San Joaquin River Hydrologic Region — Table of Contents

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Acronyms and Abbreviations Used in This Report

μg/L	micrograms per liter
af	acre-feet
af/yr	acre-feet per year
AGR	agricultural supply
CAFOs	Concentrated Animal Feeding Operations
CDFA	California Department of Food and Agriculture
CDP	Census Designated Place
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CVFPP	Central Valley Flood Protection Plan
CVJV	Central Valley Joint Venture
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
CV-SALTS	Salinity Alternatives for Long-Term Sustainability
CWA	Clean Water Act
CWC	California Water Code
CWI	California Water Institute
CWP	California Water Plan
DAC	disadvantaged community
DBCP	1,2-Dibromo-3-chloropropane
Delta	Sacramento-San Joaquin River Delta
DFW	California Department of Fish and Wildlife
DMC	Delta-Mendota Canals
DWR	California Department of Water Resources
EBMUD	East Bay Municipal Utility District
EI	energy intensity
EPA	U.S. Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
Framework	Framework for the Implementation of Water Planning
FWUA	Friant Water Users Authority
GAMA	Groundwater Ambient Monitoring and Assessment
GHG	greenhouse gas
gpm	gallons per minute
GPS	global positioning system
GWMP	groundwater management plan
GWR	groundwater recharge
HIP	high population scenario
ILRP	Irrigated Lands Regulatory Program
IRWM	integrated regional water management
IWM	integrated water management
LOP	low population growth scenario

MCL	maximum contaminant level
MHI	Median Household Income
MHMP	Multi-Hazard Mitigation Plan
million acre-feet	maf
MOA	memorandum of agreement
MOU	memorandum of understanding
MUN	municipal and domestic supply
NMFS	National Marine Fisheries Service
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NPS	non-point source pollution
OHV	off-highway vehicle
OWTS	onsite wastewater treatment systems
PA 60	San Joaquin Delta
PA 60	Sierra Foothills Planning Area
PA 60	The Middle Valley East Side Planning Area
PA 60	The Valley West Side Planning Area
PA 60	Upper West Side Uplands Planning Area
PA 60	West Side Uplands Planning Area
PA 603	Eastern Valley Floor Planning Area
PA 607	Upper Valley East Side Planning Area
PA 609	Lower Valley East Side Planning Area
PA 610	East Side Uplands Planning Area
PCE	tetrachloroethylene
PCE	tetrachloroethylene
RAP	Region Acceptance Process
ROD	Record of Decision
RWMG	regional water management group
RWQCB	Regional Water Quality Control Board
San Luis Canal	San Luis Unit Project
SJRFP	San Joaquin River Flood Protection
SJVR	San Joaquin Valley Regional
SPFC	State Plan of Flood Control
SSJID	South San Joaquin Irrigation District
State Parks	California Department of Parks and Recreation
SWP	State Water Project
SWRCB	State Water Resources Control Board
SWRCB	State Water Resources Control Board
taf/yr	thousand acre-feet per year
TAS	treatment as a state
TCE	trichloroethylene
thousand acre-feet	taf
TMDL	total maximum daily load
UNAVCO	university-governed consortium for geosciences research using geodesy

Update 2013	*California Water Plan Update 2013*
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USGS	U.S. Geological Survey
UWMP	update urban water management plan
VAMP	Vernalis Adaptive Management Program
WRCC	Western Regional Climate Center

San Joaquin River Hydrologic Region

San Joaquin River Hydrologic Region Summary

[Section is under development.]

Current State of the Region

Setting

In the San Joaquin River Hydrologic Region, one in three residents, almost $42 billion worth of assets (crops, buildings, and public infrastructure), more than 875,000 acres of agricultural land, and over 260 sensitive species are exposed to the 500-year flood event. In San Joaquin County, two out of three residents and almost $1 billion in crop value are exposed to the 500-year flood event. The complexity of existing flood management infrastructure and responsibilities requires balancing agriculture, species, water supply, and flood management needs.

Major floods occur regularly in the San Joaquin River Hydrologic Region. The more damaging floods are usually caused by spring snowmelt. The flatness of the valley floor contributes to the areal extent of these floods. Flooding in the mountainous upper watersheds is rarer due to well-developed watercourses, but might still occur, especially in intermontane valleys. These floods take a variety of forms and can be classified into six categories (slow-rise, flash, stormwater, debris flow, alluvial fan, and engineered structure failure flooding).

The San Joaquin River Hydrologic Region is in California's great Central Valley and is generally the northern portion of the San Joaquin Valley. The region is south of the Sacramento River Hydrologic Region and north of the Tulare Lake Hydrologic Region (Figure SJR-1 San Joaquin River Hydrologic Region). The region includes approximately half of the Sacramento-San Joaquin River Delta (the Delta) — those areas that are in Contra Costa, Alameda, and San Joaquin counties. The region also contains portions of the following counties: Alpine, Amador, Benito, El Dorado, Fresno, Sacramento, San Joaquin, and all of Calaveras, Madera, Mariposa, Merced, Stanislaus, and Tuolumne counties.

PLACEHOLDER Figure SJR-1 San Joaquin River Hydrologic Region

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The hydrologic region is bordered on the east by the Sierra Nevada and on the west by the coastal mountains of the Diablo Range. It includes all of the San Joaquin River drainage area extending south from the southern boundaries of the Delta to include the headwaters of the San Joaquin River in Madera County and its southern drainage in Fresno County. The region is hydrologically separated from the Tulare Lake Hydrologic Region by a low broad ridge that extends across the San Joaquin Valley between the San Joaquin and Kings rivers.

At roughly 300 miles long, the San Joaquin River is one of the state's longest rivers. It has an average annual unimpaired runoff of approximately 1.8 million acre-feet (af), and its eight major tributaries drain about 32,000 square miles of watershed. The headwaters of the San Joaquin River begin near the 14,000-foot crest of the Sierra Nevada. The river flows from the western slope of the Sierra Nevada and turns northwestward on the San Joaquin Valley floor toward the Delta where it meets the Sacramento River. The two rivers converge in the Delta, which encompasses an area of more than 1,300 square miles. The Delta is a series of islands formed by a maze of channels receiving freshwater inflow from its major tributaries, smaller streams, and the Cosumnes, Mokelumne, and Calaveras rivers. Historically, more than 40 percent of the state's annual runoff flows to the Delta via the Sacramento, San Joaquin, and Mokelumne rivers. (For more information, see the Sacramento-San Joaquin Delta Regional Report in Volume 2.)

Watersheds

The San Joaquin River is the principal river of the region, and all other streams of the region are tributary to it (see Figure SJR-2B). The Mokelumne River and its tributary the Cosumnes River originate in the central Sierra Nevada, along with the more southern Stanislaus and Tuolumne rivers. The Merced River flows from the south central Sierra Nevada and enters the San Joaquin near the City of Newman. The Chowchilla and Fresno rivers also originate in the Sierra south of the Merced River and trend westward toward the San Joaquin River. Creeks originating in the Coast Range and draining eastward into the San Joaquin River include Del Puerto Creek, Orestimba Creek, and Panoche Creek. Del Puerto Creek enters the San Joaquin near the City of Patterson, and Orestimba Creek enters north of the City of Newman. During flood years, Panoche Creek may enter the San Joaquin River or the Fresno Slough near the town of Mendota. The Kings River is a stream of the Tulare Lake Hydrologic Region, but in flood years it may contribute to the San Joaquin River, flowing northward through the James Bypass and Fresno Slough to enter near the City of Mendota. The Mud, Salt, Berrenda, and Ash sloughs also add to the San Joaquin River, and numerous lesser streams and creeks also enter the system, originating in both the Sierra Nevada and the Coast Range. The entire San Joaquin river system drains northwesterly through the Delta to Suisun Bay.

PLACEHOLDER Figure SJR-2 San Joaquin River Hydrologic Region Watersheds

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Groundwater Aquifers

Groundwater resources in the San Joaquin River Hydrologic Region are supplied by both alluvial and fractured rock aquifers. Alluvial aquifers are composed of sand and gravel or finer grained sediments, with groundwater stored within the voids, or pore space, between the alluvial sediments. Fractured-rock aquifers consist of impermeable granitic, metamorphic, volcanic, and hard sedimentary rocks, with groundwater being stored within cracks, fractures, or other void spaces. The distribution and extent of alluvial and fractured-rock aquifers and water wells vary within the region. A brief description of the aquifers for the region is provided below.

Aquifer Description

Alluvial Aquifers

The San Joaquin River Hydrologic Region contains 11 California Department of Water Resources (DWR) Bulletin 118-2003 recognized alluvial groundwater basins and subbasins which underlie approximately 5,800 square miles, or 38 percent of the region. Most of the groundwater in the region is stored in alluvial aquifers. Figure SJR-3 shows the location of the alluvial groundwater basins and subbasins and Table SJR-1 lists the associated names and numbers. Pumping from the alluvial aquifers in the region accounts for about 19 percent of California's total average annual groundwater extraction. The most heavily used groundwater basins in the region include the eight subbasins within the northern San Joaquin Valley groundwater basin — Eastern San Joaquin, Modesto, Turlock, Merced, Chowchilla, Madera, Delta-Mendota, and Tracy. As shown in Figure SJR-3, the two alluvial basins outside the San Joaquin Valley are Yosemite Valley and Los Banos Creek Valley.

