acid
HCO_3^-	bicarbonate
MTBE	methyl *tert*-butyl ether
$Na_2S_2O_3$	sodium thiosulfate
NDMA	*N*-nitrosodimethylamine
$NO_2^-+NO_3^-$	nitrite plus nitrate (as nitrogen)
PCE	perchloroethene (tetrachloroethene)
SiO_2	silicon dioxide
TCE	trichloroethene
1,2,3-TCP	1,2,3-trichloropropane
TDS	total dissolved solids
THM	trihalomethane
VOC	volatile organic compound

Groundwater-Quality Data in the Western San Joaquin Valley Study Unit, 2010: Results from the California GAMA Program

By Timothy M. Mathany, Matthew K. Landon, Jennifer L. Shelton, and Kenneth Belitz

Abstract

Groundwater quality in the approximately 2,170-square-mile Western San Joaquin Valley (WSJV) study unit was investigated by the U.S. Geological Survey (USGS) from March to July 2010, as part of the California State Water Resources Control Board (SWRCB) Groundwater Ambient Monitoring and Assessment (GAMA) Program's Priority Basin Project (PBP). The GAMA-PBP was developed in response to the California Groundwater Quality Monitoring Act of 2001 and is being conducted in collaboration with the SWRCB and Lawrence Livermore National Laboratory (LLNL). The WSJV study unit was the twenty-ninth study unit to be sampled as part of the GAMA-PBP.

The GAMA Western San Joaquin Valley study was designed to provide a spatially unbiased assessment of untreated-groundwater quality in the primary aquifer system, and to facilitate statistically consistent comparisons of untreated groundwater quality throughout California. The primary aquifer system is defined as parts of aquifers corresponding to the perforation intervals of wells listed in the California Department of Public Health (CDPH) database for the WSJV study unit. Groundwater quality in the primary aquifer system may differ from the quality in the shallower or deeper water-bearing zones; shallow groundwater may be more vulnerable to surficial contamination.

In the WSJV study unit, groundwater samples were collected from 58 wells in 2 study areas (Delta-Mendota subbasin and Westside subbasin) in Stanislaus, Merced, Madera, Fresno, and Kings Counties. Thirty-nine of the wells were selected by using a spatially distributed, randomized grid-based method to provide statistical representation of the study unit (grid wells), and 19 wells were selected to aid in the understanding of aquifer-system flow and related groundwater-quality issues (understanding wells).

The groundwater samples were analyzed for organic constituents (volatile organic compounds [VOCs], low-level fumigants, and pesticides and pesticide degradates), constituents of special interest (perchlorate, *N*-nitrosodimethylamine [NDMA], and 1,2,3-trichloropropane [1,2,3-TCP]), and naturally occurring inorganic constituents (trace elements, nutrients, dissolved organic carbon [DOC], major and minor ions, silica, total dissolved solids [TDS], alkalinity, total arsenic and iron [unfiltered] and arsenic, chromium, and iron species [filtered]). Isotopic tracers (stable isotopes of hydrogen, oxygen, and boron in water, stable isotopes of nitrogen and oxygen in dissolved nitrate, stable isotopes of sulfur in dissolved sulfate, isotopic ratios of strontium in water, stable isotopes of carbon in dissolved inorganic carbon, activities of tritium, and carbon-14 abundance), dissolved standard gases (methane, carbon dioxide, nitrogen, oxygen, and argon), and dissolved noble gases (argon, helium-4, krypton, neon, and xenon) were measured to help identify sources and ages of sampled groundwater. In total, 245 constituents and 8 water-quality indicators were measured.

Quality-control samples (blanks, replicates, or matrix spikes) were collected at 16 percent of the wells in the WSJV study unit, and the results for these samples were used to evaluate the quality of the data from the groundwater samples. Blanks rarely contained detectable concentrations of any constituent, suggesting that contamination from sample collection procedures was not a significant source of bias in the data for the groundwater samples. Replicate samples all were within acceptable limits of variability. Matrix-spike recoveries were within the acceptable range (70 to 130 percent) for approximately 87 percent of the compounds.

This study did not evaluate the quality of water delivered to consumers. After withdrawal, groundwater typically is treated, disinfected, and (or) blended with other waters to maintain water quality. Regulatory benchmarks apply to water that is delivered to the consumer, not to untreated groundwater. However, to provide some context for the results, concentrations of constituents measured in the untreated groundwater were compared with regulatory and non-regulatory health-based benchmarks established by the U.S. Environmental Protection Agency (USEPA) and CDPH, and to non-regulatory benchmarks established for aesthetic concerns by CDPH. Comparisons between data collected for this study and benchmarks for drinking water are for illustrative purposes only and are not indicative of compliance or non-compliance with those benchmarks.

Most inorganic constituents detected in groundwater samples from the 39 grid wells were detected at concentrations less than health-based benchmarks. Detections of organic and special-interest constituents from grid wells sampled in the WSJV study unit also were less than health-based benchmarks.

In total, VOCs were detected in 12 of the 39 grid wells sampled (approximately 31 percent), pesticides and pesticide degradates were detected in 9 grid wells (approximately 23 percent), and perchlorate was detected in 15 grid wells (approximately 38 percent).

Trace elements, major and minor ions, and nutrients were sampled for at 39 grid wells; most concentrations were less than health-based benchmarks. Exceptions include two detections of arsenic greater than the USEPA maximum contaminant level (MCL-US) of 10 micrograms per liter (µg/L), 20 detections of boron greater than the CDPH notification level (NL-CA) of 1,000 µg/L, 2 detections of molybdenum greater than the USEPA lifetime health advisory level (HAL-US) of 40 µg/L, 1 detection of selenium greater than the MCL-US of 50 µg/L, 2 detections of strontium greater than the HAL-US of 4,000 µg/L, and 3 detections of nitrate greater than the MCL-US of 10 µg/L.

Results for inorganic constituents with non-health-based benchmarks (iron, manganese, chloride, sulfate, and TDS) showed that iron concentrations greater than the CDPH secondary maximum contaminant level (SMCL-CA) of 300 µg/L were detected in five grid wells. Manganese concentrations greater than the SMCL-CA of 50 µg/L were detected in 16 grid wells. Chloride concentrations greater than the recommended SMCL-CA benchmark of 250 milligrams per liter (mg/L) were detected in 14 grid wells, and concentrations in 5 of these wells also were greater than the upper SMCL-CA benchmark of 500 mg/L. Sulfate concentrations greater than the recommended SMCL-CA benchmark of 250 mg/L were measured in 21 grid wells, and concentrations in 13 of these wells also were greater than the SMCL-CA upper benchmark of 500 mg/L. TDS concentrations greater than the SMCL-CA recommended benchmark of 500 mg/L were measured in 36 grid wells, and concentrations in 20 of these wells also were greater than the SMCL-CA upper benchmark of 1,000 mg/L.

Introduction

About one-half of the water used for public and domestic drinking-water supply in California is groundwater (Kenny and others, 2009). To assess the quality of ambient groundwater in aquifers used for public drinking-water supply and to establish a baseline groundwater-quality monitoring program, the California State Water Resources Control Board (SWRCB), in cooperation with the U.S. Geological Survey (USGS) and Lawrence Livermore National Laboratory (LLNL), implemented the Groundwater Ambient Monitoring and Assessment (GAMA) Program in 2000 (California Environmental Protection Agency, 2011, Web site at http://www.waterboards.ca.gov/water_issues/programs/gama/). The main goals of the GAMA Program are to improve groundwater monitoring and to increase the availability of groundwater-quality data to the public. The GAMA Program currently consists of four projects: (1) the GAMA Priority Basin Project (PBP) conducted by the USGS (U.S. Geological Survey, 2011a, California Water Science Center Web site at http://ca.water.usgs.gov/gama/); (2) the GAMA Domestic Well Project conducted by the SWRCB; (3) GAMA Special Studies conducted by LLNL; and (4) GeoTracker GAMA, conducted by the SWRCB. The GAMA-PBP primarily focuses on the deep part of the groundwater resource, which is typically used for public drinking-water supply. The GAMA Domestic Well Project generally focuses on the shallow aquifer systems, which may be particularly at risk as a result of surficial contamination. The GAMA Special Studies Project focuses on using research methods to help explain the source, fate, transport, and occurrence of chemicals that can affect groundwater quality. GeoTracker GAMA is an online interface serving data from the GAMA Program and other efforts to the public (http://geotracker.waterboards.ca.gov/).

The GAMA Program was initiated by the SWRCB in 2000 and later expanded by the Groundwater Quality Monitoring Act of 2001 (State of California, 2001a, b; Sections 10780–10782.3 of the California Water Code, Assembly Bill 599). The GAMA-PBP assesses groundwater quality in key groundwater basins that account for more than 90 percent of all groundwater used for public supply in the State. For the GAMA-PBP, the USGS, in collaboration with the SWRCB, developed the monitoring plan to assess groundwater basins through direct and other statistically reliable sample approaches (Belitz and others, 2003; California State Water Resources Control Board, 2003). Additional partners in the GAMA-PBP include LLNL, California Department of Public Health (CDPH), California Department of Water Resources (CDWR), California Department of Pesticide Regulation (CDPR), local water agencies, and well owners (Kulongoski and Belitz, 2004). Participation in the GAMA-PBP is entirely voluntary.

The GAMA-PBP is unique in California because it includes many chemical analyses that are not otherwise available in the statewide water-quality monitoring datasets. Groundwater samples collected for the GAMA-PBP are analyzed for approximately 300 chemical constituents using methods with lower detection limits than required by the CDPH for regulatory monitoring of water from drinking-water wells. These analyses will be especially useful for providing an early indication of changes in groundwater quality. In addition, the GAMA-PBP analyzes samples for a suite of constituents more extensive than required by CDPH and for a suite of chemical and isotopic tracers for understanding hydrologic and geochemical processes. This understanding of groundwater composition is useful for identifying the natural and human factors affecting water quality. Understanding the occurrence and distribution of chemical constituents of significance to water quality is important for the long-term management and protection of groundwater resources.

The range of hydrologic, geologic, and climatic conditions in California must be considered in an assessment of groundwater quality. Belitz and others (2003) partitioned the State into 10 hydrogeologic provinces, each with distinctive hydrologic, geologic, and climatic characteristics: Cascades and Modoc Plateau, Klamath Mountains, Northern Coast Ranges, Central Valley, Sierra Nevada, Basin and Range, Southern Coast Ranges, Transverse Ranges and selected Peninsular Ranges, Desert, and San Diego Drainages (fig. 1). These 10 hydrogeologic provinces include groundwater basins and subbasins designated by the CDWR (California Department of Water Resources, 2003). The lithology of the groundwater basins and subbasins generally consist of relatively permeable, unconsolidated deposits of alluvial or volcanic origin. Eighty percent of California's approximately 16,000 active and standby drinking-water wells listed in the statewide database maintained by the CDPH (hereinafter referred to as CDPH wells) are located in groundwater basins and subbasins within the 10 hydrogeologic provinces. Groundwater basins and subbasins were prioritized for sampling on the basis of the number of CDPH wells in the basin, with secondary consideration given to municipal groundwater use, agricultural pumping, the number of formerly leaking underground fuel tanks, and the number of registered pesticide applications (Belitz and others, 2003). Of the 472 basins and subbasins designated by the CDWR, 116 priority basins were selected and grouped into 35 GAMA study units, representing approximately 95 percent of the CDPH wells in California. In addition, some areas outside of the defined groundwater basins were included in the adjacent study unit to achieve representation of the 20 percent of the CDPH wells not located in the groundwater basins.

The data collected in each study unit are used for three types of water-quality assessments: (1) Status—assessment of the current quality of the groundwater resource; (2) Understanding—identification of the natural and human factors affecting groundwater quality; and (3) Trends—detection of changes in groundwater quality over time (Kulongoski and Belitz, 2004). The assessments are intended to characterize the quality of groundwater in the primary aquifer systems of the study units, not the treated drinking water delivered to consumers by water purveyors. The primary aquifer systems are defined as parts of aquifers corresponding to the perforation intervals of wells listed in the CDPH databases for the study units. The CDPH database lists wells used for municipal and community drinking-water supplies, and includes wells from systems classified as non-transient (such as those in cities, towns, and mobile-home parks) and transient (such as those in schools, campgrounds, and restaurants). Collectively, the CDPH refers to these wells as "public-supply" wells. Groundwater quality in the primary aquifers may differ from the quality in the shallow or deep parts of the aquifer system. In particular, shallow groundwater may be more vulnerable to surface contamination. As a result, samples from shallow wells (such as many private domestic wells and groundwater monitoring wells) can have greater concentrations of constituents (such as volatile organic compounds [VOCs] and nitrate) from anthropogenic sources than samples from wells screened in the underlying primary aquifer systems (Landon and others, 2010).

All published analytical data and quality-assurance/quality-control (QA/QC) data collected for the GAMA Program are stored in the web-based Geotracker Database (California State Water Resources Control Board, 2009, website at https://geotracker.waterboards.ca.gov/gama/). The Geotracker Database also stores groundwater-quality data and related reports collected by other State agencies, such as the CDPH, CDWR, CDPR, and data collected by the SWRCB and Regional Boards from groundwater monitoring wells at contaminated or remediated sites.

The Western San Joaquin Valley study unit (hereinafter referred to as the WSJV study unit) lies within the Central Valley hydrogeologic province described by Belitz and others (2003) (fig. 1). Groundwater is a major source of public drinking-water supply for many of the communities located in the WSJV study unit (Water Education Foundation, 2006); therefore, the WSJV study unit was considered high priority for sampling to provide adequate representation of the Central Valley hydrogeologic province.

This USGS Data Series Report is one of a series of reports presenting the water-quality data collected by the USGS in the WSJV study unit for the GAMA-PBP. Data Series Reports for each of the GAMA-PBP study units are available from the U.S. Geological Survey (2011b), at http://ca.water.usgs.gov/projects/gama/includes/GAMA_publications.html.

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

Provinces from Belitz and others, 2003.

Figure 1. Hydrogeologic provinces of California and the location of the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit.

Purpose and Scope

The purposes of this report are to describe (1) the hydrogeologic setting of the WSJV study unit, the study design, and the study methods; (2) the analytical results for groundwater samples collected in the WSJV study unit, and (3) the results of QC analysis. Groundwater samples were analyzed for water-quality indicators; organic, special-interest, and inorganic constituents; isotopic tracers; and dissolved gases. The chemical data presented in this report were evaluated by comparison to State and Federal drinking-water standards. The health-based and non-health based benchmarks considered for this report are those established by the U.S. Environmental Protection Agency (USEPA) and (or) the CDPH. Discussion of the factors that influence the distribution and occurrence of the constituents detected in groundwater samples will be the subject of subsequent publications.

Hydrogeologic Setting

The WSJV study unit is located in the western part of the Central Valley and includes two CDWR-defined San Joaquin Valley groundwater subbasins: Delta-Mendota and Westside (California Department of Water Resources, 2003). Combined, these subbasins define the extent of the WSJV study unit and cover an area of approximately 2,170 square miles (mi^2) in Stanislaus, Merced, Madera, Fresno, and Kings Counties, California (fig. 2). The study unit is bounded by the Southern Coast Ranges, the Stanislaus/San Joaquin county line, and numerous CDWR-defined subbasins (California Department of Water Resources, 2006a, b) (fig. 2).

The climate in the study unit is classified as Mediterranean, arid to semiarid, with hot, dry summers and cool, moist winters (U.S. Department of Commerce, National Climatic Data Center, 2010). Average rainfall across the study unit ranges from 6 inches (in.) in the southern parts of the Westside subbasin study area to 12 in. in the northern parts of the Delta-Mendota subbasin study area (PRISM Climate Group, Oregon State University, 2010). Approximately 85 to 90 percent of annual precipitation occurs as rainfall during November through April (Western Regional Climate Center, 2011).

The primary aquifer system in the study unit occurs in unconsolidated alluvial and continental deposits of the Tulare Formation (Hotchkiss and Balding, 1971; Belitz and Heimes, 1990; California Department of Water Resources, 2006a, b). The Tulare Formation is composed of mostly unconsolidated clay, silt, sand, and gravel of Pliocene and Pleistocene age. The Corcoran Clay Member of the Tulare Formation acts as the major restrictive structure to vertical groundwater and is found at depths of about 100 to 850 feet (ft) throughout the study unit (California Department of Water Resources, 2006a, b). The Corcoran Clay occurs in the subsurface throughout the study unit except along the western and eastern margins where the Quaternary alluvial and continental sediments pinch out (fig. 2).

The upper part of the Tulare Formation above the Corcoran Clay can be unconfined, semi-confined, or confined, as a result of the presence of many discontinuous lenses of clay and silt that occur throughout the alluvial and continental deposits (Hotchkiss and Balding, 1971). In the upper zone, groundwater flow is typically from the San Joaquin Valley margins towards the valley center and from south to north, following the elevation trend of the valley (Hotchkiss and Balding, 1971; Faunt, 2009).

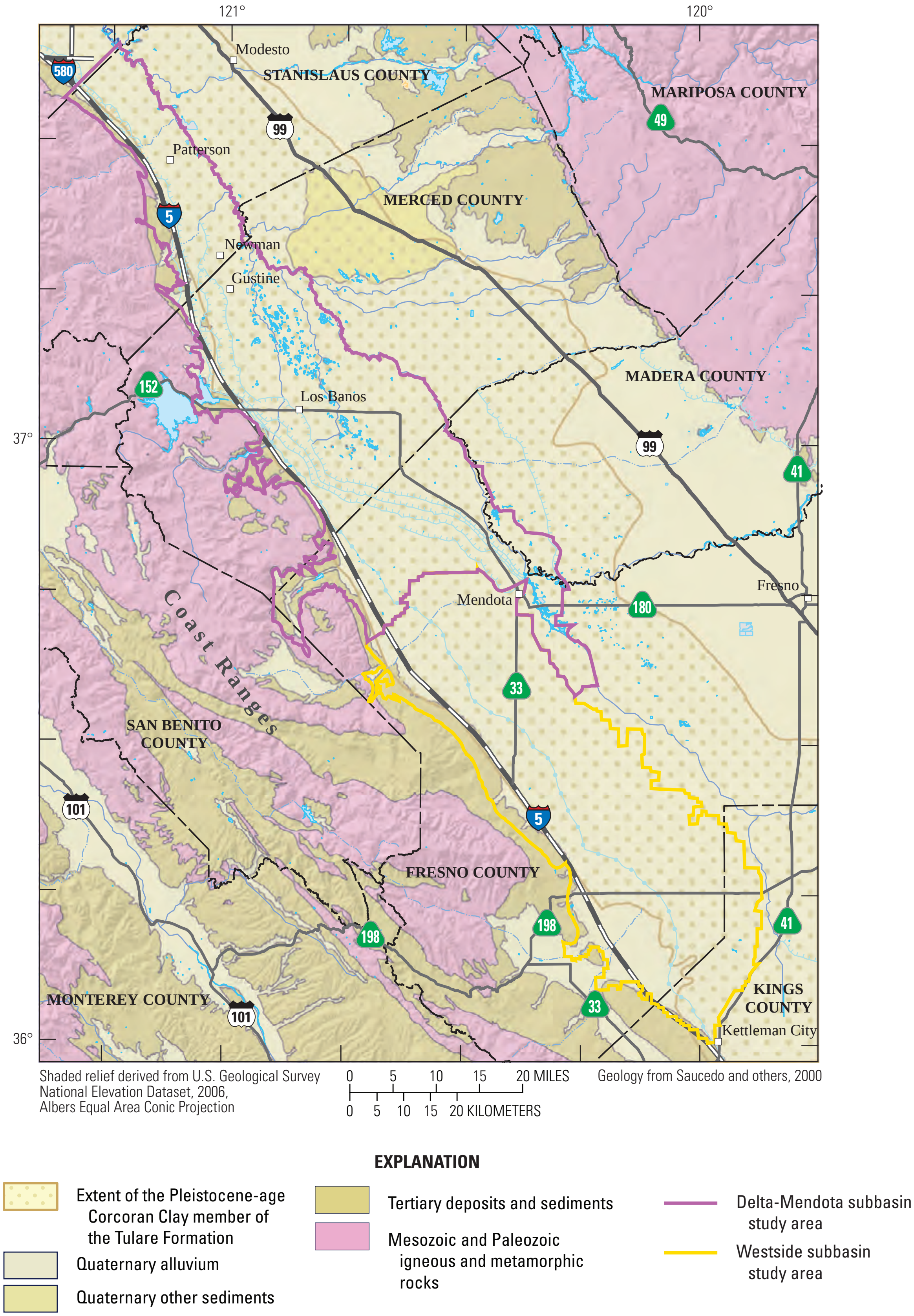
The lower part of the Tulare Formation below the Corcoran Clay is confined (Belitz and Heimes, 1990). This lower zone is underlain by saline water that may be influenced by interactions with marine sediments at greater depths. In the lower zone, groundwater flow in the system is predominantly towards the western margin of the San Joaquin Valley, but is strongly influenced by local variations in pumping stress (Belitz and Heimes, 1990; Faunt, 2009).

On the basis of differences in textures, hydrologic properties, and oxidation states, the unconsolidated deposits in the semi-confined to unconfined zone of the Tulare Formation can be divided into two major hydrogeologic units: Coast Ranges alluvium and Sierran sands (Belitz and Heimes, 1990).

The Coast Ranges alluvium (mapped as Quaternary alluvium on fig. 2), derived from the Coast Ranges to the west, is generally oxidized, and ranges in thickness from 850 ft along the Coast Ranges to 0 ft in the eastern edge of the study unit (Belitz and Heimes, 1990). The Coast Ranges alluvium was deposited in a series of coalescing alluvial fans from streams draining the Coast Ranges. Sediments deposited near the fan head, where the stream enters the valley, are typically the coarsest, and sediment texture generally becomes finer with increasing distance from the fan head and stream channels (Belitz and Heimes, 1990).

The Sierran sands (mapped as Quaternary other sediments on fig. 2) predominantly consist of well-sorted micaeous sand that is derived from the Sierra Nevada to the east. These deposits are up to 400–500 ft thick in the San Joaquin Valley trough and thin to the west, where they interfinger with the Coast Ranges alluvium. The Sierran sands are highly permeable and predominantly chemically reduced in the valley trough (Belitz and Heimes, 1990). The reduced sediments are gray-green, whereas oxidized sediments are yellow, orange, or brown as a result of oxidation of iron minerals in the sediments (Davis and others, 1959; Hotchkiss and Balding, 1971).

In addition to the Coast Ranges alluvium and Sierran sands, continental deposits and non-marine and marine sediments (mapped as Tertiary deposits and sediments on fig. 2) occur along the western margin of the study unit. These deposits are generally located above modern streambeds or the water table, but have coarse texture that may contribute to groundwater recharge along the western margin of the study unit (Hotchkiss and Balding, 1971).



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

Geology from Saucedo and others, 2000

EXPLANATION

▨	Extent of the Pleistocene-age Corcoran Clay member of the Tulare Formation
▨	Quaternary alluvium
▨	Quaternary other sediments
▨	Tertiary deposits and sediments
▨	Mesozoic and Paleozoic igneous and metamorphic rocks
—	Delta-Mendota subbasin study area
—	Westside subbasin study area

Figure 2. Boundaries of the Delta-Mendota (DM) subbasin and the Westside (WS) subbasin study areas, geologic formations, major cities, major roads, and hydrologic features.

Western San Joaquin Valley Study Unit—Delta-Mendota Subbasin Study Area

The Delta-Mendota subbasin study area (hereinafter referred to as the DM study area) is 1,170 mi^2 in area and lies in the northwestern part of the San Joaquin Valley (fig. 3). The DM study area mostly lies between the San Joaquin River near the San Joaquin Valley trough on the east and the Coast Ranges on the west. The study area is approximately 90 miles (mi) long from southeast to northwest parallel to the San Joaquin Valley axis and is 6 to 28 mi wide from the southwest valley margin to the San Joaquin River in the northeast. The city of Los Banos is the only community in the study area with a population greater than 10,000 people and had an estimated 2006 population of 34,717 (U.S. Census Bureau, 2011).

Land-surface altitudes in the study area range from approximately 30 feet above mean sea level (ft above msl) near the northeastern corner, to about 1,500 ft above msl near the southwestern corner; most of the study area has a land surface less than 150 ft above msl. The San Joaquin River at the eastern edge of the study area is the largest surface drainage feature in the study area and interacts with groundwater (forming wetlands) in the eastern part of the study area. Numerous small streams that flow intermittently after rainstorms drain from the Coast Ranges to the east into the study area. However, only Orestimba and Los Banos Creeks maintain channels to the San Joaquin River. When flowing, these tributary streams lose most of their water to seepage and evaporation before reaching the San Joaquin River (Hotchkiss and Balding, 1971). Water is imported into the study area from the Sacramento-San Joaquin Rivers Delta to the north through the Delta-Mendota canal, which runs the length of the study area from northwest to southeast, and through the San Luis Canal, which runs along the western edge of the San Joaquin Valley. Water is also imported from the San Joaquin River (Mendota Pool) at the southeast corner of the study area by way of the Outside, Main, and Chowchilla canals (fig. 3).

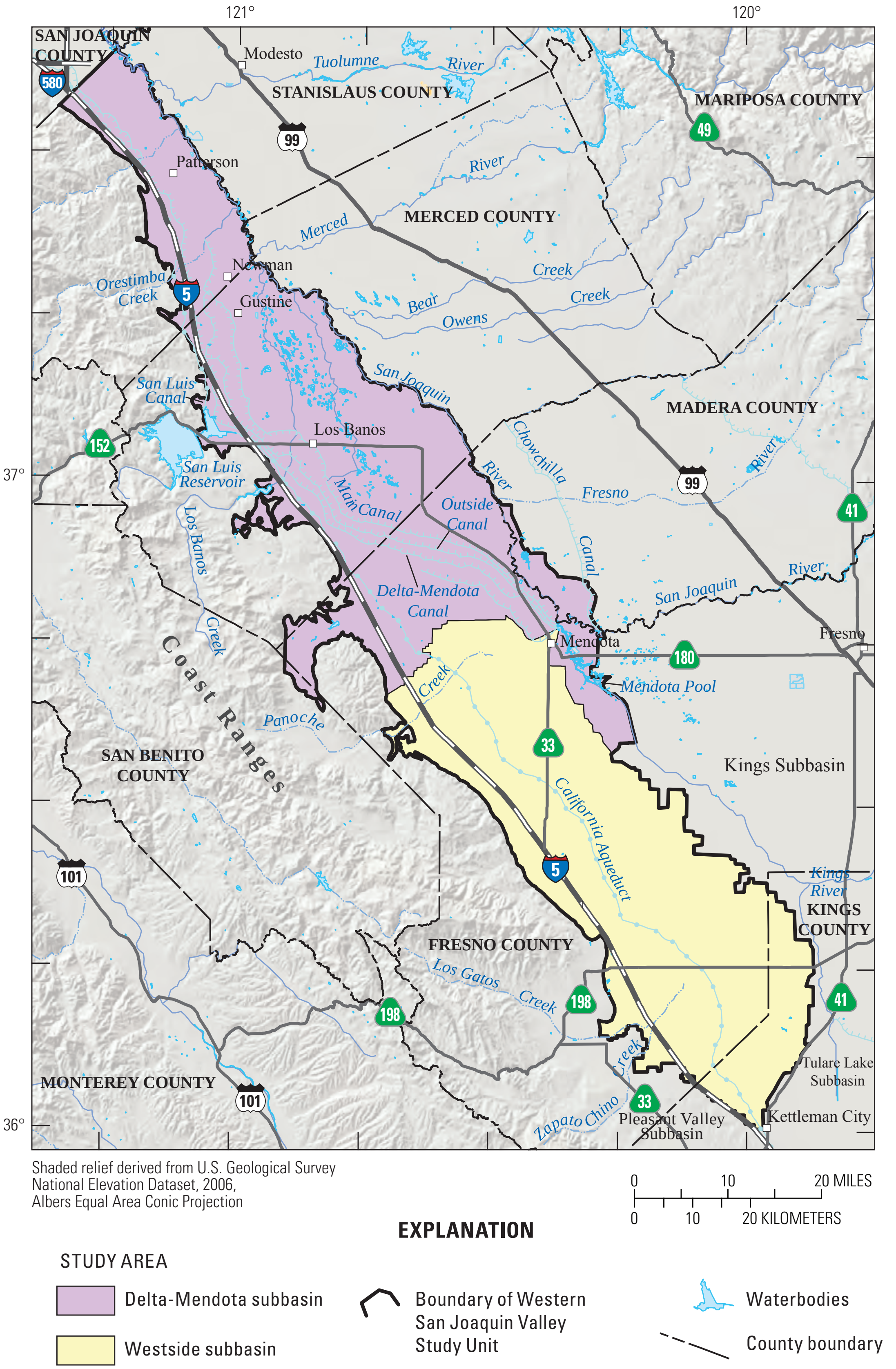
Groundwater recharge in the study area primarily occurs from the percolation of agricultural return (from applied surface water and groundwater used for irrigation). To a lesser extent, ambient recharge also occurs from seepage losses along the San Joaquin River and infiltration of runoff from the Coast Ranges into tributary streams. Groundwater discharge from the study area is primarily due to groundwater pumping and subsurface outflow to other parts of the San Joaquin Valley (California Department of Water Resources, 2006a, b; Faunt, 2009).

Western San Joaquin Valley Study Unit—Westside Subbasin Study Area

The Westside subbasin study area (hereinafter referred to as the WS study area) is 1,000 mi^2 in area and lies in the southwestern part of the San Joaquin Valley (fig. 3). The WS study area and groundwater subbasin correspond to the boundaries of the Westlands Water District (California Department of Water Resources, 2006b). The study area is approximately 60 mi long from southeast to northwest parallel to the San Joaquin Valley axis and is 13 to 24 mi wide from the southwest valley margin to the northeastern boundary. There are no communities in the study area with a population greater than 10,000 people (U.S. Census Bureau, 2011).

Land-surface altitudes in the study area range from approximately 160 ft above msl near the northeastern corner of the study area to about 1,400 ft above msl near the western margin of the study area; most of the study area has land-surface altitudes less than 500 ft above msl. The major surface-water features in the study area are the California Aqueduct and numerous streams that intermittently flow after rainstorms from the Coast Ranges into the study area. The largest of these intermittent streams are the Panoche, Los Gatos, and Zapato Chino Creeks. When flowing, these streams usually lose their water to seepage and evaporation before reaching the San Joaquin River (Belitz and Heimes, 1990). Since about 1967, water has been imported into the study area from the Sacramento-San Joaquin Rivers Delta to the north through the California Aqueduct (fig. 3).

Under current conditions, groundwater recharge in the study area is primarily from irrigation return flow, with lesser amounts of infiltration of runoff from the Coast Ranges along tributary streams. Subsurface groundwater inflow from adjacent groundwater subbasins also occurs (Faunt, 2009). Groundwater discharge from the study area is primarily due to groundwater pumping (California Department of Water Resources, 2006a, b; Faunt, 2009). Under predevelopment conditions, groundwater recharge in the study area was primarily from infiltration of stream water draining the Coast Ranges, and groundwater discharge was primarily by evapotranspiration and streamflow along the San Joaquin Valley trough (Belitz and Heimes, 1990).



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

Figure 3. The Delta-Mendota (DM) subbasin and the Westside (WS) subbasin study areas, and the boundaries of the California Department of Water Resources (CDWR) defined groundwater subbasins.

Methods

Methods used for the GAMA-PBP were selected to achieve the following objectives: (1) design a sampling plan for suitable statistical representation; (2) collect samples in a consistent manner; (3) analyze samples by using proven and reliable laboratory methods; (4) assure the quality of the groundwater data; and (5) maintain data securely and with relevant documentation. The appendix contains detailed descriptions of the sample-collection protocols and analytical methods, the QA plan, and the results of analyses of QC samples.

Study Design

The wells selected for sampling in this study reflect the combination of two well-selection strategies. For the first strategy, 39 randomized wells were selected to provide a statistically unbiased, spatially distributed assessment of the quality of groundwater resources used for public drinking-water supply. Wells sampled as part of the spatially distributed, randomized grid-cell network, hereinafter, are referred to as “grid wells.” For the second strategy, 19 non-randomized wells (hereinafter referred to as “understanding wells”) were sampled in the DM and WS study areas to aid in the understanding of aquifer-system flow and related groundwater-quality issues.

The spatially distributed wells were selected using a randomized grid-based method (Scott, 1990). The randomized grid-based method divides the study unit into equal-area grid cells; however, geographic features may force a grid cell to be divided into multiple pieces to obtain the designated coverage area for each cell. For instance, a part of a grid cell may be separated by a mountain range, but the sum of the cell parts is still considered one grid cell.

In the WSJV study unit, the approach was to sample one available CDPH well located within each grid cell. If a grid cell contained more than one CDPH well, each well randomly was assigned a rank. The highest ranking well that met basic sampling criteria (for example, sampling point located prior to treatment or capability to pump for several hours) was sampled. If a grid cell contained no accessible CDPH wells, then other types of wells, such as irrigation, domestic, and (or) commercial wells were considered for sampling. These non-CDPH wells were identified from USGS databases or by door-to-door canvassing. Wells with depths and screened intervals similar to CDPH wells in the area were selected. In this fashion, one well was selected for possible sampling in each cell to provide a spatially distributed, randomized monitoring network.

The DM study area was divided into 30 equal-area grid cells of approximately 38.9 mi^2 (approximately 100 square kilometers [km^2]) in area each; wells in 29 of the 30 grid cells were sampled (figs. 4, 5). The WS study area was divided into 10 equal-area grid cells of approximately 38.9 mi^2 (approximately 100 km^2) in area each; wells in all 10 grid cells were sampled.

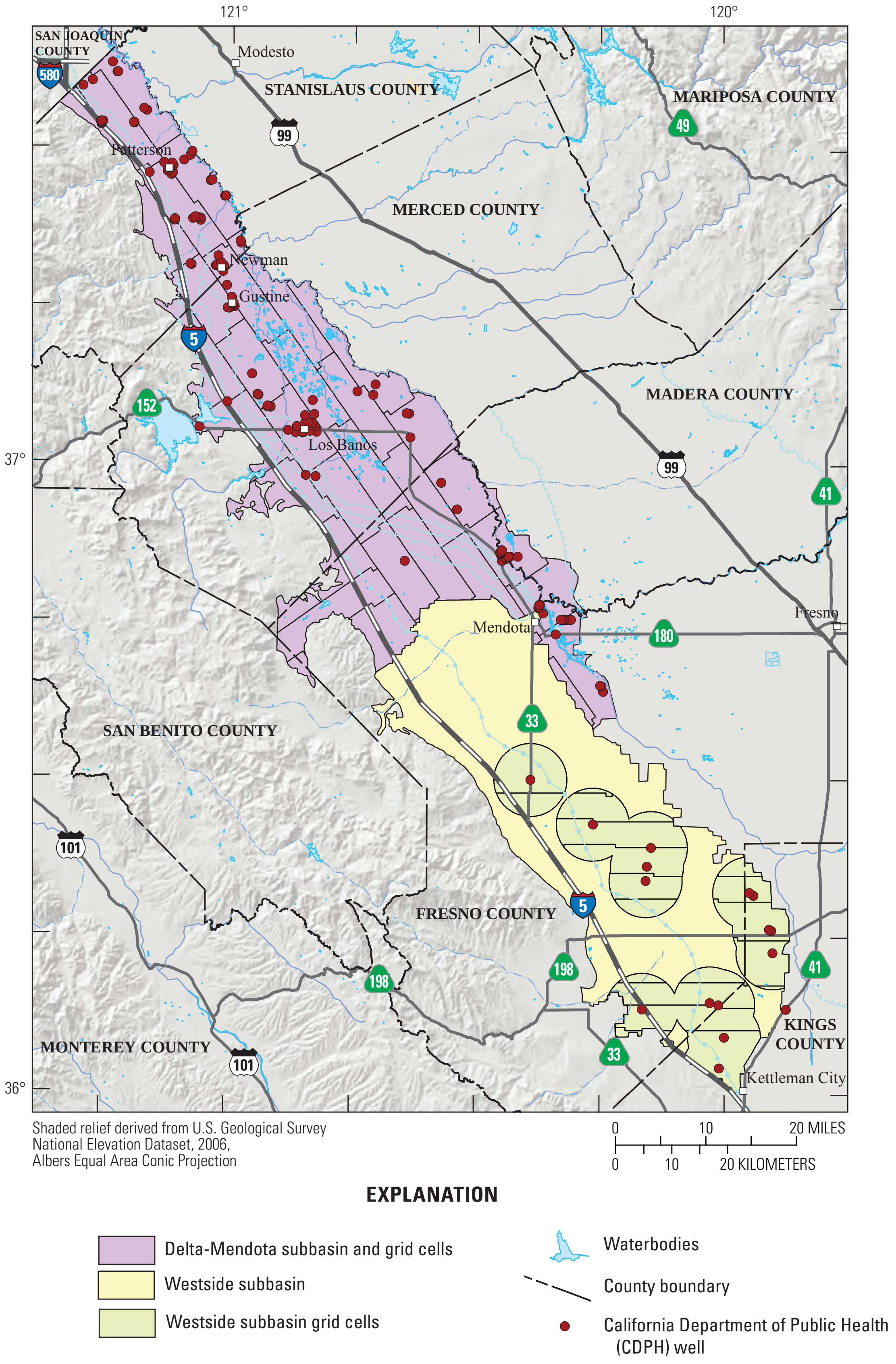
The design of the grid cells differed between the DM and WS study areas because of differences in the distributions and prevalence of CDPH wells. In the DM study area, the entire study area is divided into 30 equal-area cells. Most of the cells within the study area contain CDPH wells; 149 CDPH wells are in the study area (fig. 4). Consistent with GAMA-PBP design in other study units with many CDPH wells, the grid cells cover the entire study area.

In contrast, the WS study area had only 16 CDPH wells (fig. 4). Therefore, our approach involved using circular buffer areas around each CDPH well to delineate the grid cells was used. This allowed assessment of the part of the primary aquifer that is currently used for water supply. This strategy has been used in other GAMA-PBP study units with few and (or) unevenly distributed CDPH wells (Bennett and others, 2009; Schmitt and others, 2009). Buffer areas in the WS study area (within the WSJV study unit) have a radius of about 4 mi (fig. 5).

The 39 grid wells sampled in the WSJV study unit were numbered in the order in which samples were collected in each study area with the prefix varying by study area: “DM” for the Delta-Mendota subbasin and “WS” for the Westside subbasin (fig. 5). A grid well could not be located in one WS grid cell, so an available CDPH well located slightly outside of the study area boundary (WS-09, fig. 5) was sampled. Although the CDPH well was situated 1.3 mi away from the boundary of the WS study area, it was close to the eastern boundary and was considered to be representative of groundwater quality in the eastern part of the WS study area.

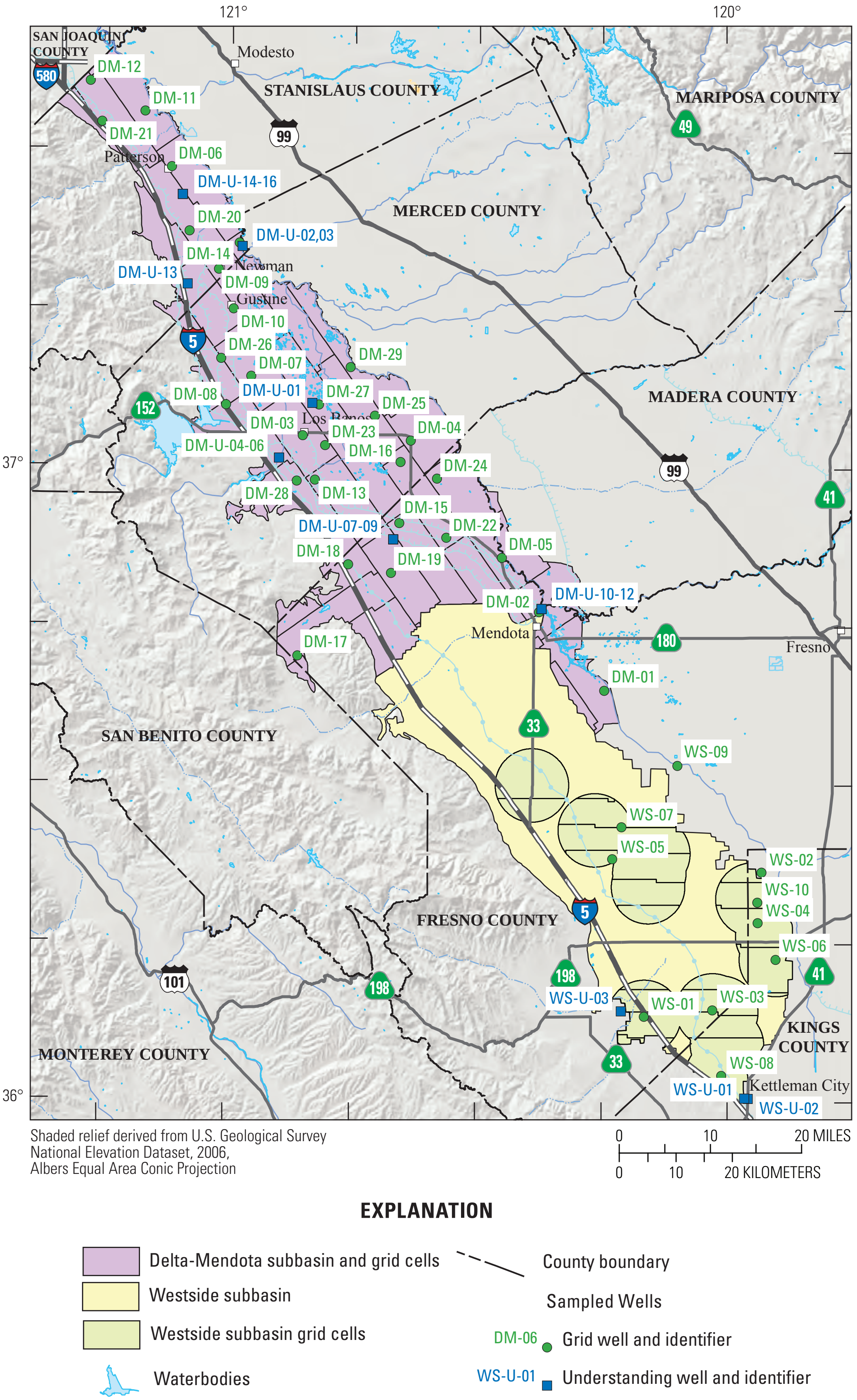
The 19 understanding wells sampled as part of the study were not included in the statistical characterization of water quality in the WSJV study unit because inclusion of these wells would lead to the overrepresentation of some cells. These additional wells were numbered in the order of sample collection, with the prefix modified from those used by the grid cells: “DM-U” or “WS-U” (“U” indicates “understanding”) (fig. 5). Of the understanding wells, 15 were short-screened monitoring wells open at different depths in the aquifer system at 6 geographic locations. The monitoring wells were sampled for the purpose of understanding vertical differences in groundwater quality and age in these six different parts of the WSJV study unit.

The GAMA alphanumeric identification number for each well, along with the date sampled, sampling schedule, land-surface altitude, well type, and available well-construction information is shown in table 1. Groundwater samples were collected during the period from March to July 2010. Grid wells included 18 CDPH wells, 10 irrigation wells, 8 domestic wells, 1 institutional well, and 2 unused wells. Understanding wells included 15 monitoring wells, 3 CDPH wells, and 1 domestic well.



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

Figure 4. The Delta-Mendota (DM) subbasin and the Westside (WS) subbasin study areas, the distribution of the grid cells, and the location of California Department of Public Health (CDPH) wells.



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

Figure 5. The Delta-Mendota (DM) subbasin and the Westside (WS) subbasin study areas, the distribution of the grid cells, and the location of sampled grid and understanding wells.

Well locations were verified by 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, and (or) other sources of construction information. Well location and information were recorded in the field on field sheets, and electronically on field laptop computers using the Alternate Place Entry (APE) program designed by the USGS. All information was verified and then uploaded into the USGS National Water Information System (NWIS) database. Well location, well owner, and well-use information is confidential.

The wells in the WSJV study unit were sampled by using a tiered analytical approach. All wells were sampled for a standard set of constituents: VOCs, low-level fumigants, pesticides and pesticide degradates, perchlorate, 1,2,3-trichloropropane (1,2,3-TCP), trace elements, nutrients, major and minor ions, silica, total dissolved solids (TDS), total arsenic and iron (unfiltered), arsenic and iron species (filtered), stable isotopes of hydrogen and oxygen in water, stable isotopes of carbon in dissolved inorganic carbon and carbon-14 abundance, activities of tritium, and dissolved noble gases. The standard set of constituents was termed the "intermediate" sampling schedule (table 2). Wells on the "slow" sampling schedule included all of the constituents on the *intermediate* sampling schedule, plus *N*-nitrosodimethylamine (NDMA), dissolved organic carbon (DOC), field alkalinity, chromium species (filtered), stable isotopes of nitrogen and oxygen in dissolved nitrate, stable isotopes of sulfur in dissolved sulfate, stable isotopes of boron in water, isotopic ratios of strontium in water, and dissolved standard gases.

Intermediate and *slow* refer to the relative time required to sample the well for all constituents on the schedule. Three *intermediate* or two *slow* wells generally could be sampled in 1 day. In the WSJV study unit, 25 of the wells were sampled on the *intermediate* sampling schedule (24 grid and 1 understanding), and 33 wells were sampled on the *slow* sampling schedule (15 grid and 18 understanding) (table 1).

Sample Collection and Analysis

Samples were collected by using USGS National Field Manual (NFM) (U.S. Geological Survey, variously dated) and modified USGS National Water-Quality Assessment (NAWQA) Program (Koterba and others, 1995) sampling protocols. These sampling protocols were followed so that samples representative of groundwater in the aquifer were collected at each site, and so that the samples were collected and handled in ways that minimized the potential for contamination; this will also allow comparison with data collected by GAMA-PBP throughout California and with other USGS projects in California and the Nation.

Groundwater samples were analyzed for 85 VOCs (table 3A); 2 low-level fumigants (table 3B); 83 pesticides and pesticide degradates (table 3C); 3 constituents of special interest (table 3D); 24 trace elements (table 3E); 5 nutrients and DOC (table 3F); 9 major and minor ions, silica, TDS, and alkalinity (table 3G); total arsenic and iron (unfiltered) and arsenic, chromium, and iron species (filtered) (table 3H), 8 stable isotopes, carbon-14 abundance, activities of tritium, 11 dissolved standard and noble gases, and helium stable isotopic ratios (table 3I). The methods used for sample collection and analysis are described in the appendix section titled "Sample Collection and Analysis."

Data Reporting

Many of the constituents presented in this report have different laboratory reporting conventions; some of the constituents were analyzed by seperate analytical laboratories or methods. The appendix section titled "Data Reporting" gives details for the laboratory reporting conventions for all constituents and the method preferences for those constituents that were analyzed by multiple methods or by multiple laboratories in the WSJV study unit.

Quality-Assurance Methods

The QA/QC procedures used for this study followed the protocols described in the NFM (U.S. Geological Survey, variously dated) and used by the NAWQA Program (Koterba and others, 1995). The QA plan followed by the USGS National Water Quality Laboratory (NWQL), the primary laboratory used to analyze samples for this study, is described in Pirkey and Glodt (1998) and Maloney (2005). QC samples collected in the WSJV study unit are blanks, replicates, and matrix and surrogate spikes. QC samples were collected to evaluate potential contamination, as well as bias and variability of the data that may have resulted from sample collection, processing, storage, transportation, and laboratory analysis. QA/QC procedures and results are described in the appendix section titled "Quality-Assurance Methods."

Quality-Control Results

Results of QC analyses (blanks, replicates, and matrix and surrogate spikes) were used to evaluate the quality of the data for the groundwater samples. On the basis of detections in laboratory and field blanks collected for this and previous GAMA-PBP study units, the laboratory reporting levels (LRLs) for 4 VOCs and 11 inorganic constituents were raised in this report (Olsen and others, 2010; Fram and others, 2012). The GAMA Program refers to these raised reporting levels as "study reporting levels" (SRLs). Detections of the four VOCs with concentrations less than the raised reporting levels were reclassified as non-detections and not presented in this report. Detections of the 11 inorganic constituents with concentrations less than the SRL are flagged with a less than or equal to symbol (≤) in this report (see tables 5, 8, 9, A3 and additional discussion in the appendix section titled “Blanks”) because the concentrations of these constituents could be less than or equal to the reported value.

Variability for 100 percent of the replicate pairs for constituents detected in samples was within the acceptable limits. Results from the replicates confirm that the procedures used to collect and analyze the samples did not introduce unacceptable levels of contamination or variability (see tables A4A-B and additional discussion in the appendix section titled “Replicates”). Median matrix-spike recoveries for 21 of the 172 organic and special-interest constituents analyzed were outside the acceptable range of between 70 and 130 percent. Constituents for which low recoveries occurred might not have been detected in some samples if they were present at concentrations near the LRLs, and constituents with high recoveries may indicate that reported values could be greater than what is in the sample (see tables 3B, 3D, A5B–C and additional discussion in the appendix section titled “Matrix Spikes”).

Comparison Benchmarks

Concentrations of constituents detected in groundwater samples were compared with USEPA and CDPH regulatory and non-regulatory drinking-water health-based benchmarks and benchmarks established for aesthetic purposes (California Department of Public Health, 2008a, b; U.S. Environmental Protection Agency, 2008a, b). The chemical data presented in this report are meant to characterize the quality of the untreated groundwater within the primary aquifer system of the WSJV study unit and are not intended to represent the treated drinking water delivered to consumers by water purveyors. The chemical composition of treated drinking water may differ from untreated groundwater because treated drinking water may be subjected to disinfection, filtration, mixing with other waters, and (or) exposure to the atmosphere prior to its delivery to consumers. Comparisons of untreated groundwater to benchmarks are for illustrative purposes only and are not indicative of compliance or non-compliance with drinking-water regulations. The following benchmarks 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 the 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, as well as lowered the benchmark concentrations for a number of constituents with MCLs established by the USEPA. In this report, a benchmark set by the USEPA and adopted by CDPH is labeled “MCL-US,” and one set by CDPH that is more stringent than the MCL-US is labeled “MCL-CA.” Well owners are notified when constituents are detected at concentrations greater than an MCL-US or an MCL-CA benchmark in samples collected for the GAMA-PBP, but these detections do not constitute violations of CDPH regulations.

- **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 greater than the action-level benchmarks trigger requirements for mandatory water treatment to reduce the corrosiveness of water to water pipes. The action levels established by the USEPA and CDPH are the same; thus, these benchmarks are labeled “AL-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 the technical qualities of drinking water, such as scaling and staining. Both the 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 are used in this report (SMCL-CA) 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 in drinking water at concentrations greater than its NL-CA, California State law requires timely notification of local governing bodies and recommends consumer notification.

- **HAL—Lifetime Health Advisory Level.** The maximum concentration of a constituent at which its presence in drinking water 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 (L) (2.1 quarts) of water per day over a 70-year lifetime by a 70-kilogram (154-pound) 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 the 10^{-5} risk level (10^{-5} equals 1/100,000). RSD5s are calculated by dividing the 10^{-4} cancer risk concentration established by the USEPA by 10 (RSD5-US).

For constituents with MCLs, detections in groundwater samples were compared to 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 groundwater samples were compared with both levels. The SMCL-US levels for these constituents correspond to their recommended SMCL-CAs. Detected concentrations of constituents without an MCL or SMCL were compared to the NL-CA. For constituents without an MCL, SMCL, or NL-CA, detected concentrations were compared with the HAL-US. For constituents without an MCL, SMCL, NL-CA, or HAL-US, detected concentrations were compared with the RSD5-US. For constituents without an MCL, SMCL, NL-CA, HAL-US, or RSD5-US, detected concentrations were compared with the AL-US. Note that using this hierarchy to select the comparison benchmark for a constituent with more than one type of established benchmark will not necessarily result in selection of the benchmark with the lowest concentration. For example, for zinc the SMCL-CA is 5,000 micrograms per liter (µg/L) and the HAL-US is 2,000 µg/L, but the comparison benchmark selected by this hierarchy is the SMCL-CA. The comparison benchmarks used in this report are listed in table 3A–I for all constituents and in tables 4–13 for constituents detected in groundwater samples from the WSJV study unit. Not all constituents analyzed for this study have established benchmarks available. Detections of constituents at concentrations greater than the selected comparison benchmarks are marked with asterisk (*) in tables 4, 5, and 8–11.

Water-Quality Results

Groundwater-Quality Data

Results from analyses of groundwater samples from the WSJV study unit are presented in tables 4–13. Groundwater samples collected in the WSJV study unit were analyzed for 245 constituents; 138 of those constituents were not detected in any of the samples, and 100 constituents were detected (tables 3A–I, 4).

For organic and special-interest constituent classes, the results tables (tables 5–7) include only constituents that were detected and the following summary statistics: the number of wells in which each constituent was detected, the frequency at which it was detected (in the study unit and in each study area), and the total number of constituents detected at each well. For the inorganic and isotopic constituent classes, the results tables (tables 8–13) include all of the wells, constituents, and samples analyzed.

Water-quality indicators measured in the field and at the NWQL are included in table 4. The results of groundwater analyses organized by compound classes are presented in tables 5–13:

- Organic constituents
  - Volatile organic compounds and low-level fumigants (table 5)
  - Pesticides and pesticide degradates (table 6)
- Constituents of special interest (table 7)
- Inorganic constituents
  - Trace elements (table 8)
  - Nutrients and dissolved organic carbon (table 9)
  - Major and minor ions, silica, and total dissolved solids (table 10)
- Total arsenic and iron (unfiltered) and arsenic, chromium, and iron species (filtered) (table 11)
- Isotopic tracers (table 12)
- Dissolved standard gases (table 13)

Water-Quality Indicators

Measurements of turbidity, dissolved oxygen, pH, specific conductance, alkalinity, and associated parameters (water temperature and bicarbonate and carbonate concentrations) are presented in table 4. Turbidity, dissolved oxygen, alkalinity, and bicarbonate and carbonate concentrations are used as indicators of natural processes that affect water chemistry. The pH value indicates the acidity of the water. Specific conductance is the measure of electrical conductivity of the water and is proportional to the amount of dissolved solids in the water.

Field pH values for 2 of the 39 grid wells sampled (1 in the DM study area and 1 in the WS study area) in the WSJV study unit exceeded the SMCL-US range for pH (<6.5 or >8.5) (table 4). Low pH in water may contribute to corrosion of pipes, and high pH in water may contribute to scaling. Laboratory pH values may be dissimilar to field pH values because the pH of groundwater may change upon removal from the ambient environment and exposure to the atmosphere; therefore, the field measurements are preferred over the laboratory results.

Field specific-conductance values for 33 of the 39 grid wells sampled were greater than the recommended SMCL-CA of 900 microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C) (approximately 85 percent) (table 4). Field specific-conductance values for 25 of 29 grid wells sampled in the DM study area were greater than the recommended SMCL-CA, and 16 of these samples had field specific-conductance values greater than the upper benchmark of 1,600 µS/cm at 25 °C. Field specific-conductance values for 8 of 10 grid wells sampled in the WS study area were greater than the recommended SMCL-CA, and 4 of these samples had values that were greater than the upper SMCL-CA.

Field specific-conductance values for 15 of the 19 understanding wells sampled (12 DM-U and 3 WS-U) were greater than the recommended SMCL-CA. Four DM-U well samples and 1 WS-U well sample had field specific-conductance values greater than the upper SMCL-CA.

Organic Constituents

VOCs are present in paints, solvents, fuels, fuel additives, refrigerants, fumigants, and disinfected water and are characterized by their tendency to evaporate. VOCs generally persist longer in groundwater than in surface water because groundwater is isolated from the atmosphere.

Of the 85 VOCs analyzed in WSJV study unit, 22 were detected in groundwater samples; all concentrations in the grid wells sampled were less than health-based benchmarks. Benzene was detected at concentrations greater than the MCL-CA of 1 µg/L in samples from the three WS-U wells (table 5). One or more VOCs were detected in 13 of the 39 grid wells sampled (about 33 percent detection frequency; table 5). Chloroform (trichloromethane) was the only VOC detected in more than 10 percent of the grid wells in the WSJV study unit. Chloroform is among the most commonly detected VOCs in groundwater nationally (Zogorski and others, 2006).

VOCs were detected in 10 of the 29 grid wells sampled in the DM study area (approximately 34 percent). Chloroform was detected in more than 10 percent of the grid wells in the DM study area. VOCs were detected in 3 of the 10 grid wells sampled in the WS study area (30 percent). Chloroform and carbon disulfide were each detected in at least 10 percent of the grid wells in the WS study area. One or more VOCs were detected in nine understanding well samples (6 DM-U and 3 WS-U).

The low-level fumigants DBCP and EDB were sampled for at all 58 wells in the WSJV study unit. DBCP was detected in two grid wells sampled in the DM study area, whereas, EDB was not detected in any of the wells in the WSJV study unit (table 5).

Pesticides are chemicals used to control weeds, insects, fungi, and other pests in agricultural, urban, and suburban settings, and include herbicides, insecticides, and fungicides. Pesticide degradates are the product of the environmental transformations of the parent pesticide, and they can have similar properties to the parent pesticide. Of the 83 pesticides and pesticide degradates analyzed in the WSJV study unit, 16 were detected in groundwater samples; all concentrations were less than health-based benchmarks (table 6). One or more pesticide compounds were detected in 9 of the 39 grid wells sampled (about 23 percent detection frequency; table 6). Simazine and deethylatrazine (2-chloro-4-isopropylamino-6-amino-*s*-triazine) were detected in more than 10 percent of the grid wells in the WSJV study unit.

Pesticides and pesticide degradates were detected in 9 of the 29 grid wells sampled in the DM study area (31 percent). Deethylatrazine, atrazine, hexazinone, and *S*-ethyl-dipropylthiocarbamate (EPTC) were detected in more than 10 percent of the grid wells in the DM study area. Simazine, deethylatrazine, and atrazine are among the nation's most commonly detected pesticide compounds in groundwater (Gilliom and others, 2006).

No pesticide and (or) pesticide degradate was detected in any of the 10 grid wells sampled in the WS study area. One or more pesticide compounds were detected in 11 of the understanding wells sampled (10 DM-U and 1 WS-U).

Constituents of Special Interest

Perchlorate, NDMA, and 1,2,3-TCP are constituents of special interest in California because they may adversely affect water quality and recently have been detected in water supplies (California Department of Public Health, 2008b). Perchlorate and 1,2,3-TCP were analyzed for at all 58 wells, and NDMA was sampled for at the 33 *slow* wells in the WSJV study unit. NDMA was not detected in any of the grid or understanding wells; as a result, NDMA is not included in table 7.

In total, perchlorate was detected in 15 of 39 grid wells sampled (about 38 percent detection frequency; table 7). Perchlorate was detected in 13 of the 29 grid wells sampled in the DM study area (approximately 45 percent). Perchlorate was detected in 2 of the 10 grid wells sampled in the WS study area (20 percent). Perchlorate was not detected at concentrations greater than the MCL-CA of 6 µg/L in any of the grid or understanding wells sampled in the WSJV study unit. 1,2,3-TCP was detected in one DM-U well sample (table 7).

Inorganic Constituents

Unlike the organic constituents and the constituents of special interest, most of the inorganic constituents are naturally present in groundwater, although their concentrations may be influenced by human activities. Inorganic constituents were sampled for at all 58 wells in the WSJV study unit.

Health-based or non-health-based benchmarks have been established for 21 of 24 trace elements analyzed in this study (table 3E). Of the 17 trace elements with health-based benchmarks, most detected concentrations in the wells sampled in the WSJV were less than established benchmarks. The exceptions were detections of arsenic, boron, molybdenum, selenium, strontium, and uranium (table 8).

Arsenic concentrations greater than the MCL-US of 10 µg/L were detected in two grid wells sampled in the DM study area (table 8). Additionally, arsenic was measured at concentrations greater than the MCL-US in five of the understanding wells sampled (three DM-U and two WS-U).

Boron concentrations greater than the NL-CA of 1,000 µg/L were detected in 20 grid wells sampled (16 in the DM study area and 4 in the WS study area; table 8). Boron concentrations greater than the NL-CA were also detected in seven of the understanding wells sampled (six DM-U and one WS-U).

Molybdenum concentrations greater than the HAL-US of 40 µg/L were detected in two grid wells sampled in the DM study area (table 8). Additionally, molybdenum was measured at a concentration greater than the HAL-US in one DM-U well sample.

A selenium concentration greater than the MCL-US of 50 µg/L was detected in one grid well sampled in the DM study area (table 8). There were no detections of selenium greater than the MCL-US in the WS study area or in the WSJV understanding wells.

Strontium concentrations greater than the HAL-US of 4,000 µg/L were detected in two grid wells sampled in the DM study area (table 8). Additionally, strontium was measured at a concentration greater than the HAL-US in one DM-U well sample.

Uranium concentrations greater than the MCL-US of 30 µg/L were detected in two DM-U well samples (table 8). There were no detections of uranium greater than the MCL-US in the WSJV grid wells.

Nutrients (nitrogen and phosphorus) and DOC present in groundwater can affect biological activity in aquifers and in surface-water bodies that receive groundwater discharge. Inorganic nitrogen may be present in the form of ammonia, nitrite, or nitrate, depending on the oxidation-reduction state of the groundwater.

All concentrations of ammonia and nitrite measured in the WSJV study unit were less than health-based benchmarks. Concentrations of nitrate greater than the MCL-US of 10 milligrams per liter (mg/L) were detected in three grid wells sampled in the DM study area and in six DM-U well samples (table 9). There were no detections of nitrate greater than the MCL-US in grid wells sampled in the WS study area.

The CDPH has established non-health-based secondary benchmarks (SMCL-CAs) that are based on aesthetic properties (such as taste, color, and odor) and technical properties (such as scaling and staining) of water, rather than on human-health concerns for iron, manganese, silver, zinc, chloride, sulfate, and TDS.

Iron and manganese are trace elements whose concentrations are affected by the oxidation-reduction state of the groundwater. Iron concentrations greater than the SMCL-CA of 300 µg/L were detected in five grid wells sampled in the DM study area (table 8).

Manganese concentrations greater than the SMCL-CA of 50 µg/L were detected in 16 grid wells (13 in the DM study area and 3 in the WS study area; table 8). Additionally, manganese was measured at concentrations greater than the SMCL-CA in eight of the understanding wells sampled (six DM-U and two WS-U).

Chloride concentrations greater than the recommended SMCL-CA benchmark of 250 mg/L were detected in 14 grid wells sampled in the DM study area, and 5 of these detections were greater than the upper SMCL-CA benchmark of 500 mg/L (table 10). Chloride was not measured at concentrations greater than the recommended SMCL-CA benchmark in any of the grid wells sampled in the WS study area. Chloride was measured at concentrations greater than the recommended SMCL-CA in six of the understanding wells sampled (five DM-U and one WS-U).

Sulfate concentrations greater than the recommended SMCL-CA benchmark of 250 mg/L were detected in 21 WSJV grid wells (13 in the DM study area and 8 in the WS study area; table 10), and 13 of these detections (9 in the DM study area and 4 in the WS study area) were greater than the upper SMCL-CA benchmark of 500 mg/L. Sulfate concentrations greater than the recommended SMCL-CA of 250 mg/L were detected in nine understanding wells sampled (eight DM-U and one WS-U), and four of these detections (three DM-U and one WS-U) were greater than the upper SMCL-CA.

TDS concentrations greater than the recommended SMCL-CA benchmark of 500 mg/L were detected in 36 WSJV grid wells sampled (27 in the DM study area and 9 in the WS study area; table 10), and 20 of these detections (16 in the DM study area and 4 in the WS study area) were greater than the upper SMCL-CA benchmark of 1,000 mg/L. TDS concentrations greater than the recommended SMCL-CA benchmark of 500 mg/L were detected in 15 of the understanding wells sampled (12 DM-U and 3 WS-U), and 7 of these detections (6 DM-U and 1 WS-U) were greater than the upper SMCL-CA.

Arsenic, chromium, and iron occur as different species, depending on the oxidation-reduction state of the groundwater. The oxidized and reduced species have different solubilities in groundwater, and the relative proportions of the oxidized and reduced species of each element can be used in the interpretation of the oxidation–reduction conditions of the aquifer.

Concentrations of total arsenic and total iron (unfiltered) and arsenic, chromium, and iron (filtered), and the dissolved concentration of either the reduced or the oxidized species of the element, are reported in table 11. Concentrations of total arsenic, total chromium, and total iron reported by the NWQL in table 8 are considered to be more accurate than the concentrations reported by the USGS National Research Program (NRP) Trace Metal Laboratory (TML), Boulder, Colorado, in table 11 (see the appendix section titled “Constituents Determined by Multiple Methods or Laboratories”).

Isotopic Tracers and Dissolved Gases

The isotopic ratios, activities, and concentrations of many elements are used as tracers of hydrologic processes (Clark and Fritz, 1997). Stable isotope ratios of hydrogen and oxygen in water (δ^{2}H and δ^{18}O) aid in the interpretation of the sources of groundwater recharge. Stable isotopic ratios reflect the altitude, latitude, and temperature of precipitation and also the extent of evaporation of the water in surface-water bodies or soils prior to infiltration into the aquifer or directly from groundwater close to land surface once in the aquifer system. In the WSJV study unit, the stable isotope ratios of hydrogen in water ranged from –88.0 to –43.3 per mil, and oxygen in water ranged from –11.6 to –5.15 per mil (table 12).

Stable isotope ratios of nitrogen and oxygen in dissolved nitrate (δ^{15}N and δ^{18}O) can be used to aid in interpretation of sources and processes affecting nitrate in aquifers. The stable isotopic ratios of nitrogen in dissolved nitrate ranged from 2.20 to 20.90 per mil, and oxygen in dissolved nitrate ranged from –0.41 to 15.97 per mil (table 12).

Stable isotope ratios of sulfur in dissolved sulfate (δ^{34}S) can be used to aid in the characterization of the groundwater system by determining the source of dissolved sulfur species and (or) aid in the understanding of chemical reactions occurring in groundwater systems, such as the microbial reduction of sulfate or the oxidation of sulfide. The stable isotope ratios of sulfur in dissolved sulfate ranged from –11.22 to 7.05 per mil (table 12).

Stable isotope ratios of boron in water (δ^{11}B) may be useful in distinguishing the sources of boron in groundwater. Natural sources include igneous rocks, evaporate minerals, seawater, and geothermal waters. Boron isotope variations have been shown to reflect mixing in the regional groundwater and the boron isotope fractionalization caused by boron removal by adsorption onto clays. As a result, boron isotopes are a useful tracer in groundwater systems in which the role of clay and minerals can be clearly identified (as a tracer for anthropogenic boron or as a tracer for seawater contamination, for example) (U.S. Geological Survey, 2004). The stable isotope ratios of boron in water ranged from 4.7 to 58.1 per mil (table 12).

Isotopic ratios of strontium in water (^{87}Sr/^{86}Sr) reflect the amounts of strontium (and other inorganic constituents) the aquifer materials are contributing to the groundwater system. In regions that have diverse geology, strontium isotope ratios may aid in identifying groundwater-flow paths. The isotopic ratios of strontium ranged from 0.7047 to 0.7079 (table 12).

Tritium activities and helium isotope ratios provide information about the age (time since recharge) of groundwater. Tritium is a short-lived radioactive isotope of hydrogen that is incorporated into the water molecule. Low levels of tritium are produced continuously by interaction of cosmic radiation with the Earth's atmosphere, and a large amount of tritium was produced as a result of atmospheric testing of nuclear weapons between 1952 and 1963. Thus, concentrations of tritium greater than background levels generally indicate the presence of water recharged since the early 1950s. Helium isotope ratios can be used in conjunction with tritium concentrations to estimate ages for young groundwater. Of the isotopic tracer constituents analyzed for this study, tritium is the only one with a health-based benchmark. All measured tritium activities in samples from the wells in the WSJV study unit were more than three orders of magnitude less than the MCL-CA benchmark (table 12).

Carbon-14 is a radioactive isotope of carbon and an age-dating tracer. Low levels of carbon-14 are produced continuously by interaction of cosmic radiation with the Earth's atmosphere and are incorporated into atmospheric carbon dioxide. Carbon dioxide dissolves in precipitation, surface water, and groundwater exposed to the atmosphere, thereby entering the hydrologic cycle. Because carbon-14 decays with a half-life of approximately 5,700 years, low activities of carbon-14, relative to modern values, generally indicate a presence of groundwater that is several thousand years old or more. Carbon-14 activities ranged from 0.340 to 106.1 percent modern carbon, and the stable isotopes of carbon in dissolved inorganic carbon (δ^{13}C) ranged from –37.47 to –6.03 per mil (table 12).

Gases dissolve in water that is in contact with the atmosphere, and the solubilities of the different gas species vary with temperature. Concentrations of dissolved standard and noble gases are used to estimate the conditions of groundwater recharge, particularly the temperature of the water at the time of recharge. Results for analyses of dissolved standard gases (methane, carbon dioxide, nitrogen, oxygen, and argon) are presented in table 13.

Future Work

Subsequent reports for the WSJV study unit will be focused on assessment of the data presented in this report by using statistical, qualitative, and quantitative approaches to evaluate the natural and human factors affecting groundwater quality in the WSJV study unit. Water-quality data contained in the CDPH databases will be used in combination with the data that are presented in this report. These subsequent reports will include the LLNL results (dissolved noble gas, tritium, and helium isotope ratios) for the WSJV study unit.

Summary

Groundwater quality in the approximately 2,170-square-mile Western San Joaquin Valley (WSJV) study unit was investigated by the U.S. Geological Survey (USGS) from March to July 2010, as part of the Priority Basin Project (PBP) of the California State Water Resources Control Board (SWRCB) Groundwater Ambient Monitoring and Assessment (GAMA) Program. The GAMA Program was created to provide a comprehensive baseline of groundwater quality in the State. The GAMA-PBP was created as a result of the Groundwater Quality Monitoring Act of 2001 (Sections 10780–10782.3 of the California Water Code, Assembly Bill 599) to assess and monitor the quality of groundwater. The GAMA-PBP is being conducted by the USGS in cooperation with the SWRCB and Lawrence Livermore National Laboratory (LLNL).

The GAMA WSJV study was designed to provide a spatially unbiased assessment of untreated-groundwater quality in the primary aquifer system and to facilitate statistically consistent comparisons of untreated-groundwater quality throughout California. The primary aquifer system is defined as parts of aquifers corresponding to the perforation intervals of wells listed in the California Department of Public Health (CDPH) database for the WSJV study unit. Groundwater quality in the primary aquifer system may differ from the quality in the shallower or deeper water-bearing zones; shallow groundwater may be more vulnerable to surficial contamination.

This study did not attempt to evaluate the quality of water delivered to consumers; after withdrawal from the ground, water typically is treated, disinfected, and blended with other waters to maintain acceptable water quality. The benchmarks used in this report apply to treated water that is served to the consumer, not to untreated groundwater. However, to provide some context for the results, concentrations of constituents measured in these groundwater samples were compared with benchmarks established by the U.S. Environmental Protection Agency (USEPA) and CDPH.

The WSJV study unit is located within the Central Valley hydrologic province and includes two groundwater subbasins defined by the California Department of Water Resources: Delta-Mendota and Westside. The WSJV study included assessment of the groundwater quality from 58 wells in Stanislaus, Merced, Madera, Fresno, and Kings Counties, California. Thirty-nine wells were selected using a randomized grid approach to achieve statistically unbiased representation of groundwater used for public drinking-water supplies (grid wells). Nineteen wells were selected to provide additional sampling density to aid in the understanding of aquifer-system flow and related groundwater-quality issues (understanding wells).

Groundwater samples were analyzed for water-quality indicators, organic constituents, constituents of special interest, and inorganic constituents. Isotopic tracers also were measured to provide a dataset that will be used to interpret the sources and ages of groundwater. In total, 245 constituents and 8 water-quality indicators were measured. This report describes the sampling, analytical, and quality-assurance methods used in the study and presents the results of the chemical analyses of the groundwater samples.

Quality-control samples (blanks, replicates, or matrix spikes) were collected at 16 percent of the wells in the WSJV study unit, and the results for these samples were used to evaluate the quality of the data for the groundwater samples. Blanks rarely contained detectable concentrations of any constituent. All replicate samples were within acceptable limits of variability, and matrix-spike recoveries were generally within the acceptable range.

Organic and inorganic constituents were sampled at all 58 wells in the WSJV study unit. Most detections were measured at concentrations less than health-based benchmarks.

In the Delta-Mendota subbasin study area grid wells, 2 detections of arsenic were greater than the USEPA maximum contaminant level (MCL-US), 16 detections of boron were greater than the CDPH notification level (NL-CA), 2 detections of molybdenum were greater than the USEPA lifetime health advisory level (HAL-US), 1 detection of selenium was greater than the MCL-US, 2 detections of strontium were greater than the HAL-US, and 3 detections of nitrate were greater than the MCL-US. In the Westside subbasin study area grid wells, four detections of boron were at concentrations greater than the NL-CA.

In the WSJV study unit understanding wells, three detections of benzene were greater than the CDPH maximum contaminant level (MCL-CA), five detections arsenic were greater than the MCL-US, seven detections of boron were greater than the NL-CA, one detection of molybdenum was greater than the HAL-US, one detection of strontium was greater than the HAL-US, two detections of uranium were greater than the MCL-US, and six detections of nitrate were greater than the MCL-US.

In the Delta-Mendota subbasin study area grid wells, 5 detections of iron were greater than the CDPH secondary maximum contaminant level (SMCL-CA), 13 detections of manganese were greater than the SMCL-CA, 14 detections of chloride were greater than the recommended SMCL-CA (5 of the detections were greater than the upper SMCL-CA), 13 detections of sulfate were greater than the SMCL-CA (9 of the detections were greater than the upper SMCL-CA), and 27 detections of TDS were greater than the recommended SMCL-CA (16 of the detections were greater than the upper SMCL-CA).

In the Westside subbasin study area grid wells, three detections of manganese were greater than the SMCL-CA, eight detections of sulfate were greater than the SMCL-CA (four of the detections were greater than the upper SMCL-CA), and nine detections of TDS were greater than the recommended SMCL-CA (four of the detections were greater than the upper SMCL-CA).

In the WSJV study unit understanding wells, 8 detections of manganese were greater than the SMCL-CA, 6 detections of chloride were greater than the recommended SMCL-CA, 9 detections of sulfate were greater than the SMCL-CA (4 of the detections were greater than the upper SMCL-CA), and 15 detections of TDS were greater than the recommended SMCL-CA (7 of the detections were greater than the upper SMCL-CA).

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Table 1. Identification, sampling, and construction information for wells sampled for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.

[Sampling schedule is described in table 2. Land-surface datum (LSD) is a datum plane that is approximately at land surface at each well. The altitude of the LSD is described in feet above the North American Vertical Datum of 1988 (NAVD 88). **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. **Other abbreviations:** ft, feet; na, not available]

Sampling information				Well type	Construction information		
GAMA well identification number	Date sampled (m/dd/ yyyy)	Sampling schedule	Altitude of LSD (ft above NAVD 88)		Well depth (ft below LSD)	Depth to top perforation (ft below LSD)	Depth to bottom perforation (ft below LSD)
WSJV grid wells (39 wells sampled)							
Delta-Mendota subbasin study area (29 grid wells sampled)							
DM-01	3/1/2010	Intermediate	165	Production	913	663	903
DM-02	3/1/2010	Slow	162	Production	250	140	250
DM-03	3/2/2010	Slow	123	Production	310	164	308
DM-04	3/2/2010	Intermediate	110	Production	180	115	172
DM-05	3/3/2010	Slow	147	Production	230	115	220
DM-06	3/4/2010	Slow	87	Production	597	342	587
DM-07	3/8/2010	Intermediate	101	Production	300	na	na
DM-08	3/8/2010	Intermediate	146	Production	260	185	na
DM-09	3/9/2010	Slow	90	Production	630	na	na
DM-10	3/9/2010	Slow	97	Production	450	370	444
DM-11	3/10/2010	Intermediate	52	Production	168	146	168
DM-12	3/11/2010	Intermediate	131	Production	350	na	na
DM-13	3/17/2010	Intermediate	154	Production	500	400	500
DM-14	3/18/2010	Intermediate	63	Production	104	na	na
DM-15	4/12/2010	Intermediate	145	Production	218	198	218
DM-16	4/12/2010	Intermediate	114	Production	150	130	150
DM-17	4/13/2010	Intermediate	1,154	Production	280	na	na
DM-18	4/13/2010	Intermediate	348	Unused	555	na	na
DM-19	4/14/2010	Slow	228	Production	350	250	350
DM-20	4/15/2010	Intermediate	140	Production	210	190	210
DM-21	4/15/2010	Intermediate	225	Production	500	na	na
DM-22	6/15/2010	Intermediate	150	Production	355	280	345
DM-23	6/15/2010	Intermediate	111	Production	200	140	200
DM-24	6/16/2010	Intermediate	122	Production	150	130	150
DM-25	6/16/2010	Slow	101	Production	150	130	150
DM-26	6/17/2010	Slow	143	Production	280	160	280
DM-27	6/24/2010	Slow	97	Production	575	350	575
DM-28	6/29/2010	Slow	196	Production	178	na	na
DM-29	6/30/2010	Intermediate	94	Production	230	na	na

Table 1. Identification, sampling, and construction information for wells sampled for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[Sampling schedule is described in table 2. Land-surface datum (LSD) is a datum plane that is approximately at land surface at each well. The altitude of the LSD is described in feet above the North American Vertical Datum of 1988 (NAVD 88). **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. **Other abbreviations:** ft, feet; na, not available]

Sampling information				Well type	Construction information		
GAMA well identification number	Date sampled (m/dd/ yyyy)	Sampling schedule	Altitude of LSD (ft above NAVD 88)		Well depth (ft below LSD)	Depth to top perforation (ft below LSD)	Depth to bottom perforation (ft below LSD)
WSJV grid wells (39 wells sampled)—Continued							
Westside subbasin study area (10 grid wells sampled)							
WS-01	3/15/2010	Intermediate	482	Production	1,000	400	1,000
WS-02	6/7/2010	Intermediate	218	Production	678	348	678
WS-03	6/7/2010	Slow	310	Production	2,109	na	na
WS-04	6/8/2010	Intermediate	237	Production	620	300	620
WS-05	6/8/2010	Slow	274	Production	1,550	650	na
WS-06	6/9/2010	Intermediate	231	Production	na	na	na
WS-07	6/10/2010	Intermediate	239	Production	1,020	650	na
WS-08	6/22/2010	Intermediate	361	Unused	1,500	592	na
WS-09	6/23/2010	Slow	185	Production	610	580	600
WS-10	7/8/2010	Slow	232	Production	600	320	600
WSJV understanding wells (19 wells sampled)							
DM-U-01	3/16/2010	Intermediate	97	Production	na	na	na
WS-U-01	6/9/2010	Slow	247	Production	630	400	630
WS-U-02	6/10/2010	Slow	278	Production	570	210	545
WS-U-03	6/23/2010	Slow	611	Production	850	na	na
Monitoring wells (15 wells sampled)							
DM-U-02	3/29/2010	Slow	69	Monitoring	113	105	110
DM-U-03	3/29/2010	Slow	69	Monitoring	20	12	17
DM-U-04	3/30/2010	Slow	175	Monitoring	110	90	110
DM-U-05	3/30/2010	Slow	175	Monitoring	355	335	355
DM-U-06	3/30/2010	Slow	175	Monitoring	160	150	160
DM-U-07	3/31/2010	Slow	168	Monitoring	550	530	550
DM-U-08	3/31/2010	Slow	168	Monitoring	395	375	395
DM-U-09	3/31/2010	Slow	168	Monitoring	215	195	215
DM-U-10	4/6/2010	Slow	166	Monitoring	550	530	550
DM-U-11	4/6/2010	Slow	166	Monitoring	78	58	78
DM-U-12	4/7/2010	Slow	166	Monitoring	350	330	350
DM-U-13	5/18/2010	Slow	190	Monitoring	380	240	260
DM-U-14	5/19/2010	Slow	115	Monitoring	430	390	410
DM-U-15	5/19/2010	Slow	115	Monitoring	115	95	115
DM-U-16	5/20/2010	Slow	115	Monitoring	255	235	255

Table 2. Classes of chemical constituents and water-quality indicators collected for the *slow* and the *intermediate* well-sampling schedules in the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.