PLACEHOLDER Figure SJR-3 Alluvial Groundwater Basins and Subbasins within the San Joaquin River Hydrologic Region

PLACEHOLDER Table SJR-1 Alluvial Groundwater Basins and Subbasins within the San Joaquin River Hydrologic Region

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Aquifer systems within the San Joaquin Valley of the region consist mostly of continental sediments eroded from the nearby surrounding mountains and deposited in the valley. The alluvial aquifer system is a complex set of interbedded aquifers and aquitards that function regionally as a single water-yielding unit (Poland 1972, quoted in Sneed 2001). The San Joaquin Valley aquifers are generally quite thick with groundwater wells extending to depths of more than 1,000 feet (Page 1986). The aquifers consist of gravel, sand, silt, and clay lenses, which become increasingly interbedded towards the center of the valley with fine-grained lake bed deposits (USGS 2011). The maximum thickness of freshwater deposits is about 4,400 feet and occurs at the south end of the valley. On a regional scale, the aquifer systems of the San Joaquin Valley Groundwater Basin can be divided into an upper unconfined to semi-confined aquifer, a series of geographically extensive confining clay layers, and a deep confined aquifer.

Alluvial deposits comprising the unconfined to semi-confined aquifers may be grouped into the Coast Range alluvium along the west side of the valley, Sierran alluvium on the east side of the valley, flood-basin deposits in the center of the valley (Faunt 2005), and buried river channel deposits within the alluvial fan and Pleistocene river courses.

Although a number of highly productive coarse-grained aquifers exist in the San Joaquin Valley of the region, fine-grained sediments comprise more than 50 percent of the valley fill deposits (Faunt 2005). Nearly continuous lake and/or marsh sediments have been present in the Tulare, Kern and Buena Vista Lake beds since Pliocene and Pleistocene time. These lake and marsh sediments formed thick clay plugs in the lake bed areas. The largest of these clay plugs is in the San Joaquin River area. Now drained, the clay marks the presence of a succession of lakes that periodically spread from the San Joaquin River area, extending outward into greater or lesser sized lakes. In the center of the spreading areas, the presence of thick (up to 3,000 feet) and extensive clay layers limit the amount of available groundwater for water supply. Six distinct lake clay layers have been identified in the geologic record. The largest of the ancestral lakes formed the "E-clay" or Corcoran Clay. The lake was geographically extensive, covering the western half of the San Joaquin Valley from the Kern Lake bed north to an area north of Modesto (Faunt 2009). The Corcoran Clay is up to 150 feet thick, occurs at a depth of about 250 feet below land surface along Highway 99 near Goshen and Pixley, and at a depth of 800 feet in the San Joaquin River bed area (Croft 1972). It is commonly described as "blue clay" on driller's logs and is one of the identifier's for the clay. The Corcoran Clay has formed a nearly impermeable barrier, separating the unconfined to semi-confined groundwater above from the confined groundwater below.

Two alluvial aquifers exist in basins outside the northern San Joaquin Valley portion of the region - Yosemite Valley and Los Banos Creek Valley. Yosemite Valley Groundwater Basin is managed by the United States National Park Service. No published literature was located that describes the occurrence and quantity of groundwater in the Los Banos Creek Valley Groundwater Basin. A review of well completion reports indicates that there are no known wells in the basin (DWR 2004).

Fractured-Rock Aquifers

Fractured-rock aquifers are typically found in the mountain and foothill areas adjacent to the Consumes, Eastern San Joaquin, Modesto, Turlock, Merced, and Madera Groundwater Basins. With few exceptions, the consolidated sediments in the Coast Range are devoid of available groundwater. Fractured rock aquifers in the region are generally associated with igneous and metamorphic rocks within the Sierra Nevada. Due to the highly variable nature of the void spaces within fractured-rock aquifers, wells drawing from fractured-rock aquifers tend to have less capacity and less reliability than wells drawing from alluvial aquifers. In fractured rock, the ability to transmit and store water decreases rapidly with depth and is small compared to sand aquifers (Swanson 1972). On average, wells drawing from fractured-rock aquifers yield less than 10 gallons per minute. With the exception of isolated areas of limestone and marble, the Sierra Nevada aquifers consist of a thin zone of decomposed rock overlying interconnected rock fractures and faults. Rock fractures can be large at the surface with planar openings of more than one or two inches. However, rock fracture openings generally diminish at depths ranging from 200 to 600 feet. There are notable exceptions, with deep wells (900 to 1,000 feet) producing yields of more than 100 gallons per minute (gpm) from fractured rock. In unweathered rock, about 5 to 15 percent of the wells median yields are less than 8 gpm and 10 percent will have yields of 50 gpm or more (Davis and Turk 1964).

Although fractured-rock aquifers are less productive compared to alluvial aquifers, groundwater from fractured rock aquifers with the Sierra Nevada foothills and mountains tend to supply individual domestic and stock wells, or small community water systems. The available supply fluctuates and is vulnerable to even short periods of low precipitation. The fractured rock is also an avenue for septic system biota to rapidly pass through areas of source water supply. Increasing development and growth in the foothills and mountains poses a risk to both supply and health, due to the interconnected nature of rock fractures and fissures.

More detailed information regarding the aquifers in the San Joaquin River Hydrologic Region is available online from California Water Plan Update 2013 (Update 2013), Volume 4, Reference Guide, the article "California's Groundwater Update 2013" and DWR Bulletin 118-2003.

Well Infrastructure and Distribution

Well logs submitted to DWR for water supply wells completed during 1977 through 2010 were used to evaluate the distribution of water wells and the uses of groundwater in the San Joaquin River Hydrologic Region. DWR does not have well logs for all the wells drilled in the region; and for some well logs, information regarding well location or use is inaccurate, incomplete, ambiguous, or missing. Hence, some well logs could not be used in the current assessment. However, for a regional scale evaluation of well installation and distribution, the quality of the data is considered adequate and informative. The number and distribution of wells in the region are grouped according to their location by county and according to six most common well-use types: domestic, irrigation, public supply, industrial, monitoring, and other. Public supply wells include all wells identified in the well completion report as municipal or public. Wells identified as “other” include a combination of the less common well types, such as stock wells, test wells, or unidentified wells (no information is listed regarding the well log).

Nine counties were included in the analysis of well infrastructure for the San Joaquin River Hydrologic Region. The number and type of wells listed by county are not necessarily indicative of number and type of wells within the entire hydrologic region. Well log data for counties that fall within multiple hydrologic regions are assigned to the hydrologic region containing the majority of alluvial groundwater basins within the county. The well log data for the San Joaquin River Hydrologic Region includes wells from Amador, Calaveras, Contra Costa, San Joaquin, Stanislaus, Merced, Tuolumne, Mariposa, and Madera Counties. Well log information listed in Table SJR-2 and illustrated in Figure SJR-4 show that the distribution and number of wells vary widely by county and by use. The total number of wells installed in the region between 1977 and 2010 is approximately 73,000, and ranges from a high of about 13,000 in Madera County to under 4,000 in Amador County. Well logs in San Joaquin and Stanislaus Counties are also high at about 11,000 each. The large proportion of wells in the three counties (47 percent) is related in part to the high proportion of the region’s population living in these counties.

In all except one county, domestic use wells make up the majority of well logs. In Contra Costa County, the number of monitoring well logs (5,773) greatly exceeds the number of domestic well logs (1,911). The lower number of domestic versus monitoring well logs in Contra Costa County is most likely the result of a more urban setting with residents mostly reliant on public water systems, coupled with groundwater contamination monitoring because of the presence of agriculture and industry. The highest numbers of irrigation well logs are in Merced (2,032), Madera (1,630), and Stanislaus (1,520) counties, located in the heart of the agricultural region of the northern San Joaquin Valley. In contrast, the mountain counties of Amador and Mariposa have the fewest numbers of irrigation well logs, 83 and 74, respectively. The public supply well logs follow high population growth in metropolitan areas of Madera (396), Stanislaus (269) and San Joaquin (229) counties; the more rural counties (Amador, Mariposa, Calaveras, and Tuolumne) have fewer numbers of public supply well logs generated over the same timeframe at 40, 74, and 79, respectively. The lone standout is Contra Costa County with 72 public supply well logs, but this could be a result of the already well developed urban communities in this county.

PLACEHOLDER Table SJR-2 Number of Well Logs by County and Use for the San Joaquin River Hydrologic Region (1977-2010)

PLACEHOLDER Figure SJR-4 Number of Well Logs by County and Land Use for the San Joaquin River Hydrologic Region (1977-2010)

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Figure SJR-5 shows that domestic wells make up the majority of well logs (65 percent) for the region, followed by monitoring wells (15 percent), and irrigation wells (about 10 percent). Statewide, domestic and irrigation wells account for about 54 and 10 percent per hydrologic region based on the total number of wells in the state.

PLACEHOLDER Figure SJR-5 Percentage of Well Logs By Use for the San Joaquin River Hydrologic Region (1977-2010)

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Figure SJR-6 shows a cyclic pattern of well installation for the region, with new well construction ranging from about 1,300 to 3,700 wells per year, with an average of about 2,200 wells per year. Installation trends for irrigation wells tend to closely follow changes in hydrology, cropping trends, and availability of alternate agricultural water supplies. Irrigation well installation in the region peaked at around 900 wells per year following the 1976-1977 drought, and continued at an installation rate ranging between 100 to 500 wells per year through 1982. Irrigation well installation dropped to approximately 50 wells in 1986 which corresponds with the wet years of the mid-1980s, before increasing again to an average of 300 wells per year during the 1989-1994 and 2008-2009 droughts. The DWR well log database does not differentiate between new irrigation wells installed and the deepening of existing wells. Therefore, a portion of irrigation well logs generated are most likely for the deepening of existing irrigation wells due to the declining groundwater levels in some areas. Much of the irrigation well infrastructure installed in the region during the late 1970s and early 1980s is still in use today.