Constituent classes	Slow schedule	Intermediate schedule	Constituent list table	Results table
Water-quality indicators				
Dissolved oxygen, temperature, pH, and specific conductance	X	X		4
Turbidity	X			4
Field alkalinity, bicarbonate, and carbonate	X			4
Organic constituents				
Volatile organic compounds (VOCs)	X	X	3A	5
Low-level fumigants	X	X	3B	5
Pesticides and pesticide degradates	X	X	3C	6
Constituents of special interest				
Perchlorate	X	X	3D	7
1,2,3-Trichloropropane (1,2,3-TCP)	X	X	3D	7
N-Nitrosodimethylamine (NDMA)	X		3D	none [1]
Inorganic constituents				
Trace elements	X	X	3E	8
Nutrients	X	X	3F	9
Dissolved organic carbon (DOC)	X		3F	9
Major and minor ions, silica, and total dissolved solids (TDS)	X	X	3G	10
Laboratory alkalinity, bicarbonate, and carbonate	X	X	3G	4
Total arsenic and iron (unfiltered) and arsenic and iron species (filtered)	X	X	3H	11
Chromium species (filtered)	X		3H	11
Stable isotopes				
Stable isotopes of hydrogen and oxygen in water	X	X	3I	12
Stable isotopes of nitrogen and oxygen in nitrate	X		3I	12
Stable isotopes of sulfur in dissolved sulfate	X		3I	12
Stable isotopes of boron in water	X		3I	12
Isotopic ratios of strontium in water	X		3I	12
Stable isotopes of carbon in dissolved inorganic carbon and carbon-14 abundance	X	X	3I	12
Radioactivity and dissolved gases				
Tritium	X	X	3I	12
Dissolved gases	X		3I	13
Dissolved noble gases, tritium, and helium isotope ratios	X	X	3I	none [2]

[1] Constituent not detected in groundwater samples.

[2] Results for dissolved noble gases, tritium, and helium isotope ratios analyzed by Lawrence Livermore National Laboratory (LLNL), Livermore, California, were not completed in time for inclusion in this report; results will be presented in a subsequent publication.

Table 3A. Volatile organic compounds (VOCs), primary uses or sources, comparative benchmarks, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) Schedule 2020.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. LRL, benchmark type, and benchmark level as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) lifetime health advisory level; MCL-CA, California Department of Public Health (CDPH) maximum contaminant level; MCL-US, USEPA maximum contaminant level; NL-CA, CDPH notification level; RSD5-US, USEPA risk specific dose at a risk factor of 10^{-5}. **Other abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; SRL, study reporting level; THM, trihalomethane; D, detected in groundwater samples (table 5); na, not available; µg/L, micrograms per liter; —, not detected; WSJV, Western San Joaquin Valley study unit; ≤, less than or equal to]

Constituent (synonym or abbreviation)	Primary use or source	USGS parameter code	CAS number [1]	LRL or SRL (µg/L)	Benchmark type	Benchmark level (µg/L)	Detection
Acetone	Solvent	81552	67-64-1	3.4	na	na	—
Acrylonitrile	Organic synthesis	34215	107-13-1	0.8	RSD5-US	0.6	—
tert-Amyl methyl ether (TAME)	Gasoline oxygenate	50005	994-05-8	0.06	na	na	—
Benzene	Gasoline hydrocarbon	34030	71-43-2	0.026	MCL-CA	1	D
Bromobenzene	Solvent	81555	108-86-1	0.022	na	na	—
Bromochloromethane	Fire retardant	77297	74-97-5	0.06	HAL-US	90	—
Bromodichloromethane	Disinfection byproduct (THM)	32101	75-27-4	0.034	MCL-US	[3] 80	—
Bromoform (Tribromomethane)	Disinfection byproduct (THM)	32104	75-25-2	0.1	MCL-US	[3] 80	D
Bromomethane (Methyl bromide)	Fumigant	34413	74-83-9	0.2	HAL-US	10	—
n-Butylbenzene	Gasoline hydrocarbon	77342	104-51-8	0.08	NL-CA	260	—
sec-Butylbenzene	Gasoline hydrocarbon	77350	135-98-8	0.034	NL-CA	260	—
tert-Butylbenzene	Gasoline hydrocarbon	77353	98-06-6	0.06	NL-CA	260	—
Carbon disulfide	Organic synthesis	77041	75-15-0	[4] 0.06	NL-CA	160	D
Carbon tetrachloride (Tetrachloromethane)	Solvent	32102	56-23-5	0.052	MCL-CA	0.5	—
Chlorobenzene	Solvent	34301	108-90-7	0.016	MCL-CA	70	—
Chloroethane	Solvent	34311	75-00-3	0.06	na	na	—
Chloroform (Trichloromethane)	Disinfection byproduct (THM)	32106	67-66-3	[5] 0.02	MCL-US	[3] 80	D
Chloromethane	Solvent	34418	74-87-3	0.14	HAL-US	30	D
3-Chloropropene	Organic synthesis	78109	107-05-1	0.08	na	na	—
2-Chlorotoluene	Solvent	77275	95-49-8	0.028	NL-CA	140	—
4-Chlorotoluene	Solvent	77277	106-43-4	0.042	NL-CA	140	—
Dibromochloromethane	Disinfection byproduct (THM)	32105	124-48-1	0.12	MCL-US	[3] 80	D
1,2-Dibromo-3-chloropropane (DBCP) [6]	Fumigant	82625	96-12-8	0.34	MCL-US	0.2	D
1,2-Dibromoethane (EDB) [6]	Fumigant	77651	106-93-4	0.05	MCL-US	0.05	—
Dibromomethane	Solvent	30217	74-95-3	0.05	na	na	—
1,2-Dichlorobenzene	Solvent	34536	95-50-1	0.028	MCL-CA	600	—
1,3-Dichlorobenzene	Solvent	34566	541-73-1	0.024	HAL-US	600	—
1,4-Dichlorobenzene	Fumigant	34571	106-46-7	0.026	MCL-CA	5	—
trans-1,4-Dichloro-2-butene	Organic synthesis	73547	110-57-6	0.36	na	na	—

Table 3A. Volatile organic compounds (VOCs), primary uses or sources, comparative benchmarks, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) Schedule 2020.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. LRL, benchmark type, and benchmark level as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) lifetime health advisory level; MCL-CA, California Department of Public Health (CDPH) maximum contaminant level; MCL-US, USEPA maximum contaminant level; NL-CA, CDPH notification level; RSD5-US, USEPA risk specific dose at a risk factor of 10^{-5}. **Other abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; SRL, study reporting level; THM, trihalomethane; D, detected in groundwater samples (table 5); na, not available; µg/L, micrograms per liter; —, not detected; WSJV, Western San Joaquin Valley study unit; ≤, less than or equal to]

Constituent (synonym or abbreviation)	Primary use or source	USGS parameter code	CAS number [1]	LRL or SRL (µg/L)	Benchmark type	Benchmark level (µg/L)	Detection
Dichlorodifluoromethane (CFC-12)	Refrigerant	34668	75-71-8	0.1	NL-CA	1,000	—
1,1-Dichloroethane (1,1-DCA)	Solvent	34496	75-34-3	0.044	MCL-CA	5	D
1,2-Dichloroethane (1,2-DCA)	Solvent	32103	107-06-2	0.08	MCL-CA	0.5	—
1,1-Dichloroethene (1,1-DCE)	Organic synthesis	34501	75-35-4	0.022	MCL-CA	6	—
cis-1,2-Dichloroethene (*cis*-1,2-DCE)	Solvent	77093	156-59-2	0.022	MCL-CA	6	—
trans-1,2-Dichloroethene (*trans*-1,2-DCE)	Solvent	34546	156-60-5	0.018	MCL-CA	10	—
1,2-Dichloropropane	Fumigant	34541	78-87-5	0.026	MCL-US	5	D
1,3-Dichloropropane	Fumigant	77173	142-28-9	0.06	na	na	—
2,2-Dichloropropane	Fumigant	77170	594-20-7	0.06	na	na	—
1,1-Dichloropropene	Organic synthesis	77168	563-58-6	0.03	na	na	—
cis-1,3-Dichloropropene	Fumigant	34704	10061-01-5	0.1	RSD5-US	[7] 4	—
trans-1,3-Dichloropropene	Fumigant	34699	10061-02-6	0.14	RSD5-US	[7] 4	—
Diethyl ether	Solvent	81576	60-29-7	0.08	na	na	—
Diisopropyl ether (DIPE)	Gasoline oxygenate	81577	108-20-3	0.06	na	na	—
Ethylbenzene	Gasoline hydrocarbon	34371	100-41-4	[2] 0.1	MCL-CA	300	D [2]
Ethyl *tert*-butyl ether (ETBE)	Gasoline oxygenate	50004	637-92-3	0.032	na	na	—
Ethyl methacrylate	Organic synthesis	73570	97-63-2	0.14	na	na	—
o-Ethyl toluene (1-Ethyl-2-methyl benzene)	Gasoline hydrocarbon	77220	611-14-3	0.032	na	na	D
Hexachlorobutadiene	Organic synthesis	39702	87-68-3	0.06	RSD5-US	9	—
Hexachloroethane	Solvent	34396	67-72-1	0.14	HAL-US	1	—
2-Hexanone (*n*-Butyl methyl ketone)	Solvent	77103	591-78-6	0.46	na	na	—
Iodomethane (Methyl iodide)	Organic synthesis	77424	74-88-4	0.26	na	na	—
Isopropylbenzene	Gasoline hydrocarbon	77223	98-82-8	0.042	NL-CA	770	D
1,3-Dichlorobenzene	Solvent	34566	541-73-1	0.024	HAL-US	600	—
1,4-Dichlorobenzene	Fumigant	34571	106-46-7	0.026	MCL-CA	5	—
trans-1,4-Dichloro-2-butene	Organic synthesis	73547	110-57-6	0.36	na	na	—
Dichlorodifluoromethane (CFC-12)	Refrigerant	34668	75-71-8	0.1	NL-CA	1,000	—
1,1-Dichloroethane (1,1-DCA)	Solvent	34496	75-34-3	0.044	MCL-CA	5	D

Table 3A. Volatile organic compounds (VOCs), primary uses or sources, comparative benchmarks, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) Schedule 2020.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. LRL, benchmark type, and benchmark level as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) lifetime health advisory level; MCL-CA, California Department of Public Health (CDPH) maximum contaminant level; MCL-US, USEPA maximum contaminant level; NL-CA, CDPH notification level; RSD5-US, USEPA risk specific dose at a risk factor of 10^{-5}. **Other abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; SRL, study reporting level; THM, trihalomethane; D, detected in groundwater samples (table 5); na, not available; µg/L, micrograms per liter; —, not detected; WSJV, Western San Joaquin Valley study unit; ≤, less than or equal to]

Constituent (synonym or abbreviation)	Primary use or source	USGS parameter code	CAS number [1]	LRL or SRL (µg/L)	Benchmark type	Benchmark level (µg/L)	Detection
1,2-Dichloroethane (1,2-DCA)	Solvent	32103	107-06-2	0.08	MCL-CA	0.5	—
1,1-Dichloroethene (1,1-DCE)	Organic synthesis	34501	75-35-4	0.022	MCL-CA	6	—
cis-1,2-Dichloroethene (*cis*-1,2-DCE)	Solvent	77093	156-59-2	0.022	MCL-CA	6	—
trans-1,2-Dichloroethene (*trans*-1,2-DCE)	Solvent	34546	156-60-5	0.018	MCL-CA	10	—
1,2-Dichloropropane	Fumigant	34541	78-87-5	0.026	MCL-US	5	D
1,3-Dichloropropane	Fumigant	77173	142-28-9	0.06	na	na	—
2,2-Dichloropropane	Fumigant	77170	594-20-7	0.06	na	na	—
1,1-Dichloropropene	Organic synthesis	77168	563-58-6	0.03	na	na	—
cis-1,3-Dichloropropene	Fumigant	34704	10061-01-5	0.1	RSD5-US	[7] 4	—
trans-1,3-Dichloropropene	Fumigant	34699	10061-02-6	0.14	RSD5-US	[7] 4	—
Diethyl ether	Solvent	81576	60-29-7	0.08	na	na	—
Diisopropyl ether (DIPE)	Gasoline oxygenate	81577	108-20-3	0.06	na	na	—
Ethylbenzene	Gasoline hydrocarbon	34371	100-41-4	[2] 0.1	MCL-CA	300	D [2]
Ethyl *tert*-butyl ether (ETBE)	Gasoline oxygenate	50004	637-92-3	0.032	na	na	—
Ethyl methacrylate	Organic synthesis	73570	97-63-2	0.14	na	na	—
o-Ethyl toluene (1-Ethyl-2-methyl benzene)	Gasoline hydrocarbon	77220	611-14-3	0.032	na	na	D
Hexachlorobutadiene	Organic synthesis	39702	87-68-3	0.06	RSD5-US	9	—
Hexachloroethane	Solvent	34396	67-72-1	0.14	HAL-US	1	—
2-Hexanone (*n*-Butyl methyl ketone)	Solvent	77103	591-78-6	0.46	na	na	—
Iodomethane (Methyl iodide)	Organic synthesis	77424	74-88-4	0.26	na	na	—
Isopropylbenzene	Gasoline hydrocarbon	77223	98-82-8	0.042	NL-CA	770	D
1,2,3-Trimethylbenzene	Gasoline hydrocarbon	77221	526-73-8	0.06	na	na	D
1,2,4-Trimethylbenzene	Gasoline hydrocarbon	77222	95-63-6	[2] 0.56	NL-CA	330	—
1,3,5-Trimethylbenzene	Organic synthesis	77226	108-67-8	0.032	NL-CA	330	—
Vinyl bromide (Bromoethene)	Fire retardant	50002	593-60-2	0.12	na	na	—
Vinyl chloride (Chloroethene)	Organic synthesis	39175	75-01-4	0.06	MCL-CA	0.5	—

Table 3A. Volatile organic compounds (VOCs), primary uses or sources, comparative benchmarks, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) Schedule 2020.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. LRL, benchmark type, and benchmark level as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) lifetime health advisory level; MCL-CA, California Department of Public Health (CDPH) maximum contaminant level; MCL-US, USEPA maximum contaminant level; NL-CA, CDPH notification level; RSD5-US, USEPA risk specific dose at a risk factor of 10^{-5}. **Other abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; SRL, study reporting level; THM, trihalomethane; D, detected in groundwater samples (table 5); na, not available; µg/L, micrograms per liter; —, not detected; WSJV, Western San Joaquin Valley study unit; ≤, less than or equal to]

Constituent (synonym or abbreviation)	Primary use or source	USGS parameter code	CAS number [1]	LRL or SRL (µg/L)	Benchmark type	Benchmark level (µg/L)	Detection
m- plus *p*-Xylene	Gasoline hydrocarbon	85795	108-38-3 / 106-42-3	[2] 0.4	MCL-CA	[8] 1,750	D [2]
o-Xylene	Gasoline hydrocarbon	77135	95-47-6	[2] 0.1	MCL-CA	[8] 1,750	D [2]

[1] This report contains CAS Registry Numbers® (CASRNs), which is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CASRNs through CAS Client Services℠.

[2] The SRLs were defined by Fram and others (2012). Values measured at concentrations less than or equal to the SRL have been flagged with a ≤ symbol, reclassified as non-detections, and not included in the calculations of detection frequencies (with the exception of wells WS-U-01 and WS-U-02 [see the appendix section titled “Detections in Blanks and Application of SRLs” for details]).

[3] The MCL-US benchmark for trihalomethanes is the sum of chloroform, bromoform, bromodichloromethane, and dibromochloromethane.

[4] The SRL was defined based on the highest concentration detected in the WSJV blanks. Values measured at concentrations less than or equal to the SRL have been flagged with a ≤ symbol, reclassified as non-detections, and not included in the calculations of detection frequencies.

[5] The SRL was defined based on a detection in the WSJV equipment blank and only can potentially affect monitoring well samples. Values measured at concentrations less than or equal to the SRL have been flagged with a ≤ symbol and reclassified as non-detections.

[6] Analyzed on NWQL Schedules 2020 and 1306.

[7] The RSD5 benchmark for 1,3-dichloropropene is the sum of its isomers (*cis* and *trans*).

[8] The MCL-CA benchmarks for *m*- plus *p*-xylene and *o*-xylene is the sum of all three xylene compounds.

Table 3B. Low-level fumigants, primary uses or sources, comparative benchmarks, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) Schedule 1306.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. LRL, benchmark type, and benchmark level as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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. **Other abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; D, detected in groundwater samples (table 5); µg/L, micrograms per liter; —, not detected]

Constituent (synonym or abbreviation)	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Benchmark type	Benchmark level (µg/L)	Detection
1,2-Dibromo-3-chloropropane (DBCP) [1]	Fumigant	82625	96-12-8	0.03	MCL-US	0.2	D
1,2-Dibromoethane (EDB) [1]	Fumigant	77651	106-93-4	0.018	MCL-US	0.05	—

[1] Analyzed on NWQL Schedules 1306 and 2020.

Table 3C. Pesticides and pesticide degradates, primary uses or sources, comparative benchmarks, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) Schedule 2033.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. LRL, benchmark type, and benchmark level as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) lifetime health advisory level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, USEPA maximum contaminant level; RSD5-US, USEPA risk specific dose at a risk factor of 10^{-5}; **Other abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; D, detected in groundwater samples (table 6); na, not available; µg/L, micrograms per liter; —, not detected]

Constituent (synonym or abbreviation)	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Benchmark type	Benchmark level (µg/L)	Detection
Acetochlor	Herbicide	49260	34256-82-1	0.010	na	na	—
Alachlor	Herbicide	46342	15972-60-8	0.008	MCL-US	2	—
Atrazine	Herbicide	39632	1912-24-9	0.007	MCL-CA	1	D
Azinphos-methyl	Insecticide	82686	86-50-0	0.12	na	na	—
Azinphos-methyl oxon	Insecticide degradate	61635	961-22-8	0.042	na	na	—[1]
Benfluralin	Herbicide	82673	1861-40-1	0.014	na	na	—[1]
Carbaryl	Insecticide	82680	63-25-2	0.06	RSD5-US	400	—
Carbofuran	Insecticide	82674	1563-66-2	0.060	MCL-CA	18	—
2-Chloro-2,6-diethylacetanilide	Herbicide degradate	61618	6967-29-9	0.010	na	na	—
4-Chloro-2-methylphenol	Herbicide degradate	61633	1570-64-5	0.0032	na	na	—
Chlorpyrifos	Insecticide	38933	2921-88-2	0.010	HAL-US	2	—
Chlorpyrifos oxon	Insecticide degradate	61636	5598-15-2	0.05	na	na	—[1]
Cyanazine	Herbicide	04041	21725-46-2	0.022	HAL-US	1	—
Cyfluthrin	Insecticide	61585	68359-37-5	0.016	na	na	—[1]
λ-Cyhalothrin	Insecticide	61595	91465-08-6	0.010	na	na	—[1]
Cypermethrin	Insecticide	61586	52315-07-8	0.020	na	na	—[1]
DCPA (Dacthal)	Herbicide	82682	1861-32-1	0.0076	HAL-US	70	D
Deethylatrazine (2-Chloro-4-isopropylamino-6-amino-*s*-triazine)	Herbicide degradate	04040	6190-65-4	0.014	na	na	D
Desulfinylfipronil	Insecticide degradate	62170	na	0.012	na	na	—
Desulfinylfipronil amide	Insecticide degradate	62169	na	0.029	na	na	—
Diazinon	Insecticide	39572	333-41-5	0.005	HAL-US	1	—
Diazinon oxon	Insecticide degradate	61638	962-58-3	0.0060	na	na	—
3,4-Dichloroaniline	Herbicide degradate	61625	95-76-1	0.0042	na	na	D
3,5-Dichloroaniline	Herbicide degradate	61627	626-43-7	0.0030	na	na	D
Dichlorvos	Insecticide	38775	62-73-7	0.02	na	na	—[1]
Dicrotophos	Insecticide	38454	141-66-2	0.08	na	na	—[1]
Dieldrin	Insecticide	39381	60-57-1	0.009	RSD5-US	0.02	—
2,6-Diethylaniline	Herbicide degradate	82660	579-66-8	0.006	na	na	D
Dimethoate	Insecticide	82662	60-51-5	0.006	na	na	—[1]
Disulfoton	Insecticide	82677	298-04-4	0.04	HAL-US	0.7	—
Disulfoton sulfone	Insecticide degradate	61640	2497-06-5	0.0136	na	na	—
α-Endosulfan	Insecticide	34362	959-98-8	0.006	na	na	—
Endosulfan sulfate	Insecticide degradate	61590	1031-07-8	0.014	na	na	—
Ethion	Insecticide	82346	563-12-2	0.008	na	na	—[1]
Ethion monoxon	Insecticide degradate	61644	17356-42-2	0.021	na	na	—
Ethoprophos	Herbicide	82672	13194-48-4	0.016	na	na	—
S-Ethyl-dipropylthiocarbamate (EPTC)	Herbicide	82668	759-94-4	0.0020	na	na	D

Table 3C. Pesticides and pesticide degradates, primary uses or sources, comparative benchmarks, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) Schedule 2033.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. LRL, benchmark type, and benchmark level as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) lifetime health advisory level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, USEPA maximum contaminant level; RSD5-US, USEPA risk specific dose at a risk factor of 10^{-5}; **Other abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; D, detected in groundwater samples (table 6); na, not available; µg/L, micrograms per liter; —, not detected]

Constituent (synonym or abbreviation)	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Benchmark type	Benchmark level (µg/L)	Detection
2-Ethyl-6-methylaniline	Herbicide degradate	61620	24549-06-2	0.0098	na	na	D
Fenamiphos	Insecticide	61591	22224-92-6	0.030	HAL-US	0.7	—
Fenamiphos sulfone	Insecticide degradate	61645	31972-44-8	0.053	na	na	—
Fenamiphos sulfoxide	Insecticide degradate	61646	31972-43-7	0.08	na	na	—[1]
Fipronil	Insecticide	62166	120068-37-3	0.018	na	na	—
Fipronil sulfide	Insecticide degradate	62167	120067-83-6	0.013	na	na	—
Fipronil sulfone	Insecticide degradate	62168	120068-36-2	0.024	na	na	—
Fonofos	Insecticide	04095	944-22-9	0.0044	HAL-US	10	—
Hexazinone	Herbicide	04025	51235-04-2	0.008	HAL-US	400	D[1]
Iprodione	Fungicide	61593	36734-19-7	0.014	na	na	—
Isofenphos	Insecticide	61594	25311-71-1	0.006	na	na	—
Malaoxon	Insecticide degradate	61652	1634-78-2	0.08	na	na	—
Malathion	Insecticide	39532	121-75-5	0.016	HAL-US	100	—
Metalaxyl	Fungicide	61596	57837-19-1	0.007	na	na	D
Methidathion	Insecticide	61598	950-37-8	0.006	na	na	—
Metolachlor	Herbicide	39415	51218-45-2	0.014	HAL-US	700	D
Metribuzin	Herbicide	82630	21087-64-9	0.012	HAL-US	70	—
Molinate	Herbicide	82671	2212-67-1	0.002	MCL-CA	20	D
Myclobutanil	Fungicide	61599	88671-89-0	0.010	na	na	—
1-Naphthol	Insecticide degradate	49295	90-15-3	0.036	na	na	—[1]
Oxyfluorfen	Herbicide	61600	42874-03-3	0.010	na	na	—[1]
Paraoxon-methyl	Insecticide degradate	61664	950-35-6	0.010	na	na	—[1]
Parathion-methyl	Insecticide	82667	298-00-0	0.008	HAL-US	1	—
Pendimethalin	Herbicide	82683	40487-42-1	0.012	na	na	—
cis-Permethrin	Insecticide	82687	54774-45-7	0.014	na	na	—[1]
Phorate	Insecticide	82664	298-02-2	0.02	na	na	—
Phorate oxon	Insecticide degradate	61666	2600-69-3	0.027	na	na	—
Phosmet	Insecticide	61601	732-11-6	0.034	na	na	—[1]
Phosmet oxon	Insecticide degradate	61668	3735-33-9	0.0511	na	na	—[1]
Prometon	Herbicide	04037	1610-18-0	0.012	HAL-US	100	D
Prometryn	Herbicide	04036	7287-19-6	0.006	na	na	D
Pronamide	Herbicide	82676	23950-58-5	0.0036	RSD5-US	20	—
Propanil	Herbicide	82679	709-98-8	0.010	na	na	—
Propargite	Insecticide	82685	2312-35-8	0.020	na	na	—[1]
cis-Propiconazole	Fungicide	79846	60207-90-1	0.006	na	na	—[2]
trans-Propiconazole	Fungicide	79847	60207-90-1	0.02	na	na	—
Simazine	Herbicide	04035	122-34-9	0.006	MCL-US	4	D
Tebuconazole	Fungicide	62852	107534-96-3	0.020	na	na	—
Tebuthiuron	Herbicide	82670	34014-18-1	0.028	HAL-US	500	D[2]

Table 3C. Pesticides and pesticide degradates, primary uses or sources, comparative benchmarks, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) Schedule 2033.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. LRL, benchmark type, and benchmark level as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) lifetime health advisory level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, USEPA maximum contaminant level; RSD5-US, USEPA risk specific dose at a risk factor of 10^{-5}; **Other abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; D, detected in groundwater samples (table 6); na, not available; µg/L, micrograms per liter; —, not detected]

Constituent (synonym or abbreviation)	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Benchmark type	Benchmark level (µg/L)	Detection
Tefluthrin	Insecticide	61606	79538-32-2	0.010	na	na	—[1]
Terbufos	Insecticide	82675	13071-79-9	0.018	HAL-US	0.4	—
Terbufos oxon sulfone	Insecticide degradate	61674	56070-15-6	0.045	na	na	—[1]
Terbuthylazine	Herbicide	04022	5915-41-3	0.006	na	na	—
Thiobencarb	Herbicide	82681	28249-77-6	0.016	MCL-CA	70	—
Tribufos	Defoliant	61610	78-48-8	0.018	na	na	—[1]
Trifluralin	Herbicide	82661	1582-09-8	0.018	HAL-US	10	—

[1] The median 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.

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

Table 3D. Constituents of special interest, primary uses or sources, comparative benchmarks, and reporting information for Weck Laboratories, Inc., City of Industry, California, analyses.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. MRL, benchmark type, and benchmark level as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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; MCL-CA, California Department of Public Health (CDPH) maximum contaminant level; NL-CA, CDPH notification level. **Other abbreviations:** CAS, Chemical Abstract Service; MRL, minimum reporting level; D, detected in groundwater samples (table 7); µg/L, micrograms per liter; —, not detected]

Constituent (synonym or abbreviation)	Primary use or source	USGS parameter code	CAS number	MRL (µg/L)	Benchmark type	Benchmark level (µg/L)	Detection
Perchlorate	Rocket fuel, fireworks, flares	63790	14797-73-0	0.10	MCL-CA	6	D
1,2,3-Trichloropropane (1,2,3-TCP)	Fumigant, solvent	77443	96-18-4	0.005	HAL-US	40	D
N-Nitrosodimethylamine (NDMA)	Disinfection byproduct	34438	62-75-9	0.002	NL-CA	0.010	—

Table 3E. Trace elements, comparative benchmarks, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) Schedule 1948.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. LRL, benchmark type, and benchmark level as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) action level; HAL-US, USEPA lifetime health advisory level; MCL-CA, California Department of Public Health (CDPH) maximum contaminant level; MCL-US, USEPA maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level. **Other abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; SRL, study reporting level; D, detected in groundwater samples (table 8); na, not available; µg/L, micrograms per liter; —, not detected; WSJV, Western San Joaquin Valley study unit]

Constituent	USGS parameter code	CAS number	LRL or SRL (µg/L)	Benchmark type	Benchmark level (µg/L)	Detection
Aluminum	01106	7429-90-5	[1] 1.6	MCL-CA	1,000	D
Antimony	01095	7440-36-0	0.054	MCL-US	6	D
Arsenic	01000	7440-38-2	0.044	MCL-US	10	D
Barium	01005	7440-39-3	[1] 0.36	MCL-CA	1,000	D
Beryllium	01010	7440-41-7	0.012	MCL-US	4	D
Boron	01020	7440-42-8	2.8	NL-CA	1,000	D
Cadmium	01025	7440-43-9	0.02	MCL-US	5	D
Chromium	01030	7440-47-3	[1] 0.42	MCL-CA	50	D
Cobalt	01035	7440-48-4	[2] 0.33	na	na	D
Copper	01040	7440-50-8	[1] 1.7	AL-US	1,300	D
Iron	01046	7439-89-6	[1] 6	SMCL-CA	300	D
Lead	01049	7439-92-1	[1] 0.65	AL-US	15	D
Lithium	01130	7439-93-2	0.44	na	na	D
Manganese	01056	7439-96-5	[2] 0.52	SMCL-CA	50	D
Molybdenum	01060	7439-98-7	0.028	HAL-US	40	D
Nickel	01065	7440-02-0	[1] 0.36	MCL-CA	100	D
Selenium	01145	7782-49-2	0.040	MCL-US	50	D
Silver	01075	7440-22-4	[2] 0.01	SMCL-CA	100	D
Strontium	01080	7440-24-6	0.40	HAL-US	4,000	D
Thallium	01057	7440-28-0	0.020	MCL-US	2	—
Tungsten	01155	7440-33-7	[1] 0.11	na	na	D
Uranium	22703	7440-61-1	0.008	MCL-US	30	D
Vanadium	01085	7440-62-2	0.16	NL-CA	50	D
Zinc	01090	7440-66-6	[1] 4.8	SMCL-CA [3]	5,000	D

[1] The SRL was defined by Olsen and others (2010).

[2] The SRL was defined based on the highest concentration detected in the WSJV blanks.

[3] The secondary maximum contaminant level for zinc is listed as SMCL-CA because SMCLs established by CDPH are used in this report for all constituents that have SMCL-CA values.

Table 3F. Nutrients and dissolved organic carbon (DOC), comparative benchmarks, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) Schedule 2755 and Laboratory Code 2613.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. LRL, benchmark type, and benchmark level as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) lifetime health advisory level; MCL-US, USEPA maximum contaminant level. **Other abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; SRL, study reporting level; D, detected in groundwater samples (table 9); na, not available; mg/L, milligrams per liter; WSJV, Western San Joaquin Valley study unit; ≤, less than or equal to]

Constituent	USGS parameter code	CAS number	LRL or SRL (mg/L)	Benchmark type	Benchmark level (mg/L)	Detection
Ammonia (as nitrogen)	00608	7664-41-7	[2] 0.016	HAL-US	[3] 24.7	D
Nitrate plus nitrite (as nitrogen) [1]	00631	na	0.04	MCL-US	10	D
Nitrite (as nitrogen)	00613	14797-65-0	[2] 0.001	MCL-US	1	D
Total nitrogen (ammonia + nitrite + nitrate + organic nitrogen)	62854	17778-88-0	0.10	na	na	D
Phosphate, orthophosphate (as phosphorus)	00671	14265-44-2	0.008	na	na	D
Dissolved organic carbon (DOC)	00681	na	0.66	na	na	D

[1] Nitrite plus nitrate (as nitrogen) is referred to as nitrate in the text for clarity.

[2] The SRL was defined based on a detection in a WSJV blank. Values measured at concentrations less than or equal to the SRL are reclassified as ≤ the value reported by the laboratory.

[3] 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.”

Table 3G. Major and minor ions, silica, total dissolved solids (TDS), and alkalinity, comparative benchmarks, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) Schedule 1948.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. LRL, benchmark type, and benchmark level as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (CDPH) maximum contaminant level; SMCL-CA, CDPH secondary maximum contaminant level. **Other abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; D, detected in groundwater samples (table 10); na, not available; mg/L, milligrams per liter; SiO_2, silicon dioxide; $CaCO_3$, calcium carbonate]

Constituent (synonym or abbreviation)	USGS parameter code	CAS number	LRL (mg/L)	Benchmark type	Benchmark level (mg/L)	Detection
Bromide	71870	24959-67-9	0.02	na	na	D
Calcium	00915	7440-70-2	0.044	na	na	D
Chloride	00940	16887-00-6	0.12	SMCL-CA	[1] 250 (500)	D
Fluoride	00950	16984-48-8	0.08	MCL-CA	2	D
Iodide	71865	7553-56-2	0.002	na	na	D
Magnesium	00925	7439-95-4	0.016	na	na	D
Potassium	00935	7440-09-7	0.064	na	na	D
Sodium	00930	7440-23-5	0.10	na	na	D
Sulfate	00945	14808-79-8	0.18	SMCL-CA	[1] 250 (500)	D
Silica (as SiO_2)	00955	7631-86-9	0.058	na	na	D
Total dissolved solids (TDS)	70300	na	10	SMCL-CA	[1] 500 (1,000)	D
Laboratory alkalinity (as $CaCO_3$) [2]	29801	na	1	na	na	D

[1] The SMCL-CA benchmarks for chloride, sulfate, and TDS have recommended and upper benchmark levels. The upper benchmark level is shown in parentheses.

[2] Laboratory alkalinity results are presented in table 4.

Table 3H. Total arsenic and iron (unfiltered) and arsenic, chromium, and iron species (filtered), comparative benchmarks, and reporting information for the U.S. Geological Survey (USGS) National Research Laboratory (NRP) Trace Metal Laboratory (TML), Boulder, Colorado, analyses.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. MDL, benchmark type, and benchmark level as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (CDPH) maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; SMCL-CA, CDPH secondary maximum contaminant level. **Other abbreviations:** CAS, Chemical Abstract Service; MDL, method detection limit; na, not available; µg/L, micrograms per liter; D, detected in groundwater samples (table 11)]

Constituent	USGS parameter code	CAS number	MDL (µg/L)	Benchmark type	Benchmark level (µg/L)	Detection
Arsenic (total, unfiltered)	na	na	0.5	MCL-US	10	D
Arsenic-III (filtered)	99034	22569-72-8	1	na	na	D
Arsenic (total, filtered)	99033	7440-38-2	0.5	MCL-US	10	D
Chromium (total, filtered)	01030	7440-47-3	1	MCL-CA	50	D
Chromium-VI (filtered)	01032	18540-29-9	1	na	na	D
Iron (total, unfiltered)	na	na	2	SMCL-CA	300	D
Iron-II (filtered)	01047	7439-89-6	2	na	na	D
Iron (total, filtered)	01046	7439-89-6	2	SMCL-CA	300	D

Table 3I. Isotopic tracers, comparison benchmarks, and reporting information for laboratory analyses.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Laboratory entity codes in the USGS National Water Information System (NWIS) for laboratories other than the USGS National Water Quality Laboratory (NWQL) are given in parentheses after the laboratory names. Benchmark type and benchmark value as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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. **Elements:** H, hydrogen; O, oxygen; N, nitrogen; S, sulfur; B, boron; Sr, strontium; C, carbon. **Reporting units:** µg/L, micrograms per liter; mg/L, milligrams per liter; pCi/L, picocuries per liter; cm^3 STP/g, cubic centimeters of gas at standard temperature and pressure per gram of water. **Other abbreviations:** CAS, Chemical Abstract Service; na, not available; D, detected in groundwater samples (tables 12 and 13); %, percent; pmc, percent modern carbon; NRP, National Research Program]

Constituent	USGS parameter code	CAS number	Method uncertainty	Reporting units	Benchmark type	Benchmark level (pCi/L)	Detection
Dissolved standard gases [1]							
Methane	76994	74-82-8	na	µg/L	na	na	D
Carbon dioxide	00405	124-39-9	na	mg/L	na	na	D
Nitrogen	00597	7727-37-9	na	mg/L	na	na	D
Oxygen	62971	7782-44-7	na	mg/L	na	na	D
Argon	82043	7440-37-1	na	mg/L	na	na	D
Dissolved noble gases [2]							
Argon	85563	7440-37-1	2%	cm^3 STP/g	na	na	na
Helium-4	85561	7440-59-7	2%	cm^3 STP/g	na	na	na
Krypton	85565	7439-90-9	2%	cm^3 STP/g	na	na	na
Neon	61046	7440-01-09	2%	cm^3 STP/g	na	na	na
Xenon	85567	7440-63-3	2%	cm^3 STP/g	na	na	na
Isotope ratios							
Helium-3 / Helium-4 [2]	61040	na / 7440-59-7	0.75%	atom ratio	na	na	na
δ^{2}H in water [3]	82082	na	2	per mil	na	na	D
δ^{18}O in water [3]	82085	na	0.20	per mil	na	na	D
δ^{15}N in dissolved nitrate [3]	82690	na	0.50	per mil	na	na	D
δ^{18}O in dissolved nitrate [3]	63041	na	1.00	per mil	na	na	D
δ^{34}S in dissolved sulfate [3]	49932	na	0.4	per mil	na	na	D
δ^{11}B in water [4]	62648	na	na	per mil	na	na	D
Strontium isotope ratio (^{87}Sr/^{86}Sr) [4]	75978	na	0.00005	atom ratio	na	na	D
δ^{13}C in dissolved inorganic carbon [5]	82081	na	0.05	per mil	na	na	D
Radioactive constituents							
C-14 [5]	49933	14762-75-5	0.0015	pmc	na	na	D
Tritium [2, 6]	07000	10028-17-8	1	pCi/L	MCL-CA	20,000	D

[1] USGS Chlorofluorocarbon Laboratory, Reston, Virginia (USGSCFCVA).

[2] Lawrence Livermore National Laboratory, Livermore, California (CA-LLNL).

[3] USGS Stable Isotope Laboratory, Reston, Virginia (USGSSIVA).

[4] USGS NRP Metals Isotope Research Laboratory, Menlo Park, California (USGSMICA).

[5] Woods Hole Oceanographic Institution, National Ocean Sciences Accelerator Mass Spectrometry Facility [NOMAS], Woods Hole, Massachusetts (MA-WHAMS).

[6] USGS Stable Isotope and Tritium Laboratory [SITL], Menlo Park, California (USGSH3CA). SITL tritium data are reported using the conventions used by the USGS for radioactive consituents (see table 12).

Table 4. Water-quality indicators in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to June 2010.

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and RL as of March 1, 2010. **Benchmark type:** SMCL-US, U.S. Environmental Protection Agency secondary maximum contaminant level; SMCL-CA, California Department of Public Health secondary maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; °C, degree Celsius; mg/L, milligrams per liter; nc, not collected; na, not available; NTRU, nephelometric turbidity unit; RL, reporting level or range; µS/cm, microsiemens per centimeter; <, less than; >, greater than; $CaCO_3$, calcium carbonate; *, value is at a concentration greater than the benchmark level; **, value is at a concentration greater than the upper benchmark level; —, not detected]

GAMA well identification number	Turbidity, field (NTRU) (63676)	Dissolved oxygen, field (mg/L) (00300)	Water temperature, field (°C) (00010)	pH, laboratory (standard units) (00403)	pH, field (standard units) (00400)	Specific conductance, laboratory (µS/cm at 25°C) (90095)	Specific conductance, field (µS/cm at 25°C) (00095)	Alkalinity, laboratory (mg/L as $CaCO_3$) (29801)	Alkalinity, field (mg/L as $CaCO_3$) (29802)	Bicarbonate, field (mg/L) (63786)	Bicarbonate [3] (mg/L)	Carbonate, field (mg/L) (63788)	Carbonate [3] (mg/L)
Benchmark type	**SMCL-CA**	**na**	**na**	**SMCL-US**	**SMCL-US**	**SMCL-CA**	**SMCL-CA**	**na**	**na**	**na**	**na**	**na**	**na**
Benchmark level	**[1] 5**	**na**	**na**	**<6.5 or >8.5**	**<6.5 or >8.5**	**[2] 900 (1,600)**	**[2] 900 (1,600)**	**na**	**na**	**na**	**na**	**na**	**na**
[RL]	**[0.1]**	**[0.2]**	**[0.0-38.5]**	**[0-14]**	**[0-14]**	**[5]**	**[5]**	**[1]**	**[1]**	**[1]**	**[1]**	**[1]**	**[1]**
WSJV grid wells (39 wells sampled)													
Delta-Mendota subbasin study area (29 grid wells sampled)													
DM-01	nc	<0.2	24.0	7.9	8.0	*1,140	*1,050	118	nc	nc	143	nc	0.5
DM-02	nc	<0.2	19.0	7.8	7.8	**2,410	**2,170	230	216	262	279	1.1	0.8
DM-03	nc	3.1	20.5	7.5	7.4	847	846	214	202	245	260	0.4	0.4
DM-04	nc	<0.2	18.5	7.8	7.6	661	673	182	nc	nc	221	nc	0.6
DM-05	nc	<0.2	19.5	7.2	7.2	619	626	97.0	92.4	112	118	0.1	0.1
DM-06	nc	1.7	21.0	7.6	7.5	*1,590	*1,570	194	187	227	236	0.5	0.4
DM-07	nc	5.6	21.0	7.7	7.5	*1,160	*1,190	226	nc	nc	274	nc	0.6
DM-08	nc	5.0	22.5	7.6	7.5	*1,540	*1,560	280	nc	nc	340	nc	0.6
DM-09	nc	0.9	20.5	7.6	7.6	*1,510	*1,500	227	216	263	276	0.6	0.5
DM-10	nc	1.0	22.0	7.8	7.9	**1,830	**1,800	198	190	229	240	0.9	0.7
DM-11	nc	6.0	19.5	7.7	7.7	**1,840	**1,830	233	nc	nc	283	nc	0.7
DM-12	nc	5.0	21.0	7.5	7.6	*1,120	*1,110	199	nc	nc	242	nc	0.4
DM-13	nc	<0.2	25.5	7.9	7.9	**1,740	**1,700	157	nc	nc	190	nc	0.7
DM-14	nc	0.5	20.5	7.6	7.5	**3,030	**3,030	327	nc	nc	397	nc	0.7
DM-15	nc	<0.2	23.0	7.6	7.5	**2,350	**2,350	72.0	nc	nc	87.5	nc	0.2

Table 4. Water-quality indicators in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to June 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and RL as of March 1, 2010. **Benchmark type:** SMCL-US, U.S. Environmental Protection Agency secondary maximum contaminant level; SMCL-CA, California Department of Public Health secondary maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; °C, degree Celsius; mg/L, milligrams per liter; nc, not collected; na, not available; NTRU, nephelometric turbidity unit; RL, reporting level or range; µS/cm, microsiemens per centimeter; <, less than; >, greater than; $CaCO_3$, calcium carbonate; *, value is at a concentration greater than the benchmark level; **, value is at a concentration greater than the upper benchmark level; —, not detected]

GAMA well identification number	Turbidity, field (NTRU) (63676)	Dissolved oxygen, field (mg/L) (00300)	Water temperature, field (°C) (00010)	pH, laboratory (standard units) (00403)	pH, field (standard units) (00400)	Specific conductance, laboratory (µS/cm at 25°C) (90095)	Specific conductance, field (µS/cm at 25°C) (00095)	Alkalinity, laboratory (mg/L as $CaCO_3$) (29801)	Alkalinity, field (mg/L as $CaCO_3$) (29802)	Bicarbonate, field (mg/L) (63786)	Bicarbonate [3] (mg/L)	Carbonate, field (mg/L) (63788)	Carbonate [3] (mg/L)
Benchmark type	**SMCL-CA**	**na**	**na**	**SMCL-US**	**SMCL-US**	**SMCL-CA**	**SMCL-CA**	**na**	**na**	**na**	**na**	**na**	**na**
Benchmark level	**[1] 5**	**na**	**na**	**<6.5 or >8.5**	**<6.5 or >8.5**	**[2] 900 (1,600)**	**[2] 900 (1,600)**	**na**	**na**	**na**	**na**	**na**	**na**
[RL]	**[0.1]**	**[0.2]**	**[0.0-38.5]**	**[0-14]**	**[0-14]**	**[5]**	**[5]**	**[1]**	**[1]**	**[1]**	**[1]**	**[1]**	**[1]**
WSJV grid wells (39 wells sampled)—Continued													
Delta-Mendota subbasin study area (29 grid wells sampled)—Continued													
DM-16	nc	<0.2	19.0	7.7	7.5	**1,990	**2,000	82.0	nc	nc	99.5	nc	0.2
DM-17	nc	<0.2	43.0	*9.0	*8.7	**4,110	**4,150	35.0	nc	nc	38.5	nc	1.8
DM-18	nc	<0.2	25.5	7.5	7.5	**3,470	**3,520	72.0	nc	nc	87.6	nc	0.1
DM-19	nc	0.2	23.0	7.7	7.7	**1,730	**1,700	69.0	103	125	83.8	0.4	0.2
DM-20	nc	7.1	20.0	7.6	7.5	**1,800	**1,830	78.0	nc	nc	94.8	nc	0.2
DM-21	nc	6.7	20.0	7.7	7.6	*1,220	*1,200	223	nc	nc	271	nc	0.6
DM-22	nc	<0.2	21.5	7.3	7.1	**4,850	**4,850	207	nc	nc	252	nc	0.2
DM-23	nc	1.3	21.0	7.8	7.6	803	805	185	nc	nc	224	nc	0.7
DM-24	nc	<0.2	19.0	7.1	7.0	**2,080	**1,970	265	nc	nc	323	nc	0.2
DM-25	nc	<0.2	19.5	7.0	7.3	*932	*920	166	[4] 161	[4] 196	202	[4] 0.3	0.1
DM-26	nc	4.6	19.5	7.3	7.1	*1,250	*1,240	296	[4] 269	[4] 327	360	[4] 0.3	0.3
DM-27	nc	<0.2	26.0	8.1	7.9	**2,820	**2,920	119	112	136	143	—	0.8
DM-28	nc	6.3	20.0	7.4	7.1	**3,850	**3,740	214	199	242	260	0.4	0.3
DM-29	nc	<0.2	18.0	6.9	6.8	**1,610	**1,650	201	nc	nc	245	nc	0.1

Table 4. Water-quality indicators in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to June 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and RL as of March 1, 2010. **Benchmark type:** SMCL-US, U.S. Environmental Protection Agency secondary maximum contaminant level; SMCL-CA, California Department of Public Health secondary maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; °C, degree Celsius; mg/L, milligrams per liter; nc, not collected; na, not available; NTRU, nephelometric turbidity unit; RL, reporting level or range; µS/cm, microsiemens per centimeter; <, less than; >, greater than; $CaCO_3$, calcium carbonate; *, value is at a concentration greater than the benchmark level; **, value is at a concentration greater than the upper benchmark level; —, not detected]

GAMA well identification number	Turbidity, field (NTRU) (63676)	Dissolved oxygen, field (mg/L) (00300)	Water temperature, field (°C) (00010)	pH, laboratory (standard units) (00403)	pH, field (standard units) (00400)	Specific conductance, laboratory (µS/cm at 25°C) (90095)	Specific conductance, field (µS/cm at 25°C) (00095)	Alkalinity, laboratory (mg/L as $CaCO_3$) (29801)	Alkalinity, field (mg/L as $CaCO_3$) (29802)	Bicarbonate, field (mg/L) (63786)	Bicarbonate[3] (mg/L)	Carbonate, field (mg/L) (63788)	Carbonate[3] (mg/L)
Benchmark type	**SMCL-CA**	**na**	**na**	**SMCL-US**	**SMCL-US**	**SMCL-CA**	**SMCL-CA**	**na**	**na**	**na**	**na**	**na**	**na**
Benchmark level	**[1]5**	**na**	**na**	**<6.5 or >8.5**	**<6.5 or >8.5**	**[2]900 (1,600)**	**[2]900 (1,600)**	**na**	**na**	**na**	**na**	**na**	**na**
[RL]	**[0.1]**	**[0.2]**	**[0.0-38.5]**	**[0-14]**	**[0-14]**	**[5]**	**[5]**	**[1]**	**[1]**	**[1]**	**[1]**	**[1]**	**[1]**
WSJV grid wells (39 wells sampled)—Continued													
Westside subbasin study area (10 grid wells sampled)													
WS-01	nc	10.1	24.0	7.6	7.7	*1,510	*1,470	144	nc	nc	175	nc	0.3
WS-02	nc	<0.2	23.0	8.4	8.3	763	763	330	nc	nc	393	nc	4.5
WS-03	nc	<0.2	26.0	7.9	7.8	**1,820	**1,830	76.0	65.5	78.8	92.0	0.5	0.3
WS-04	nc	<0.2	24.0	8.1	8.1	*1,380	*1,380	54.0	nc	nc	65.0	nc	0.4
WS-05	nc	<0.2	32.0	*8.6	*8.6	**1,640	**1,680	62.0	54.8	66.8	72.7	—	1.3
WS-06	nc	<0.2	22.0	8.5	8.5	**2,950	**2,970	11.0	nc	nc	12.8	nc	0.2
WS-07	nc	0.2	28.0	8.2	8.3	*1,280	*1,320	78.0	nc	nc	93.7	nc	0.7
WS-08	nc	0.9	28.0	8.3	8.5	858	889	58.0	nc	nc	69.3	nc	0.6
WS-09	nc	<0.2	23.0	8.0	7.6	*1,010	*1,060	200	189	231	242	—	1.1
WS-10	0.3	<0.2	24.0	8.0	7.9	**1,980	**1,970	89.0	82.1	99.0	108	0.5	0.5
WSJV understanding wells (19 wells sampled)													
DM-U-01	nc	<0.2	21.0	7.5	7.7	*1,390	*1,360	206	nc	nc	251	nc	0.4
WS-U-01	nc	<0.2	26.0	8.3	8.3	*1,480	*1,520	135	131	160	162	—	1.5
WS-U-02	nc	<0.2	26.5	8.3	8.3	*1,160	*1,180	79.0	79.9	97.4	94.5	—	0.9
WS-U-03	nc	<0.2	29.5	8.1	8.0	**1,700	**1,740	62.0	57.0	69.5	74.7	—	0.4

Table 4. Water-quality indicators in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to June 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and RL as of March 1, 2010. **Benchmark type:** SMCL-US, U.S. Environmental Protection Agency secondary maximum contaminant level; SMCL-CA, California Department of Public Health secondary maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; °C, degree Celsius; mg/L, milligrams per liter; nc, not collected; na, not available; NTRU, nephelometric turbidity unit; RL, reporting level or range; µS/cm, microsiemens per centimeter; <, less than; >, greater than; $CaCO_3$, calcium carbonate; *, value is at a concentration greater than the benchmark level; **, value is at a concentration greater than the upper benchmark level; —, not detected]

GAMA well identification number	Turbidity, field (NTRU) (63676)	Dissolved oxygen, field (mg/L) (00300)	Water temperature, field (°C) (00010)	pH, laboratory (standard units) (00403)	pH, field (standard units) (00400)	Specific conductance, laboratory (µS/cm at 25°C) (90095)	Specific conductance, field (µS/cm at 25°C) (00095)	Alkalinity, laboratory (mg/L as $CaCO_3$) (29801)	Alkalinity, field (mg/L as $CaCO_3$) (29802)	Bicarbonate, field (mg/L) (63786)	Bicarbonate [3] (mg/L)	Carbonate, field (mg/L) (63788)	Carbonate [3] (mg/L)
Benchmark type	**SMCL-CA**	**na**	**na**	**SMCL-US**	**SMCL-US**	**SMCL-CA**	**SMCL-CA**	**na**	**na**	**na**	**na**	**na**	**na**
Benchmark level	**[1] 5**	**na**	**na**	**<6.5 or >8.5**	**<6.5 or >8.5**	**[2] 900 (1,600)**	**[2] 900 (1,600)**	**na**	**na**	**na**	**na**	**na**	**na**
[RL]	**[0.1]**	**[0.2]**	**[0.0-38.5]**	**[0-14]**	**[0-14]**	**[5]**	**[5]**	**[1]**	**[1]**	**[1]**	**[1]**	**[1]**	**[1]**
WSJV understanding wells (19 wells sampled)—Continued													
Monitoring wells (15 wells sampled)													
DM-U-02	nc	0.5	21.0	7.3	7.3	**3,060	**3,040	408	[4] 392	[4] 476	497	[4] 1.0	0.5
DM-U-03	nc	6.6	22.0	7.1	7.0	**3,270	**3,270	346	[4] 332	[4] 403	422	[4] 0.4	0.2
DM-U-04	1.2	3.0	20.5	7.6	7.4	686	691	176	156	190	214	—	0.4
DM-U-05	0.4	5.6	22.0	7.6	7.7	728	738	182	160	196	221	—	0.4
DM-U-06	4.4	2.0	20.5	7.8	7.7	644	642	185	164	200	224	—	0.7
DM-U-07	0.8	0.4	25.5	8.3	8.3	*1,570	*1,580	298	266	324	357	—	3.3
DM-U-08	6.0	0.3	24.5	7.9	7.8	*1,410	*1,400	161	145	176	195	—	0.7
DM-U-09	1.8	0.2	22.0	7.5	7.4	**2,690	**2,660	109	93.0	113	133	—	0.2
DM-U-10	0.3	0.3	22.0	8.1	7.9	**2,570	**2,610	133	[4] 128	[4] 154	160	[4] 1.0	0.9
DM-U-11	3.0	0.3	19.0	7.2	7.3	*948	*961	600	[4] 246	[4] 298	731	[4] 0.5	0.5

Table 4. Water-quality indicators in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to June 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and RL as of March 1, 2010. **Benchmark type:** SMCL-US, U.S. Environmental Protection Agency secondary maximum contaminant level; SMCL-CA, California Department of Public Health secondary maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; °C, degree Celsius; mg/L, milligrams per liter; nc, not collected; na, not available; NTRU, nephelometric turbidity unit; RL, reporting level or range; µS/cm, microsiemens per centimeter; <, less than; >, greater than; $CaCO_3$, calcium carbonate; *, value is at a concentration greater than the benchmark level; **, value is at a concentration greater than the upper benchmark level; —, not detected]

GAMA well identification number	Turbidity, field (NTRU) (63676)	Dissolved oxygen, field (mg/L) (00300)	Water temperature, field (°C) (00010)	pH, laboratory (standard units) (00403)	pH, field (standard units) (00400)	Specific conductance, laboratory (µS/cm at 25°C) (90095)	Specific conductance, field (µS/cm at 25°C) (00095)	Alkalinity, laboratory (mg/L as $CaCO_3$) (29801)	Alkalinity, field (mg/L as $CaCO_3$) (29802)	Bicarbonate, field (mg/L) (63786)	Bicarbonate [3] (mg/L)	Carbonate, field (mg/L) (63788)	Carbonate [3] (mg/L)
Benchmark type	**SMCL-CA**	**na**	**na**	**SMCL-US**	**SMCL-US**	**SMCL-CA**	**SMCL-CA**	**na**	**na**	**na**	**na**	**na**	**na**
Benchmark level	**[1] 5**	**na**	**na**	**<6.5 or >8.5**	**<6.5 or >8.5**	**[2] 900 (1,600)**	**[2] 900 (1,600)**	**na**	**na**	**na**	**na**	**na**	**na**
[RL]	**[0.1]**	**[0.2]**	**[0.0-38.5]**	**[0-14]**	**[0-14]**	**[5]**	**[5]**	**[1]**	**[1]**	**[1]**	**[1]**	**[1]**	**[1]**
WSJV understanding wells (19 wells sampled)—Continued													
Monitoring wells (15 wells sampled)—Continued													
DM-U-12	0.6	0.6	21.0	7.8	7.9	*1,360	*1,380	177	[4] 170	[4] 204	215	[4] 1.4	0.6
DM-U-13	0.5	7.9	23.0	7.4	7.2	415	430	106	101	124	129	—	0.1
DM-U-14	0.4	3.5	22.5	7.8	7.6	*1,320	*1,340	192	185	224	233	0.7	0.7
DM-U-15	nc	4.8	20.0	7.7	7.4	898	*939	221	216	262	268	0.7	0.6
DM-U-16	0.9	9.3	23.0	7.7	7.5	*1,530	*1,550	155	148	179	188	0.5	0.4

[1] The SMCL-CA benchmark for turbidity pertains only to surface-water samples.

[2] The SMCL-CA benchmark for specific conductance has recommended and upper benchmark levels. The upper benchmark level is shown in parentheses.

[3] Bicarbonate and carbonate concentrations were calculated from the laboratory alkalinity and pH values using the advanced speciation method (http://or.water.usgs.gov/alk/methods.html) with $pK_1 = 6.35$, $pK_2 = 10.33$, and $pK_W = 14$.

[4] Alkalinity, bicarbonate, and carbonate values generated by the incremental titration method (USGS parameter codes: 39086, 00453, and 00452; respectively).

Table 5. Volatile organic compounds (VOCs) and low-level fumigants detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to June 2010.

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed, but only samples with detections are listed. Detected constituents are grouped by primary use or source and listed in order of decreasing detection frequency in the 39 grid wells. All constituents are listed in table 3A. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin subbasin study area understanding well; WS, Westside study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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; MCL-CA, California Department of Public Health (CDPH) maximum contaminant level; NL-CA, CDPH notification level; HAL-US, USEPA lifetime health advisory level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; ≤, less than or equal to; LRL, laboratory reporting level; SRL, study reporting level; µg/L, micrograms per liter; na, not available; —, not detected; *, value is at a concentration greater than the benchmark level; NWQL, USGS National Water Quality Laboratory]

Primary use or source	Trihalomethane			Natural	Fumigant		Gasoline oxygenate	Solvent		
GAMA well identification number	**Chloroform (Trichloromethane) (µg/L) (32106)**	**Dibromo-chloromethane (µg/L) (32105)**	**Bromoform (Tribromomethane) (µg/L) (32104)**	**Carbon disulfide (µg/L) (77041)**	**1,2-Dibromo-3-chloropropane (DBCP)[1] (µg/L) (82625)**	**1,2-Dichloro-propane (µg/L) (34541)**	**Methyl *tert*-butyl ether (MTBE) (µg/L) (78032)**	**1,1-Dichloro-ethane (1,1-DCA) (µg/L) (34496)**	**Trichloro-ethene (TCE) (µg/L) (39180)**	**Chloro-methane (µg/L) (34418)**
Benchmark type	**MCL-US**	**MCL-US**	**MCL-US**	**NL-CA**	**MCL-US**	**MCL-US**	**MCL-CA**	**MCL-CA**	**MCL-US**	**HAL-US**
Benchmark level	**[3] 80**	**[3] 80**	**[3] 80**	**160**	**0.2**	**5**	**13**	**5**	**5**	**30**
[LRL or SRL]	**[0.03, [5] 0.02]**	**[0.12]**	**[0.1]**	**[0.03] [6]**	**[0.03]**	**[0.026]**	**[0.1]**	**[0.044]**	**[0.022]**	**[0.14]**
WSJV grid wells (39 wells sampled)										
Number of wells with detections	4	1	1	3	2	1	2	1	1	0
Detection frequency (percent)	10.1	2.6	2.6	7.7	5.1	2.6	5.1	2.6	2.6	0
Total detections										
Delta-Mendota subbasin study area (29 grid wells sampled)										
DM-03	0.06	—	—	—	—	—	—	—	E0.03	—
DM-05	—	—	—	—	—	—	E0.05	—	—	—
DM-06	—	E0.10	0.73	—	—	—	—	—	—	—
DM-08	0.31	—	—	—	—	—	—	—	—	—
DM-11	—	—	—	—	E0.04	—	—	—	—	—
DM-17	—	—	—	E1.06	—	—	—	—	—	—
DM-20	—	—	—	—	0.07	—	—	—	—	—
DM-21	0.06	—	—	—	—	—	—	—	—	—
DM-24	—	—	—	≤0.03	—	—	E0.06	E0.04	—	—
DM-29	—	—	—	—	—	0.04	—	—	—	—
Number of wells with detections	3	1	1	1	2	1	2	1	1	0
Detection frequency (percent)	10.3	3.4	3.4	3.4	6.9	3.4	6.9	3.4	3.4	0
Total detections										

Table 5. Volatile organic compounds (VOCs) and low-level fumigants detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to June 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed, but only samples with detections are listed. Detected constituents are grouped by primary use or source and listed in order of decreasing detection frequency in the 39 grid wells. All constituents are listed in table 3A. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin subbasin study area understanding well; WS, Westside study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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; MCL-CA, California Department of Public Health (CDPH) maximum contaminant level; NL-CA, CDPH notification level; HAL-US, USEPA lifetime health advisory level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; ≤, less than or equal to; LRL, laboratory reporting level; SRL, study reporting level; µg/L, micrograms per liter; na, not available; —, not detected; *, value is at a concentration greater than the benchmark level; NWQL, USGS National Water Quality Laboratory]

Primary use or source	**Trihalomethane**			**Natural**	**Fumigant**		**Gasoline oxygenate**	**Solvent**		
GAMA well identification number	**Chloroform (Trichloromethane) (µg/L) (32106)**	**Dibromo-chloromethane (µg/L) (32105)**	**Bromoform (Tribromomethane) (µg/L) (32104)**	**Carbon disulfide (µg/L) (77041)**	**1,2-Dibromo-3-chloropropane (DBCP)[1] (µg/L) (82625)**	**1,2-Dichloro-propane (µg/L) (34541)**	**Methyl *tert*-butyl ether (MTBE) (µg/L) (78032)**	**1,1-Dichloro-ethane (1,1-DCA) (µg/L) (34496)**	**Trichloro-ethene (TCE) (µg/L) (39180)**	**Chloro-methane (µg/L) (34418)**
Benchmark type	**MCL-US**	**MCL-US**	**MCL-US**	**NL-CA**	**MCL-US**	**MCL-US**	**MCL-CA**	**MCL-CA**	**MCL-US**	**HAL-US**
Benchmark level	**[3] 80**	**[3] 80**	**[3] 80**	**160**	**0.2**	**5**	**13**	**5**	**5**	**30**
[LRL or SRL]	**[0.03, [5] 0.02]**	**[0.12]**	**[0.1]**	**[0.03] [6]**	**[0.03]**	**[0.026]**	**[0.1]**	**[0.044]**	**[0.022]**	**[0.14]**
WSJV grid wells (39 wells sampled)—Continued										
Westside subbasin study area (10 grid wells sampled)										
WS-02	—	—	—	E0.38	—	—	—	—	—	—
WS-06	—	—	—	0.05	—	—	—	—	—	—
WS-09	0.03	—	—	—	—	—	—	—	—	—
Number of wells with detections	1	0	0	2	0	0	0	0	0	0
Detection frequency (percent)	10.0	0	0	20.0	0	0	0	0	0	0
Total detections										
WSJV understanding wells (19 wells sampled) [7]										
WS-U-01	—	—	—	0.10	—	—	—	—	—	—
WS-U-02	—	—	—	—	—	—	—	—	—	—
WS-U-03	—	—	—	—	—	—	—	—	—	—
Montioring wells (15 wells sampled)										
DM-U-04	—	—	—	—	—	—	—	—	—	E0.01
DM-U-05	—	—	—	—	—	—	—	—	—	E0.02
DM-U-07	—	—	—	—	—	—	—	—	—	E0.02
DM-U-11	—	—	—	—	—	—	—	—	—	—
DM-U-14	—	—	—	≤0.03	—	—	—	—	—	E0.01
DM-U-16	≤0.02	—	—	—	—	—	—	—	—	—

Table 5. Volatile organic compounds (VOCs) and low-level fumigants detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to June 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed, but only samples with detections are listed. Detected constituents are grouped by primary use or source and listed in order of decreasing detection frequency in the 39 grid wells. All constituents are listed in table 3A. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin subbasin study area understanding well; WS, Westside study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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; MCL-CA, California Department of Public Health (CDPH) maximum contaminant level; NL-CA, CDPH notification level; HAL-US, USEPA lifetime health advisory level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; ≤, less than or equal to; LRL, laboratory reporting level; SRL, study reporting level; µg/L, micrograms per liter; na, not available; —, not detected; *, value is at a concentration greater than the benchmark level; NWQL, USGS National Water Quality Laboratory]

Primary use or source	Hydrocarbons													
GAMA well identification number	**Benzene (µg/L) (34030)**	**1,2,3-Tri-methyl-benzene (µg/L) (77221)**	**1,2,3,4-Tetra-methyl-benzene (µg/L) (49999)**	**1,2,3,5-Tetra-methyl-benzene (µg/L) (50000)**	***o*-Ethyl toluene (1-Ethyl-2-methyl benzene) (µg/L) (77220)**	**4-Isopropyl-1-methyl benzene (µg/L) (77356)**	**Isopropyl-benzene (µg/L) (77223)**	***n*-Propyl-benzene (µg/L) (77224)**	**Ethyl-benzene [2] (µg/L) (34371)**	**Toluene [2] (µg/L) (34010)**	***m*- plus *p*-Xylene [2] (µg/L) (85795)**	***o*-Xylene [2] (µg/L) (77135)**	**Detections per well**	**VOC detection summary**
Benchmark type	**MCL-CA**	**na**	**na**	**na**	**na**	**na**	**NL-CA**	**NL-CA**	**MCL-CA**	**MCL-CA**	**MCL-CA**	**MCL-CA**		
Benchmark level	**1**	**na**	**na**	**na**	**na**	**na**	**770**	**260**	**300**	**150**	**[4] 1,750**	**[4] 1,750**		
[LRL or SRL]	**[0.026]**	**[0.06]**	**[0.08]**	**[0.08]**	**[0.032]**	**[0.06]**	**[0.042]**	**[0.036]**	**[0.036]**	**[0.69]**	**[0.08]**	**[0.032]**		
WSJV grid wells (39 wells sampled)														
Number of wells with detections	1	0	0	0	0	0	0	0	0	0	0	0		13
Detection frequency (percent)	2.6	0	0	0	0	0	0	0	0	0	0	0		33
Total detections														17
Delta-Mendota subbasin study area (29 grid wells sampled)														
DM-03	—	—	—	—	—	—	—	—	—	—	—	—	2	
DM-05	—	—	—	—	—	—	—	—	—	—	—	—	1	
DM-06	—	—	—	—	—	—	—	—	—	—	—	—	2	
DM-08	—	—	—	—	—	—	—	—	—	—	—	—	1	
DM-11	—	—	—	—	—	—	—	—	—	—	—	—	1	
DM-17	E0.02	—	—	—	—	—	—	—	—	—	—	—	2	
DM-20	—	—	—	—	—	—	—	—	—	—	—	—	1	
DM-21	—	—	—	—	—	—	—	—	—	—	—	—	1	
DM-24	—	—	—	—	—	—	—	—	—	—	—	—	2	
DM-29	—	—	—	—	—	—	—	—	—	—	—	—	1	

Table 5. Volatile organic compounds (VOCs) and low-level fumigants detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to June 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed, but only samples with detections are listed. Detected constituents are grouped by primary use or source and listed in order of decreasing detection frequency in the 39 grid wells. All constituents are listed in table 3A. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin subbasin study area understanding well; WS, Westside study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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; MCL-CA, California Department of Public Health (CDPH) maximum contaminant level; NL-CA, CDPH notification level; HAL-US, USEPA lifetime health advisory level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; ≤, less than or equal to; LRL, laboratory reporting level; SRL, study reporting level; µg/L, micrograms per liter; na, not available; —, not detected; *, value is at a concentration greater than the benchmark level; NWQL, USGS National Water Quality Laboratory]

Primary use or source	Hydrocarbons													
GAMA well identification number	**Benzene (µg/L) (34030)**	**1,2,3-Tri-methyl-benzene (µg/L) (77221)**	**1,2,3,4-Tetra-methyl-benzene (µg/L) (49999)**	**1,2,3,5-Tetra-methyl-benzene (µg/L) (50000)**	***o*-Ethyl toluene (1-Ethyl-2-methyl benzene) (µg/L) (77220)**	**4-Isopropyl-1-methyl benzene (µg/L) (77356)**	**Isopropyl-benzene (µg/L) (77223)**	***n*-Propyl-benzene (µg/L) (77224)**	**Ethyl-benzene[2] (µg/L) (34371)**	**Toluene[2] (µg/L) (34010)**	***m*- plus *p*-Xylene[2] (µg/L) (85795)**	***o*-Xylene[2] (µg/L) (77135)**	**Detections per well**	**VOC detection summary**
Benchmark type	**MCL-CA**	**na**	**na**	**na**	**na**	**na**	**NL-CA**	**NL-CA**	**MCL-CA**	**MCL-CA**	**MCL-CA**	**MCL-CA**		
Benchmark level	**1**	**na**	**na**	**na**	**na**	**na**	**770**	**260**	**300**	**150**	**[4]1,750**	**[4]1,750**		
[LRL or SRL]	**[0.026]**	**[0.06]**	**[0.08]**	**[0.08]**	**[0.032]**	**[0.06]**	**[0.042]**	**[0.036]**	**[0.036]**	**[0.69]**	**[0.08]**	**[0.032]**		
WSJV grid wells (39 wells sampled)—Continued														
Delta-Mendota subbasin study area (29 grid wells sampled)—Continued														
Number of wells with detections	1	0	0	0	0	0	0	0	0	0	0	0		10
Detection frequency (percent)	3.4	0	0	0	0	0	0	0	0	0	0	0		34
Total detections														14
Westside subbasin study area (10 grid wells sampled)														
WS-02	—	—	—	—	—	—	—	—	—	—	—	—	1	
WS-06	—	—	—	—	—	—	—	—	—	—	—	—	1	
WS-09	—	—	—	—	—	—	—	—	—	—	—	—	1	
Number of wells with detections	0	0	0	0	0	0	0	0	0	0	0	0		3
Detection frequency (percent)	0	0	0	0	0	0	0	0	0	0	0	0		30
Total detections														3
WSJV understanding wells (19 wells sampled)[7]														
WS-U-01	*6.98	—	—	—	—	—	—	—	0.04	—	—	0.05	3	
WS-U-02	*138	E0.04	—	—	0.05	—	0.07	E0.01	0.78	0.03	0.10	0.11	9	
WS-U-03	*2.85	—	—	—	—	—	—	—	—	—	—	—	1	

Table 5. Volatile organic compounds (VOCs) and low-level fumigants detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to June 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed, but only samples with detections are listed. Detected constituents are grouped by primary use or source and listed in order of decreasing detection frequency in the 39 grid wells. All constituents are listed in table 3A. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin subbasin study area understanding well; WS, Westside study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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; MCL-CA, California Department of Public Health (CDPH) maximum contaminant level; NL-CA, CDPH notification level; HAL-US, USEPA lifetime health advisory level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; ≤, less than or equal to; LRL, laboratory reporting level; SRL, study reporting level; µg/L, micrograms per liter; na, not available; —, not detected; *, value is at a concentration greater than the benchmark level; NWQL, USGS National Water Quality Laboratory]

Primary use or source	**Hydrocarbons**													
GAMA well identification number	**Benzene (µg/L) (34030)**	**1,2,3-Tri-methyl-benzene (µg/L) (77221)**	**1,2,3,4-Tetra-methyl-benzene (µg/L) (49999)**	**1,2,3,5-Tetra-methyl-benzene (µg/L) (50000)**	***o*-Ethyl toluene (1-Ethyl-2-methyl benzene) (µg/L) (77220)**	**4-Isopropyl-1-methyl benzene (µg/L) (77356)**	**Isopropyl-benzene (µg/L) (77223)**	***n*-Propyl-benzene (µg/L) (77224)**	**Ethyl-benzene [2] (µg/L) (34371)**	**Toluene [2] (µg/L) (34010)**	***m*- plus *p*-Xylene [2] (µg/L) (85795)**	***o*-Xylene [2] (µg/L) (77135)**	**Detections per well**	**VOC detection summary**
Benchmark type	**MCL-CA**	**na**	**na**	**na**	**na**	**na**	**NL-CA**	**NL-CA**	**MCL-CA**	**MCL-CA**	**MCL-CA**	**MCL-CA**		
Benchmark level	**1**	**na**	**na**	**na**	**na**	**na**	**770**	**260**	**300**	**150**	**[4] 1,750**	**[4] 1,750**		
[LRL or SRL]	**[0.026]**	**[0.06]**	**[0.08]**	**[0.08]**	**[0.032]**	**[0.06]**	**[0.042]**	**[0.036]**	**[0.036]**	**[0.69]**	**[0.08]**	**[0.032]**		
WSJV understanding wells (19 wells sampled) [7]—Continued														
Monitoring wells (15 wells sampled)														
DM-U-04	—	—	—	—	—	—	—	—	—	—	—	—	1	
DM-U-05	—	—	—	—	—	—	—	—	—	—	—	—	1	
DM-U-07	—	—	—	—	—	—	—	—	—	—	—	—	1	
DM-U-11	E0.03	E0.02	0.20	0.60	—	E0.03	—	—	—	≤0.02	—	—	5	
DM-U-14	—	—	—	—	—	—	—	—	—	—	—	—	1	
DM-U-16	—	—	—	—	—	—	—	—	—	—	—	—	1	

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[1] Anaylzed on NWQL Schedules 2020 and 1306.

[2] The SRLs were defined by Fram and others (2012). Values measured at concentrations less than or equal to the SRL have been flagged with a ≤ symbol, reclassified as non-detections, and not included in the calculations of detection frequencies (with the exception of wells WS-U-01 and WS-U-02 [see the appendix section titled "Detections in Blanks and Application of SRLs" for details]).

[3] The MCL-US benchmark for trihalomethanes is the sum of chloroform, bromoform, bromodichloromethane, and dibromochloromethane.

[4] The MCL-CA benchmarks for *m*- plus *p*-xylene and *o*-xylene is the sum all three xylene compounds.

[5] The SRL was defined based on a detection in the WSJV equipment blank and only can potentially affect monitoring well samples. Values measured at concentrations less than or equal to the SRL have been flagged with a ≤ symbol and reclassified as non-detections.

[6] The SRL was defined based on the highest concentration detected in the WSJV blanks. Values measured at concentrations less than or equal to the SRL have been flagged with a ≤ symbol, reclassified as non-detections, and not included in the calculations of detection frequencies.

[7] Understanding wells were not included in statistical calculations.