The large fluctuation of domestic well drilling is likely associated with population booms and residential housing construction. The increase in domestic well drilling in the region during the late 1980s and early 1990s as well as early through mid-2000s is likely due to increases in housing construction during this time. Similarly, the 2007 to 2010 decline in domestic well drilling is likely due to declining economic conditions and related drop in housing construction.

PLACEHOLDER Figure SJR-6 Number of Well Logs Filed per Year by Use for the San Joaquin River Hydrologic Region (1977-2010)

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Monitoring wells in the region were first recorded in significant numbers in 1987, with over 450 wells installed; the number increased to a high of about 900 in 1989. The onset of monitoring well installation in the mid- to late-1980s is likely associated with federal underground storage tank programs signed into law in the mid-1980s. Since 1984, monitoring well installation in the region has averaged approximately 420 wells per year. Between 2004 and 2008, monitoring well installation in the region somewhat declined to approximately 390 monitoring wells per year. Overall, the total number and average number of monitoring well records for the region appears to be low considering the number of remedial action sites within the region by the California State Water Resources Control Board (www.geotracker.ca.gov).

More detailed information regarding assumptions and methods of reporting well log information is available online from Update 2013, Volume 4, Reference Guide, the article "California's Groundwater Update 2013."

California Statewide Groundwater Elevation Monitoring (CASGEM) Basin Prioritization

The Legislature in 2009, as part of a larger package of water-related bills, passed Senate Bill 7x 6 (SBx7 6; Part 2.11 to Division 6 of the California Water Code Section 10920 et seq.), requiring that groundwater elevation data be collected in a systematic manner on a statewide basis and be made readily and widely available to the public. DWR was charged with administering the program, which was later named the "California Statewide Groundwater Elevation Monitoring" or "CASGEM" Program. The new legislation requires DWR to identify the current extent of groundwater elevation monitoring within each of the alluvial groundwater basins defined under Bulletin 118-2003. The legislation also requires DWR to prioritize groundwater basins to help identify, evaluate, and determine the need for additional groundwater level monitoring by considering available data. Box SJR-1 provides a summary of these data considerations and resulting possible prioritization category of basins.

More detailed information on groundwater basin prioritization is available online from Update 2013, Volume 4, Reference Guide, the article "California's Groundwater Update 2013."

PLACEHOLDER Box SJR-1 California Statewide groundwater Elevation Monitoring (CASGEM) Basin Prioritization Data Considerations

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Figure SJR-7 shows the groundwater basin prioritization for the region. Of the 11 basins within the region, seven basins were identified as high priority, two as medium priority, and the remaining two basins as very low priority. Table SJR-3 lists the high, medium, and very low CASGEM priority groundwater basins for the region. The seven high and two medium priority basins account for 99 percent of the population and 99 percent of groundwater supply in the region. The basin prioritization could be a valuable tool to help evaluate, focus, and align limited resources for effective groundwater management, and reliability and sustainability of groundwater resources.

PLACEHOLDER Figure SJR-7 CASGEM Groundwater Basin Prioritization for the San Joaquin River Hydrologic Region

PLACEHOLDER Table SJR-3 CASGEM Groundwater Basin Prioritization for the San Joaquin River Hydrologic Region

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San Joaquin River Hydrologic Region Groundwater Monitoring Efforts

Groundwater resource monitoring and evaluation is a key aspect to understanding groundwater conditions, identifying effective resource management strategies, and implementing sustainable resource management practices. California Water Code (Section 10753.7) requires local agencies seeking State funds administered by DWR to prepare and implement groundwater management plans that include monitoring of groundwater levels, groundwater quality degradation, inelastic land subsidence, and changes in surface water flow and quality that directly affect groundwater levels or quality. This section summarizes some of the groundwater level, groundwater quality, and land subsidence monitoring efforts within the San Joaquin River Hydrologic Region. Groundwater level monitoring well information includes only active monitoring wells — those wells that have been measured since January 1, 2010.

Additional information regarding the methods, assumptions, and data availability associated with the groundwater monitoring is available online from Update 2013, Volume 4, Reference Guide, the article "California's Groundwater Update 2013."

Groundwater Level Monitoring

A list of the number of monitoring wells in the region by monitoring agencies, cooperators, and CASGEM monitoring entities is provided in Table SJR-4. The locations of these monitoring wells by monitoring entity and monitoring well type are shown in Figure SJR-8. San Joaquin River Hydrologic Region has the third largest number of groundwater level monitoring wells of the ten hydrologic regions. Table SJR-4 shows that a total of 1,532 wells in the region have been actively monitored for groundwater levels since 2010. DWR monitors a total of 117 wells; the U.S. Bureau of Reclamation (USBR) monitors 227 wells; and the U.S. Geological Survey (USGS) monitors groundwater levels in 38 wells. In addition to the State and federal agency, 11 cooperators and six CASGEM monitoring entities combined monitor a total of 428 wells in seven basins and subbasins. A comparison of Figure SJR-7 discussed previously and Figure SJR-8 indicate that all basins identified as having a high or medium priority are under the CASGEM groundwater basin prioritization have been monitored for groundwater levels.

PLACEHOLDER Table SJR-4 Groundwater Level Monitoring Wells by Monitoring Entity in the San Joaquin River Hydrologic Region

PLACEHOLDER Figure SJR-8 Monitoring Well Location by Agency, Monitoring Cooperator, and CASGEM Monitoring Entity in the San Joaquin River Hydrologic Region

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

The groundwater level monitoring wells are categorized by the type of well use and include domestic, irrigation, observation, public supply, and other. Groundwater level monitoring wells identified as "other" include a combination of the less common well types, such as stock wells, test wells, industrial wells, or unidentified wells (no information listed on the well log). Wells listed as "observation" also include those wells described by drillers in the well logs as "monitoring" wells. Well depths in the region tend to be deeper than other hydrologic regions. Declining groundwater levels, poor quality shallow aquifers, and highly productive deeper confined aquifer zones all contribute to the need for deeper well construction in the region relative to other hydrologic regions. Domestic wells are typically relatively shallow and are in the upper portion of the aquifer system, while irrigation wells tend to be deeper and are in the middle-to-deeper portion of the aquifer system. Some observation wells are constructed as a nested or clustered set of dedicated monitoring wells, designed to characterize groundwater conditions at specific and discrete production intervals throughout the aquifer system. Figure SJR-9 shows that wells identified as other and irrigation account for 67 and 21 percent, respectively, of the monitoring wells in the region, while wells listed as public supply comprise five percent of the total; observation wells comprise only four percent of the total.

PLACEHOLDER Figure SJR-9 Percentage of Monitoring Wells by Use in the San Joaquin River Hydrologic Region

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Groundwater Quality Monitoring

Groundwater quality monitoring is an important aspect to effective groundwater basin management and is one of the components that are required to be included in groundwater management planning in order for local agencies to be eligible for State funds. Numerous State, federal, and local agencies participate in groundwater quality monitoring efforts throughout California. A number of the existing groundwater quality monitoring efforts were initiated as part of the Groundwater Quality Monitoring Act of 2001, which implemented goals to improve and increase the statewide availability of groundwater quality data. A summary of the larger groundwater quality monitoring efforts and references for additional information are provided below.

Regional and statewide groundwater quality monitoring information and data are available on the State Water Resources Control Board's (SWRCB's) Groundwater Ambient Monitoring and Assessment (GAMA) Web site and the GeoTracker GAMA groundwater information system developed as part of the Groundwater Quality Monitoring Act of 2001. The GAMA Web site describes GAMA program and provides links to all published GAMA and related reports. The GeoTracker GAMA groundwater information system geographically displays information and includes analytical tools and reporting features to assess groundwater quality. This system currently includes groundwater data from the SWRCB, Regional Water Quality Control Boards (RWQCBs), California Department of Public Health (CDPH), Department of Pesticide Regulation (DPR), DWR, USGS, and Lawrence Livermore National Laboratory (LLNL). In addition to groundwater quality data, GeoTracker GAMA has more than 2.5-million depth to groundwater measurements from the RWQCBs and DWR, and also has oil and gas hydraulically fractured well information from the California Division of Oil, Gas, and Geothermal Resources. Table SJR-5 provides agency-specific groundwater quality information. Additional information regarding assessment and reporting of groundwater quality information is furnished later in this report.

PLACEHOLDER Table SJR-5 Sources of Groundwater Quality Information

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Land Subsidence Monitoring

Land subsidence has been shown to occur in areas experiencing significant declines in groundwater levels. Land subsidence investigations in the San Joaquin River Hydrologic Region include monitoring efforts such as,

- California Aqueduct elevation surveys,
- Borehole extensometer monitoring,
- USGS satellite remote sensing studies using interferometric synthetic aperture radar (InSAR),
- Caltrans highway 152 elevation monitoring, and
- Global positioning system (GPS) array monitoring.

DWR conducts periodic elevation surveys along the California Aqueduct to measure land subsidence along the canal and guide maintenance repairs as needed. DWR surveys compare elevations along portions of the aqueduct in Fresno and Kings Counties for years 2000, 2006 and 2009.

A borehole extensometer is designed to act as benchmark anchored to a geologically stable portion of the lower aquifer. Most of the borehole extensometers in the region were constructed in the 1950s and 1960s during the planning and construction of the State and federal water projects. After completion of the water projects, it was commonly thought that the threat of land subsidence had largely been eliminated. As a result, land subsidence investigations became less of a priority and the borehole extensometer monitoring wells fell into disrepair. In 2009, the USGS evaluated twelve of the inactive borehole extensometers for potential repair and reuse (Sneed 2011). Four extensometers were selected to be rehabilitated. There are currently seven active borehole extensometers in the area — six in Tulare Lake Hydrologic Region and one in San Joaquin River Hydrologic Region.

InSAR is a remote sensing tool that uses satellite radar signals to measure deformation of the Earth's crust at a high degree of spatial detail and measurement resolution (USGS 2000). In cooperation with DWR and USBR, the USGS is currently evaluating 2007 to 2011 InSAR data for evidence of subsidence in the San Joaquin River and Tulare Lake Hydrologic Regions.

As part of Highway Elevation Monitoring, Caltrans periodically resurveys their network of existing benchmarks along key sections of highway. In 1998 and again in 2004, Caltrans performed elevation surveys along State Route 152 across the San Joaquin Valley from the San Luis Dam to State Route 99 with the aim to compare these new data with 1972 survey results. Prior surveys have been done at approximately 16 year intervals. The surveys are typically limited to the highway right-of-way and likely miss some of the larger land subsidence areas.

A university-governed consortium for geosciences research using geodesy (UNAVCO) operates the Plate Boundary Observatory (PBO) and uses precision GPS monitoring sites for western United States plate tectonics studies. The UNAVCO GPS stations provide continuous monitoring of the land surface elevation providing a potential direct measurement of subsidence. There are 13 GPS stations in the San Joaquin Valley. Several of these are close to the edge of the valley and provide only partial insight into the regional magnitude of subsidence, while others lie outside of areas susceptible to subsidence (see http://pbo.unavco.org).

The results from the above subsidence monitoring are provided later in this report.

Ecosystems

Government and privately held forested lands in the Sierra Nevada consist of pine, mixed conifer, and fir forests. The Sierra foothills and rangelands consist of chaparral communities, oak woodlands, riparian habitat, and grass savannas. These areas have been significantly influenced by rural inhabitation and livestock grazing. Riparian habitats exist along rivers, streams, lakes, and ponds.

The Diablo Range contains oak woodlands, grasslands, and chaparral (shrub and brush) communities. Much of these areas have also been used for livestock grazing.

The San Joaquin Valley floor is mostly developed for agricultural production, but has pockets of expanding urbanized areas. Riparian areas exist in the Delta and along rivers, streams, ditches and canals, sloughs, and flood channels. Wetlands are primarily located in private waterfowl hunting areas and government-managed refuges and wildlife areas. Vernal pools are found primarily along the edges of the valley.

According to the Grasslands Water District in Merced County, only 5 percent of the Central Valley's historical 4 million acres of wetlands exist today. Habitat also includes riparian forests, native grasslands, and vernal pools. The remaining wetlands in the Central Valley must be intensively managed to support waterfowl populations that depend on the Central Valley for wintering habitat. The Central Valley Project Improvement Act Section 3406(d) (Refuge Water Supply) establishes the primary goal of providing a firm water supply for wildlife refuges. This firm water supply has helped to create new wetlands and enhance existing wetlands, resulting in increases in populations of federal- and State-listed species — particularly avian species — and other wildlife species such as the giant garter snake (*Thamnophis gigas*). The firm water supply has helped to reduce the concentration of salts and other contaminants, thereby improving water quality on the refuges and the quality of water discharged from the refuges.

PLACEHOLDER Table SJR-6 Critical Species in the San Joaquin River Hydrologic Region

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Table SJR-6 shows critical species in the San Joaquin River Hydrologic Region. Table SJR-7 shows critical plant species that are endemic to the San Joaquin River Hydrologic Region.

PLACEHOLDER Table SJR-7 Critical Plant Species Endemic to the San Joaquin River Hydrologic Region

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Flood

Common types of floods in the San Joaquin River Hydrologic Region include stormwater, slow-rise, and flash flooding. Floods in the San Joaquin Valley originate principally from melting of the Sierra snowpack and from rainfall. Flooding from snowmelt typically occurs in the spring and has a lengthy runoff period. Flooding from rainfall occurs in the winter and early spring.

Major floods occur regularly in the San Joaquin River Hydrologic Region. The more damaging floods are usually caused by spring snowmelt. The flatness of the valley floor contributes to the areal extent of these floods. Flooding in the mountainous upper watersheds is rarer due to well-developed watercourses, but might still occur, especially in intermontane valleys. These floods take a variety of forms and can be classified into six categories (slow-rise, flash, stormwater, debris flow, alluvial fan, and engineered structure failure flooding).

Historic Floods

Floods have been recorded in the San Joaquin Valley for more than 175 years. Most notable in the 19th century was the Great Flood of 1861-1862. Central Valley floods of 1907 and 1909 revised flood management plans of the time and led to development of the San Joaquin River flood management system. The San Joaquin River Hydrologic Region experiences some urban and small-stream flooding in every large storm. The Great Flood of 1861-1862 inundated large areas of the West Coast states from Canada to Mexico.

In December 1955 through January 1956, heavy rainfall and snowmelt occurred in the upper watersheds of the east side tributaries to the San Joaquin River. This caused extensive flooding along the river and all its major east side tributaries, as well as flooding on the larger west side tributaries. This flood caused extensive damage to agriculture, homes, and public facilities. Thousands of people were evacuated from their homes during the Christmas holiday season and several people died of heart attacks during the flood. Unusually high tides aggravated the situation by impeding the passage of floodwater through the Delta.

In January 1997, 14 levee breaches occurred on the San Joaquin River between Fresno and the Chowchilla Bypass, inundating agricultural lands that included many vineyards north of the river. The San Joaquin River also flooded a mobile home park in Madera County and damaged the bridge on State Highway 145. There was extensive damage in Yosemite Valley from Merced River overflow. Yosemite National Park was closed and highways in the region sustained damage. Multiple levee breaches occurred on the San Joaquin River near Vernalis, flooding agricultural lands.

For a complete record of floods, refer to the *California Flood Future Report* Attachment C: Flood History of California Technical Memorandum.

Climate

The Coast Range Mountains isolate the San Joaquin Valley from the coastal California marine effects. Although coastal temperatures often are mild in the summer, the maximum average daily temperature in the valley reaches a high of 101 degrees in late July. Daily temperatures during the warmest months range between 76 and 115 degrees Fahrenheit. The northern part of the San Joaquin Hydrologic River Region benefits from Delta breezes during hot summers, leading to evening cooling that does not reliably occur in the southern portion of this region.

Winter temperatures on the valley floor are usually mild, but drop below freezing during occasional cold spells. Frost occurs in most fall/winter seasons, typically between late November and early March. This region experiences a wide range of precipitation that varies from low rainfall amounts on the valley floor to extensive snowfall in the higher elevations of the Sierra Nevada. The snow that remains after winter serves as stored water before it melts in the spring and summer. The average annual precipitation of several Sierra Nevada stations is about 35 inches. Snowmelt from the mountains is a major contributor to local eastern San Joaquin Valley water supplies. The San Joaquin River and storage at Lake Millerton provide water for the Friant Unit of the federal Central Valley Project (CVP).

The upland climate on the west side of the valley resembles that of the eastern Sierra Nevada foothills: long, hot, and often dry summers with mild winters. In the winter, tule fog occurs in the region's southern portion more often than in its northern portion. Average annual precipitation ranges from about 22 inches near Stockton in the north to about 11 inches in the southern portion; it decreases to about 6.5 inches near the drier southwestern corner of the region.

Demographics

Population

The estimated population of the San Joaquin River Hydrologic Region was approximately 2.1 million people in 2010, according to the U.S. Census Bureau. Approximately 5 percent of the state's total population lives in this region, and 70 percent of the region's population lives in incorporated cities.

Between 2005 and 2010, the region grew by about 105,200 people, a growth of about 5 percent over the 5-year period. Table SJR-8 shows San Joaquin River Hydrologic Region population by county for 2005 and 2010.

PLACEHOLDER Table SJR-8 San Joaquin River Hydrologic Region Population by County for 2005 and 2010

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The most populous city in the San Joaquin River Hydrologic Region is Stockton, with a 2010 estimated population of 291,707. Table SJR-9 lists the top 10 most populous cities within the San Joaquin River Hydrologic Region. These cities account for about half of the population of the entire region.

PLACEHOLDER Table SJR-9 Top 10 Most Populous Cities within the San Joaquin River Hydrologic Region

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Tribal Communities

Table SJR-10 shows the federally recognized tribes in the San Joaquin River Hydrologic Region.

PLACEHOLDER Table SJR-10 Federally Recognized Tribes in the San Joaquin River Hydrologic Region

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Federal Clean Water Act (CWA) Programs and Tribes

Under the Clean Water Act, the U.S. Environmental Protection Agency (EPA) administers programs that support federally recognized tribes to address non-point-source pollution (NPS), water pollution control programs, and watershed based planning efforts. Because of unique and extremely complex historical circumstances, there are a large number of non-recognized tribes in California, including terminated tribes that may be seeking restoration or recognition by the United States. Tribal existence and identity do not depend on federal recognition or acknowledgement of a tribe. However, in order to be eligible for CWA programs, a tribe must be federally recognized, along with additional requirements. One of the requirements is receiving treatment as a State (TAS) authorization pursuant to Section 518(e) of the CWA.

Section 319 of the CWA authorizes federal grants to States and tribes in order to implement approved programs and on-the-ground projects to reduce non-point-source pollutions problems. In the San Joaquin River Hydrologic Region, there are four tribes with TAS status and are eligible for Section 319 program funding: Big Sandy Rancheria of Mono Indians, Picayune Rancheria of Chukchansi Indians, Shingle Springs Band of Miwok Indians, and Table Mountain Rancheria.