Table 6. Pesticides and pesticide degradates detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed, but only samples with detections are listed. Detected constituents are grouped by primary use or source and then listed in order of decreasing detection frequency in the 39 grid wells. All constituents are listed in table 3B. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta Mendota subbasin study area understanding well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) maximum contaminant level; HAL-US, USEPA lifetime health advisory level; MCL-CA, California Department of Public Health maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; LRL, laboratory reporting level; µg/L, micrograms per liter; na, not available; —, not detected]

Primary use or source	**Herbicide**									
GAMA well identification number	**Simazine (µg/L) (04035)**	**Atrazine (µg/L) (39632)**	**Hexazinone (µg/L) (04025)**	***S*-Ethyl-dipropylthiocarbamate (EPTC) (µg/L) (82668)**	**Molinate (µg/L) (82671)**	**Prometryn (µg/L) (04036)**	**Metolachlor (µg/L) (39415)**	**Prometon (µg/L) (04037)**	**DCPA (Dacthal) (µg/L) (82682)**	**Tebuthiuron (µg/L) (82670)**
Benchmark type	**MCL-US**	**MCL-CA**	**HAL-US**	**na**	**MCL-CA**	**na**	**HAL-US**	**HAL-US**	**HAL-US**	**HAL-US**
Benchmark level	**4**	**1**	**400**	**na**	**20**	**na**	**700**	**400**	**70**	**500**
[LRL]	**[0.006]**	**[0.007]**	**[0.008]**	**[0.002]**	**[0.0026]**	**[0.006]**	**[0.014]**	**[0.012]**	**[0.0076]**	**[0.028]**
WSJV grid wells (39 wells sampled)										
Number of wells with detections	6	3	3	3	1	1	0	0	0	0
Detection frequency (percent)	15.4	7.7	7.7	7.7	2.6	2.6	0	0	0	0
Total Detections										
Delta-Mendota subbasin study area (29 grid wells sampled)										
DM-02	—	—	—	0.008	E0.007	—	—	—	—	—
DM-03	E0.006	E0.006	—	—	—	—	—	—	—	—
DM-05	—	—	0.029	E0.007	—	—	—	—	—	—
DM-08	0.010	—	—	—	—	—	—	—	—	—
DM-20	E0.006	E0.006	—	—	—	—	—	—	—	—
DM-21	0.008	—	—	—	—	—	—	—	—	—
DM-26	0.011	—	—	—	—	—	—	—	—	—
DM-28	E0.007	0.019	0.009	—	—	—	—	—	—	—
DM-29	—	—	0.045	0.074	—	0.006	—	—	—	—
Number of wells with detections	6	3	3	3	1	1	0	0	0	0
Detection frequency (percent)	20.7	10.3	10.3	10.3	3.4	3.4	0	0	0	0
Total Detections										

Table 6. Pesticides and pesticide degradates detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed, but only samples with detections are listed. Detected constituents are grouped by primary use or source and then listed in order of decreasing detection frequency in the 39 grid wells. All constituents are listed in table 3B. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta Mendota subbasin study area understanding well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) maximum contaminant level; HAL-US, USEPA lifetime health advisory level; MCL-CA, California Department of Public Health maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; LRL, laboratory reporting level; µg/L, micrograms per liter; na, not available; —, not detected]

Primary use or source	**Herbicide**									
GAMA well identification number	**Simazine (µg/L) (04035)**	**Atrazine (µg/L) (39632)**	**Hexazinone (µg/L) (04025)**	***S*-Ethyl-dipropylthiocarbamate (EPTC) (µg/L) (82668)**	**Molinate (µg/L) (82671)**	**Prometryn (µg/L) (04036)**	**Metolachlor (µg/L) (39415)**	**Prometon (µg/L) (04037)**	**DCPA (Dacthal) (µg/L) (82682)**	**Tebuthiuron (µg/L) (82670)**
Benchmark type	**MCL-US**	**MCL-CA**	**HAL-US**	**na**	**MCL-CA**	**na**	**HAL-US**	**HAL-US**	**HAL-US**	**HAL-US**
Benchmark level	**4**	**1**	**400**	**na**	**20**	**na**	**700**	**400**	**70**	**500**
[LRL]	**[0.006]**	**[0.007]**	**[0.008]**	**[0.002]**	**[0.0026]**	**[0.006]**	**[0.014]**	**[0.012]**	**[0.0076]**	**[0.028]**
WSJV understanding wells (19 wells sampled) [1]										
DM-U-01	—	—	0.012	—	—	E0.001	—	—	—	E0.01
WS-U-01	—	0.013	—	—	—	—	0.015	—	—	—
Montioring wells (15 wells sampled)										
DM-U-02	E0.007	—	—	—	—	—	E0.014	—	—	—
DM-U-03	—	—	—	—	—	—	—	0.02	—	—
DM-U-05	—	—	—	—	—	—	—	—	—	—
DM-U-06	E0.008	—	—	—	—	—	—	—	—	—
DM-U-10	—	—	—	—	—	—	—	—	—	—
DM-U-11	—	—	0.027	0.014	E0.007	—	—	—	E0.004	—
DM-U-14	0.01	E0.007	0.024	—	—	—	0.023	—	—	—
DM-U-15	0.033	E0.007	0.076	—	—	—	0.045	0.02	—	—
DM-U-16	0.019	0.015	—	—	—	—	E0.013	—	—	—

Table 6. Pesticides and pesticide degradates detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed, but only samples with detections are listed. Detected constituents are grouped by primary use or source and then listed in order of decreasing detection frequency in the 39 grid wells. All constituents are listed in table 3B. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta Mendota subbasin study area understanding well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) maximum contaminant level; HAL-US, USEPA lifetime health advisory level; MCL-CA, California Department of Public Health maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; LRL, laboratory reporting level; µg/L, micrograms per liter; na, not available; —, not detected]

Primary use or source	**Herbicide degradate**					**Fungicide**		
GAMA well identification number	**Deethylatrazine (2-Chloro-4-isopropylamino-6-amino-*s*-triazine) (µg/L) (04040)**	**3,4-Dichloroaniline (µg/L) (61625)**	**2,6-Diethylaniline (µg/L) (82660)**	**2-Ethyl-6-methylaniline (µg/L) (61620)**	**3,5-Dichloroaniline (µg/L) (61627)**	**Metalaxyl (µg/L) (61596)**	**Pesticide detections per well**	**Pesticide detection summary**
Benchmark type	**na**	**na**	**na**	**na**	**na**	**na**		
Benchmark level	**na**	**na**	**na**	**na**	**na**	**na**		
[LRL]	**[0.014]**	**[0.0042]**	**[0.006]**	**[0.0098]**	**[0.003]**	**[0.007]**		
WSJV grid wells (39 wells sampled)								
Number of wells with detections	6	2	1	1	1	0		9
Detection frequency (percent)	15.4	5.1	2.6	2.6	2.6	0		23
Total detections								28
Delta-Mendota subbasin study area (29 grid wells sampled)								
DM-02	—	—	—	—	—	—	2	
DM-03	E0.012	—	—	—	—	—	3	
DM-05	—	—	—	—	—	—	2	
DM-08	E0.013	—	—	—	—	—	2	
DM-20	E0.009	—	—	—	—	—	3	
DM-21	E0.007	—	—	—	—	—	2	
DM-26	E0.008	—	—	—	—	—	2	
DM-28	E0.028	E0.004	—	—	0.004	—	6	
DM-29	—	E0.005	E0.005	E0.002	—	—	6	
Number of wells with detections	6	2	1	1	1	0		9
Detection frequency (percent)	20.7	6.9	3.4	3.4	3.4	0		31
Total detections								28

Table 6. Pesticides and pesticide degradates detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed, but only samples with detections are listed. Detected constituents are grouped by primary use or source and then listed in order of decreasing detection frequency in the 39 grid wells. All constituents are listed in table 3B. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta Mendota subbasin study area understanding well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) maximum contaminant level; HAL-US, USEPA lifetime health advisory level; MCL-CA, California Department of Public Health maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; LRL, laboratory reporting level; µg/L, micrograms per liter; na, not available; —, not detected]

Primary use or source	**Herbicide degradate**					**Fungicide**		
GAMA well identification number	**Deethylatrazine (2-Chloro-4-isopropylamino-6-amino-*s*-triazine) (µg/L) (04040)**	**3,4-Dichloroaniline (µg/L) (61625)**	**2,6-Diethylaniline (µg/L) (82660)**	**2-Ethyl-6-methylaniline (µg/L) (61620)**	**3,5-Dichloroaniline (µg/L) (61627)**	**Metalaxyl (µg/L) (61596)**	**Pesticide detections per well**	**Pesticide detection summary**
Benchmark type	**na**	**na**	**na**	**na**	**na**	**na**		
Benchmark level	**na**	**na**	**na**	**na**	**na**	**na**		
[LRL]	**[0.014]**	**[0.0042]**	**[0.006]**	**[0.0098]**	**[0.003]**	**[0.007]**		
WSJV understanding wells (19 wells sampled) [1]								
DM-U-01	—	—	—	—	—	—	3	
WS-U-01	—	—	—	—	—	—	2	
Montioring wells (15 wells sampled)								
DM-U-02	—	—	—	—	—	—	2	
DM-U-03	—	—	—	—	—	—	1	
DM-U-05	E0.009	—	—	—	—	—	1	
DM-U-06	—	—	—	—	—	—	1	
DM-U-10	—	E0.008	—	—	—	—	1	
DM-U-11	—	E0.215	—	—	—	—	5	
DM-U-14	E0.011	—	—	—	—	0.015	6	
DM-U-15	E0.009	E0.006	—	—	—	0.054	8	
DM-U-16	E0.016	—	—	—	—	—	4	

[1] Understanding wells were not included in statistical calculations.

Table 7. Constituents of special interest detected in the samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Information about the constituent given in table 3D. Samples from all 58 wells were analyzed for perchlorate and 1,2,3-TCP. Samples from the 33 slow wells were analyzed for NDMA. Only well samples with detections are listed. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well. Benchmark type, benchmark level, and MRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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; HAL-US, U.S. Environmental Protection Agency lifetime health advisory level. **Other abbreviations:** USGS, U.S. Geological Survey; 1,2,3-TCP, 1,2,3-Trichloropropane; NDMA, *N*-Nitrosodimethylamine; MRL, method reporting level; µg/L, micrograms per liter; —, not detected]

GAMA well identification number	**Perchlorate (µg/L) (63790)**	**1,2,3-TCP (µg/L) (77443)**
Benchmark type	**MCL-CA**	**HAL-US**
Benchmark level	**6**	**40**
[MRL]	**[0.10]**	**[0.005]**
WSJV grid wells (39 wells sampled)		
Number of wells with detections	15	0
Detection frequency (percent)	38	0
Delta-Mendota subbasin study area (29 grid wells sampled)		
DM-03	0.33	—
DM-06	1.20	—
DM-07	0.44	—
DM-08	0.29	—
DM-09	0.33	—
DM-10	0.30	—
DM-11	1.29	—
DM-12	1.32	—
DM-14	0.30	—
DM-20	4.53	—
DM-26	0.46	—
DM-28	1.32	—
Number of wells with detections	13	0
Detection frequency (percent)	45	0
Westside subbasin study area (10 grid wells sampled)		
WS-01	1.15	—
WS-03	0.12	—
Number of wells with detections	2	0
Detection frequency (percent)	20	0
WSJV understanding wells (19 wells sampled) [1]		
Monitoring wells (15 wells sampled)		
DM-U-02	0.29	—
DM-U-03	0.62	—
DM-U-04	0.16	—
DM-U-05	0.47	—
DM-U-06	0.12	—
DM-U-15	0.48	—
DM-U-16	2.51	0.016

[1] Understanding wells were not included in statistical calculations.

Table 8. Trace elements collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed. Information about the constituents given in table 3E. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) action level; HAL-US, USEPA lifetime health advisory level; MCL-CA, California Department of Public Health (CDPH) maximum contaminant level; MCL-US, USEPA maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; LRL, laboratory reporting level; SRL, study reporting level; µg/L, micrograms per liter; na, not available; —, not detected; ≤, less than or equal to; *, value is at a concentration greater than the benchmark level]

GAMA well identification number	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)
Benchmark type	**MCL-CA**	**MCL-US**	**MCL-US**	**MCL-CA**	**MCL-US**	**NL-CA**	**MCL-US**	**MCL-CA**	**na**	**AL-US**	**SMCL-CA**	**AL-US**
Benchmark level	**1,000**	**6**	**10**	**1,000**	**4**	**1,000**	**5**	**50**	**na**	**1,300**	**300**	**15**
[LRL or SRL]	**[1.6] [1]**	**[0.054]**	**[0.044]**	**[0.36] [1]**	**[0.012]**	**[2.8]**	**[0.02]**	**[0.42] [1]**	**[0.33] [2]**	**[1.7] [1]**	**[6] [1]**	**[0.65] [1]**
WSJV grid wells (39 wells sampled)												
Delta-Mendota subbasin study area (29 grid wells sampled)												
DM-01	5.7	0.10	*15.7	14.0	E0.01	*1,130	0.18	—	≤0.01	—	40	≤0.02
DM-02	—	—	0.19	55.0	0.01	*1,360	0.06	—	≤0.08	—	*524	≤0.11
DM-03	—	0.74	7.1	66.0	—	673	—	29.5	≤0.07	—	—	≤0.03
DM-04	—	E0.03	9.6	294	—	162	E0.02	—	≤0.06	3.6	40	2.47
DM-05	E1.8	—	3.5	132	—	249	0.03	—	≤0.02	—	*400	—
DM-06	—	—	1.2	25.0	—	564	—	26.2	≤0.05	—	10	≤0.20
DM-07	—	—	1.8	69.0	—	*1,630	—	11.7	≤0.05	12.0	10	1.00
DM-08	—	—	2.0	82.0	—	*1,620	—	2.4	≤0.05	—	≤4	≤0.15
DM-09	—	E0.10	1.0	43.0	—	666	E0.03	4.2	≤0.10	—	≤4	1.20
DM-10	—	—	2.3	48.0	—	*1,540	E0.08	1.6	≤0.05	—	—	≤0.11
DM-11	—	E0.09	1.7	50.0	—	627	—	21.1	≤0.13	—	≤5	≤0.06
DM-12	—	—	0.5	21.0	—	*1,320	—	11.6	≤0.07	—	6	1.42
DM-13	—	—	1.7	46.0	—	*2,440	—	—	≤0.16	—	61	—
DM-14	—	0.16	1.2	40.0	—	*1,260	—	24.4	≤0.16	E2.1	—	≤0.27
DM-15	—	E0.30	2.1	13.0	—	*3,070	0.22	—	0.34	—	—	1.04
DM-16	—	E0.08	5.0	346	—	740	E0.06	—	≤0.15	—	82	1.06
DM-17	—	E0.83	E1.2	12.0	—	*13,700	—	—	≤0.27	—	—	—
DM-18	—	E0.33	1.5	25.0	—	*2,710	—	—	≤0.24	—	*3,260	—
DM-19	—	—	0.85	11.0	—	*3,220	0.34	4.8	≤0.14	—	—	≤0.27

Table 8. Trace elements collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed. Information about the constituents given in table 3E. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) action level; HAL-US, USEPA lifetime health advisory level; MCL-CA, California Department of Public Health (CDPH) maximum contaminant level; MCL-US, USEPA maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; LRL, laboratory reporting level; SRL, study reporting level; µg/L, micrograms per liter; na, not available; —, not detected; ≤, less than or equal to; *, value is at a concentration greater than the benchmark level]

GAMA well identification number	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)
Benchmark type	**MCL-CA**	**MCL-US**	**MCL-US**	**MCL-CA**	**MCL-US**	**NL-CA**	**MCL-US**	**MCL-CA**	**na**	**AL-US**	**SMCL-CA**	**AL-US**
Benchmark level	**1,000**	**6**	**10**	**1,000**	**4**	**1,000**	**5**	**50**	**na**	**1,300**	**300**	**15**
[LRL or SRL]	**[1.6]** [1]	**[0.054]**	**[0.044]**	**[0.36]** [1]	**[0.012]**	**[2.8]**	**[0.02]**	**[0.42]** [1]	**[0.33]** [2]	**[1.7]** [1]	**[6]** [1]	**[0.65]** [1]
WSJV grid wells (39 wells sampled)—Continued												
Delta-Mendota subbasin study area (29 grid wells sampled)—Continued												
DM-20	—	—	0.84	28.0	—	394	—	16.6	0.40	—	≤4	0.82
DM-21	—	E0.22	0.79	27.0	—	*2,820	—	1.1	≤0.12	—	87	≤0.09
DM-22	—	0.17	9.3	31.0	0.03	*1,350	0.08	≤0.32	0.69	—	187	—
DM-23	E2.0	0.52	9.4	86.0	0.02	932	0.04	31.0	≤0.09	—	—	≤0.05
DM-24	—	E0.05	3.7	127	E0.01	471	0.02	≤0.12	≤0.21	—	*1,160	≤0.06
DM-25	—	—	7.6	57.0	E0.01	379	0.06	≤0.07	≤0.09	—	270	≤0.18
DM-26	—	E0.05	1.4	54.0	0.01	757	E0.02	13.6	≤0.19	2.1	7	1.56
DM-27	E3.4	E0.07	7.9	19.0	0.05	*1,970	E0.10	≤0.24	≤0.11	—	63	—
DM-28	12.3	E0.07	1.2	34.0	0.03	*1,970	—	23.2	0.51	≤1.4	17	1.04
DM-29	—	—	*15.6	223	E0.01	224	0.02	—	≤0.23	—	*11,200	≤0.03
Westside subbasin study area (10 grid wells sampled)												
WS-01	—	—	0.98	22.0	—	613	—	4.4	≤0.17	≤1.5	25	≤0.12
WS-02	7.8	—	0.42	37.0	0.03	*1,120	0.07	≤0.19	≤0.10	≤0.98	14	≤0.54
WS-03	12.9	0.06	1.6	17.0	E0.01	549	0.10	≤0.22	0.59	—	≤3	1.20
WS-04	11.0	0.06	2.3	19.0	0.02	772	0.11	≤0.11	0.35	≤1.6	67	≤0.29
WS-05	24.7	0.07	5.4	34.0	0.03	*1,350	0.20	≤0.23	≤0.23	—	8	—
WS-06	E6.7	E0.09	2.8	11.0	E0.02	*1,030	0.27	—	2.4	—	E7	≤0.49
WS-07	4.7	—	2.7	20.0	0.02	*1,100	0.11	—	≤0.12	—	40	—
WS-08	E2.8	0.11	7.8	10.0	E0.01	500	0.06	≤0.07	≤0.11	—	41	0.68
WS-09	E2.7	—	1.1	90.0	0.02	940	0.06	≤0.23	≤0.10	—	88	≤0.49
WS-10	E2.5	—	3.7	27.0	0.02	933	0.07	—	0.65	—	24	≤0.05

Table 8. Trace elements collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed. Information about the constituents given in table 3E. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) action level; HAL-US, USEPA lifetime health advisory level; MCL-CA, California Department of Public Health (CDPH) maximum contaminant level; MCL-US, USEPA maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; LRL, laboratory reporting level; SRL, study reporting level; µg/L, micrograms per liter; na, not available; —, not detected; ≤, less than or equal to; *, value is at a concentration greater than the benchmark level]

GAMA well identification number	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)
Benchmark type	**MCL-CA**	**MCL-US**	**MCL-US**	**MCL-CA**	**MCL-US**	**NL-CA**	**MCL-US**	**MCL-CA**	**na**	**AL-US**	**SMCL-CA**	**AL-US**
Benchmark level	**1,000**	**6**	**10**	**1,000**	**4**	**1,000**	**5**	**50**	**na**	**1,300**	**300**	**15**
[LRL or SRL]	**[1.6] [1]**	**[0.054]**	**[0.044]**	**[0.36] [1]**	**[0.012]**	**[2.8]**	**[0.02]**	**[0.42] [1]**	**[0.33] [2]**	**[1.7] [1]**	**[6] [1]**	**[0.65] [1]**
WSJV understanding wells (19 wells sampled)												
DM-U-01	—	E0.04	*13.4	66.0	—	850	E0.02	—	≤0.15	—	122	≤0.02
WS-U-01	E2.3	0.12	*17.1	47.0	E0.01	718	0.06	≤0.20	≤0.08	—	21	—
WS-U-02	E2.6	0.10	*11.9	35.0	E0.01	590	0.06	≤0.24	≤0.07	—	7	≤0.02
WS-U-03	9.2	E0.03	3.8	11.0	0.03	*1,240	E0.05	≤0.10	≤0.15	—	43	≤0.10
Monitoring wells (15 wells sampled)												
DM-U-02	—	—	0.92	14.0	—	*1,660	—	14.8	≤0.15	—	≤3	—
DM-U-03	—	E0.19	3.3	84.0	—	*1,640	0.19	5.2	≤0.15	—	≤3	—
DM-U-04	E2.6	0.76	5.1	69.0	—	543	0.02	0.95	≤0.05	—	—	≤0.02
DM-U-05	—	0.66	7.4	73.0	—	751	0.02	5.2	≤0.06	—	≤5	≤0.02
DM-U-06	E2.0	0.98	9.7	57.0	—	639	0.04	1.8	≤0.06	—	—	—
DM-U-07	—	—	*12.8	22.0	—	*1,740	0.25	—	≤0.12	—	10	—
DM-U-08	—	E0.28	7.9	42.0	—	*2,550	E0.13	E0.58	≤0.20	—	8	—
DM-U-09	—	—	0.42	17.0	—	*2,610	—	8.4	≤0.14	—	—	—
DM-U-10	—	E0.32	7.1	26.0	—	*1,460	0.27	—	≤0.10	—	—	—
DM-U-11	9.8	0.22	9.5	31.0	—	311	0.18	≤0.09	0.39	≤0.82	76	≤0.06
DM-U-12	—	E0.29	*18.1	31.0	—	743	—	—	≤0.06	—	10	—
DM-U-13	E3.1	0.13	7.2	53.0	—	257	0.05	0.89	≤0.09	—	—	≤0.02
DM-U-14	E1.9	0.17	1.8	39.0	0.01	464	0.05	10.4	0.38	—	—	—
DM-U-15	E2.1	0.09	1.3	33.0	E0.01	919	0.04	6.6	≤0.24	—	—	—
DM-U-16	—	E0.09	1.8	27.0	—	492	E0.05	17.3	≤0.27	—	—	—

Table 8. Trace elements collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed. Information about the constituents given in table 3E. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) action level; HAL-US, USEPA lifetime health advisory level; MCL-CA, California Department of Public Health (CDPH) maximum contaminant level; MCL-US, USEPA maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; LRL, laboratory reporting level; SRL, study reporting level; µg/L, micrograms per liter; na, not available; —, not detected; ≤, less than or equal to; *, value is at a concentration greater than the benchmark level]

GAMA well identification number	Lithium (µg/L) (01130)	Manganese (µg/L) (01056)	Molybdenum (µg/L) (01060)	Nickel (µg/L) (01065)	Selenium (µg/L) (01145)	Silver (µg/L) (01075)	Strontium (µg/L) (01080)	Thallium (µg/L) (01057)	Tungsten (µg/L) (01155)	Uranium (µg/L) (22703)	Vanadium (µg/L) (01085)	Zinc (µg/L) (01090)
Benchmark type	**na**	**SMCL-CA**	**HAL-US**	**MCL-CA**	**MCL-US**	**SMCL-CA**	**HAL-US**	**MCL-US**	**na**	**MCL-US**	**NL-CA**	**SMCL-CA**
Benchmark level	**na**	**50**	**40**	**100**	**50**	**100**	**4,000**	**2**	**na**	**30**	**50**	**5,000**
[LRL or SRL]	**[0.44]**	**[0.52] [2]**	**[0.028]**	**[0.36] [1]**	**[0.040]**	**[0.010] [2]**	**[0.40]**	**[0.020]**	**[0.11] [1]**	**[0.008]**	**[0.16]**	**[4.8] [1]**
WSJV grid wells (39 wells sampled)												
Delta-Mendota subbasin study area (29 grid wells sampled)												
DM-01	16.4	*93.1	28.1	≤0.07	—	≤0.005	140	—	43.8	2.07	0.42	—
DM-02	26.3	*842	7.7	0.75	0.13	—	920	—	3.5	0.13	0.48	23.0
DM-03	14.7	—	0.70	0.47	0.95	—	812	—	≤0.03	3.13	12.1	—
DM-04	9.7	*583	2.8	0.41	—	—	688	—	1.0	1.66	0.18	12.9
DM-05	31.1	*414	2.7	≤0.30	E0.03	—	477	—	0.34	0.01	0.37	—
DM-06	58.1	E1.0	1.0	E0.54	8.1	—	1,750	—	—	6.33	6.1	—
DM-07	25.6	E1.1	1.4	E0.47	0.69	E0.025	803	—	—	1.90	9.7	53.8
DM-08	20.8	—	2.3	E0.43	0.36	—	1,150	—	—	2.99	4.8	—
DM-09	41.3	≤0.50	2.2	0.83	1.8	E0.018	1,390	—	—	5.05	5.8	10.6
DM-10	36.6	25.6	7.6	—	1.6	—	916	—	≤0.07	1.81	5.7	—
DM-11	27.3	≤0.40	0.80	1.2	10.5	E0.017	898	—	—	2.63	6.1	—
DM-12	52.9	—	1.2	≤0.33	4.5	—	1,040	—	—	3.83	2.2	13.2
DM-13	24.8	*237	4.1	E0.53	—	—	1,850	—	0.36	0.08	E0.52	—
DM-14	42.3	—	1.3	1.1	1.6	0.032	2,740	—	≤0.06	12.7	4.4	≤4.4
DM-15	79.2	*493	39.1	2.3	E0.38	—	3,060	—	0.88	5.30	—	—
DM-16	20.0	*872	7.1	0.76	—	—	1,060	—	0.97	0.98	3.3	—
DM-17	71.0	E3.9	0.90	—	—	—	415	—	44.0	—	9.0	—
DM-18	151	*163	1.5	1.6	—	—	*5,610	—	—	—	2.1	—
DM-19	106	E1.4	*67.1	1.6	7.9	—	1,280	—	—	4.04	5.6	—

Table 8. Trace elements collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed. Information about the constituents given in table 3E. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) action level; HAL-US, USEPA lifetime health advisory level; MCL-CA, California Department of Public Health (CDPH) maximum contaminant level; MCL-US, USEPA maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; LRL, laboratory reporting level; SRL, study reporting level; µg/L, micrograms per liter; na, not available; —, not detected; ≤, less than or equal to; *, value is at a concentration greater than the benchmark level]

GAMA well identification number	Lithium (µg/L) (01130)	Manganese (µg/L) (01056)	Molybdenum (µg/L) (01060)	Nickel (µg/L) (01065)	Selenium (µg/L) (01145)	Silver (µg/L) (01075)	Strontium (µg/L) (01080)	Thallium (µg/L) (01057)	Tungsten (µg/L) (01155)	Uranium (µg/L) (22703)	Vanadium (µg/L) (01085)	Zinc (µg/L) (01090)
Benchmark type	**na**	**SMCL-CA**	**HAL-US**	**MCL-CA**	**MCL-US**	**SMCL-CA**	**HAL-US**	**MCL-US**	**na**	**MCL-US**	**NL-CA**	**SMCL-CA**
Benchmark level	**na**	**50**	**40**	**100**	**50**	**100**	**4,000**	**2**	**na**	**30**	**50**	**5,000**
[LRL or SRL]	**[0.44]**	**[0.52] [2]**	**[0.028]**	**[0.36] [1]**	**[0.040]**	**[0.010] [2]**	**[0.40]**	**[0.020]**	**[0.11] [1]**	**[0.008]**	**[0.16]**	**[4.8] [1]**
WSJV grid wells (39 wells sampled)—Continued												
Delta-Mendota subbasin study area (29 grid wells sampled)—Continued												
DM-20	69.1	—	0.80	2.4	28.9	—	2,130	—	—	2.81	4.5	—
DM-21	82.8	6.8	3.6	1.0	2.2	—	798	—	—	2.83	2.6	84.0
DM-22	194	*3,190	11.0	3.8	0.09	E0.014	*4,090	—	1.8	4.11	3.9	≤2.9
DM-23	24.2	4.6	2.6	0.46	5.8	—	802	—	0.19	4.85	19.7	≤1.6
DM-24	27.2	*2,680	3.0	1.9	E0.04	—	1,300	—	0.23	0.46	1.2	≤4.7
DM-25	9.1	*617	9.3	0.42	0.04	—	413	—	2.0	1.61	0.81	≤2.0
DM-26	28.5	1.0	1.2	1.5	0.83	≤0.005	1,120	—	—	4.98	6.6	7.3
DM-27	31.3	*363	*47.7	0.65	E0.05	—	643	—	1.6	0.38	2.8	—
DM-28	70.9	≤0.40	0.90	3.4	*65.8	0.029	3,170	—	—	6.54	5.6	≤3.3
DM-29	8.9	*4,750	3.0	1.7	0.09	—	1,000	—	0.40	0.90	0.4	≤1.7
Westside subbasin study area (10 grid wells sampled)												
WS-01	30.8	2.9	4.2	0.54	10.1	—	1,250	—	≤0.04	3.55	6.2	88.5
WS-02	2.6	18.0	10.1	1.1	0.06	—	132	—	86.4	0.64	3.5	—
WS-03	33.9	6.9	12.4	5.0	34.9	0.016	1,970	—	≤0.03	2.23	7.9	18.2
WS-04	12.5	40.3	15.3	2.7	0.39	—	745	—	0.41	1.04	5.9	≤2.9
WS-05	10.6	29.3	31.4	1.3	E0.04	0.016	357	—	19.8	0.14	2.6	≤2.8
WS-06	8.3	32.5	38.6	21.7	0.53	—	2,670	—	0.15	0.03	8.0	≤4.3
WS-07	24.1	*60.1	22.0	0.56	E0.02	—	525	—	12.8	0.08	0.34	—
WS-08	11.1	11.6	12.6	≤0.25	1.9	—	147	—	0.62	0.15	33.5	16.7

Table 8. Trace elements collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed. Information about the constituents given in table 3E. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) action level; HAL-US, USEPA lifetime health advisory level; MCL-CA, California Department of Public Health (CDPH) maximum contaminant level; MCL-US, USEPA maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; LRL, laboratory reporting level; SRL, study reporting level; µg/L, micrograms per liter; na, not available; —, not detected; ≤, less than or equal to; *, value is at a concentration greater than the benchmark level]

GAMA well identification number	Lithium (µg/L) (01130)	Manganese (µg/L) (01056)	Molybdenum (µg/L) (01060)	Nickel (µg/L) (01065)	Selenium (µg/L) (01145)	Silver (µg/L) (01075)	Strontium (µg/L) (01080)	Thallium (µg/L) (01057)	Tungsten (µg/L) (01155)	Uranium (µg/L) (22703)	Vanadium (µg/L) (01085)	Zinc (µg/L) (01090)
Benchmark type	**na**	**SMCL-CA**	**HAL-US**	**MCL-CA**	**MCL-US**	**SMCL-CA**	**HAL-US**	**MCL-US**	**na**	**MCL-US**	**NL-CA**	**SMCL-CA**
Benchmark level	**na**	**50**	**40**	**100**	**50**	**100**	**4,000**	**2**	**na**	**30**	**50**	**5,000**
[LRL or SRL]	**[0.44]**	**[0.52]** [2]	**[0.028]**	**[0.36]** [1]	**[0.040]**	**[0.010]** [2]	**[0.40]**	**[0.020]**	**[0.11]** [1]	**[0.008]**	**[0.16]**	**[4.8]** [1]
WSJV grid wells (39 wells sampled)—Continued												
Westside subbasin study area (10 grid wells sampled)—Continued												
WS-09	29.4	*144	9.4	0.54	0.04	—	138	—	13.9	0.10	2.3	26.5
WS-10	18.7	*144	30.9	1.4	0.09	—	1,170	—	3.6	0.42	0.65	≤2.4
WSJV understanding wells (19 wells sampled)												
DM-U-01	25.9	*335	3.7	0.52	—	—	1,460	—	0.77	13.0	0.40	9.4
WS-U-01	15.3	*85.5	11.7	0.38	0.07	—	321	—	2.1	0.18	9.0	—
WS-U-02	13.7	40.2	13.4	≤0.32	0.19	—	348	—	0.71	0.49	9.3	≤1.6
WS-U-03	14.9	*91.0	24.8	0.97	0.75	—	550	—	0.40	0.52	4.7	≤3.7
Monitoring wells (15 wells sampled)												
DM-U-02	40.0	1.5	1.2	1.1	1.7	E0.028	2,390	—	≤0.09	*34.7	3.6	—
DM-U-03	7.1	—	29.3	2.8	6.4	E0.031	1,910	—	≤0.07	*56.6	8.0	—
DM-U-04	12.0	4.0	1.4	0.55	0.61	—	605	—	0.17	1.11	6.2	—
DM-U-05	12.8	3.2	1.7	0.54	0.47	—	561	—	0.15	1.79	7.2	≤1.4
DM-U-06	11.4	5.4	2.5	0.65	0.61	—	455	—	0.36	1.97	6.7	—
DM-U-07	10.9	*66.2	*55.0	1.1	—	—	163	—	1.9	0.42	E0.63	—
DM-U-08	52.8	*130	22.6	E0.93	2.5	—	857	—	0.77	4.95	8.0	—
DM-U-09	86.0	25.1	9.0	1.0	6.0	—	*4,930	—	≤0.10	3.25	2.0	—
DM-U-10	16.6	*112	38.9	—	—	—	308	—	6.5	4.65	3.0	—
DM-U-11	10.5	*366	30.0	2.0	0.12	0.014	292	—	5.3	6.39	1.9	—
DM-U-12	13.9	*52.7	0.90	E0.67	—	—	101	—	26.6	0.77	7.3	—
DM-U-13	2.2	5.5	5.8	0.83	0.69	—	436	—	0.33	0.45	21.2	—

Table 8. Trace elements collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed. Information about the constituents given in table 3E. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) action level; HAL-US, USEPA lifetime health advisory level; MCL-CA, California Department of Public Health (CDPH) maximum contaminant level; MCL-US, USEPA maximum contaminant level; NL-CA, CDPH notification level; SMCL-CA, CDPH secondary maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; LRL, laboratory reporting level; SRL, study reporting level; µg/L, micrograms per liter; na, not available; —, not detected; ≤, less than or equal to; *, value is at a concentration greater than the benchmark level]

GAMA well identification number	Lithium (µg/L) (01130)	Manganese (µg/L) (01056)	Molybdenum (µg/L) (01060)	Nickel (µg/L) (01065)	Selenium (µg/L) (01145)	Silver (µg/L) (01075)	Strontium (µg/L) (01080)	Thallium (µg/L) (01057)	Tungsten (µg/L) (01155)	Uranium (µg/L) (22703)	Vanadium (µg/L) (01085)	Zinc (µg/L) (01090)
Benchmark type	**na**	**SMCL-CA**	**HAL-US**	**MCL-CA**	**MCL-US**	**SMCL-CA**	**HAL-US**	**MCL-US**	**na**	**MCL-US**	**NL-CA**	**SMCL-CA**
Benchmark level	**na**	**50**	**40**	**100**	**50**	**100**	**4,000**	**2**	**na**	**30**	**50**	**5,000**
[LRL or SRL]	**[0.44]**	**[0.52]** [2]	**[0.028]**	**[0.36]** [1]	**[0.040]**	**[0.010]** [2]	**[0.40]**	**[0.020]**	**[0.11]** [1]	**[0.008]**	**[0.16]**	**[4.8]** [1]
WSJV understanding wells (19 wells sampled)—Continued												
Monitoring wells (15 wells sampled)—Continued												
DM-U-14	23.1	12.9	2.4	2.8	8.1	0.013	1,720	—	0.15	3.46	6.6	—
DM-U-15	62.1	1.1	3.2	2.1	1.4	≤0.005	841	—	≤0.08	13.2	3.5	—
DM-U-16	88.1	4.0	3.5	2.7	11.6	E0.021	1,310	—	≤0.06	4.88	5.3	—

[1] The SRL was defined by Olsen and others (2010). Values measured at concentrations less than or equal to the SRL have been flagged with a ≤ symbol and reclassified as less than or equal to the value reported by the laboratory.

[2] The SRL was defined based on the highest concentration detected in WSJV blanks. Values measured at concentrations less than or equal to the SRL have been flagged with a ≤ symbol and reclassified as less than or equal to the value reported by the laboratory.

Table 9. Nutrients and dissolved organic carbon (DOC) detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed for nutrients. Samples from 30 wells were analyzed for DOC. Information about the constituents given in table 3F. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) lifetime health advisory level; MCL-US, USEPA maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; LRL, laboratory reporting level; SRL, study reporting level; mg/L, milligrams per liter; na, not available; —, not detected; nc, not collected; *, value is at a concentration greater than the benchmark level; ≤, less than or equal to; NWQL, USGS National Water Quality Laboratory]

GAMA well identification number	Ammonia (as nitrogen) (mg/L) (00608)	Nitrite (as nitrogen) (mg/L) (00613)	Nitrite plus nitrate (as nitrogen) [1] (mg/L) (00631)	Total nitrogen (ammonia + nitrate + nitrite + organic nitrogen) (mg/L) (62854)	Phosphate, orthophosphate (as phosphorus) (mg/L) (00671)	DOC (mg/L) (00681)
Benchmark type	**HAL-US**	**MCL-US**	**MCL-US**	**na**	**na**	**na**
Benchmark level	**[2] 24.7**	**1**	**10**	**na**	**na**	**na**
[LRL or SRL]	**[0.016] [3]**	**[0.001] [3]**	**[0.04]**	**[0.10]**	**[0.006]**	**[0.66]**
WSJV grid wells (39 wells sampled)						
Delta-Mendota subbasin study area (29 grid wells sampled)						
DM-01	0.12	—	—	0.13	0.083	nc
DM-02	0.25	—	—	0.30	0.061	1.5
DM-03	—	—	4.66	4.89	0.050	E0.5
DM-04	0.13	—	—	0.16	0.120	nc
DM-05	0.18	—	—	0.24	0.026	1.2
DM-06	—	—	4.56	4.62	0.026	—
DM-07	—	—	4.08	4.13	0.044	nc
DM-08	—	—	2.58	2.50	0.055	nc
DM-09	—	—	4.84	4.79	0.030	E0.3
DM-10	0.06	0.002	2.14	2.21	0.037	—
DM-11	—	—	*14.5	15.9	0.041	nc
DM-12	—	—	6.02	6.57	0.027	nc
DM-13	0.24	—	—	0.24	0.055	nc
DM-14	—	—	2.60	2.58	0.042	nc
DM-15	0.30	—	E0.03	0.32	0.050	nc
DM-16	0.29	—	—	0.27	0.107	nc
DM-17	3.8	—	—	3.85	E0.05	nc
DM-18	1.1	—	—	1.05	0.009	nc
DM-19	—	—	1.22	1.24	0.022	—
DM-20	—	—	*20.0	19.9	0.027	nc
DM-21	—	≤0.001	4.56	4.27	0.036	nc
DM-22	0.66	—	—	0.62	0.088	nc
DM-23	—	—	2.66	2.64	0.050	nc
DM-24	0.32	—	—	0.39	0.076	nc
DM-25	0.13	—	—	0.11	0.151	E0.6

Table 9. Nutrients and dissolved organic carbon (DOC) detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed for nutrients. Samples from 30 wells were analyzed for DOC. Information about the constituents given in table 3F. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) lifetime health advisory level; MCL-US, USEPA maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; LRL, laboratory reporting level; SRL, study reporting level; mg/L, milligrams per liter; na, not available; —, not detected; nc, not collected; *, value is at a concentration greater than the benchmark level; ≤, less than or equal to; NWQL, USGS National Water Quality Laboratory]

GAMA well identification number	Ammonia (as nitrogen) (mg/L) (00608)	Nitrite (as nitrogen) (mg/L) (00613)	Nitrite plus nitrate (as nitrogen) [1] (mg/L) (00631)	Total nitrogen (ammonia + nitrate + nitrite + organic nitrogen) (mg/L) (62854)	Phosphate, orthophosphate (as phosphorus) (mg/L) (00671)	DOC (mg/L) (00681)
Benchmark type	**HAL-US**	**MCL-US**	**MCL-US**	**na**	**na**	**na**
Benchmark level	**[2] 24.7**	**1**	**10**	**na**	**na**	**na**
[LRL or SRL]	**[0.016] [3]**	**[0.001] [3]**	**[0.04]**	**[0.10]**	**[0.006]**	**[0.66]**
WSJV grid wells (39 wells sampled)—Continued						
Delta-Mendota subbasin study area (29 grid wells sampled)—Continued						
DM-26	—	—	7.06	7.56	0.029	E0.5
DM-27	0.36	≤0.001	—	[4] 0.31	0.051	E0.4
DM-28	≤0.01	—	*23.8	23.9	0.031	1.1
DM-29	0.48	0.002	—	0.55	—	nc
Westside subbasin study area (10 grid wells sampled)						
WS-01	—	—	7.16	7.42	0.023	nc
WS-02	0.52	0.002	—	0.73	0.149	nc
WS-03	E0.02	0.007	8.70	8.52	0.022	—
WS-04	—	0.006	0.05	E0.08	0.017	nc
WS-05	0.76	—	—	0.77	0.017	1.5
WS-06	0.09	—	0.27	0.37	0.011	nc
WS-07	0.26	≤0.001	—	0.29	0.028	nc
WS-08	≤0.01	0.086	0.57	[4] 0.56	0.022	nc
WS-09	0.48	≤0.001	—	0.53	0.170	1.9
WS-10	0.24	—	—	0.22	0.035	E0.6
WSJV understanding wells (19 wells sampled)						
DM-U-01	E0.02	—	—	E0.05	0.100	nc
WS-U-01	0.70	—	—	0.72	0.046	E0.5
WS-U-02	0.81	0.008	0.13	1.02	0.030	E0.6
WS-U-03	E0.02	≤0.001	—	—	0.011	—
Monitoring wells (15 wells sampled)						
DM-U-02	—	—	1.57	1.57	0.039	1.3
DM-U-03	—	—	*13.0	12.7	0.848	2.1
DM-U-04	—	—	1.98	1.97	0.104	0.7
DM-U-05	—	—	2.61	2.48	0.047	E0.4
DM-U-06	—	0.004	1.47	1.51	0.172	E0.4
DM-U-07	0.25	—	—	0.36	0.139	2.8
DM-U-08	0.07	—	—	E0.08	0.099	E0.4

Table 9. Nutrients and dissolved organic carbon (DOC) detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed for nutrients. Samples from 30 wells were analyzed for DOC. Information about the constituents given in table 3F. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (USEPA) lifetime health advisory level; MCL-US, USEPA maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; E, estimated or having a higher degree of uncertainty; LRL, laboratory reporting level; SRL, study reporting level; mg/L, milligrams per liter; na, not available; —, not detected; nc, not collected; *, value is at a concentration greater than the benchmark level; ≤, less than or equal to; NWQL, USGS National Water Quality Laboratory]

GAMA well identification number	Ammonia (as nitrogen) (mg/L) (00608)	Nitrite (as nitrogen) (mg/L) (00613)	Nitrite plus nitrate (as nitrogen) [1] (mg/L) (00631)	Total nitrogen (ammonia + nitrate + nitrite + organic nitrogen) (mg/L) (62854)	Phosphate, orthophosphate (as phosphorus) (mg/L) (00671)	DOC (mg/L) (00681)
Benchmark type	**HAL-US**	**MCL-US**	**MCL-US**	**na**	**na**	**na**
Benchmark level	[2] **24.7**	**1**	**10**	**na**	**na**	**na**
[LRL or SRL]	**[0.016]** [3]	**[0.001]** [3]	**[0.04]**	**[0.10]**	**[0.006]**	**[0.66]**
WSJV understanding wells (19 wells sampled)—Continued						
Monitoring wells (15 wells sampled)—Continued						
DM-U-09	—	0.002	*12.7	13.9	0.032	—
DM-U-10	0.05	—	—	E0.07	0.068	E0.5
DM-U-11	0.45	—	—	0.60	1.99	6.8
DM-U-12	0.08	—	—	E0.10	0.289	nc
DM-U-13	E0.02	0.048	*14.1	14.8	0.237	E0.4
DM-U-14	≤0.01	0.184	*11.6	11.8	0.023	7.5
DM-U-15	—	0.037	*13.4	13.8	0.088	0.9
DM-U-16	E0.02	0.018	*12.9	12.8	0.022	E0.6

[1] Nitrite plus nitrate, (as nitrogen) is reffered to as nitrate in the text for clarity.

[2] 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."

[3] The SRL was defined based on a detection in a WSJV blank. Values measured at concentrations less than or equal to the SRL have been flagged with a ≤ symbol and reclassified as less than or equal to the value reported by the laboratory.

[4] Total nitrogen concentrations in these samples are less than the sum of the filtered nitrogen constituents and fall outside the USGS NWQL acceptance criterion of a 10 percent relative percent difference. However, the absolute difference is ≤0.011 mg/L, thus, the unacceptable replication is unlikely to affect interpretation of the data.

Table 10. Major and minor ions, silica, and total dissolved solids (TDS) detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed. Information about the constituents given in table 3G. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (CDPH) maximum contaminant level; SMCL-CA, CDPH secondary maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; LRL, laboratory reporting level; mg/L, milligrams per liter; SiO_2, silicon dioxide; E, estimated or having a higher degree of uncertainty; na, not available; —, not detected; *, value is at a concentration greater than the recommended benchmark level; **, value is at a concentration greater than the upper benchmark level]

GAMA well identification number	Bromide (mg/L) (71870)	Calcium (mg/L) (00915)	Chloride (mg/L) (00940)	Fluoride (mg/L) (00950)	Iodide (mg/L) (71865)	Magnesium (mg/L) (00925)	Potassium (mg/L) (00935)	Sodium (mg/L) (00930)	Sulfate (mg/L) (00945)	Silica (as SiO_2) (mg/L) (00955)	Total dissolved solids (TDS) (mg/L) (70300)
Benchmark type	**na**	**na**	**SMCL-CA**	**MCL-CA**	**na**	**na**	**na**	**na**	**SMCL-CA**	**na**	**SMCL-CA**
Benchmark level	**na**	**na**	**[1] 250 (500)**	**2**	**na**	**na**	**na**	**na**	**[1] 250 (500)**	**na**	**[1] 500 (1,000)**
[LRL]	**[0.02]**	**[0.044]**	**[0.12]**	**[0.08]**	**[0.002]**	**[0.016]**	**[0.064]**	**[0.10]**	**[0.18]**	**[0.058]**	**[10]**
WSJV grid wells (39 wells sampled)											
Delta-Mendota subbasin study area (29 grid wells sampled)											
DM-01	0.25	15.0	56.7	0.85	0.112	1.55	2.29	205	*319	65.2	*772
DM-02	0.97	105	*320	0.18	0.180	25.6	5.12	386	**606	38.0	**1,680
DM-03	0.28	52.0	92.5	0.12	0.004	28.6	2.37	76.1	77.4	48.7	*537
DM-04	0.18	46.9	79.9	0.10	0.025	18.3	1.98	52.8	42.5	29.5	397
DM-05	0.27	25.0	89.0	—	0.034	16.4	3.10	64.8	71.3	30.2	381
DM-06	0.63	88.1	204	0.24	0.004	69.6	1.95	126	*338	28.4	**1,090
DM-07	0.67	44.7	197	0.28	0.038	29.9	1.49	141	74.0	29.3	*729
DM-08	0.79	63.6	*258	0.36	0.035	41.0	1.98	185	143	22.6	*959
DM-09	0.97	87.9	*256	0.20	0.081	45.8	2.83	144	170	27.8	*946
DM-10	1.41	59.9	*326	0.18	0.340	34.8	2.32	255	225	27.1	**1,140
DM-11	1.08	67.5	*306	0.14	0.009	129	2.52	110	235	27.0	**1,130
DM-12	0.38	70.5	105	0.17	0.005	26.8	2.04	118	210	26.8	*722
DM-13	0.94	87.8	*264	0.17	0.293	43.2	2.92	179	*334	32.2	**1,130
DM-14	1.19	158	*429	0.24	0.030	112	3.86	314	**737	24.4	**2,130
DM-15	0.54	214	124	0.18	0.439	72.6	3.36	207	**1,080	32.0	**1,940
DM-16	1.98	76.2	**535	0.13	0.369	39.9	2.98	248	84.2	23.3	**1,100
DM-17	3.93	40.9	**1,350	0.45	2.64	E0.04	5.66	741	5.33	65.6	**2,290
DM-18	2.78	162	**846	0.24	0.672	114	5.78	344	**509	20.9	**2,100
DM-19	0.59	83.5	147	0.34	0.657	39.6	1.97	218	**545	32.6	**1,200
DM-20	0.80	168	164	0.15	0.005	86.7	2.45	99.6	**555	26.4	**1,300
DM-21	0.33	52.9	107	0.48	0.012	46.2	2.51	142	*258	19.1	*765
DM-22	3.62	310	**1,050	0.12	0.674	135	8.17	594	**1,000	49.9	**3,380
DM-23	0.24	41.6	82.0	0.20	0.021	26.8	1.85	90.3	102	43.3	*521
DM-24	1.04	101	*390	0.09	0.093	57.1	4.08	220	213	33.4	**1,260
DM-25	0.39	35.8	149	0.15	0.074	18.2	1.58	128	77.4	26.0	*537

Table 10. Major and minor ions, silica, and total dissolved solids (TDS) detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed. Information about the constituents given in table 3G. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (CDPH) maximum contaminant level; SMCL-CA, CDPH secondary maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; LRL, laboratory reporting level; mg/L, milligrams per liter; SiO_2, silicon dioxide; E, estimated or having a higher degree of uncertainty; na, not available; —, not detected; *, value is at a concentration greater than the recommended benchmark level; **, value is at a concentration greater than the upper benchmark level]

GAMA well identification number	Bromide (mg/L) (71870)	Calcium (mg/L) (00915)	Chloride (mg/L) (00940)	Fluoride (mg/L) (00950)	Iodide (mg/L) (71865)	Magnesium (mg/L) (00925)	Potassium (mg/L) (00935)	Sodium (mg/L) (00930)	Sulfate (mg/L) (00945)	Silica (as SiO_2) (mg/L) (00955)	Total dissolved solids (TDS) (mg/L) (70300)
Benchmark type	**na**	**na**	**SMCL-CA**	**MCL-CA**	**na**	**na**	**na**	**na**	**SMCL-CA**	**na**	**SMCL-CA**
Benchmark level	**na**	**na**	**[1] 250 (500)**	**2**	**na**	**na**	**na**	**na**	**[1] 250 (500)**	**na**	**[1] 500 (1,000)**
[LRL]	**[0.02]**	**[0.044]**	**[0.12]**	**[0.08]**	**[0.002]**	**[0.016]**	**[0.064]**	**[0.10]**	**[0.18]**	**[0.058]**	**[10]**
WSJV grid wells (39 wells sampled)—Continued											
Delta-Mendota subbasin study area (29 grid wells sampled)—Continued											
DM-26	0.43	88.5	136	0.28	0.018	47.8	1.59	99.0	139	25.4	*764
DM-27	1.82	51.7	*473	0.22	0.400	18.4	3.27	535	**610	29.3	**1,770
DM-28	2.20	220	**600	0.17		141	3.02	444	**918	24.2	**2,750
DM-29	0.63	114	235	0.13	0.063	42.3	3.31	151	216	27.0	*966
Westside subbasin study area (10 grid wells sampled)											
WS-01	0.45	94.8	96.2	0.23	—	52.1	2.55	137	*492	34.2	**1,110
WS-02	0.23	11.1	47.7	0.99	0.165	1.28	1.13	160	8.33	23.3	470
WS-03	0.50	134	111	0.18	0.081	52.9	2.02	188	**706	24.4	**1,360
WS-04	0.21	85.5	56.9	0.27	0.194	8.82	1.30	195	**533	18.5	*954
WS-05	1.15	38.4	250	0.49	0.375	0.97	1.09	287	*312	17.6	*991
WS-06	0.29	570	89.3	0.26	0.290	3.55	1.62	201	**1,730	12.3	**2,780
WS-07	0.15	65.1	39.0	0.29	0.095	9.78	1.83	200	*487	26.6	*909
WS-08	0.14	22.6	27.3	0.22	0.029	1.83	1.07	153	*291	30.9	*569
WS-09	0.46	16.8	95.8	0.53	0.236	2.63	2.17	203	162	59.5	*672
WS-10	0.26	173	75.5	0.20	0.219	19.6	1.95	268	**817	26.2	**1,480
WSJV understanding wells (19 wells sampled)											
DM-U-01	0.41	85.7	194	0.18	0.162	54.1	2.15	110	*264	37.3	*911
WS-U-01	1.53	37.9	*319	0.10	0.491	4.87	1.05	259	111	28.6	*855
WS-U-02	0.97	31.7	188	0.16	0.224	5.50	1.06	198	207	27.3	*805
WS-U-03	0.34	72.2	93.0	0.14	0.102	19.7	2.80	276	**634	11.5	**1,140
Monitoring wells (15 wells sampled)											
DM-U-02	1.35	127	*429	0.20	0.128	129	3.22	321	**696	25.1	**2,110
DM-U-03	1.57	164	*467	0.27	0.025	131	2.95	331	**802	21.9	**2,300
DM-U-04	0.23	46.6	63.1	0.24	0.007	28.0	2.60	47.9	75.1	37.3	432
DM-U-05	0.29	51.3	79.9	0.20	0.006	24.3	2.27	57.2	62.9	31.8	430
DM-U-06	0.18	42.6	47.1	0.21	0.010	20.2	2.99	55.7	67.7	29.2	392
DM-U-07	0.53	15.5	112	0.26	0.499	2.72	1.14	302	*316	29.8	**1,020
DM-U-08	0.90	47.9	*256	0.36	1.95	18.1	2.81	217	152	41.1	*827

Table 10. Major and minor ions, silica, and total dissolved solids (TDS) detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Samples from all 58 wells were analyzed. Information about the constituents given in table 3G. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and LRL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (CDPH) maximum contaminant level; SMCL-CA, CDPH secondary maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; LRL, laboratory reporting level; mg/L, milligrams per liter; SiO_2, silicon dioxide; E, estimated or having a higher degree of uncertainty; na, not available; —, not detected; *, value is at a concentration greater than the recommended benchmark level; **, value is at a concentration greater than the upper benchmark level]

GAMA well identification number	Bromide (mg/L) (71870)	Calcium (mg/L) (00915)	Chloride (mg/L) (00940)	Fluoride (mg/L) (00950)	Iodide (mg/L) (71865)	Magnesium (mg/L) (00925)	Potassium (mg/L) (00935)	Sodium (mg/L) (00930)	Sulfate (mg/L) (00945)	Silica (as SiO_2) (mg/L) (00955)	Total dissolved solids (TDS) (mg/L) (70300)
Benchmark type	**na**	**na**	**SMCL-CA**	**MCL-CA**	**na**	**na**	**na**	**na**	**SMCL-CA**	**na**	**SMCL-CA**
Benchmark level	**na**	**na**	**[1] 250 (500)**	**2**	**na**	**na**	**na**	**na**	**[1] 250 (500)**	**na**	**[1] 500 (1,000)**
[LRL]	**[0.02]**	**[0.044]**	**[0.12]**	**[0.08]**	**[0.002]**	**[0.016]**	**[0.064]**	**[0.10]**	**[0.18]**	**[0.058]**	**[10]**
WSJV understanding wells (19 wells sampled)—Continued											
Monitoring wells (15 wells sampled)—Continued											
DM-U-09	1.13	240	*322	0.24	1.13	89.3	2.59	223	**916	31.8	**2,050
DM-U-10	1.77	34.4	*453	0.48	0.411	4.13	2.75	462	*474	24.0	**1,650
DM-U-11	0.32	33.9	96.4	0.40	0.074	13.1	4.51	136	81.7	20.9	*568
DM-U-12	0.87	10.1	206	0.62	0.259	1.09	3.67	280	185	57.5	*861
DM-U-13	0.11	21.6	23.7	0.35	0.011	10.7	4.33	47.5	21.7	75.5	337
DM-U-14	0.53	87.7	118	0.17	0.020	55.1	3.28	109	*296	24.8	*907
DM-U-15	0.27	64.1	62.0	0.53	0.006	29.2	1.05	87.0	121	25.2	*593
DM-U-16	0.74	100	135	0.52	0.006	62.2	2.19	142	*422	25.6	**1,070

[1] The SMCL-CA benchmarks for chloride, sulfate, and TDS have recommended and upper benchmark levels. The upper benchmark level is shown in parentheses.

Table 11. Total arsenic and iron (unfiltered) and arsenic, chromium, and iron species (filtered) detected in samples collected for the Western San Joaquin Valley Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to June 2010.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Information about the constituents given in table 3H. Samples for total arsenic and iron (unfiltered) and arsenic and iron species (filtered) were collected at all 58 wells. Samples for chromium species were collected at 33 slow wells. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and MDL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (CDPH) maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; SMCL-CA, CDPH secondary maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; MDL, method detection limit; na, not available; µg/L, micrograms per liter; *, value is at a concentration greater than the benchmark level; nc, not collected; —, not detected; NWQL, National Water Quality Laboratory]

GAMA well identification number	Arsenic (total, unfiltered) (µg/L) (na)	Arsenic-III (filtered) (µg/L) (99034)	Arsenic (total, filtered) (µg/L) [1] (99033)	Iron (total, unfiltered) (µg/L) (na)	Iron-II (filtered) (µg/L) (01047)	Iron (total, filtered) (µg/L) (01046)	Chromium (total, filtered) (µg/L) (01030)	Chromium-VI (filtered) (µg/L) (01032)
Benchmark type	**MCL-US**	**na**	**MCL-US**	**SMCL-CA**	**na**	**SMCL-CA**	**MCL-CA**	**na**
Benchmark level	**10**	**na**	**10**	**300**	**na**	**300**	**50**	**na**
[MDL]	**[0.5]**	**[1]**	**[0.5]**	**[2]**	**[2]**	**[2]**	**[0.1]**	**[0.1]**
WSJV grid wells (39 wells sampled)								
Delta-Mendota subbasin study area (29 grid wells sampled)								
DM-01	*13.3	*10.8	*13.2	42.9	25.0	41.4	nc	nc
DM-02	—	—	—	*535	*490	*507	—	—
DM-03	5.4	—	5.2	—	—	—	31.6	31.9
DM-04	8.2	8.4	8.4	45.5	27.6	45.6	nc	nc
DM-05	2.9	2.9	2.9	*809	*408	*410	—	0.1
DM-06	0.94	—	1.1	35.9	4.2	8.6	30.5	27.4
DM-07	1.4	—	1.4	7.0	—	9.5	nc	nc
DM-08	1.7	—	1.6	23.0	—	2.9	nc	nc
DM-09	0.67	—	0.65	14.7	—	—	nc	nc
DM-10	1.7	—	1.5	6.3	—	4.0	1.7	1.3
DM-11	1.1	—	1.1	6.3	—	4.0	nc	nc
DM-12	—	—	—	5.7	—	5.6	7.5	3.8
DM-13	2.2	1.8	1.8	*752	55.1	65.4	nc	nc
DM-14	0.94	—	0.90	2.2	—	2.8	nc	nc
DM-15	1.9	—	1.9	47.9	—	2.0	nc	nc
DM-16	3.9	3.7	3.8	87.7	83.4	91.0	nc	nc
DM-17	—	—	—	36.1	2.8	3.0	nc	nc
DM-18	1.0	1.0	1.0	*3,310	*3,065	*3,453	nc	nc
DM-19	0.56	—	—	10.5	—	—	5.2	5.1
DM-20	0.64	—	0.64	4.5	—	—	nc	nc
DM-21	0.78	—	0.54	*790	26.7	70.9	nc	nc
DM-22	7.6	7.5	7.5	206	154	182	nc	nc
DM-23	8.3	—	8.5	—	—	—	nc	nc
DM-24	3.2	3.2	3.2	*1,135	*1,067	*1,133	nc	nc
DM-25	6.9	6.7	6.7	272	266	275	—	—

Table 11. Total arsenic and iron (unfiltered) and arsenic, chromium, and iron species (filtered) detected in samples collected for the Western San Joaquin Valley Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to June 2010.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Information about the constituents given in table 3H. Samples for total arsenic and iron (unfiltered) and arsenic and iron species (filtered) were collected at all 58 wells. Samples for chromium species were collected at 33 slow wells. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and MDL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (CDPH) maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; SMCL-CA, CDPH secondary maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; MDL, method detection limit; na, not available; µg/L, micrograms per liter; *, value is at a concentration greater than the benchmark level; nc, not collected; —, not detected; NWQL, National Water Quality Laboratory]

GAMA well identification number	Arsenic (total, unfiltered) (µg/L) (na)	Arsenic-III (filtered) (µg/L) (99034)	Arsenic (total, filtered) (µg/L)[1] (99033)	Iron (total, unfiltered) (µg/L) (na)	Iron-II (filtered) (µg/L) (01047)	Iron (total, filtered) (µg/L) (01046)	Chromium (total, filtered) (µg/L) (01030)	Chromium-VI (filtered) (µg/L) (01032)
Benchmark type	**MCL-US**	**na**	**MCL-US**	**SMCL-CA**	**na**	**SMCL-CA**	**MCL-CA**	**na**
Benchmark level	**10**	**na**	**10**	**300**	**na**	**300**	**50**	**na**
[MDL]	**[0.5]**	**[1]**	**[0.5]**	**[2]**	**[2]**	**[2]**	**[0.1]**	**[0.1]**
WSJV grid wells (39 wells sampled)—Continued								
Delta-Mendota subbasin study area (29 grid wells sampled)—Continued								
DM-26	0.86	—	0.87	8.0	—	7.4	13.4	12.1
DM-27	6.7	4.8	6.5	81.5	16.8	68.0	—	—
DM-28	—	—	—	12.0	—	11.0	23.2	17.0
DM-29	*14.5	*14.2	*14.2	*11,700	*10,900	*11,200	nc	nc
Westside subbasin study area (10 grid wells sampled)								
WS-01	0.89	—	0.80	141	4.9	26.4	nc	nc
WS-02	—	—	—	10.3	—	—	nc	nc
WS-03	1.0	—	1.0	159	—	3.0	—	—
WS-04	1.9	—	1.9	79.6	14.6	62.1	nc	nc
WS-05	4.0	—	3.9	14.6	6.9	6.5	—	—
WS-06	1.7	—	1.8	24.8	—	4.0	nc	nc
WS-07	2.6	2.6	2.6	41.8	35.5	43.2	nc	nc
WS-08	7.7	—	7.5	*326	19.1	41.3	nc	nc
WS-09	0.66	—	0.64	2.4	85.9	87.9	0.10	—
WS-10	3.2	2.0	3.2	36.0	23.8	24.3	0.40	—
WSJV understanding wells (19 wells sampled)								
DM-U-01	*12.8	7.6	*12.6	143	111	126	nc	nc
WS-U-01	*12.4	*11.6	*12.5[2]	23.8	20.9	20.8	—	—
WS-U-02	*10.2	—	*10.4	7.5	4.2	6.1	1.0	0.29
WS-U-03	3.5	2.3	3.2	277	16.2	45.1	—	—
Monitoring wells (15 wells sampled)								
DM-U-02	0.79	—	0.73	56.9	—	2.1	15.0	15.0
DM-U-03	2.7	—	2.7	3.9	—	—	6.1	5.2
DM-U-04	6.5	—	4.3	10.8	3.1	—	0.92	0.77
DM-U-05	6.4	—	6.2	4.4	—	—	5.4	5.2
DM-U-06	8.0	—	8.4	13.2	—	—	1.8	1.3
DM-U-07	*12.5	*11.7	*11.7	6.0	—	—	0.48	0.55
DM-U-08	6.6	5.8	6.4	58.1	—	5.9	0.42	0.17

Table 11. Total arsenic and iron (unfiltered) and arsenic, chromium, and iron species (filtered) detected in samples collected for the Western San Joaquin Valley Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to June 2010.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. Information about the constituents given in table 3H. Samples for total arsenic and iron (unfiltered) and arsenic and iron species (filtered) were collected at all 58 wells. Samples for chromium species were collected at 33 slow wells. **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type, benchmark level, and MDL as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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 (CDPH) maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; SMCL-CA, CDPH secondary maximum contaminant level. **Other abbreviations:** USGS, U.S. Geological Survey; MDL, method detection limit; na, not available; µg/L, micrograms per liter; *, value is at a concentration greater than the benchmark level; nc, not collected; —, not detected; NWQL, National Water Quality Laboratory]

GAMA well identification number	Arsenic (total, unfiltered) (µg/L) (na)	Arsenic-III (filtered) (µg/L) (99034)	Arsenic (total, filtered) (µg/L) [1] (99033)	Iron (total, unfiltered) (µg/L) (na)	Iron-II (filtered) (µg/L) (01047)	Iron (total, filtered) (µg/L) (01046)	Chromium (total, filtered) (µg/L) (01030)	Chromium-VI (filtered) (µg/L) (01032)
Benchmark type	**MCL-US**	**na**	**MCL-US**	**SMCL-CA**	**na**	**SMCL-CA**	**MCL-CA**	**na**
Benchmark level	**10**	**na**	**10**	**300**	**na**	**300**	**50**	**na**
[MDL]	**[0.5]**	**[1]**	**[0.5]**	**[2]**	**[2]**	**[2]**	**[0.1]**	**[0.1]**
WSJV understanding wells (19 wells sampled)—Continued								
Monitoring wells (15 wells sampled)—Continued								
DM-U-09	—	—	—	6.0	—	—	9.7	8.5
DM-U-10	6.5	4.2	6.4	6.7	—	—	—	—
DM-U-11	8.3	7.4	8.0	95.7	63.2	75.0	0.25	—
DM-U-12	*15.9	3.0	*16.0	4.1	2.5	3.1	—	—
DM-U-13	6.5	—	6.5	14.0	—	—	1.6	1.1
DM-U-14	1.3	—	1.3	2.1	—	—	10.8	10.2
DM-U-15	1.1	—	1.1	2.0	—	—	7.2	6.7
DM-U-16	1.4	—	1.4	18.5	—	—	19.5	19.7

[1] Reported values are for filtered samples acidified with hydrochloric acid (HCl). Filtered unacidified samples also were collected and analyzed for comparison with the acidified samples because of potential concerns about arsenic loss under sulfate-reducing conditions in some cases using the HCl-preservation method (Planer-Friedrich and others, 2007). However, unless otherwise noted, all HCl-preserved samples had higher arsenic concentrations than unacidified samples and values closer to those measured by the USGS NWQL in filtered samples preserved with nitric acid.

[2] Arsenic concentration measured in a filtered unacidified sample was 15.0 µg/L.

Table 12. Isotopic tracers detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to June 2010.

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Information about the constituents given in table 3I. Samples from all 58 wells were analyzed for stable isotopes of hydrogen and oxygen in water and tritium activities. Samples from 19 wells were analyzed for stable isotopes of nitrogen in dissolved nitrate. Samples from 33 wells were analyzed for stable isotopes of sulfur in dissolved sulfate. Samples from 34 wells were analyzed for stable isotopes of boron and strontium in water. Samples from 57 wells were analyzed for stable isotopes of carbon in dissolved inorganic carbon and carbon-14 abundance. Stable isotope ratios of hydrogen, oxygen, nitrogen, sulfur, boron, and carbon 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. Stable isotope ratios of strontium are reported as the abundance of atoms of the heavier isotope to the lighter isotope of the element. Carbon-14 is reported as percent modern carbon. Tritium values less than the sample-specific critical level (ssL_C) are reported as non-detections (—). **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type and benchmark level as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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. **Other abbreviations:** USGS, U.S. Geological Survey; H, hydrogen; O, oxygen; N, nitrogen; S, sulfur; B, boron; Sr, strontium; C, carbon; CSU, 1-sigma combined standard uncertainty; pCi/L, picocurie per liter; na, not available; pmc, percent modern carbon; —, not detected; ±, plus or minus; nc, not collected]

GAMA well identification number	$\delta^{2}H$ of water (per mil) (82082)	$\delta^{18}O$ of water (per mil) (82085)	Tritium (pCi/L) (07000)		$\delta^{15}N$ of nitrate (per mil) (82690)	$\delta^{18}O$ of nitrate (per mil) (63041)	$\delta^{34}S$ of sulfate (per mil) (49932)	$\delta^{11}B$ (per mil) (62648)	Strontium isotope ratio ($^{87}Sr/^{86}Sr$) (atom ratio) (75978)	$\delta^{13}C$ (per mil) (82081)	Carbon-14 (pmc) (49933)
Benchmark type	**na**	**na**	**MCL-CA**		**na**	**na**	**na**	**na**	**na**	**na**	**na**
Benchmark level	**na**	**na**	**20,000**		**na**	**na**	**na**	**na**	**na**	**na**	**na**
			Result ± CSU	**ssL_C**							
WSJV grid wells (39 wells sampled)											
Delta-Mendota subbasin study area (29 grid wells sampled)											
DM-01	–65.8	–9.00	—	0.35	nc	nc	nc	nc	nc	–19.28	2.160
DM-02	–77.6	–10.2	15.8 ± 0.64	0.35	nc	nc	–11.22	36.6	0.7066	–22.12	89.77
DM-03	–61.3	–8.36	7.2 ± 0.61	0.41	4.90	0.83	–4.22	13.1	0.7063	–14.12	89.38
DM-04	–84.4	–11.2	11.2 ± 0.54	0.38	nc	nc	nc	nc	nc	–15.25	106.8
DM-05	–72.6	–9.87	9.9 ± 0.73	0.41	nc	nc	–5.18	24.0	0.7072	–14.62	101.6
DM-06	–58.9	–7.88	3.0 ± 0.45	0.38	6.86	2.58	–9.25	15.0	0.7074	–13.33	59.94
DM-07	–58.1	–7.82	3.8 ± 0.45	0.41	nc	nc	nc	nc	nc	–14.31	71.37
DM-08	–60.9	–8.20	7.6 ± 0.61	0.41	nc	nc	nc	nc	nc	–14.95	93.67
DM-09	–66.4	–8.75	10.6 ± 0.54	0.38	7.04	1.47	–7.03	25.1	0.7071	–14.50	76.89
DM-10	–59.8	–7.80	3.6 ± 0.41	0.35	8.86	2.40	–8.02	29.8	0.7068	–14.70	41.63
DM-11	–65.1	–8.42	8.4 ± 0.51	0.38	nc	nc	nc	nc	nc	–13.81	84.16
DM-12	–61.3	–7.94	3.3 ± 0.41	0.35	nc	nc	nc	nc	nc	–11.98	35.08
DM-13	–61.3	–8.20	—	0.38	nc	nc	nc	nc	nc	–12.86	17.37
DM-14	–67.9	–8.90	10.7 ± 0.51	0.32	nc	nc	nc	nc	nc	–13.15	89.18
DM-15	–65.7	–8.80	—	0.32	nc	nc	nc	nc	nc	–13.29	5.890

Table 12. Isotopic tracers detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to June 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Information about the constituents given in table 3I. Samples from all 58 wells were analyzed for stable isotopes of hydrogen and oxygen in water and tritium activities. Samples from 19 wells were analyzed for stable isotopes of nitrogen in dissolved nitrate. Samples from 33 wells were analyzed for stable isotopes of sulfur in dissolved sulfate. Samples from 34 wells were analyzed for stable isotopes of boron and strontium in water. Samples from 57 wells were analyzed for stable isotopes of carbon in dissolved inorganic carbon and carbon-14 abundance. Stable isotope ratios of hydrogen, oxygen, nitrogen, sulfur, boron, and carbon 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. Stable isotope ratios of strontium are reported as the abundance of atoms of the heavier isotope to the lighter isotope of the element. Carbon-14 is reported as percent modern carbon. Tritium values less than the sample-specific critical level (ssL_C) are reported as non-detections (—). **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type and benchmark level as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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. **Other abbreviations:** USGS, U.S. Geological Survey; H, hydrogen; O, oxygen; N, nitrogen; S, sulfur; B, boron; Sr, strontium; C, carbon; CSU, 1-sigma combined standard uncertainty; pCi/L, picocurie per liter; na, not available; pmc, percent modern carbon; —, not detected; ±, plus or minus; nc, not collected]

GAMA well identification number	$\delta^{2}H$ of water (per mil) (82082)	$\delta^{18}O$ of water (per mil) (82085)	Tritium (pCi/L) (07000)		$\delta^{15}N$ of nitrate (per mil) (82690)	$\delta^{18}O$ of nitrate (per mil) (63041)	$\delta^{34}S$ of sulfate (per mil) (49932)	$\delta^{11}B$ (per mil) (62648)	Strontium isotope ratio ($^{87}Sr/^{86}Sr$) (atom ratio) (75978)	$\delta^{13}C$ (per mil) (82081)	Carbon-14 (pmc) (49933)
Benchmark type	na	na	MCL-CA		na	na	na	na	na	na	na
Benchmark level	na	na	20,000		na	na	na	na	na	na	na
			Result ± CSU	ssL_C							
WSJV grid wells (39 wells sampled)—Continued											
Delta-Mendota subbasin study area (29 grid wells sampled)—Continued											
DM-16	–85.8	–11.4	—	0.32	nc	nc	nc	nc	nc	–30.80	33.70
DM-17	–54.0	–5.49	0.90 ± 0.32	0.32	nc	nc	nc	22.6	0.7047	–12.45	7.900
DM-18	–63.5	–7.80	—	0.32	nc	nc	nc	nc	nc	–6.03	5.360
DM-19	–68.4	–9.07	—	0.32	28.56	15.97	–13.46	7.9	0.7071	–9.94	1.310
DM-20	–55.7	–7.36	6.8 ± 0.48	0.35	nc	nc	nc	nc	nc	–11.88	63.08
DM-21	–58.7	–7.68	7.4 ± 0.41	0.32	nc	nc	nc	nc	nc	–12.17	90.62
DM-22	–67.4	–8.88	—	0.38	nc	nc	nc	nc	nc	–27.69	13.84
DM-23	–53.2	–7.07	—	0.41	nc	nc	nc	nc	nc	–10.72	49.12
DM-24	–75.9	–9.89	17.0 ± 0.64	0.38	nc	nc	nc	nc	nc	–14.59	114.6
DM-25	–88.0	–11.6	1.8 ± 0.41	0.38	nc	nc	–5.21	26.2	0.7072	–17.28	82.07
DM-26	–66.4	–8.98	8.4 ± 0.41	0.32	5.84	1.66	–3.90	19.2	0.7070	–15.80	100.3
DM-27	–67.8	–8.84	—	0.35	nc	nc	–7.05	19.6	0.7063	–18.01	1.300
DM-28	–66.9	–8.62	10.6 ± 0.48	0.32	4.89	2.04	–6.98	29.0	0.7067	na[1]	na[1]
DM-29	–74.6	–9.58	9.2 ± 0.41	0.32	nc	nc	nc	nc	nc	–15.78	107.9

Table 12. Isotopic tracers detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to June 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Information about the constituents given in table 3I. Samples from all 58 wells were analyzed for stable isotopes of hydrogen and oxygen in water and tritium activities. Samples from 19 wells were analyzed for stable isotopes of nitrogen in dissolved nitrate. Samples from 33 wells were analyzed for stable isotopes of sulfur in dissolved sulfate. Samples from 34 wells were analyzed for stable isotopes of boron and strontium in water. Samples from 57 wells were analyzed for stable isotopes of carbon in dissolved inorganic carbon and carbon-14 abundance. Stable isotope ratios of hydrogen, oxygen, nitrogen, sulfur, boron, and carbon 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. Stable isotope ratios of strontium are reported as the abundance of atoms of the heavier isotope to the lighter isotope of the element. Carbon-14 is reported as percent modern carbon. Tritium values less than the sample-specific critical level (ssL_C) are reported as non-detections (—). **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type and benchmark level as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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. **Other abbreviations:** USGS, U.S. Geological Survey; H, hydrogen; O, oxygen; N, nitrogen; S, sulfur; B, boron; Sr, strontium; C, carbon; CSU, 1-sigma combined standard uncertainty; pCi/L, picocurie per liter; na, not available; pmc, percent modern carbon; —, not detected; ±, plus or minus; nc, not collected]

GAMA well identification number	δ^{2}H of water (per mil) (82082)	δ^{18}O of water (per mil) (82085)	Tritium (pCi/L) (07000)		δ^{15}N of nitrate (per mil) (82690)	δ^{18}O of nitrate (per mil) (63041)	δ^{34}S of sulfate (per mil) (49932)	δ^{11}B (per mil) (62648)	Strontium isotope ratio (^{87}Sr/^{86}Sr) (atom ratio) (75978)	δ^{13}C (per mil) (82081)	Carbon-14 (pmc) (49933)
Benchmark type	**na**	**na**	**MCL-CA**		**na**	**na**	**na**	**na**	**na**	**na**	**na**
Benchmark level	**na**	**na**	**20,000**		**na**	**na**	**na**	**na**	**na**	**na**	**na**
			Result ± CSU	**ssL_C**							
WSJV grid wells (39 wells sampled)—Continued											
Westside study subbasin area (10 grid wells sampled)											
WS-01	–51.0	–7.25	—	0.41	nc	nc	nc	nc	nc	–8.07	63.77
WS-02	–77.2	–10.7	1.5 ± 0.35	0.35	nc	nc	nc	nc	nc	–14.39	0.340
WS-03	–52.2	–7.13	—	0.32	10.60	9.47	–8.40	13.4	0.7064	–12.00	12.62
WS-04	–57.6	–7.98	—	0.32	nc	nc	nc	nc	nc	–12.07	8.520
WS-05	–63.7	–8.69	—	0.38	nc	nc	–3.82	4.7	0.7068	–26.92	0.830
WS-06	–58.4	–7.97	—	0.41	nc	nc	nc	nc	nc	–13.02	11.54
WS-07	–64.3	–8.56	—	0.38	nc	nc	nc	nc	nc	–12.95	5.350
WS-08	–66.2	–9.11	—	0.35	nc	nc	nc	nc	nc	–12.37	2.650
WS-09	–70.0	–9.39	—	0.32	nc	nc	5.43	26.6	0.7077	–24.29	1.050
WS-10	–59.7	–8.23	—	0.32	nc	nc	–6.62	6.9	0.7067	–15.83	5.080
WSJV understanding wells (19 wells sampled)											
DM-U-01	–54.8	–7.37	3.2 ± 0.41	0.35	nc	nc	nc	nc	nc	–11.93	72.58
WS-U-01	–66.5	–9.00	—	0.38	nc	nc	–1.92	5.4	0.7068	–24.05	0.900
WS-U-02	–67.1	–9.03	—	0.38	20.90	6.37	–4.17	9.9	0.7064	–12.27	1.520
WS-U-03	–61.0	–8.07	—	0.32	nc	nc	–8.68	15.6	0.7059	–11.19	1.570

Table 12. Isotopic tracers detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to June 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Information about the constituents given in table 3I. Samples from all 58 wells were analyzed for stable isotopes of hydrogen and oxygen in water and tritium activities. Samples from 19 wells were analyzed for stable isotopes of nitrogen in dissolved nitrate. Samples from 33 wells were analyzed for stable isotopes of sulfur in dissolved sulfate. Samples from 34 wells were analyzed for stable isotopes of boron and strontium in water. Samples from 57 wells were analyzed for stable isotopes of carbon in dissolved inorganic carbon and carbon-14 abundance. Stable isotope ratios of hydrogen, oxygen, nitrogen, sulfur, boron, and carbon 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. Stable isotope ratios of strontium are reported as the abundance of atoms of the heavier isotope to the lighter isotope of the element. Carbon-14 is reported as percent modern carbon. Tritium values less than the sample-specific critical level (ssL_C) are reported as non-detections (—). **GAMA well identification number:** DM, Delta-Mendota subbasin study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. Benchmark type and benchmark level as of March 1, 2010. **Benchmark type:** Maximum contaminant level benchmarks 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. **Other abbreviations:** USGS, U.S. Geological Survey; H, hydrogen; O, oxygen; N, nitrogen; S, sulfur; B, boron; Sr, strontium; C, carbon; CSU, 1-sigma combined standard uncertainty; pCi/L, picocurie per liter; na, not available; pmc, percent modern carbon; —, not detected; ±, plus or minus; nc, not collected]

GAMA well identification number	δ^{2}H of water (per mil) (82082)	δ^{18}O of water (per mil) (82085)	Tritium (pCi/L) (07000)		δ^{15}N of nitrate (per mil) (82690)	δ^{18}O of nitrate (per mil) (63041)	δ^{34}S of sulfate (per mil) (49932)	δ^{11}B (per mil) (62648)	Strontium isotope ratio (^{87}Sr/^{86}Sr) (atom ratio) (75978)	δ^{13}C (per mil) (82081)	Carbon-14 (pmc) (49933)
Benchmark type	**na**	**na**	**MCL-CA**		**na**	**na**	**na**	**na**	**na**	**na**	**na**
Benchmark level	**na**	**na**	**20,000**		**na**	**na**	**na**	**na**	**na**	**na**	**na**
			Result ± CSU	**ssL_C**							
WSJV understanding wells (19 wells sampled)—Continued											
Monitoring wells (15 wells sampled)											
DM-U-02	–65.0	–8.39	11.0 ± 0.73	0.32	13.93	7.83	–6.87	19.7	0.7079	–13.37	98.56
DM-U-03	–61.5	–8.10	7.9 ± 0.48	0.38	7.43	–0.41	–6.69	21.1	0.7078	–13.14	102.8
DM-U-04	–43.3	–5.15	6.3 ± 0.51	0.32	5.82	2.62	–2.68	10.7	0.7064	–12.97	106.1
DM-U-05	–49.8	–6.61	5.4 ± 0.45	0.38	3.63	1.73	–2.60	17.2	0.7068	–12.70	90.55
DM-U-06	–44.9	–6.00	5.0 ± 0.48	0.32	5.16	2.39	–3.10	15.6	0.7064	–12.77	96.81
DM-U-07	–68.2	–9.27	—	0.35	nc	nc	7.05	22.6	0.7063	–19.21	0.900
DM-U-08	–65.5	–8.71	—	0.35	nc	nc	–7.23	8.1	0.7069	–11.63	5.130
DM-U-09	–61.9	–8.04	—	0.35	14.66	14.76	–12.53	15.9	0.7069	–11.77	13.11
DM-U-10	–65.6	–8.72	—	0.35	nc	nc	–6.86	60.7	0.7065	–39.64	0.660
DM-U-11	–68.7	–9.00	8.0 ± 0.38	0.32	nc	nc	0.21	18.1	0.7077	–14.95	85.62
DM-U-12	–75.7	–10.0	—	0.32	nc	nc	–3.37	58.1	0.7067	–37.47	4.200
DM-U-13	–53.1	–6.67	0.30 ± 0.38	0.35	3.04	2.24	3.10	12.4	0.7072	–13.18	54.59
DM-U-14	–61.9	–8.09	14.6 ± 0.61	0.35	3.37	0.95	–10.29	17.0	0.7074	–13.85	61.69
DM-U-15	–65.3	–8.75	11.1 ± 0.51	0.32	2.69	0.72	–8.17	7.2	0.7079	–15.82	93.00
DM-U-16	–63.5	–8.26	9.7 ± 0.48	0.32	2.20	0.38	–10.10	12.9	0.7075	–13.01	70.56

[1] Sample was ruined during preparation at the laboratory.