Section 106 of the CWA authorizes federal grants to assist State and interstate agencies in administering water pollution control programs. Tribes with TAS status can receive Section 106 funding. This program allows tribes to address water quality issues by developing monitoring programs, water quality assessment, standards development, planning, and other activities intended to manage reservation water resources. In the San Joaquin River Hydrologic Region, there are six tribes involved in Section 106 programs and activities: Big Sandy Rancheria of Mono Indians, Buena Vista Rancheria, Picayune Rancheria of Chukchansi Indians, Shingle Springs Band of Miwok Indians, Table Mountain Rancheria, and Tuolumne Band of Me-Wuk Indians.

Table SJR-11 shows tribes within integrated regional water management (IRWM) regions in the San Joaquin River Hydrologic Region.

PLACEHOLDER Table SJR-11 Tribes within Integrated Regional Water Management Regions in the San Joaquin River Hydrologic Region

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Disadvantaged Communities

Disadvantaged communities (DAC) are defined as those communities having a Median Household Income (MHI) of 80 percent of statewide MHI. While the smaller towns, such as Chowchilla, Gustine, and Firebaugh, are mainly rural and engaged in the farming industry, the larger cities, such as Stockton, Merced, and Madera are only about 20 to 30 percent rural versus urban. Furthermore, the residents of these larger cities are mainly employed in the educational services and healthcare sectors.

Table SJR-12 lists DACs by cities and their population and MHI within the San Joaquin River Hydrologic Region. Figure SJR-10 displays the MHI for these cities graphically.

PLACEHOLDER Table SJR-12 Disadvantaged Communities (Cities) within the San Joaquin River Hydrologic Region

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PLACEHOLDER Figure SJR-10 Median Household Income (MHI) for Disadvantaged Communities (DACs) within the San Joaquin River Hydrologic Region: Cities

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Another census entity used in the identification of DACs is Census Designated Place (CDP). A CDP is a statistical entity, defined for each decennial census according to Census Bureau guidelines, comprising a densely settled concentration of population that is not within an incorporated place, but is locally identified by a name. Table SJR-13 lists the poorest 20 CDPs (also DACs) within the San Joaquin River Hydrologic Region by population (> 2,000) and MHI. Figure SJR-11 shows these places by MHI.

PLACEHOLDER Table SJR-13 Poorest 20 Census Designated Places within the San Joaquin River Hydrologic Region with Populations Greater than 2,000

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PLACEHOLDER Figure SJR-11 Median Household Income (MHI) for Disadvantaged Communities (DACs) within the San Joaquin River Hydrologic Region: Poorest 20 Census Designated Places

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Land Use Patterns

Agriculture remains the dominant economic sector of the San Joaquin River Hydrologic Region. Agricultural production, processing, packaging, handling, shipping, and the sales of goods and services supporting agriculture represent a major economic and land use activity. Urban development has increased over the last two decades with the significant population growth in cities such as Stockton, Tracy, Manteca, Galt, Lodi, Modesto, Turlock, Merced (University of California, Merced, which opened in September 2005, has a student population of about 5,800), Los Banos, and Madera, which in turn, has encroached into the surrounding agricultural lands. Pacheco and Altamont passes serve as commuting corridors into the Bay Area and contribute to the growth of valley communities. Nonetheless, vast tracts of productive agricultural land continue to surround these cities.

More people are settling in the Sierra Nevada foothills and mountains and a greater number of visitors are taking advantage of the area's recreational activities, such as golfing, sightseeing, camping, backpacking, boating, cycling, fishing, and water- and snow-skiing.

The valley portion of the region constitutes about 3.5 million acres, the eastern foothills and mountains total about 5.8 million acres, and the western coastal mountains comprise about 900,000 acres.

The San Joaquin Valley is recognized as one of the most important and productive agricultural areas in the United States. It contains roughly 2 million acres of irrigated cropland with an annual agricultural output valued at more than $ 9.3 billion (from 2010 county agricultural commissioner reports). Figure SJR-12 shows gross agricultural value for the San Joaquin River Hydrologic Region for 2005-2010 by county.

PLACEHOLDER Figure SJR-12 San Joaquin River Hydrologic Region Gross Agricultural Value for 2005-2010, in Millions of Dollars

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The San Joaquin River Hydrologic Region has a high diversity of crops with the top five single crop types in acreage being almonds, corn, alfalfa, grapes and processing tomatoes. Although higher in acreage, "other field" and "other deciduous" crops can be assorted types and no single crop is probably greater in acreage than processing tomatoes. Figure SJR-13 shows the top 10 crop types in the San Joaquin River Region by acreage by water year for 2005-2009.

PLACEHOLDER Figure SJR-13 Top 10 Crop Types by Acreage for the San Joaquin River Region for 2005-2009

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In addition to agriculture, other important industries in the region include food processing, chemical production, lumber and wood products, glass, textiles, paper, machinery, fabricated metal products, and variety of other goods.

Although the valley floor is primarily privately owned agricultural land, much of the Sierra Nevada is national forest. Government-owned public lands include the El Dorado, Stanislaus, and Sierra National Forests and Yosemite National Park. Public lands amount to about one-third of the region's total land area. The national forest and park lands include more than 2.9 million acres. U.S. Bureau of Land Management and military properties occupy more than 200,000 and 5,100 acres, respectively. State parks, recreational areas, and other State property occupy about 80,000 acres.

Regional Resource Management Conditions

The Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, and Cosumnes rivers are tributaries of the San Joaquin River and drain the central Sierra Nevada. The lower portions of the watersheds provide runoff from rainfall. The higher elevations of the watersheds supply snowmelt runoff during the late spring and early summer. These tributaries supply significant surface water for local use.

The Chowchilla and Fresno rivers in Madera County receive water from the lower elevations of the Sierra Nevada foothills. Most of the runoff comes directly from rainfall. Buchanan Dam on the Chowchilla River forms Eastman Lake; Hidden Dam on the Fresno River forms Hensley Lake. The CVP's Friant Unit provides surface water to the southeastern valley floor via the Madera Canal from Lake Millerton, but the largest share of CVP supplies from Lake Millerton is sent to the Friant Water Users Authority in the Tulare Lake Hydrologic Region. Delta waters are brought into the region along the west side of the valley by the State Water Project (SWP) California Aqueduct, and the federal San Luis Unit Project (San Luis Canal) and Delta-Mendota Canal.

Surface water from the Sierra Nevada is of high quality and reasonably dependable. The available water meets roughly half of the local water needs. Imported water adds to the surface water supply and groundwater meets the remainder water use needs. Reductions of imported supplies from drought, legal actions, and other compliance requirements are a concern for local suppliers who seek long-term availability, stability, and reliability of imported supplies. Existing local surface water supplies are also strained by increases in local demand, environmental needs, and water needed for restoration purposes.

Water in the Environment

Restoration of Central Valley wetlands and habitat is critical to the preservation of many species of fish and wildlife in the San Joaquin Valley. Beginning in the 1990s, agencies made progress in their efforts to set aside and restore wetland habitat acreage. In 1990, the San Joaquin River Management Program was formed to restore the river system, which led to completion of the San Joaquin River Management Plan in 1995. The management plan identified nearly 80 consensus-based actions intended to benefit the San Joaquin River system, addressing six problem areas: flood protection, water quality, water supply, wildlife, fisheries, and recreation. These actions are organized into projects, feasibility studies, and riparian habitat acquisitions. Agencies participating in the program included U.S. Fish and Wildlife Service (USFWS), USBR, U.S. Army Corps of Engineers (USACE), and DWR. An advisory council was created that included representatives from counties and cities in the area, water user interests, and wildlife groups. The management program concluded in 2007 and some restoration activities are now managed through the San Joaquin River Restoration Program.

In 2002, River Partners began a restoration project west of Modesto along the San Joaquin River. Seven hundred seventy-seven acres of riparian habitat were restored on the West Unit of the San Joaquin River National Wildlife Refuge. Since then, 2,350 acres of habitat on the refuge have been restored by River Partners.

The San Joaquin Valley is a major stop on the Pacific Flyway, a north/south pathway along the West Coast for migratory birds. The birds travel between their breeding grounds in the north and their wintering grounds in the south. Within the San Joaquin River Hydrologic Region, wildlife refuges, managed by the USFWS, and wildlife areas, managed by the California Department of Fish and Wildlife (DFW), include San Luis National Wildlife Refuge, which encompasses 26,600 acres; the San Joaquin River National Wildlife Refuge, 7,000 acres; Merced National Wildlife Refuge, 10,262 acres; Los Banos Wildlife Area, 6,217 acres; Volta Wildlife Area, 2,891 acres; the North Grasslands Wildlife Area, 7,069 acres; the White Slough Wildlife Area, 969 acres; and the Isenberg Sandhill Crane Reserve (managed by DFW), 361 acres. The Cosumnes River Preserve in the northern region is managed by the Nature Conservancy. At 46,000 acres, it has become the largest refuge area in the region. The main source of surface water supplies for many of the wildlife refuges within the San Joaquin River region is the CVP (via Central Valley Project Improvement Act - CVPIA). Table SJR-14 shows CVP supplies for wildlife refuges in the region.

PLACEHOLDER Table SJR-14 Central Valley Project Supplies for Select Wildlife Refuges in the San Joaquin River Region

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Private hunting clubs and other privately held lands also provide wetland habitat. The Grasslands Resources Conservation District includes about 70,000 acres, of which 36,068 acres are irrigated habitat, encompassing gun and duck clubs in the Grasslands area near Merced. The Grasslands WD provides these clubs with CVP surface water supplies. The Merced NWR receives water via the Merced Irrigation District.