Table 13. Results for analyses of dissolved standard gases detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Information about the constituents given in table 3I. Samples from 33 wells were analyzed for dissolved standard gases in water. **GAMA well identification number:** DM, Delta-Mendota study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. **Other abbreviations:** USGS, U.S. Geological Survey; µg/L, micrograms per liter; mg/L, milligrams per liter; na, not available; —, not detected]

GAMA well identification number	Carbon dioxide (mg/L) (00405)	Dissolved oxygen (mg/L) (62971)	Argon (mg/L) (82043)	Dissolved nitrogen gas (mg/L) (00597)	Methane (µg/L) (76994)
Benchmark type	**na**	**na**	**na**	**na**	**na**
Benchmark level	**na**	**na**	**na**	**na**	**na**
WSJV grid wells (15 wells sampled)					
Delta-Mendota subbasin study area (11 grid wells sampled)					
DM-02	8.59	0.45	0.68	21.07	0.012
DM-03	13.47	5.06	0.68	21.22	—
DM-05	8.48	4.37	0.55	15.53	0.016
DM-06	10.02	3.83	0.60	17.24	—
DM-09	14.22	0.84	0.66	20.83	—
DM-10	7.46	0.90	0.65	22.54	—
DM-19	3.83	0.28	0.65	22.23	—
DM-25	12.04	0.29	0.68	20.94	0.007
DM-26	27.56	2.99	0.66	19.45	—
DM-27	2.04	0.26	0.70	21.88	0.002
DM-28	21.30	6.90	0.73	23.27	—
Westside subbasin study area (4 grid wells sampled)					
WS-03	2.77	0.22	0.60	19.07	—
WS-05	0.32	0.24	0.68	21.12	0.058
WS-09	6.11	0.26	0.71	21.72	0.009
WS-10	1.71	0.25	0.73	24.18	0.008
WSJV understanding wells (18 wells sampled)					
WS-U-01	0.99	0.22	0.64	17.18	6.638
WS-U-02	0.78	0.29	0.84	28.37	0.091
WS-U-03	0.57	0.23	0.57	16.65	0.777
Monitoring wells (15 wells sampled)					
DM-U-02	34.69	0.28	0.67	20.54	—
DM-U-03	54.31	6.26	0.60	16.58	—
DM-U-04	11.75	3.01	0.84	25.75	—
DM-U-05	7.55	5.10	0.73	21.39	—
DM-U-06	7.23	1.49	0.78	23.63	—
DM-U-07	2.97	0.27	0.75	22.98	0.008
DM-U-08	5.36	0.28	0.69	24.86	—
DM-U-09	7.22	0.27	0.62	20.40	—
DM-U-10	2.22	0.28	0.74	23.42	0.001
DM-U-11	22.39	0.23	0.64	19.05	0.612

Table 13. Results for analyses of dissolved standard gases detected in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[The five-digit USGS parameter code below the constituent name is used to uniquely identify a specific constituent or property. Information about the constituents given in table 3I. Samples from 33 wells were analyzed for dissolved standard gases in water. **GAMA well identification number:** DM, Delta-Mendota study area grid well; DM-U, Delta-Mendota subbasin study area understanding well; WS, Westside subbasin study area grid well; WS-U, Westside subbasin study area understanding well. **Other abbreviations:** USGS, U.S. Geological Survey; µg/L, micrograms per liter; mg/L, milligrams per liter; na, not available; —, not detected]

GAMA well identification number	Carbon dioxide (mg/L) (00405)	Dissolved oxygen (mg/L) (62971)	Argon (mg/L) (82043)	Dissolved nitrogen gas (mg/L) (00597)	Methane (µg/L) (76994)
Benchmark type	**na**	**na**	**na**	**na**	**na**
Benchmark level	**na**	**na**	**na**	**na**	**na**
WSJV understanding wells (18 wells sampled)—Continued					
Monitoring wells (15 wells sampled)—Continued					
DM-U-12	22.94	0.26	0.71	22.94	0.001
DM-U-13	15.51	4.79	0.59	17.22	—
DM-U-14	9.08	1.35	0.74	23.95	—
DM-U-15	14.80	1.63	0.68	19.28	—
DM-U-16	12.33	5.02	0.77	25.25	—

Appendix

This appendix includes discussions of the methods used to collect and analyze groundwater samples and report the resulting water-quality data. These methods were selected to obtain representative samples of the groundwater from each well and to minimize the potential for contamination of the samples or bias in the data. Procedures used to collect and assess QC data, and the results of the QC assessments also are discussed.

In the WSJV study unit, groundwater samples were collected and QA/QC procedures were implemented using standard and modified USGS protocols from the NFM (U.S. Geological Survey, variously dated; Wilde and others, 1999, 2004) and the NAWQA Program (Koterba and others, 1995). The QA plan followed by the NWQL, the primary laboratory used to analyze samples for this study, is described in Maloney (2005) and Pirkey and Glodt (1998).

Sample Collection and Analysis

Prior to sampling, each well was pumped continuously to purge at least three casing-volumes of water from the well (Wilde and others, 1999). Production wells were sampled by using Teflon® tubing with brass and stainless-steel fittings attached to a sampling point on the well discharge pipe as close to the well head as possible. The sampling point was located upstream from water-storage tanks or well-head treatment systems (if present). If a chlorinating system was attached to the well, the chlorinator was shut off, when possible, before the well was purged and sampled, in order to clear all chlorine out of the system. The absence of free chlorine was verified using a Hach® field test kit. Monitoring wells were sampled by using a Grunfos® submersible sampling pump with Teflon® tubing and stainless-steel fittings. For the *intermediate* schedule, samples were collected at the well head using a foot-long length of Teflon® tubing. For the *slow* schedule, the samples were either collected in the same manner as the *intermediate* schedule or collected inside an enclosed chamber located inside a mobile laboratory and connected to the well head by a 10–50 ft length of the Teflon® tubing (Lane and others, 2003). All fittings and lengths of Teflon® tubing were cleaned between samples (Wilde, 2004).

For the field measurements, groundwater was pumped through a flow-through chamber (attached to the sampling point) fitted with a multi-probe meter that simultaneously measures the field water-quality indicators—dissolved oxygen, temperature, pH, and specific conductance. Turbidity was measured in the field with a calibrated turbidity meter. Field measurements were made in accordance with protocols in the NFM (Radtke and others, 2005; Wilde and Radtke, 2005; Lewis, 2006; Wilde, 2006; Wilde and others, 2006). All sensors on the multi-probe meter were calibrated daily. Measured turbidity, dissolved oxygen, temperature, pH, and specific conductance values were recorded at 5-minute (min) intervals, and when these values remained stable for a minimum of 30 min, samples for laboratory analyses then were collected.

Field measurements and instrument calibrations were recorded on field record sheets and electronically on field laptop computers using the Personal Computer Field Form (PCFF) program. Analytical service requests for the NWQL were generated by PCFF, whereas analytical service requests for non-NWQL analysis were entered into laboratory-specific spreadsheets. Information from PCFF was uploaded directly into the USGS NWIS database at the end of every week of sample collection.

Prior to sample collection, polyethylene sample bottles were pre-rinsed three times using deionized water, and then once with native sample water before sample collection. Samples requiring acidification were acidified to a pH of between 2 and 1 with the appropriate acids using ampoules of certified, traceable concentrated acids obtained from the NWQL.

VOC and low-level fumigant samples were each collected in three 40-mL sample vials that were purged with three vial volumes of groundwater before bottom-filling to eliminate atmospheric contamination. One to one (1:1) hydrochloric acid to water (HCl/H_2O) solution was added as a preservative to the VOC samples, but not to the low-level fumigant samples. 1,2,3-TCP samples were collected by top-filling two 40-mL sample vials (provided by Weck Laboratories, Inc. [Weck], City of Industry, California) that were pre-treated with 0.5 mL 6 Normal (N) HCl acid as a preservative. Each sample to be analyzed for perchlorate was collected in a 125-milliliter (mL) polystyrene bottle and then filtered in two or three 20-mL aliquots of groundwater through a 0.20-micrometer (µm) pore-size Corning® syringe-tip disk filter into a sterilized 125-mL bottle. Tritium samples were collected by bottom-filling one 1-L polyethylene bottle and one 1-L glass bottle with unfiltered groundwater, after first overfilling the bottles with three volumes of unfiltered groundwater. Total arsenic and iron (unfiltered) samples were collected by top filling a 250-mL polyethylene bottle that was covered with tape to prevent light exposure with unfiltered groundwater and acidified with 6-N HCl as a preservative. Samples for analysis of stable isotopes of hydrogen and oxygen in water were collected in a 60-mL clear glass bottle filled with unfiltered groundwater, sealed with a conical cap, and secured with electrical tape to prevent leakage and evaporation.

Pesticides and pesticide degradates and NDMA samples were collected in 1-L baked amber glass bottles. Samples for pesticides and pesticide degradates were filtered through a 0.7-µm nominal pore-size glass fiber filter during collection, whereas the NDMA samples were filtered at Weck prior to analysis. NDMA sample containers, treated with 0.05 gram (g) of sodium thiosulfate ($Na_2S_2O_3$) as a preservative, were provided by Weck.

Trace element, major and minor ion, silica, and TDS samples required filling one 250-mL polyethylene bottle with unfiltered groundwater and one 500-mL and one 250-mL polyethylene bottle with filtered groundwater (Wilde and others, 2004). Filtration was done using a 0.45-µm pore-size PALL® unvented capsule filter that was pre-rinsed with 2 L of deionized water, and then rinsed with 1 L of groundwater prior to sampling. The 250-mL filtered sample then was preserved with 7.5-N nitric acid. Samples for nutrients and stable isotopes of nitrogen and oxygen in dissolved nitrate each were filtered into 125-mL brown polyethylene bottles. Samples for arsenic and iron species were filtered into a 250-mL polyethylene bottle that was covered with tape to prevent light exposure and preserved with 6-N hydrochloric acid. Samples for stable isotopes of sulfur in dissolved sulfate were filtered into 1-L polyethylene bottles. Samples for stable isotopes of boron and isotopic ratios of strontium in water were filtered into one 250-mL polyethylene bottle and secured with electrical tape to prevent leakage and evaporation. Samples for stable isotopes of carbon in dissolved inorganic carbon and carbon-14 abundance were filtered and bottom filled into 500-mL glass bottles that first were overfilled with three bottle volumes of filtered groundwater. These samples had no headspace and were sealed with conical caps to avoid atmospheric contamination. Samples for field alkalinity titrations were collected by filtering groundwater into a 500-mL polyethylene bottle.

Chromium species samples were collected at the hose bib at the well head using a 10-mL syringe with an attached 0.45-µm pore-size MILLEX®HA disk filter. After the syringe was rinsed thoroughly and filled with groundwater, 4 mL of sample water was forced through the disk filter; the next 2 mL of the groundwater were filtered slowly into a small centrifuge vial for analysis of total chromium. Chromium-VI then was collected by attaching a small cation-exchange column to the syringe filter after conditioning the column with 2 mL of sample water; an additional 2 mL of sample water was collected in a second centrifuge vial. Both vials were preserved with 10 microliters (µL) of 7.5-N nitric acid (Ball and McCleskey, 2003a, b).

DOC samples were collected from the hose bib at the well head using a Teflon® filtration apparatus attached to a foot-long length of Teflon® tubing. For each sample, 100 mL of groundwater and (or) certified inorganic-free blank water was first filtered to waste through the baked 0.7-µm nominal pore-size glass-fiber filter, then 100 mL of groundwater was filtered into a 125-mL baked amber glass bottle (Wilde and others, 2004). Each sample then was preserved immediately by lowering the pH to between 2 and 1 with 4.5-N sulfuric acid.

Dissolved standard gases were collected by using a copper tube sampling apparatus attached to the hose bib at the well head. Each sample was collected by bottom filling two 150-mL glass serum bottles that were first overfilled with approximately 5 gallons of unfiltered groundwater. These samples had no headspace or air bubbles inside the bottles and were sealed underwater to avoid atmospheric contamination.

Dissolved noble gases were collected in ⅜-inch-diameter copper tubes using reinforced nylon tubing connected to the hose bib at the well head. Groundwater was flushed through the tubing to dislodge bubbles before the flow was restricted with a back-pressure valve. Clamps on either side of the copper tube then were tightened, trapping a sample of groundwater for analyses of dissolved noble gases (Weiss, 1968).

Field alkalinity was measured in the mobile laboratory at the well site. Alkalinity was measured on filtered samples by Gran's titration method (Gran, 1952). Titration data were entered directly into PCFF, and the concentrations of bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}) automatically were calculated from the titration data using the advanced speciation method (http://or.water.usgs.gov/alk/methods.html) with $pK_1 = 6.35$, $pK_2 = 10.33$, and $pK_W = 14$. Concentrations of HCO_3^- and CO_3^{2-} also were calculated from the laboratory alkalinity and laboratory pH measurements.

Temperature-sensitive samples were stored on ice prior to, and during daily shipping to the various laboratories. The non-temperature- or non-time-sensitive samples for chromium species, tritium, stable isotopes of hydrogen and oxygen in water, stable isotopes of sulfur in dissolved sulfate, stable isotopes of boron, isotopic ratios of strontium in water, and dissolved noble gases were shipped monthly. Temperature- or time-sensitive samples for VOCs, low-level fumigants, pesticides and pesticide degradates, perchlorate, NDMA, 1,2,3-TCP, trace elements, nutrients, DOC, major and minor ions, silica, and TDS were shipped daily. The temperature-sensitive samples for total (unfiltered) arsenic and iron, filtered arsenic and iron species, and dissolved standard gases were stored on ice and shipped weekly. Samples for stable isotopes of nitrogen and oxygen in dissolved nitrate and stable isotopes of carbon in dissolved inorganic carbon and carbon-14 abundance were stored on ice, archived in a laboratory refrigerator and (or) freezer, and shipped after results for nitrate and alkalinity were received from the NWQL.

Nine laboratories performed chemical analyses for this study (table A1), although most of the analyses were performed at the NWQL or by laboratories contracted by the NWQL. The NWQL maintains a rigorous QA program (Pirkey and Glodt, 1998; Maloney, 2005). Laboratory QC 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 tested continuously, and laboratory reporting levels are updated accordingly. NWQL maintains National Environmental Laboratory Accreditation Program (NELAP) and other certifications (http://www.nelac-institute.org/accred-labs.php). In addition, the USGS Branch of Quality Systems (BQS) maintains independent oversight of QA at the NWQL and laboratories contracted by the NWQL. The BQS also runs the National Field Quality Assurance Program (NFQA) that includes annual testing of all USGS field personnel for proficiency in making field water-quality measurements (http://internalbqs.cr.usgs.gov/NFQA/NFQA.php). Results for analyses made at the NWQL or by laboratories contracted by the NWQL are uploaded directly into the USGS NWIS database. Results of analyses made at other laboratories are compiled in a project database and uploaded from there into the USGS NWIS database. Some laboratory QC data are stored in the USGS NWIS database also.

Data Reporting

Laboratory Reporting Conventions

The USGS NWQL uses different conventions for reporting results for organic, inorganic, and radioactive constituents. The USGS NWQL uses the LRL for reporting analytical results for most organic constituents. The LRL is set to minimize the reporting of false negatives (not detecting a compound when it actually is present in a sample) to less than 1 percent (Childress and others, 1999). The NWQL updates LRL values regularly, and the values listed in this report were in effect during the period that groundwater samples from the WSJV study unit were analyzed (March to July 2010).

The LRL usually 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 level (MDL) determinations made over an extended period of time. 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). LT-MDLs continually are monitored and updated (Childress and others, 1999; U.S. Environmental Protection Agency, 2002). Concentrations less than the LT-MDL are reported as non-detections with a dash (–) in the data tables.

Concentrations between the LRL and the LT-MDL are reported as having a higher degree of uncertainty (coded by the letter "E" preceding the values in the tables and text). For information-rich methods, detections less than the LT-MDL have high certainty of presence, but the precise concentration is uncertain. These values are also E-coded. Information-rich methods are those that utilize gas chromatography or high-performance liquid chromatography (HPLC) with mass spectrometry detection, such as those methods used to analyze VOCs and pesticides. Compounds are identified by 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-coded values also may result from detections outside the range of calibration standards, from detections that did not meet all laboratory QC criteria, and from samples that were diluted prior to analysis (Childress and others, 1999).

Some constituents in this study are reported by using minimum reporting levels (MRLs) or method uncertainties (MU). The MRL is the smallest measurable concentration of a constituent that may be reliably reported when 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.

Results for most constituents are given using the LRL, MDL, or MRL values provided by the analyzing laboratories. Results for some organic and inorganic constituents are presented using SRLs derived from assessing results from QC samples associated with groundwater samples collected as part of the GAMA-PBP [see the appendix section titled "Methods for Determining Study Reporting Levels (SRLs)"].

The methods used for analysis of tritium measure activities by counting techniques (table A1). Activity often is used instead of concentration for reporting the presence of radioactive constituents. Activity of these constituents in groundwater is measured in units of picocuries per liter (pCi/L), and 1 pCi/L 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.

The reporting limit for tritium is based on sample-specific critical levels (ssL_C) (McCurdy and others, 2008). The critical level is analogous to the LT-MDL used for reporting analytical results for organic and non-radioactive inorganic constituents. Here, the critical level is defined as the minimum measured activity that indicates a positive detection of the radionuclide in the sample with less than a 5-percent probability of a false positive detection. Sample-specific critical levels are used for radioactive measurements because the critical level is sensitive to sample size and sample yield during analytical processing and is dependent on instrument background, on counting times for the sample and background, and on the characteristics of the instrument being used and the nuclide being measured. An ssL_C is calculated for each sample, and the measured activity in the sample is compared to the ssL_C associated with that sample. Measured activities less than the ssL_C are reported as non-detections with a dash (–) in the data tables.

The analytical uncertainties associated with measurement of activities also are sensitive to sample-specific parameters, including sample size, sample yield during analytical processing, and time elapsed between sample collection and various steps in the analytical procedure, as well as parameters associated with the instrumentation. Therefore, measured activities of tritium are reported with sample-specific combined standard uncertainties (CSU). The CSU is reported at the 68-percent confidence level (1-sigma).

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

$$\delta^{i}E = \left[\frac{R_{sample}}{R_{reference}} - 1\right] x1{,}000 \text{ per mil} \tag{A1}$$

where

i is the atomic mass of the heavier isotope of the element,

E is the element (H for hydrogen, O for oxygen, N for nitrogen, S for sulfur, B for boron, and C for carbon),

R_{sample} is the ratio of the abundance of the heavier isotope of the element (^{2}H, ^{18}O, ^{15}N, ^{34}S, ^{11}B, ^{13}C) to the lighter isotope of the element (^{1}H, ^{16}O, ^{14}N, ^{32}S, ^{10}B, ^{12}C) in the sample, and

$R_{reference}$ is the ratio of the abundance of the heavier isotope of the element to the lighter isotope of the element in the reference material.

The reference material for oxygen and hydrogen is Vienna Standard Mean Ocean Water (VSMOW), which is assigned δ^{18}O and δ^{2}H values of 0 per mil (note than δ^{2}H is sometimes written as δD because the common name of the heavier isotope of hydrogen, hydrogen-2, is deuterium). The reference material for nitrogen is atmospheric nitrogen gas, which is assigned a δ^{15}N value of 0 per mil. The reference material for sulfur is Vienna Canon Diablo Troilite (VCDT), which is assigned a δ^{34}S value of 0 per mil. The reference material for boron is the National Institute of Standards and Technology (NIST) reference material SRM 951 boric acid, which is assigned a δ^{11}B value of 0 per mil (Coplen and others, 2002). The reference material for carbon is Vienna Pee Dee Belemnite (VPDB), which is assigned a δ^{13}C value of 0 per mil. Positive values indicate enrichment of the heavier isotope, and negative values indicate depletion of the heavier isotope, compared to the ratios observed in the standard reference material. Isotopic ratios of strontium in water are presented as the abundance of atoms of the heavier isotope (^{87}Sr) to the lighter isotope (^{86}Sr) of the element.

Constituents Determined by Multiple Methods or Laboratories

Ten constituents targeted in this study were measured by more than one analytical method or by more than one laboratory (table A2). The preferred methods for these constituents were selected on the basis of the procedure recommended by the NWQL (http://wwwnwql.cr.usgs.gov/dyn.shtml?Preferred_method_selection_procedure).

The water-quality indicators—alkalinity, pH, and specific conductance—were measured in the field and at the NWQL. The field measurements are the preferred method for all three constituents; however, both measurements are reported (table 4). Field values are generally preferred because field conditions are considered more representative of groundwater conditions (Hem, 1985).

DBCP and EDB each appear on the following NWQL analytical schedules: VOCs (Schedule 2020; table 3A) and low-level fumigants (Schedule 1306; table 3B). For constituents collected on Schedules 2020 and 1306, the preferred method was Schedule 1306.

1,2,3-TCP was measured at the NWQL (reporting level was an LRL of 0.12 µg/L) and Weck (reporting level was an MRL of 0.005 µg/L) (table 3A, D). Both sets of results are reported for this constituent.

For total arsenic, chromium, and iron (filtered) concentrations, the approved method, Schedule 1948 (table 3E), used by the NWQL is preferred over the research methods used by the NRP-TML (table 3H); however, both measurements are reported (tables 8 and 11). The concentrations measured by the NRP-TML are only used to calculate ratios of redox species for arsenic, chromium, and iron.

For example,

$$\frac{\mathrm{Cr(III)}}{\mathrm{Cr(VI)}} = \frac{\mathrm{Cr(T)} - \mathrm{Cr(VI)}}{\mathrm{Cr(VI)}} \tag{A2}$$

where

Cr(T) is the total chromium concentration (measured),

Cr(VI) is the concentration of hexavalent chromium (measured), and

Cr(III) is the concentration of trivalent chromium (calculated).

Tritium also was measured at two laboratories: LLNL and USGS Stable Isotope and Tritium Laboratory, Menlo Park, California (SITL) (table 3I). Only tritium data from the SITL was available for reporting at the time of this publication (table 12).

Quality-Assurance Methods and Results

The purpose of QA is to identify which data best represent environmental conditions and which may have been affected by contamination or bias during sample collection, processing, storage, transportation, and (or) laboratory analysis. Four types of QC measurements were evaluated in this study: (1) blank samples were collected to assess positive bias as a result of contamination during sample handling or analysis, (2) replicate samples were collected to assess variability, (3) matrix-spike tests were done to assess positive or negative bias, and (4) surrogate compounds were added to samples analyzed for organic constituents to assess potential bias from laboratory analytical methods. Results that were found to have significant bias, on the basis of the QC data collected from this study and previous studies, were flagged with an appropriate remark code (described in subsequent sections) and were not used to calculate detection frequencies or other statistical analyses.

Blanks

The primary purposes of collecting blanks are to evaluate the magnitude of potential contamination of samples with compounds of interest during sample handling or analysis, and to identify and mitigate the sources of sample contamination.

Methods of Blank Collection and Analysis

Blanks were collected using blank water certified by the NWQL to contain less than the reporting levels for selected constituents investigated in the study (http://wwwnwql.cr.usgs.gov/USGS/OBW/obw.html). Nitrogen-purged, organic-free blank water was used for blanks of organic constituents, and inorganic-free blank water was used for blanks of inorganic constituents. Three types of blanks were collected:

- Field blanks were collected to assess potential contamination of samples during collection, processing, transport, and analysis. To collect field blanks, blank water either was pumped or poured through the sampling equipment (fittings and tubing) used to collect groundwater samples, then processed and transported using the same protocols used for the groundwater samples. Typically, 12 liters of blank water were pumped or poured through the sampling equipment before each field blank was collected. Field blanks were analyzed for VOCs, low-level fumigants, pesticides and pesticide degradates, perchlorate, 1,2,3-TCP, NDMA, trace elements, nutrients, DOC, major and minor ions, silica, TDS, total arsenic and iron (unfiltered), and arsenic, chromium, and iron species (filtered).

- Source-solution blanks are collected at the beginning of a study or when using a new lot of blank water to assess potential contamination of samples during transport and analysis, and potential contamination of the certified blank water obtained from the NWQL. Source-solution blanks were collected by pouring blank water directly into sample containers that were preserved, stored, shipped, and analyzed in the same manner as the groundwater samples. Source-solution blanks were analyzed for VOCs, low-level fumigants, pesticides and pesticide degradates, perchlorate, NDMA, 1,2,3-TCP, trace elements, major and minor ions, silica, TDS, total arsenic and iron (unfiltered), and arsenic, chromium, and iron species (filtered).

- An equipment blank was collected at the beginning of the study unit at the USGS Sacramento Field Office to assess whether the Grunfos® submersible sampling pump was sufficiently clean to be used for collection of samples from monitoring wells in the WSJV study unit. The equipment blank was analyzed for VOCs, pesticides and pesticide degradates, perchlorate, NDMA, 1,2,3-TCP, trace elements, nutrients, DOC, major and minor ions, silica, and TDS.

Blanks were not collected for stable isotopes. Stable isotopes of hydrogen, oxygen, nitrogen, sulfur, boron, strontium, and carbon are an intrinsic property of any of these elements; therefore, the concept of a blank does not apply to these ratios. In addition, blanks were not collected for tritium or dissolved gases. Tritium and dissolved gases are in the atmosphere and would dissolve into any solution used in collecting a blank, making it impractical to collect a blank for these constituents.

Methods for Determining Study Reporting Levels (SRLs)

SRLs for selected VOCs were defined by Fram and others (2012) on the basis of the assessment of results from field blanks, source-solution blanks, laboratory instrument blanks, and groundwater samples from the first 32 GAMA PBP study units (May 2004 through September 2010). SRLs were established for those VOCs that had evidence of potential contamination due to field or laboratory processes. Detections of VOCs having concentrations less than or equal to the SRLs were reclassified as non-detections.

SRLs for trace elements detected in field blanks collected in the first 20 GAMA PBP study units (May 2004 through January 2008) were defined by Olsen and others (2010) on the basis of statistical assessment of results from the field blanks. The assessment used order statistics and binomial probabilities to construct an upper confidence limit (Hahn and Meeker, 1991) for the maximum concentration of constituents possibly introduced while groundwater samples were collected, transported, and analyzed. Detections of trace elements having concentrations less than or equal to the SRLs were reported with a ≤ symbol preceding the value to indicate that the true value may be less than or equal to the reported value (including the possibility of being a non-detection).

SRLs for other constituents collected for the WSJV study unit were defined as equal to the highest concentration measured in the blanks. Detections of organic constituents in groundwater samples at concentrations less than or equal to the SRLs have been reclassified as non-detections. Detections of inorganic constituents in groundwater samples at concentrations less than or equal to the SRLs have been reclassified with a ≤ symbol preceding the reported value to indicate that the true value may be less than or equal to the reported value (including the possibility of being a non-detection).

In the USGS NWIS database, data affected by SRLs (if any) are accompanied with the following comment: Result is < or = reported value, based on QC data.

Detections in Blanks and Application of SRLs

Table A3 presents a summary of detections in the blanks (eight field blanks, three source-solution blanks, and one equipment blank) and the SRLs that were applied for the WSJV study unit. Blanks were collected at up to 17 percent of the sites sampled in the WSJV study unit.

Four VOCs (acetone, carbon disulfide, chloroform, and toluene) were detected in blanks collected for the WSJV study unit, and each also have SRLs defined by Fram and others (2012). Detections of VOCs in groundwater samples with concentrations less than or equal to the SRL (defined by the blank detections or by Fram and others, 2012) were flagged with a ≤ symbol and reclassified as non-detections. An additional four VOCs (1,2,4-trimethylbenzene, ethylbenzene, *m*- plus *p*-xylene, and *o*-xylene) have SRLs defined by Fram and others (2012) and were detected in groundwater samples (table 5).

Acetone was detected in one field blank at a concentration of E0.3 µg/L. Acetone was not detected in groundwater samples; therefore, definition of an SRL was not necessary.

Carbon disulfide was detected in one field blank at a concentration of 0.06 µg/L. This concentration is greater than the SRL of E0.03 µg/L defined by Fram and others (2012). The SRL of 0.03 µg/L was defined on the basis of statistical assessment of results from field blanks collected during 32 GAMA study units; therefore, it was considered appropriate to use this value, rather than the higher concentration measured in the field blank, as the SRL.

Chloroform was detected in the equipment blank at a concentration of E0.02 µg/L. This concentration is equal to the defined SRL for groundwater samples collected with monitoring well equipment (Fram and others, 2012).

1,2,4-Trimethylbenzene has an SRL of 0.56 µg/L as defined by Fram and others (2012). 1,2,4-Trimethylbenzene was detected at a concentration less than the SRL in one groundwater sample (WS-07: E0.02 µg/L); therefore, this result is not presented in table 5.

Toluene was detected in three field blanks and one source-solution blank at concentrations ranging from E0.01 µg/L to 0.04 µg/L. Toluene has an SRL of 0.69 µg/L as defined by Fram and others (2012). The SRL of 0.69 µg/L was used on the basis on these results. Toluene was detected at concentrations less than or equal to the SRL in two groundwater samples (WS-U-02: 0.03 µg/L; DM-U-11: E0.02 µg/L); the latter of which (DM-U-11) was reclassified as a non-detection.

Ethylbenzene, *m*- plus *p*-xylene, and *o*-xylene were not detected in blanks collected for the WSJV study unit, but were detected in samples from wells WS-U-01 and WS-U-02. Additionally, toluene was detected in groundwater samples from WS-U-02 (see previous paragraph). The concentrations of ethylbenzene and *o*-xylene in WS-U-01 and of *m*- plus *p*-xylenes, *o*-xylene, and toluene in WS-U-02 were less than the SRLs established by Fram and others, 2012). However, multiple lines of evidence suggested that the detections of the hydrocarbons ethylbenzene, *m*- plus *p*-xylene, *o*-xylene, and toluene are more likely to be the result of environmental occurrence of these compounds in the groundwater sampled from these wells; therefore, SRLs were not applied and the data were not reclassified in table 5.

First, WS-U-02 was previously sampled by the GAMA-PBP in 2005 (well TLR-07, ***Southeast San Joaquin Valley***: Burton and others, 2008); ethylbenzene, *m*- plus *p*-xylene, *o*-xylene, and toluene and high concentrations of benzene were all detected in this well in 2005 and in the sample collected for the WSJV study unit. Such repeated detections of the same compounds in the same well sampled 5 years apart are more likely to reflect actual presence of these compounds in the well rather than random contamination. Second, data from the CDPH database indicated historical detections of benzene in WS-U-01 and WS-U-02, often at concentrations greater than the MCL-CA of 1 µg/L. These results indicate that there is a history of hydrocarbon presence in the sampled groundwater in these wells. Because the LRLs of the analyses reported in the CDPH database are much higher than those used by the GAMA-PBP and because concentrations of ethylbenzene, *m*- plus *p*-xylene, *o*-xylene, and toluene measured by the GAMA-PBP were much lower than the concentrations of benzene, it is not surprising that these other hydrocarbons have not generally been detected in the CDPH analyses. Third, it is not unexpected that groundwater that is highly affected by hydrocarbon contamination (as evidenced by the high concentrations of benzene in these wells) would also have detections of other relatively soluble hydrocarbons, including ethylbenzene, *m*- plus *p*-xylene, *o*-xylene, and toluene.

Seven trace elements (cobalt, copper, lead, manganese, molybdenum, silver, and tungsten) were detected in blanks collected for the WSJV study unit. An additional four trace elements (chromium, iron, nickel, and zinc) were detected in groundwater samples at concentrations less than or equal to the SRLs defined by Olsen and others (2010). Detections of trace elements in groundwater samples with concentrations less than or equal to the SRL were flagged with a ≤ symbol in table 8.

Cobalt was detected in all eight field blanks and in the equipment blank at concentrations ranging from 0.10 µg/L to 0.33 µg/L. An SRL of 0.33 µg/L was defined on the basis of the blank results.

Copper was detected in two field blanks at concentrations of E0.59 µg/L and E0.84 µg/L, respectively. Copper has an SRL of 1.7 µg/L as defined by Olsen and others (2010). The SRL of 1.7 µg/L was used on the basis of these results.

Lead was detected in all three field blanks at concentrations ranging from E0.02 µg/L to 0.04 µg/L. Lead has an SRL of 0.65 µg/L as defined by Olsen and others

(2010). The SRL of 0.65 µg/L was used on the basis of these results.

Manganese was detected in all eight field blanks and the equipment blank at concentrations ranging from 0.21 µg/L to 0.52 µg/L. An SRL of 0.52 µg/L was defined on the basis of the blank results.

Molybdenum was detected in a field blank and the equipment blank, both at concentrations of E0.02 µg/L. Molybdenum was not detected in groundwater samples at concentrations less than or equal to those measured in the blanks; therefore, application of an SRL was not necessary (table 8).

Silver was detected in a field blank and the equipment blank at concentrations of 0.010 µg/L and E0.005 µg/L, respectively. An SRL of 0.010 µg/L was defined on the basis of the blank results.

Tungsten was detected in a field blank at a concentration of 0.03 µg/L. Tungsten has an SRL of 0.11 µg/L as defined by Olsen and others (2010). The SRL of 0.11 µg/L was used based on these results.

Two nutrients were detected in one field blank; ammonia (as nitrogen) (E0.02 µg/L) and nitrite (as nitrogen) (E0.001 µg/L). SRLs were defined for each nutrient on the basis of the blank results.

Alkalinity and TDS each were detected in one field blank at concentrations of E4 mg/L and 34 mg/L, respectively. Alkalinity and TDS were not detected in groundwater samples at concentrations less than or equal to those measured in the field blanks; therefore, application of an SRL was not necessary (tables 4 and 10).

Replicates

Sequential replicate samples were collected to assess the precision of the water-quality data. Estimates of data precision are needed to assess whether differences between concentrations in samples are because of differences in groundwater quality or because of variability that may result from collecting, processing, and analyzing the samples.

Methods of Assessment of Replicate Samples

Three methods for measuring variability were used to assess precision over the range of measured concentrations found in groundwater samples. The variability between results in the pairs of sequential replicate samples was represented by the standard deviation (SD) for low concentrations and by relative standard deviation (RSD) for high concentrations (Anderson, 1987; Mueller and Titus, 2005). The RSD is defined as the SD divided by the mean concentration for each replicate pair of samples expressed as a percentage. The boundary between concentrations of each metric was used was defined as five times the selected reporting level (RL) for each constituent. The RL may be an LRL, SRL, MDL, or MRL for each constituent; therefore pairs with mean concentrations < 5 RL used the SD, and pairs with mean concentrations ≥ 5 RL used the RSD.

Replicate pairs of analyses of all constituents except for radiochemical constituents were evaluated as follows:

- If both values were reported as detections, the SD or RSD was calculated. Acceptable precision is defined as an SD of less than ½ RL or an RSD of less than 10 percent. For comparison, an RSD of 10 percent is equivalent to a relative percent difference (RPD) of 14 percent.
- If both values were reported as non-detections, the variability was set to zero by definition.
- If one value was reported as a non-detection, and the other value was reported as a detection less than the RL, then a value of zero was substituted for the non-detection, and the SD was calculated. Substituting zero for the non-detection would yield the maximum estimate of variability for the replicate pair.
- If one value for a sample pair was reported as a non-detection and the other value was flagged with a ≤ symbol (less than or equal to the SRL), or if both values were flagged with a ≤ symbol, the SD was not calculated because the values may be analytically identical. The ≤ symbol indicates that the value is a maximum potential concentration and the true concentration could be less than the RL for the other sample in the pair.
- If one value was reported as a non-detection and the other value was reported as a detection greater than the RL, the variability for the pair was considered unacceptable.

Replicate pairs of analyses of radiochemical constituents were evaluated using the following equation (McCurdy and others, 2008):

$$z = \frac{|R_1 - R_2|}{\sqrt{(CSU_1^2 + CSU_2^2)}} \tag{A3}$$

where

z is the test statistic,

R_1 and R_2 are the results for the two samples in the replicate pair, and

CSU_1 and CSU_2 are the combined standard uncertainties associated with the results.

Values of $z < 1.65$ correspond to significant levels (p) $< \alpha$, where $\alpha = 0.05$, and thus indicate replicate pairs with acceptable precision. Replicate pairs with values that are statistically indistinguishable at a confidence level (α) of $\alpha = 0.05$ are defined as acceptable.

If results from replicate sample pairs indicate that variability is unacceptable for a constituent, then this greater variability must be considered when interpreting the data. If measured concentrations are slightly greater than a water-quality benchmark, then actual concentrations could be less than that benchmark. Similarly, if measured concentrations are slightly less than a water-quality benchmark, then actual concentrations could be greater than a benchmark. If a constituent has high variability in replicate sample pairs, then a larger difference between concentrations measured in two samples is required to conclude that the two samples have significantly different concentrations.

Variability in Replicate Samples

Table A4A–B summarize the results of replicate analyses for constituents detected in groundwater samples collected in the WSJV study unit. Replicate samples were collected for up to 10 percent of the samples collected. Of the 1,370 replicate pairs of constituents analyzed, 93 were for constituents detected in at least one groundwater sample. Of these 93 pairs, none were outside the limits for acceptable variability.

Six replicate pairs of samples were analyzed for the VOCs, and all pairs were composed of two values reported as non-detections with the exception of one replicate pair for chloroform and one replicate pair for MTBE. The replicate pairs all yielded two values reported as detections, and all replicate pair analysis resulted in SDs within acceptable precision.

Six replicate pairs of samples were analyzed for the low-level fumigants, and all pairs were composed of two values reported as non-detections.

Six replicate pairs of samples were analyzed for the pesticide and pesticide degradate compounds, and all pairs were composed of two values reported as non-detections with the exception of two replicate pairs each for metolachlor and one replicate pair for simazine, deethylatrazine, atrazine, hexazinone, *S*-ethyl-dipropylthiocarbamate (EPTC), and 3,4-dichloroaniline. The replicate pairs all yielded two values reported as detections, and all replicate pair analysis resulted in SDs within acceptable precision.

Six replicate pairs for perchlorate and 1,2,3-TCP and four replicate pairs for NDMA were analyzed at Weck for variability. Five of the replicate pairs for perchlorate and 1,2,3-TCP and all of the replicate pairs for NDMA were composed of two values reported as non-detections. The remaining replicate pairs for perchlorate and 1,2,3-TCP yielded two values reported as detections, and each replicate pair analysis resulted in an SD or RSD within acceptable precision.

Six replicate pairs of samples were analyzed for DOC, and one of these pairs was composed of two values reported as non-detections. The five remaining replicate pairs yielded two values reported as detections, and all replicate pair analyses resulted in SDs within acceptable precision.

Replicate pairs of samples were analyzed for trace elements, nutrients, major and minor ions, silica, TDS, total arsenic and iron (unfiltered), and arsenic, chromium, and iron species (filtered). All replicate pairs were either composed of two values reported as non-detections or two values reported as detections. The analyses for all replicate pairs reported as detections resulted in SDs and RSDs within acceptable variability.

Six replicate pairs for tritium were analyzed for variability. All replicate pairs yielded statistically similar results ($p \leq 0.05$) and were, therefore, considered acceptable.

Matrix Spikes

Addition of a known concentration of a constituent (spike) to a replicate groundwater sample enables the laboratory to determine the effect of the matrix, in this case groundwater, on the analytical technique used to measure the constituent. The known compounds added in matrix spikes are the same as those analyzed in the groundwater samples. This enables an analysis of matrix interferences on a compound-by-compound basis. For this study, matrix spikes were added by the laboratories performing the analysis rather than in the field. Low and high matrix-spike recoveries may be a potential concern if the concentration of a compound in a groundwater sample is close to the benchmark; a low recovery could result in a falsely measured concentration less than the benchmark, whereas a high recovery could result in a falsely measured concentration greater than the benchmark.

The GAMA-PBP defined the data-quality objective range for acceptable median matrix-spike recoveries as 70 to 130 percent. Only constituents with median matrix-spike recoveries outside of this range were flagged as having unacceptable recoveries. Matrix spikes were performed for VOCs, low-level fumigants, pesticides and pesticide degradates, 1,2,3-TCP, and NDMA because the analytical methods for these constituents may be susceptible to matrix interferences.

Matrix-Spike Recoveries

Table A5A–D presents a summary of matrix-spike recoveries for the WSJV study unit. Spiked samples were collected at up to 16 percent of the wells sampled.

Six groundwater samples were spiked with VOCs to calculate matrix-spike recoveries. Median matrix-spike recoveries for all 85 spike compounds were between 70 and 130 percent. Two spike compounds (hexachlorobutadiene and styrene) had at least one matrix-spike recovery < 70 percent. Two spike compounds (acetone and DBCP) had at least one matrix-spike recovery > 130 percent, and DCBP was detected in groundwater samples (table A5A).

Eight groundwater samples were spiked with low-level fumigants to calculate matrix-spike recoveries. Median matrix-spike recoveries for both spike compounds were between 70 and 130 percent. DBCP had at least one matrix-spike recovery > 130 percent and two recoveries < 70 percent. EDB had three matrix-spike recoveries < 70 percent.

Eight groundwater samples were spiked with pesticide and pesticide degradate compounds to calculate matrix-spike recoveries. Median matrix-spike recoveries for 61 of the 83 spike compounds were between 70 and 130 percent. Twenty of the spike compounds had median matrix-spike recoveries < 70 percent, and two had median matrix-spike recoveries > 130 percent. Of the 16 compounds detected in groundwater samples, 14 had median matrix-spike recoveries within the acceptable range (table A5C).

The median matrix-spike recovery for hexazinone was less than the acceptable range (64.7 percent). Hexazinone was detected in three DM study area grid wells (0.029 µg/L, 0.009 µg/L, and 0.045 µg/L) and four DM-U wells (0.012 µg/L, 0.027 µg/L, 0.024 µg/L, and 0.076 µg/L; table 6). The minimum detected concentration (E0.009 µg/L) is slightly greater than the LRL of 0.008 µg/L. Because hexazinone was detected at a concentration of 0.001 µg/L, greater than the LRL, it was determined that the less than acceptable median matrix-spike recovery did not affect the NWQL analysis and results.

The median matrix-spike recovery for tebuthiuron was greater than the acceptable range (138.3 percent). Tebuthiuron was detected in one understanding well (DM-U-01) at a concentration of E0.01 µg/L (table 6). Because tebuthiuron was detected at a concentration an order of magnitude less than the LRL of 0.028 µg/L (table 6), it was determined that the less than acceptable median matrix-spike recovery did not affect the NWQL analysis and results.

At least one matrix-spike recovery for 44 pesticide and pesticide degradate spike compounds was < 70 percent. Of these spike compounds, deethylatrazine, 2-ethyl-6-methylaniline, and hexazinone were detected in groundwater samples. One pesticide and pesticide degradate spike compound (fipronil sulfide) had at least one matrix-spike recovery < 70 percent and one matrix-spike recovery > 130 percent, but it was not detected in groundwater samples. At least one matrix-spike recovery for seven pesticide and pesticide degradate spike compounds was > 130 percent. Of these spike compounds, tebuthiuron was detected in groundwater samples.

Four groundwater samples were spiked with NDMA, and nine groundwater samples were spiked with 1,2,3-TCP to calculate matrix-spike recoveries at Weck. All median matrix-spike recoveries were between 70 and 130 percent.

Surrogate Compounds

Surrogate compounds are added to groundwater samples in the laboratory prior to analysis to evaluate the recovery of similar constituents. Surrogate compounds were added in the laboratory to all groundwater and QC samples that were analyzed by the NWQL for VOCs and pesticides and pesticide degradates. Surrogates are used to identify general problems that may arise during laboratory sample analysis that could affect the analysis results for all compounds in that sample. Potential problems include matrix interferences (such as high levels of DOC) that produce a positive bias or incomplete laboratory recovery (possibly because of improper maintenance and calibration of analytical equipment) that produces a negative bias. A 70 to 130 percent recovery of surrogates, in general, is considered acceptable; values outside of this range indicate possible problems with the processing and analysis of samples (Connor and others, 1998; Sandstrom and others, 2001).

Surrogate Compound Recoveries

Table A6 presents a summary of the surrogate recoveries for the WSJV study unit. The table lists the surrogate, the analytical schedule on which it was applied, the number of analyses for blank and groundwater samples, the number of surrogate recoveries < 70 percent, and the number of surrogate recoveries > 130 percent for the blank and groundwater samples. Blank and groundwater samples were considered separately to assess whether or not the matrixes present in groundwater samples affect surrogate recoveries.

Most surrogate recoveries for the blank and groundwater samples were within the acceptable range of 70 to 130 percent. In total, 92 percent of the blank and 93 percent of the groundwater sample surrogate recoveries for VOC analyses were within the acceptable range. In addition, 92 percent of the blank and 94 percent of the groundwater sample surrogate recoveries for pesticide and pesticide degradate analyses were within the acceptable range. There were no significant differences between VOC and pesticide and pesticide degradate surrogate recoveries in blank and groundwater samples (Wilcoxon rank sum test, $p < 0.05$).

Laboratory Quality-Control Results for Inorganic Constituents

Laboratory bias as indicated from internal laboratory QC tests was investigated to determine whether or not the WSJV study unit data were affected by laboratory procedures. The BQS operates the Inorganic Blind Sample Project (IBSP) to monitor and evaluate the quality of results for analyses of trace elements, nutrients, major and minor ions, silica, and TDS by the NWQL. The IBSP submits standard reference samples consisting of natural matrix water samples spiked with reagent chemicals that contain known concentrations of the inorganic constituents (Farrar and Long, 1997). The IBSP data are readily available on the BQS website, and the BQS issues monthly summaries of the results, reporting the amount of bias observed in the results (http://bqs.usgs.gov/IBSP/).

The BQS monthly summaries were examined for March through July 2010, the period of time during which samples were analyzed for the WSJV study unit. During this time period, the BQS reported that four inorganic constituents showed evidence of bias: a positive bias for barium, cadmium, and molybdenum and a negative bias for magnesium. Examination of the results for the IBSP samples for these four constituents indicated that the analytical biases reported by the BQS were not significant.

The IBSP samples for barium had concentrations ranging from 26.0 µg/L to 63.0 µg/L. The average difference between the measured and expected concentrations was 1.0 µg/L (standard deviation = 2.0 µg/L), and the average relative percent difference between the measured and expected concentrations was 3 percent (standard deviation = 4 percent). The MCL-CA for barium is 1,000 µg/L; thus, the estimate of bias from the ISBP samples would be relevant for assessment of whether groundwater samples have barium concentrations greater than or less than the MCL-CA concentration or greater than or less than one-half of the MCL-CA concentration. However, the maximum concentration of barium in samples from the WSJV study unit was 346 µg/L (table 8); thus, a potential positive bias of 1.0 µg/L, or 3 percent, would not result in a measured concentration greater than either threshold when the true concentration would have been below the threshold.

The IBSP samples for cadmium had concentrations ranging from 0.18 µg/L to 1.7 µg/L. The average difference between the measured and expected concentrations was 0.12 µg/L (standard deviation = 0.08 µg/L), and the average relative percent difference between the measured and expected concentrations was 24 percent (standard deviation = 38 percent). The MCL-US for cadmium is 5 µg/L, thus the estimate of bias from the ISBP samples would be relevant for assessment of whether groundwater samples have cadmium concentrations greater than or less than the MCL-US concentration or greater than or less than one-half of the MCL-US concentration. However, the maximum concentration of cadmium in samples from the WSJV study unit was 0.34 µg/L (table 8); thus, a potential positive bias of 0.12 µg/L, or 24 percent, would not result in a measured concentration above either threshold when the true concentration would have been below the threshold.

The IBSP samples for molybdenum had concentrations ranging from 1.8 µg/L to 33.4 µg/L. The average difference between the measured and expected concentrations was 0.50 µg/L (standard deviation = 0.79 µg/L), and the average relative percent difference between the measured and expected concentrations was 5 percent (standard deviation = 4 percent). The HAL-US for molybdenum is 40 µg/L, thus the estimate of bias from the ISBP samples would be relevant for assessment of whether groundwater samples have molybdenum concentrations greater than or less than the HAL-US concentration or greater than or less than one-half of the HAL-US concentration. Taking into account the potential positive bias of 0.5 µg/L or 5 percent for molybdenum concentrations reported by the NWQL, there would have been no significant change in whether the reported values were greater than or less than the HAL-US concentration or greater than or less than one-half of the HAL-US concentration.

The IBSP samples for magnesium had concentrations ranging from 0.05 mg/L to 7.3 mg/L. The average difference between the measured and expected concentrations was –0.17 mg/L (standard deviation = 0.22 mg/L), and the average relative percent difference between the measured and expected concentrations was –5 percent (standard deviation = 4 percent). A negative bias of 5 percent or 0.17 mg/L can only potentially affect measured concentrations of less than 7.3 mg/L in WSJV study unit groundwater samples (table 10). Magnesium does not currently have an established regulatory/non-regulatory health-based or aesthetic benchmark; therefore, this negative bias will not affect the assessments of groundwater quality being made by the GAMA-PBP.

Table A1. Analytical methods used by the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) and contract laboratories.

[Laboratory entity codes in the USGS National Water Information System (NWIS) for laboratories other than the USGS National Water Quality Laboratory (NWQL) are given in parentheses after the laboratory names. **Abbreviations:** USGS, U.S. Geological Survey; UV, ultraviolet; USEPA, U.S. Environmental Protection Agency; VOC, volatile organic compound; DOC, dissolved organic carbon; NRP, USGS National Reasearch Program]

Constituent	Analytical method	Laboratory and analytical schedule	Citation(s)
Water-quality indicators			
Field parameters	Calibrated field meters and test kits	USGS field measurement	U.S. Geological Survey, variously dated
Organic constituents			
VOCs	Purge and trap capillary gas chromatography/mass spectrometry	NWQL, Schedule 2020	Connor and others, 1998
Low-level fumigants	Micro-extraction and gas chromatography/electron-capture detection (USEPA method 504.1)	NWQL, Schedule 1306	Eichelberger, 1993
Pesticides and pesticide degradates	Solid-phase extraction and gas chromatography/mass spectrometry	NWQL, Schedule 2033	Zaugg and others, 1995; Lindley and others, 1996; Sandstrom and others, 2001; Madsen and others, 2003
Constituents of special interest			
Perchlorate	Liquid chromatography with mass spectrometry/mass spectrometry (USEPA Method 331.0)	Weck Laboratories, Inc. [Weck], City of Industry, California (CA-WECK), standard operating procedure ORG099.R01	U.S. Environmental Protection Agency, 2005
1,2,3-Trichloropropane (1,2,3-TCP)	Isotopic dilution purge and trap/gas chromatography/mass spectrometry	Weck Laboratories, Inc. [Weck], City of Industry, California (CA-WECK), standard operating procedure ORG083	Okamoto and others, 2002
N-Nitrosodimethylamine (NDMA)	Isotopic dilution with gas chromatography and chemical-ionization mass spectrometry (USEPA Method 1625 modified)	Weck Laboratories, Inc. [Weck], City of Industry, California (CA-WECK), standard operating procedure ORG065.R10	U.S. Environmental Protection Agency, 1989; Plomley and others, 1994
Inorganic constituents			
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; Faires, 1993; Fishman, 1993; McLain, 1993; American Public Health Association, 1998; Garbarino, 1999; Garbarino and others, 2006
Nutrients	Alkaline persulfate digestion, Kjedahl digestion	NWQL, Schedule 2755	Fishman, 1993; Patton and Kryskalla, 2003
DOC	UV-promoted persulfate oxidation and infrared spectrometry	NWQL, Laboratory Code 2613	Brenton and Arnett, 1993
Total arsenic and iron (unfiltered) and arsenic, chromium, and iron species (filtered)	Various techniques of ultraviolet visible (UV-VIS) spectrophotometry and atomic absorbance spectroscopy	USGS NRP Trace Metal Laboratory [TML], Boulder, Colorado (USGSTMCO)	Stookey, 1970; To and others, 1998; Ball and McCleskey, 2003a and 2003b; McCleskey and others, 2003
Stable isotopes of hydrogen and oxygen in 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
Stable isotopes of nitrogen and oxygen in dissolved nitrate	Denitrifier method and mass spectrometry	USGS Stable Isotope Laboratory, Reston, Virginia (USGSSIVA), NWQL Laboratory Code 2900	Révész and Casciotti, 2007

Table A1. Analytical methods used by the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) and contract laboratories.—Continued

[Laboratory entity codes in the USGS National Water Information System (NWIS) for laboratories other than the USGS National Water Quality Laboratory (NWQL) are given in parentheses after the laboratory names. **Abbreviations:** USGS, U.S. Geological Survey; UV, ultraviolet; USEPA, U.S. Environmental Protection Agency; VOC, volatile organic compound; DOC, dissolved organic carbon; NRP, USGS National Reasearch Program]

Constituent	Analytical method	Laboratory and analytical schedule	Citation(s)
		Stable isotopes	
Stable isotopes of sulfur in dissolved sulfate	Vacuum extraction and mass spectrometry	USGS Stable Isotope Laboratory, Reston, Virginia (USGSSIVA), NWQL Laboratory Code 1951	Carmody and others, 1998
Stable isotopes of boron in water	Negative thermal-ionization mass spectrometry	USGS NRP Metals Isotope Research Laboratory, Menlo Park, California (USGSMICA)	Vengosh and others, 1989; Dwyer and Vengosh, 2008
Isotopic ratio of strontium in water	Chemical separations and thermal-ionization mass spectrometry	USGS NRP Metals Isotope Research Laboratory, Menlo Park, California (USGSMICA)	Bullen and others, 1996
Stable isotopes of carbon in dissolved inorganic carbon and carbon-14 abundance	Accelerator mass spectrometry	Woods Hole Oceanographic Institution, National Ocean Sciences Accelerator Mass Spectrometry Facility [NOSAMS], Woods Hole, Massachusetts (MA-WHAMS), NWQL Schedule 2255	Vogel and others, 1987; Donahue and others, 1990; McNichol and others, 1992; Gagnon and Jones, 1993; McNichol and others, 1994; Schneider and others, 1994
		Radioactivity and dissolved gases	
Tritium	Electrolytic enrichment-liquid scintillation	USGS Stable Isotope and Tritium Laboratory [SITL], Menlo Park, California (USGSH3CA), NWQL Schedule 1565	Thatcher and others, 1977
Dissolved standard gases (argon, carbon dioxide, methane, nitrogen, and oxygen)	Gas chromatography/thermal conductivity detector and flame ionization detector	USGS Chlorofluorocarbon Laboratory, Reston, Virginia (USGSCFCVA)	Busenberg and others, 2001
Dissolved noble gases (argon, helium-4, krypton, neon, and xenon), tritium, and helium isotope ratios	Helium-3 in-growth and mass spectrometry	Lawrence Livermore National Laboratory [LLNL], Livermore, California (CA-LLNL)	Moran and others, 2002; Eaton and others, 2004

Table A2. Preferred analytical methods or laboratories for selected constituents collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.

[Preferred analytical schedules/methods are selected on the basis of the procedure recommended by the NWQL (http://wwwnwql.cr.usgs.gov/dyn.shtml?Preferred_method_selection_procedure).
Abbreviations: USGS, U.S. Geological Survey; NWQL, USGS National Water Quality Laboratory, Denver, Colorado; DBCP, 1,2-Dibromo-3-chloropropane; EDB, 1,2-Dibromoethane; NRP, USGS National Research Project; VOC, volatile organic compound; 1,2,3-TCP, 1,2,3-Trichloropropane; Weck, Weck Laboratories Inc., City of Industry, California; TML, USGS NRP Trace Metal Laboratory, Boulder, Colorado; LLNL, Lawrence Livermore National Laboratory, Livermore, California; SITL, USGS Stable Isotope and Tritium Laboratory, Menlo Park, California; np, no preference]

Constituent (synonym or abbreviation)	Primary constituent classification	Analytical methods or laboratory	Preferred analytical method or laboratory
Results from preferred method reported			
Low-level DBCP	Fumigant	Schedule 1306 (NWQL), Schedule 2020 (NWQL)	Schedule 1306
Low- level EDB	Fumigant	Schedule 1306 (NWQL), Schedule 2020 (NWQL)	Schedule 1306
Results from both methods reported			
pH	Water-quality indicator	field, Schedule 1948 (NWQL)	field
Specific conductance	Water-quality indicator	field, Schedule 1948 (NWQL)	field
Alkalinity	Water-quality indicator	field, Schedule 1948 (NWQL)	field
1,2,3-TCP	VOC	Schedule 2020 (NWQL), Weck	Weck
Arsenic (total, filtered)	Trace element	Schedule 1948 (NWQL), TML	Schedule 1948
Chromium (total, filtered)	Trace element	Schedule 1948 (NWQL), TML	Schedule 1948
Iron (total, filtered)	Trace element	Schedule 1948 (NWQL), TML	Schedule 1948
Tritium	Inorganic tracer	SITL, LLNL	np

Table A3. Constituents detected in blanks and the study reporting level (SRL) analysis for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.

[The SRLs were defined by: (1) the highest concentration in blanks collected for this study unit, (2) Fram and others (2012), or (3) Olsen and others (2010). **Abbreviations:** LRL, laboratory reporting level; volatile organic compound, VOC; ≤, less than or equal to; E, estimated or having a higher degree of uncertainty; µg/L, micrograms per liter; mg/L, milligrams per liter; nv, no value in category; —, not detected; TDS, total dissolved solids]

Constituent	Number of blank detections / total number of blanks			LRL	Concentrations detected in blanks	SRL	Number of groundwater samples ≤ -coded / total number of detections
	Field blanks	Source-solution blanks	Equipment blank				
VOCs (µg/L)							
Acetone	1/8	0/3	0/1	0.8	E0.3	nv	0/0
Carbon disulfide	1/8	0/3	0/1	0.04	0.06	0.06	2/6
Chloroform (trichloromethane)	0/8	0/3	1/1	0.03	E0.02	0.03	0/5
Ethylbenzene	0/8	0/3	0/1	0.036	—	0.1	0/2
Toluene	3/8	1/3	0/1	0.018	E0.01, E0.03, E0.04, 0.04	0.69	1/2
1,2,4-Trimethylbenzene	0/8	0/3	0/1	0.032	—	0.56	1/1
m- plus *p*-Xylene	0/8	0/3	0/1	0.08	—	0.4	0/1
o-Xylene	0/8	0/3	0/1	0.032	—	0.1	0/2
Trace elements (µg/L)							
Chromium	0/8	0/2	0/1	0.12	—	0.42	14/41
Cobalt	8/8	0/2	1/1	0.010	0.10, 0.16, 0.18, 0.21, 0.22, 0.27, 0.28, 0.33, 0.33, 0.33	0.33	48/58
Copper	2/8	0/2	0/1	1.0	E0.59, E0.84	1.7	5/9
Iron	0/8	0/2	0/1	6	—	6	8/43
Lead	3/8	0/2	0/1	0.030	E0.02, E0.02, 0.04	0.65	27/38
Manganese	8/8	0/2	1/1	0.26	E0.21, E0.23, 0.30, 0.37, 0.45, 0.46, 0.49, 0.51, 0.52	0.52	3/52
Molybdenum	1/8	0/2	1/1	0.028	E0.02, E0.02	nv	0/58
Nickel	0/8	0/2	0/1	0.12	—	0.36	5/55
Silver	1/8	0/2	1/1	0.010	E0.005, 0.01	0.01	3/17
Tungsten	1/8	0/2	0/1	0.020	0.03	0.11	10/46
Zinc	0/8	0/2	0/1	2.8	—	4.8	14/26
Nutrients and major ions (mg/L)							
Ammonia (as nitrogen)	1/8	0/0	0/1	0.02	E0.02	E0.02	3/36
Nitrite (as nitrogen)	1/8	0/0	0/1	0.002	E0.001	nv	0/18
Alkalinity	1/8	0/2	0/1	8	E4	nv	0/58
TDS	1/8	0/2	0/1	10	34	nv	0/58

Table A4A. Quality-control summary for replicate analyses of organic constituents, constituents of special interest, and dissolved organic carbon (DOC) in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.

[Constituents for which all replicate pairs were non-detections are not listed. **Abbreviations:** SD, percent standard deviation; RSD, percent relative standard deviation; ≤, less than or equal to; >, greater than; <, less than; RL; reporting level; nv, no value in category]

Constituent	Number of non-detections / number of replicates	Number of ≤-coded replicates	Number of SDs > ½ RL / number of replicates with concentration < 5 times the RL	Concentrations of replicates with SDs > ½ RL (groundwater sample, replicate)	Number of RSDs > 10 percent / number of replicates with concentration > 5 times the RL	Concentrations of replicates with RSDs > 10 percent (groundwater sample, replicate)
Volatile organic compounds (VOCs)						
Chloroform (Trichloromethane)	5/6	nv	0/1	nv	nv	nv
Methyl *tert*-butyl ether (MTBE)	5/6	nv	0/1	nv	nv	nv
Pesticides and pesticide degradates						
Simazine	5/6	nv	0/1	nv	nv	nv
Deethylatrazine (2-Chloro-4-isopropylamino-6-amino-*s*-triazine)	5/6	nv	0/1	nv	nv	nv
Atrazine	5/6	nv	0/1	nv	nv	nv
Hexazinone	5/6	nv	0/1	nv	nv	nv
S-Ethyl-dipropylthiocarbamate (EPTC)	5/6	nv	0/1	nv	nv	nv
3,4-Dichloroaniline	5/6	nv	0/1	nv	nv	nv
Metolachlor	4/6	nv	0/2	nv	nv	nv
Constituents of special interest						
Perchlorate	5/6	nv	nv	nv	0/1	nv
Dissolved organic carbon (DOC)						
DOC	1/6	nv	0/5	nv	nv	nv

Table A4B. Quality-control summary for replicate analyses of inorganic constituents in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.

[Constituents for which all replicate pairs were non-detections are not listed. **Abbreviations:** SD, percent standard deviation; RSD, percent relative standard deviation in percent; RL, reporting level; >, greater than; <, less than; ≤, less than or equal to; nv, no value in category]

Constituent	Number of non-detections or <-coded replicates / number of replicates	Number of SDs > ½ RL / number of replicates with concentration < 5 times the RL	Concentrations of replicates with SDs > ½ RL (groundwater sample, replicate)	Number of RSDs > 10 percent / number of replicates with concentration > 5 times the RL	Concentrations of replicates with RSDs > 10 percent (groundwater sample, replicate)
Trace Elements					
Aluminum	3/6	0/3	nv	nv	nv
Antimony	3/6	0/3	nv	nv	nv
Arsenic	0/6	nv	nv	0/6	nv
Barium	0/6	nv	nv	0/6	nv
Beryllium	5/6	0/1	nv	nv	nv
Boron	0/6	nv	nv	0/6	nv
Cadmium	1/6	0/1	nv	0/4	nv
Chromium	4/6	nv	nv	0/2	nv
Cobalt	5/6	0/1	nv	nv	nv
Copper	4/6	0/2	nv	nv	nv
Iron	3/6	nv	nv	0/3	nv
Lead	4/6	nv	nv	0/2	nv
Lithium	0/6	nv	nv	0/6	nv
Manganese	0/6	nv	nv	0/6	nv
Molybdenum	0/6	nv	nv	0/6	nv
Nickel	2/6	0/1	nv	0/3	nv
Selenium	2/6	0/1	nv	0/3	nv
Silver	4/6	0/1	nv	0/1	nv
Strontium	0/6	nv	nv	0/6	nv
Tungsten	0/6	0/1	nv	0/5	nv
Uranium	0/6	0/1	nv	0/5	nv
Vanadium	0/6	0/1	nv	0/5	nv
Zinc	5/6	0/1	nv	nv	nv
Nutrients					
Ammonia (as nitrogen)	1/6	0/3	nv	0/2	nv
Nitrate plus nitrite (as nitrogen) [1]	3/6	0/1	nv	0/2	nv
Nitrite (as nitrogen)	4/6	0/1	nv	0/1	nv
Total nitrogen (ammonia + nitrite + nitrate + organic nitrogen)	0/6	0/4	nv	0/2	nv
Phosphate, orthophosphate (as phosphorus)	0/6	0/4	nv	0/2	nv
Major and minor ions, silica, and total dissolved soilds (TDS)					
Bromide	0/6	nv	nv	0/6	nv
Calcium	0/6	nv	nv	0/6	nv
Chloride	0/6	nv	nv	0/6	nv
Fluoride	0/6	0/4	nv	0/2	nv
Iodide	0/6	0/1	nv	0/5	nv
Magnesium	0/6	nv	nv	0/6	nv
Potassium	0/6	nv	nv	0/6	nv
Sodium	0/6	nv	nv	0/6	nv

Table A4B. Quality-control summary for replicate analyses of inorganic constituents in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[Constituents for which all replicate pairs were non-detections are not listed. **Abbreviations:** SD, percent standard deviation; RSD, percent relative standard deviation in percent; RL, reporting level; >, greater than; <, less than; ≤, less than or equal to; nv, no value in category]

Constituent	Number of non-detections or <-coded replicates / number of replicates	Number of SDs > ½ RL / number of replicates with concentration < 5 times the RL	Concentrations of replicates with SDs > ½ RL (groundwater sample, replicate)	Number of RSDs > 10 percent / number of replicates with concentration > 5 times the RL	Concentrations of replicates with RSDs > 10 percent (groundwater sample, replicate)
Major and minor ions, silica, and total dissolved soilds (TDS) —Continued					
Sulfate	0/6	nv	nv	0/6	nv
Silica (as SiO_2)	0/6	nv	nv	0/6	nv
TDS	0/6	nv	nv	0/6	nv
Total arsenic and iron (unfiltered) and arsenic, chromium, and iron species (filtered)					
Arsenic (total, unfiltered)	0/6	nv	nv	nv	nv
Iron (total, unfiltered)	1/6	5/6	nv	nv	nv
Arsenic (total, filtered)	0/6	nv	nv	0/6	nv
Arsenic-III (filtered)	2/6	nv	nv	0/4	nv
Chromium (total, filtered)	1/4	0/1	nv	0/2	nv
Chromium-VI	0/4	0/2	nv	0/2	nv
Iron (total, filtered)	1/6	5/6	nv	nv	nv
Iron-II (filtered)	1/6	5/6	nv	nv	nv

[1] Nitrite plus nitrate (as nitrogen) is referred to as nitrate in the text for clarity.

Table A5A. Quality-control summary for matrix-spike recoveries of volatile organic compounds (VOCs) in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.

[Acceptable recovery range is between 70 and 130 percent]

Constituent	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)
Acetone	6	101	150	123.4
Acrylonitrile	6	99	119	111.9
tert-Amyl methyl ether (TAME)	6	90	103	94.7
Benzene [1]	6	96	111	100.9
Bromobenzene	6	90	103	94.6
Bromochloromethane	6	102	112	106.5
Bromodichloromethane	6	94	108	104.3
Bromoform (Tribromomethane) [1]	6	84	109	99.4
Bromomethane (Methyl bromide)	6	92	118	106.4
n-Butylbenzene	6	79	106	90.1
sec-Butylbenzene	6	85	109	93.7
tert-Butylbenzene	6	89	114	101.2
Carbon disulfide [1]	6	75	91	77.5
Carbon tetrachloride (Tetrachloromethane)	6	94	110	97.5
Chlorobenzene	6	92	102	95.5
Chloroethane	6	101	112	103.3
Chloroform (Trichloromethane) [1]	6	101	116	112.9
Chloromethane	6	103	116	105.7
3-Chloropropene	6	107	121	110.2
2-Chlorotoluene	6	90	114	95.8
4-Chlorotoluene	6	87	114	97.1
Dibromochloromethane [1]	6	88	110	102.5
1,2-Dibromo-3-chloropropane (DBCP) [1]	6	94	132	105.2
1,2-Dibromoethane (EDB)	6	94	110	101.0
Dibromomethane	6	95	111	100.3
1,2-Dichlorobenzene	6	92	112	98.8
1,3-Dichlorobenzene	6	88	113	97.1
1,4-Dichlorobenzene	6	86	112	95.7
trans-1,4-Dichloro-2-butene	6	84	113	94.9
Dichlorodifluoromethane (CFC-12)	6	70	99	87.6
1,1-Dichloroethane (1,1-DCA) [1]	6	100	116	105.2
1,2-Dichloroethane (1,2-DCA)	6	101	117	109.0
1,1-Dichloroethene (1,1-DCE)	6	91	104	97.3
cis-1,2-Dichloroethene (*cis*-1,2-DCE)	6	97	109	101.8
trans-1,2-Dichloroethene (*trans*-1,2-DCE)	6	97	116	101.1
1,2-Dichloropropane [1]	6	95	104	98.9
1,3-Dichloropropane	6	97	110	103.6
2,2-Dichloropropane	6	89	97	92.0
1,1-Dichloropropene	6	89	100	92.5
cis-1,3-Dichloropropene	6	82	97	88.4
trans-1,3-Dichloropropene	6	82	95	89.6
Diethyl ether	6	104	121	105.9
Diisopropyl ether (DIPE)	6	91	113	96.3

Table A5A. Quality-control summary for matrix-spike recoveries of volatile organic compounds (VOCs) in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[Acceptable recovery range is between 70 and 130 percent]

Constituent	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)
Ethylbenzene [2]	6	87	100	94.0
Ethyl *tert*-butyl ether (ETBE)	6	88	101	94.2
Ethyl methacrylate	6	90	100	94.6
o-Ethyl toluene [1]	6	79	106	91.5
Hexachlorobutadiene	6	65	89	80.0
Hexachloroethane	6	78	110	96.1
2-Hexanone (*n*-Butyl methyl ketone)	6	82	107	96.2
Iodomethane (Methyl iodide)	6	106	126	110.7
Isopropylbenzene [1]	6	82	109	92.8
4-Isopropyl-1-methyl benzene [1]	6	77	110	95.7
Methyl acrylate	6	92	119	109.3
Methyl acrylonitrile	6	96	123	113.3
Methyl *tert*-butyl ether (MTBE) [1]	6	100	116	104.8
Methyl *iso*-butyl ketone (MIBK)	6	86	104	95.5
Methylene chloride (Dichloromethane)	6	94	108	100.0
Methyl ethyl ketone (2-butanone, MEK)	6	94	111	109.0
Methyl methacrylate	6	88	101	92.2
Naphthalene	6	82	111	100.5
Perchloroethene (PCE, Tetrachloroethene)	6	92	108	104.6
n-Propylbenzene [1]	6	84	100	93.8
Styrene	6	32	105	87.6
1,1,1,2-Tetrachloroethane	6	90	112	96.3
1,1,2,2-Tetrachloroethane	6	93	109	99.8
Tetrahydrofuran	6	88	122	109.8
1,2,3,4-Tetramethylbenzene [1]	6	74	108	95.1
1,2,3,5-Tetramethylbenzene [1]	6	79	122	104.9
Toluene [2]	6	93	107	96.6
1,2,3-Trichlorobenzene	6	87	114	98.5
1,2,4-Trichlorobenzene	6	78	100	87.5
1,1,1-Trichloroethane (1,1,1-TCA)	6	95	107	102.0
1,1,2-Trichloroethane (1,1,2-TCA)	6	96	112	105.5
Trichloroethene (TCE) [1]	6	92	107	95.6
Trichlorofluoromethane (CFC-11)	6	86	115	100.3
1,2,3-Trichloropropane (1,2,3-TCP)	6	96	115	101.1
Trichlorotrifluoroethane (CFC-113)	6	79	101	87.9
1,2,3-Trimethylbenzene [1]	6	83	121	102.0
1,2,4-Trimethylbenzene	6	85	118	100.1
1,3,5-Trimethylbenzene	6	87	109	95.6

Table A5A. Quality-control summary for matrix-spike recoveries of volatile organic compounds (VOCs) in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[Acceptable recovery range is between 70 and 130 percent]

Constituent	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)
Vinyl bromide (Bromoethene)	6	99	110	101.2
Vinyl chloride (Chloroethene)	6	104	125	113.2
m- plus *p*-Xylene [2]	6	86	111	96.8
o-Xylene [2]	6	86	101	91.9

[1] Constituent detected in groundwater samples.

[2] The SRLs were defined by Fram and others (2012). Values measured at concentrations less than or equal to the SRL have been flagged with a ≤ symbol, reclassified as non-detections, and not included in the calculations of detection frequencies (with the exception of wells WS-U-01 and WS-U-02 [see the appendix section titled “Detections in Blanks and Application of SRLs” for details]).

Table A5B. Quality-control summary for matrix-spike recoveries of low-level fumigants in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.

[Acceptable recovery range is between 70 and 130 percent]

Constituent	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)
1,2-Dibromo-3-chloropropane (DBCP) [1]	8	42	115	95.7
1,2-Dibromoethane (EDB)	8	48	112	84.4

[1] Constituent detected in groundwater samples.

Table A5C. Quality-control summary for matrix-spike recoveries of pesticides and pesticide degradates in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.

[Acceptable recovery range is between 70 and 130 percent]

Constituent	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)
Acetochlor	8	86	117	102.0
Alachlor	8	90	115	103.0
Atrazine [1]	8	89	117	102.0
Azinphos-methyl	8	55	137	104.5
Azinphos-methyl oxon	8	41	89	68.1
Benfluralin	8	56	85	71.2
Carbaryl	8	83	144	105.5
Carbofuran	8	83	150	111.6
2-Chloro-2,6-diethylacetanilide	8	88	116	96.6
4-Chloro-2-methylphenol	8	59	93	79.3
Chlorpyrifos	8	72	101	89.1
Chlorpyrifos oxon	8	18	47	33.5
Cyanazine	8	64	125	104.9
Cyfluthrin	8	36	93	64.1
λ-Cyhalothrin	8	28	73	54.9
Cypermethrin	8	37	84	65.8
DCPA (Dacthal) [1]	8	98	116	110.9
Deethylatrazine (2-Chloro-4-isopropylamino-6-amino-*s*-triazine) [1]	8	24	112	89.8
Desulfinylfipronil	8	74	129	101.0
Desulfinylfipronil amide	8	38	107	84.3
Diazinon	8	80	104	95.6
Diazinon oxon	8	71	107	94.7
3,4-Dichloroaniline [1]	8	74	98	90.2
3,5-Dichloroaniline [1]	8	86	103	97.1
Dichlorvos	8	13	38	22.0
Dicrotophos	8	8	48	32.7
Dieldrin	8	70	106	85.6
2,6-Diethylaniline [1]	8	81	101	95.6
Dimethoate	8	16	70	57.9
Disulfoton	8	58	86	75.2
Disulfoton sulfone	8	74	103	85.2
α-Endosulfan	8	63	108	78.3
Endosulfan sulfate	8	63	115	93.2
Ethion	8	45	89	69.2
Ethion monoxon	8	53	99	76.3
Ethoprophos	8	87	118	100.5
S-Ethyl-dipropylthiocarbamate (EPTC) [1]	8	76	108	94.4
2-Ethyl-6-methylaniline [1]	8	66	99	88.7
Fenamiphos	8	74	101	93.0
Fenamiphos sulfone	8	60	113	92.5
Fenamiphos sulfoxide	8	17	75	39.0
Fipronil	8	74	144	95.1
Fipronil sulfide	8	67	143	99.1
Fipronil sulfone	8	55	99	81.1
Fonofos	8	80	100	92.8
Hexazinone [1]	8	46	85	64.7

Table A5C. Quality-control summary for matrix-spike recoveries of pesticides and pesticide degradates in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.—Continued

[Acceptable recovery range is between 70 and 130 percent]

Constituent	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)
Iprodione	8	60	126	84.0
Isofenphos	8	80	133	104.0
Malaoxon	8	69	106	85.6
Malathion	8	79	111	96.3
Metalaxyl [1]	8	92	117	110.9
Methidathion	8	66	108	87.2
Metolachlor [1]	8	83	114	104.9
Metribuzin	8	64	105	92.6
Molinate [1]	8	89	109	99.5
Myclobutanil	8	75	109	78.2
1-Naphthol	8	12	52	33.7
Oxyfluorfen	8	44	83	62.7
Paraoxon-methyl	8	51	98	68.3
Parathion-methyl	8	72	125	87.5
Pendimethalin	8	72	118	82.3
cis-Permethrin	8	33	107	59.3
Phorate	8	54	80	78.0
Phorate oxon	8	75	119	102.3
Phosmet	8	22	76	56.8
Phosmet oxon	8	16	64	45.1
Prometon [1]	8	91	113	103.2
Prometryn [1]	8	91	117	105.6
Pronamide	8	78	110	96.1
Propanil	8	83	124	104.0
Propargite	8	44	94	68.1
cis-Propiconazole	8	105	260	131.9
trans-Propiconazole	8	59	113	84.4
Simazine [1]	8	88	112	100.4
Tebuconazole	8	51	103	80.6
Tebuthiuron [1]	8	89	210	138.3
Tefluthrin	8	41	60	51.3
Terbufos	8	59	95	84.7
Terbufos oxon sulfone	8	42	105	75.2
Terbuthylazine	8	97	117	107.1
Thiobencarb	8	88	114	102.3
Tribufos	8	33	68	56.7
Trifluralin	8	58	89	73.4

[1] Constituent detected in groundwater samples.

Table A5D. Quality-control summary for matrix-spike recoveries of constituents of special interest in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.

[Acceptable recovery range is between 70 and 130 percent]

Constituent	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)
1,2,3-Trichloropropane (1,2,3-TCP) [1]	9	95	117	110
N-Nitrosodimethylamine (NDMA)	4	86	131	113.0

[1] Constituent detected in groundwater samples.

Table A6. Quality-control summary for surrogate recoveries of volatile organic compounds (VOCs) and pesticides and pesticide degradates in samples collected for the Western San Joaquin Valley (WSJV) Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California, March to July 2010.

[**Abbreviations:** NWQL, U.S. Geological Survey National Water Quality Laboratory; VOC, volatile organic compound]

Surrogate	NWQL analytical schedule	Constituent class analyzed	Number of blanks analyzed	Median recovery in blanks (percent)	Number of surrogate recoveries less than 70 percent in blanks	Number of surrogate recoveries greater than 130 percent in blanks	Number of groundwater samples analyzed	Median recovery in samples (percent)	Number of surrogate recoveries less than 70 percent in samples	Number of surrogate recoveries greater than 130 percent in samples
1-Bromo-4-fluorobenzene	2020	VOC	13	90	0	0	58	89	0	0
1,2-Dichloroethane-*d4*	2020	VOC	13	127	0	3	58	125	0	13
Toluene-*d8*	2020	VOC	13	94	0	0	58	93	0	0
Diazinon-*d10*	2033	Pesticide	12	81	2	0	58	84	7	0
α-HCH-*d6*	2033	Pesticide	12	89	0	0	58	94	0	0

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