Various rivers and streams with instream flow requirements and Wild and Scenic designations are within the San Joaquin River Hydrologic Region. The Mokelumne, Stanislaus, Tuolumne, Merced, and San Joaquin rivers have instream flow requirements. DFW is required by the Public Resources Code Sections 10000-10005 to develop flow recommendations for watercourses and streams throughout the state for which minimum flow levels need to be established in order to assure the continued viability of fish and wildlife resources. These flow recommendations are considered by the State Water Resources Control Board (SWRCB) in regulatory actions related to appropriation of water and other planning activities.

The Tuolumne and Merced rivers also have Wild and Scenic designations. The National Wild and Scenic Rivers System was created by Congress in 1968 to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. While the designation neither prohibits development nor gives the federal government control over private property, it does prohibit federal support for actions, such as the construction of dams or other instream activities that would harm a river's free-flowing condition, water quality, or outstanding resource values. Recreation, agricultural practices, residential development, and other uses may continue. Protection of the river is provided through voluntary stewardship by landowners and river users and through regulation and programs of federal, State, local, or tribal governments. For more information, see http://www.rivers.gov/rivers/.

Water Supplies

Surface

On the valley floor, many agricultural and municipal users receive water supply from large irrigation districts, such as the Modesto, Merced, Oakdale, South San Joaquin, Madera, and Turlock irrigation districts. Most of this region's imported surface water supplies are delivered by the CVP, which averages about 1.9 million acre-feet per year. In addition, Oak Flat Water District receives about 4,500 acre-feet per year from the SWP. Most of the surface water in the upper San Joaquin River is stored and diverted at Friant Dam and is then conveyed north through the Madera Canal and south through the Friant-Kern Canal. Average annual diversions from the San Joaquin River through the Friant-Kern and Madera canals total about 1.3-million af/yr, 260,000 af/yr for the Madera Canal, and 1.03 million af for the Friant-Kern Canal.

The tributaries of the San Joaquin River provide the region with high-quality water that constitutes most of the surface water supplies for local uses. Much of this water is regulated by reservoirs and used on the east side of the San Joaquin Valley.

The availability and use of groundwater is of critical importance in the San Joaquin Valley. Water use requirements are met through a three-pronged supply strategy. Water use is first met by developed local surface water supplies. In areas where insufficient surface water exists, imported surface water is contracted through the SWP and the CVP. Where no surface water is available or where needs can be met by groundwater, local groundwater is pumped. Shortfalls in surface supplies can be made up with groundwater where it is available and of sufficient quality. Figure SJR-14 shows water supplies for the San Joaquin River region for water years 2005-2010. Total supply by source is shown, as well as percent of supply by source for a given year. The figure shows declining surface water supplies and increasing groundwater supplies over time due to the drought of 2007-2009. Total supplies are less during the years leading up to the drought because more rain fell during this time, which required less surface supplies for a given application. For a summary of the regional water inflows and out flows, see Figure SJR-15.

PLACEHOLDER Figure SJR-14 San Joaquin River Hydrologic Region Water Supplies for Water Years 2005-2010

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PLACEHOLDER Figure SJR-15 San Joaquin River Hydrologic Region Inflows and Outflows

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Figure SJR-16 shows annual deliveries by the CVP south of the Delta and SWP systems by percentage of contracted amounts for the years 2005-2010. During the drought years of 2007-2009, agricultural surface water supplies were the most severely impacted. Table SJR-15 displays the annual deliveries by percentage of contracted amounts for the years 1998-2010. CVPIA began in 2001, as shown in the table (Wildlife column), and has since seen all of their requests for CVP supplies fulfilled.

PLACEHOLDER Figure SJR-16 South of Delta Central Valley Project and State Water Project Annual Deliveries (Percentage of Contracted Amount)

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PLACEHOLDER Table SJR-15 South of Delta Central Valley Project and State Water Project (SWP) Deliveries (Percentage of Contract Amounts)

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Federal land reservations for tribes have an associated reserved federal water right. This federal water right may predate existing State water rights or fall outside the jurisdiction of State water rights law. These federally reserved water rights are not subject to loss due to non-use. As water use increases around these reserved water rights, the potential for conflict also increases. Quantification and timing of these reserved water rights will be keys to resolving conflicts with the other surrounding water rights holders.

In 2006, the North Fork Rancheria of Mono Indians entered into a 20-year memorandum of understanding (MOU) with Madera Irrigation District. This MOU provides mechanisms to address and offset water-related impacts of rancheria development. Among the issues it covers are aquifer recharge, monitoring water usage, “right to farm,” and creation of a water advisory committee.

Recycled Municipal Water

According to the 2009 Municipal Wastewater Recycling Survey, compiled by the SWRCB, 28,888 af/yr are being recycled in the San Joaquin Hydrologic Region. Most of the recycled water was used for agricultural irrigation. Some of the recycled water was used for landscape irrigation, industrial uses, commercial uses, natural systems, and golf course irrigation. (SWRCB 2011a) State policy encourages increased use of recycled water, but recognizes the potential of recycled water to contribute to exceeding or threatening to exceed water quality objectives due to salt and nutrients (SWRCB 2009). Therefore, the policy requires stakeholders to work together to develop salt and nutrient management plans.

In the Central Valley, of which the San Joaquin River Hydrologic Region is a part of, the Central Valley Region Water Quality Control Board and the SWRCB, as part of a stakeholder effort, are developing a comprehensive salt and nitrate management plan for the Central Valley. The Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) is a strategic initiative to address problems with salinity and nitrates in the surface waters and groundwaters of the Central Valley. The long-term plan developed under CV-SALTS will identify and require discharger implementation of management measures aimed at the reduction and/or control of major sources of salt and nitrate as well as support activities that alleviate known impairments to drinking water supplies. As this issue impacts all users (stakeholders) of water within the San Joaquin River Hydrologic Region, it is important that all stakeholders participate in CV-SALTS to be part of the development and have input on the implementation of salt and nitrate management within the San Joaquin River Hydrologic Region. For the

Central Valley, the only acceptable process to develop the salt and nutrient management plans that are required under State policy is through CV-SALTS (SWRCB 2009).

Groundwater

The amount and timing of groundwater extraction, along with the location and type of its use, are fundamental components for building a groundwater basin budget and identifying effective options for groundwater management. Although some types of groundwater extractions are reported for some California basins, the majority of groundwater pumpers are not required to monitor, meter, or publicly record their annual groundwater extraction amounts. Groundwater supply estimates furnished herein are based on water supply and balance information derived from DWR land use surveys, and from groundwater supply information voluntarily provided to DWR by water purveyors or other State agencies.

Groundwater supply is reported by water year (October 1 through September 30) and categorized according to agriculture, urban, and managed wetland uses. The associated information is presented by planning area (PA), county, and by the type of use. Reference to total water supply represents the sum of surface water and groundwater supplies in the region, and local reuse.

2005-2010 Average Annual Groundwater Supply and Trend

With a 2005-2010 average annual extraction volume of 3.2 million acre-foot (maf), groundwater pumping in the San Joaquin River Hydrologic Region accounts for 19 percent of all the groundwater extraction in California – the second highest among the 10 hydrologic regions in California, behind Tulare Lake Hydrologic Region with 38 percent and ahead of Sacramento River Hydrologic Region with 17 percent of the total.

Table SJR-16 provides the 2005-2010 average annual groundwater supply by PA and by type of use, while Figure SJR-17 depicts the PA locations and the associated 2005-2010 groundwater supply in the region. The estimated average annual 2005-2010 total water supply for the region is about 8.3 maf. Out of the 8.3 maf total supply, groundwater supply is 3.2 maf and represents 38 percent of the region's total water supply; 58 percent (0.4 maf) of the overall urban water use and 36 percent (2.6 maf) of the overall agricultural water use being met by groundwater. Groundwater contributes to 38 percent (0.2 maf) of the supply required for meeting managed wetland uses in the region. Thus more than 81 percent of the groundwater supply in the region is used to meet agricultural water use, while only 13 and 6 percent are used to meet urban and managed wetland uses, respectively (2.6 maf versus 0.4 maf and 0.2 maf).

PLACEHOLDER Table SJR-16 San Joaquin River Hydrologic Region Average Annual Groundwater Supply by Planning Area and by Type of Use (2005-2010)

PLACEHOLDER Figure SJR-17 Contribution of Groundwater to the San Joaquin River Hydrologic Region Water Supply by Planning Area (2005-2010)

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As shown in Table SJR-16 and Figure SJR-17, the largest groundwater PA in the region, Lower Valley East Side rely on more than 1.2 maf of groundwater pumping to meet 57 percent of the agricultural water use and 100 percent of the urban water use. The annual pumping volumes and reliance on groundwater supplies are also relatively high in Valley West Side (761 taf), Eastern Valley Floor (477 taf) and Middle

Valley East Side (405 taf) PAs. Although on average only18.4 taf of groundwater is pumped annually in East Side Uplands PA, it relies on groundwater for 98 percent of its total water supply. Similarly, the smallest groundwater user, Western Uplands PA is 100 percent dependent on groundwater supply to meet its water uses. Many of the PAs in the region depend heavily on groundwater to meet their urban water uses. Groundwater status reports from groundwater management agencies overlying selected PAs in the region acknowledge that the average annual groundwater extraction commonly exceeds sustainable aquifer yield.

Regional totals for groundwater based on county area will vary from the PA estimates shown in Table SJR-16 because county boundaries do not necessarily align with PA or hydrologic region boundaries. Calaveras, Madera, Mariposa, San Joaquin, Stanislaus, and Tuolumne Counties are fully contained within the San Joaquin River Hydrologic Region, while Amador, Contra Costa, Merced, Alpine, Fresno, Alameda, Sacramento, El Dorado, and San Benito Counties are partially contained within the region. For the San Joaquin River Hydrologic Region, groundwater supply is reported for nine counties - Amador, Calaveras, Contra Costa, Madera, Mariposa, Merced, San Joaquin, Stanislaus, and Tuolumne Counties (Table SJR-17). Groundwater supply for Alpine, Fresno, Alameda, Sacramento, El Dorado, and San Benito Counties are discussed in the regional reports for the relevant hydrologic regions. Overall, groundwater contributes to about 37 percent of the total water supply for the nine-county area; the range varies from less than one percent to 68 percent for individual counties. Although most of the groundwater extraction in the nine-county area occurs for agricultural water use, groundwater supplies meet over one-thirds of the agricultural water use. In contrast, although overall groundwater extraction for urban water use is significantly less, groundwater supplies meet about half of the urban water use. Almost all of managed wetlands use in the nine-county area occurs in Merced County.

More detailed information regarding groundwater water supply and use analysis is available online from Update 2013, Volume 4, Reference Guide, the article "California's Groundwater Update 2013."

PLACEHOLDER Table SJR-17 San Joaquin River Hydrologic Region Average Annual Groundwater Supply by County and by Type of Use (2005-2010)

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Changes in annual groundwater supply and type of use may be related to a number of factors, such as changes in surface water availability, urban and agricultural growth, market fluctuations, and water use efficiency practices.

Figures SJR-18 and SJR-19 summarize the 2002 through 2010 groundwater supply trends for the San Joaquin River Hydrologic Region. The right side of Figure SJR-18 illustrates the annual amount of groundwater versus total water supply, while the left side identifies the percent of the overall water supply provided by groundwater relative to total water supply. The center column in the figure identifies the water year along with the corresponding amount of precipitation, as a percentage of the 30-year running average for the region. Figure SJR-19 shows the annual amount and percentage of groundwater supply trends for meeting urban, agricultural, and managed wetland uses.

PLACEHOLDER Figure SJR-18 San Joaquin River Hydrologic Region Annual Groundwater Water Supply Trend (2002-2010)

PLACEHOLDER Figure SJR-19 San Joaquin River Hydrologic Region Annual Groundwater Supply Trend by Type of Use (2002-2010)

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Figure SJR-18 indicates that the annual water supply for the region has fluctuated between 2002 and 2010 depending on annual precipitation amounts. Between 2002 and 2010, annual water supply fluctuated between 7.5 maf and 9.1 maf. Figures SJR-18 and SJR-19 indicate that during the same period, groundwater supply has fluctuated between 2.4 maf and 3.8 maf, and provided between 31 and 43 percent of the total water supply for the region. Figure SJR-19 indicates that groundwater supply meeting agricultural use ranged from 72 to 84 percent of the annual groundwater extraction while groundwater supply meeting urban use ranged from 10 to 20 percent of the annual groundwater extraction, with the remaining groundwater extraction meeting managed wetland uses. Figure SJR-19 also illustrates that in areas of high water uses, relatively small changes in the percent of groundwater supply required can result in larges changes in the volume of groundwater extraction. For example, between 2005 and 2009, the percentage of groundwater supply to meet water use increased from 31 to 43 percent. The 12 percent increase in groundwater towards the total supply for the region resulted in a 60 percent increase in the amount of groundwater extraction - from 2.4 maf in 2005 to 3.8 maf in 2009.

Water Uses

At higher elevations in the Sierra Nevada, reservoirs capture water to produce hydroelectric power. In some locations, a sequence of plants produces power. Some diversions occur for local use. A network of canals, ditches, tunnels, and flumes was constructed in the 1850s for mining and timber purposes. Some of the remnants of those systems remain in use today. As surface water moves closer to the foothills/valley floor, larger reservoirs provide storage for flood control and other purposes, such as power production, diversion, conservation storage, fish and habitat releases, and salinity control. Conservation storage is most often used for urban and agricultural purposes. This lower and larger storage is often operated by or in conjunction with valley irrigation districts that hold water rights and distribute the surface water to their users. Reservoirs and downstream releases also provide recreational opportunities.

Cities in the San Joaquin Valley predominately developed groundwater to supply residents. As a consequence, many of the major population areas experienced groundwater depressions. The stress on the groundwater system and costs, limitations, and uncertainties of treating water at each wellhead has created a gradual movement toward using treated surface water.

Throughout the region, individual and private owners maintain groundwater wells to meet individual needs. In the foothill and mountain areas, groundwater is the primary supply. Well interference problems have resulted from larger-capacity water system wells that are close to other wells and are pumped at relatively high rates for prolonged periods. In other areas, further large-scale dense development may require a supplemental water supply to augment the available groundwater.

Drinking Water

The region has an estimated 438 community drinking water systems. The majority (over 80 percent) of these community drinking water systems are considered small (serving less than 3,300 people) with most small water systems serving less than 500 people (see Table SJR-18). Small water systems face unique financial and operational challenges in providing safe drinking water. Given their small customer base, many small water systems cannot develop or access the technical, managerial, and financial resources needed to comply with new and existing regulations. These water systems may be geographically isolated, and their staff often lacks the time or expertise to make needed infrastructure repairs, install or operate treatment processes, or develop comprehensive source water protection plans, financial plans or asset management plans (EPA 2012).

PLACEHOLDER Table SJR-18 Drinking Water Systems in the San Joaquin River Hydrologic Region

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In contrast, medium and large water systems account for less than 20 percent of region's drinking water systems; however, these systems deliver drinking water to over 90 percent of the region's population (see Table SJR-18). These water systems generally have the financial resources to hire staff to oversee daily operations and maintenance needs and hire staff to plan for future infrastructure replacement and capital improvements. This helps to ensure that existing and future drinking water standards can be met.

In the Central Valley, many rural homes maintain wells for domestic purposes. These domestic wells tend to be more shallow than agricultural wells due to the lower necessary flow rates. However, due to their shallow nature, they tend to draw water from nearer the ground surface which subjects them to potential contamination from percolating water or other sources.

Water Conservation Act of 2009 (SB x7-7) Implementation Status and Issues

Seventeen San Joaquin River urban water suppliers have submitted 2010 urban water management plans to DWR. The Water Conservation Act of 2009 (SB x7-7) required urban water suppliers to calculate baseline water use and set 2015 and 2020 water use targets. San Joaquin River Hydrologic Region had a population-weighted baseline average water use of 237 gallons per capita per day with an average population-weighted 2020 target of 196 gallons per capita per day. The baseline and target data for the San Joaquin River urban water suppliers is available on DWR Urban Water Use Efficiency Web site.

The Water Conservation Act of 2009 required agricultural water suppliers to prepare and adopt agricultural water management plans by December 31, 2012 update those plans by December 31, 2015, and every 5 years thereafter. Seven San Joaquin River agricultural water suppliers have submitted 2012 agricultural water management plans to DWR.

Water Balance Summary

Figure SJR-20 summarizes the total developed water supplies and distribution of the dedicated water uses within this hydrologic region for the ten years from 2001 through 2010. As indicated by the variations in the horizontal bars, the distribution of the dedicated supply to various uses can change significantly based on the wetness or dryness of the water year. The more detailed numerical information about the developed water supplies and uses is presented in the Volume 5 *Technical Guide*, which provides a breakdown of the components of developed supplies used for agricultural, urban, and environmental purposes and Water Portfolio data.

PLACEHOLDER Figure SJR-20 San Joaquin Hydrologic Water Balance by Water Year, 2001-2010

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For the San Joaquin River Hydrologic Region, agricultural water uses are the largest component of the developed water uses and urban water use is a very small portion of the total. Dedicated water required for instream flows and managed wetlands are also a significant component of water use in this region. Groundwater is also a significant source of supply for this region, and the reuse of agricultural water runoff is also a major source of supply to downstream water users. The specific water balances for these areas is contained in Volume 5 of Update 2013.

The Upper West Side Uplands Planning Area (PA 601) contains more urban applied water (95-105 taf (thousand acre-feet) annually), including substantial industrial and large landscape uses, than agricultural use (30-40 taf). There is no environmental water use (managed wetlands or instream) in this planning area.

Most of the water supply comes from local sources (about 60110 taf annually). Some CVP deliveries are made (13-22 taf). While some groundwater is extracted, more is recharged into the basin so there is a net recharge in recent years. About 5,000 af of water is reused annually.

The San Joaquin Delta (PA 602) is both more populated (87-132 taf urban applied water) and much more agricultural (0.75 to 1.1 maf (million acre-feet) applied water) than PA 601. There is also 0.5 to 0.6 taf applied to managed wetlands.

Most of the water supply comes from local deliveries and drainage from upstream (660-960 taf). Smaller amounts are delivered through the CVP, SWP, and other federal projects (34-70 taf total). The remainder of the supply comes from groundwater (25-50 taf) and reuse (100-165 taf).

The Eastern Valley Floor Planning Area (PA 603) applies about the same amount of water for urban uses and maybe ten percent less for agricultural uses as PA 602. There is about one taf applied water for managed wetlands, but no environmental instream requirements.

About 60 percent of the water supply comes from groundwater and forty percent from various surface water sources.

In the Sierra Foothills Planning Area (PA 604), urban applied water ranges from about 40-55 taf and applied water for agricultural uses from 17-37 taf. There are both instream requirements (95-300 taf/yr (thousand acre-feet per year) and wild and scenic river designations (0.5-2.1 maf), but no managed wetlands.

The instream requirement water supply (wild and scenic and instream requirements) comes from local sources, of course. The supplies for the agricultural and urban applied water come about equally from surface water and groundwater.

In the West Side Uplands Planning Area (PA 605), recordable water use (over 50 af/yr) did not start appearing until 2008. Urban use has grown from 0.1 taf in 2008 to 0.4 taf in 2010. There is no recordable agricultural or environmental use in this planning area. The water supply comes entirely from groundwater.

The Valley West Side Planning Area (PA 606) is primarily agricultural with about 30-35 taf Urban applied water and 1.5-1.9 maf of agricultural applied water. There are no instream environmental requirements, but substantial managed wetlands with 426-454 taf/yr applied water.

Supply is primarily from the CVP (1.1-1.3 maf) with substantial groundwater use (533-980 taf annually). Limited local supplies, inflow drainage and SWP deliveries make up the difference.

The Upper Valley East Side Planning Area (PA 607) uses about 150 taf/yr for urban uses and 0.9-1.1 maf for agriculture. There is an instream requirement that takes about 100-470 taf/yr and some managed wetlands using about 13 taf/yr.

Most of the water supply comes from local sources and drainage from upstream sources. About 200-280 taf comes from groundwater pumping and a small amount from the CVP.

The Middle Valley East Side Planning Area (PA 608) uses from about 66-79 taf of urban water and 0.9-1.2 maf of agricultural applied water per year. There is no environmental water use in this planning area. Between one-half and two-thirds of the water supply comes from local sources and the rest from pumping groundwater.

The Lower Valley East Side Planning Area (PA 609) urban areas apply 92-102 taf annually for primarily residential uses. Agricultural applied water is higher here also, at about 1.9-2.2 maf per year. There are instream requirements here also, of about 68-84 taf per year, all of which is reused downstream. Flows to managed wetlands equal about 45 taf per year.

Most of the water supplies for AP 609 come from groundwater (1-1.6 maf), with substantial amounts (30 to nearly 50 percent) returning to the groundwater basin. The rest of the supply comes from surface water sources (local supplies, inflow drainage from upstream and CVP) with the reuse from the instream requirements.

The East Side Uplands Planning Area (PA 610) is located on the west side of the Sierra Nevada Mountains which makes the area a source of supply for the valley, but limits it as either an agricultural or urban area. This shows up in the annual urban use of 15-17 taf and the agricultural use of 3-4 taf. There is substantial wild and scenic river flow through there, all of which is reused downstream in other planning areas. The supply for the agricultural and urban uses comes from groundwater.

Table SJR-19 presents information about the total water supply available to this region for the 10 years from 2001 through 2010, and the estimated distribution of these water supplies to all uses. The annual change in the region's surface water and groundwater storage is also estimated, as part of the balance between supplies and uses. In wetter water years, water will usually be added to storage; during drier water years, storage volumes may be reduced. Of the total water supply to the region, more than half is either used by native vegetation; evaporates to the atmosphere; provides some of the water for agricultural crops and managed wetlands (effective precipitation); or flows to the Pacific Ocean and salt sinks like saline groundwater aquifers. The remaining portion, identified as consumptive use of applied water, is distributed among urban and agricultural uses and for diversions to managed wetlands. For some of the data values presented in Table SJR-19, the numerical values were developed by estimation techniques because actual measured data are not available for all categories of water supply and use.

PLACEHOLDER Table SJR-19 San Joaquin River Hydrologic Region Water Balance for 2001-2010 (thousand acre-feet)

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Project Operations

The East Bay Municipal Utility District (EBMUD) and San Francisco Public Utilities Commission move water originating in the San Joaquin River Hydrologic Region across the valley for use in the San Francisco Bay Area. EBMUD transports water from the Mokelumne River via the Mokelumne Aqueduct. This water goes to Alameda and Contra Costa counties in the East Bay. The City/County of San Francisco and other nearby cities receive water through the Hetch Hetchy Aqueduct from the Tuolumne River.

Other facilities in this region include Camanche Dam/Reservoir on the Mokelumne River, Donnells and Beardsley dams/reservoirs on the Middle Fork of the Stanislaus River, Tulloch Dam/Reservoir, and New Melones Dam/Lake on the Stanislaus River, New Don Pedro Dam/Lake on the Tuolumne River, and New Exchequer Dam/Lake McClure on the Merced River.

USACE projects on the eastside of the San Joaquin River watershed that impound streams tributary to the river are primarily flood dams and include Hidden Dam on the Fresno River, Buchanan Dam on the Chowchilla River, Mariposa Dam on Mariposa Creek, Owens Dam on Owens Creek, Bear Dam on Bear Creek, and Burns Dam on Burns Creek. Although these are flood control projects, this group of reservoirs has provided an average annual outflow over the last 35 years of about 230,000 af.

The SWP and the CVP transfer Delta water into the San Joaquin Valley along the west side. The federal pumping plant near Tracy pumps into the Delta-Mendota Canal, which travels to San Luis Reservoir then toward the trough of the valley to Mendota Pool. The State pumping plant near Byron pumps into the California Aqueduct, which travels to San Luis Reservoir and then continues southward serving Kern County and Southern California. A portion of the California Aqueduct is a State-federal joint-use facility serving the San Luis Unit of the federal project. San Luis Reservoir is a joint-use pump storage facility.

Contra Costa Water District diverts from the Delta. Its Contra Costa Canal is fed from the Rock Slough Intake. Los Vaqueros Reservoir is filled using the Old River Intake. Current construction of the Alternate Intake Project is occurring in and around Victoria Island.

Most of the San Joaquin River is diverted at Lake Millerton/Friant Dam for use by federal water contractors. Water is moved northwestward in the Madera Canal and southeastward in the Friant-Kern Canal. Downstream, water reaching the Mendota Pool through the Delta-Mendota Canal may be released below the pool for contractual users. Previously, releases downstream into the river were primarily flood flows or to meet minimum flow requirements for prior water rights holders. For many decades, stretches of the river between Gravelly Ford and Mendota Pool and from Mendota Pool to the Merced River had minimal or no flows. However, in October 2009, interim flows began as part of the San Joaquin River restoration program, and in the fall of 2010, the often dry San Joaquin was reconnected to the Pacific Ocean. Full restoration flows are scheduled to begin no later than January 2014.

Levee and Channel System

Constructed facilities in the San Joaquin River Hydrologic Region consist of the San Joaquin River Flood Protection (SJRFP) system and other flood protection works. Regional facilities include eight major multipurpose reservoirs with flood management reservations, eight major flood management reservoirs, six smaller flood management reservoirs, bypasses, diversions, levees, channels and channel improvements, control structures, clearing and snagging, and bank protection.

The SJRFP system includes eight projects consisting of Farmington Flood Control Basin on Littlejohns Creek, Canal Creek Flood Detention Reservoir on Canal Creek, Bear Creek Flood Detention Reservoir on Bear Creek, Burns Creek Flood Detention Reservoir on Burns Creek, Owens Creek Flood Detention Reservoir on Owens Creek, Mariposa Creek Flood Detention Reservoir on Mariposa Creek, smaller reservoirs on Mustang Creek, Deer Creek, Dry Creek, the North Fork Tuolumne River, and Bear Creek, bypasses, diversions, levees, channels, channel improvements, control structures, clearing and snagging, and bank protection on the San Joaquin River and many of its major tributaries. The SJRFP system works together with most of the other listed reservoirs and lakes.

Regional multi-purpose reservoirs with flood control reservations are Millerton Lake on the San Joaquin River, Camanche Reservoir on the Mokelumne River, New Hogan Lake on the Calaveras River, New Melones Lake on the Stanislaus River, Don Pedro Lake on the Tuolumne River, Lake McClure on the Merced River, Eastman Lake on the Chowchilla River, and Hensley Lake on the Fresno River. Other major flood control reservoirs are Los Banos Reservoir on Los Banos Creek and Marsh-Kellogg Creeks Debris Reservoir on Marsh and Kellogg Creeks. Smaller reservoirs are on the Mokelumne and North Fork Mokelumne Rivers, and Deer, Dry, Bear, and Mustang Creeks.

A substantial portion of the San Joaquin River Hydrologic Region is within the implementation area of the 2012 Central Valley Flood Protection Plan (CVFPP). The CVFPP proposes a systemwide investment approach for sustainable, integrated flood management in areas currently protected by facilities of the State Plan of Flood Control (SPFC).

- Major SPFC facilities along the San Joaquin River and tributaries include: Chowchilla Bypass (and levees), which begins at the San Joaquin River downstream from Gravelly Ford, diverts San Joaquin River flows, and discharges the flows into the Eastside Bypass.
- Eastside Bypass (and levees), which begins at the Fresno River, collects drainage from the east, and discharges to the San Joaquin River between Fremont Ford and Bear Creek.
- Mariposa Bypass, which begins at the Eastside Bypass and discharges to the San Joaquin River (and levees).

- Approximately 99 miles of levees along the San Joaquin River.
- Approximately 135 miles of levees along San Joaquin River tributaries and distributaries.
- Six instream control structures (Chowchilla Bypass Control Structure, San Joaquin River Control Structure, Mariposa Bypass Control Structure, Eastside Bypass Control Structure, Sand Slough Control Structure, and San Joaquin River Structure).
- Two major pumping plants.

The SPFC represents a portion of the Central Valley flood management system for which the State has special responsibilities, as defined in the California Water Code (CWC) Section 9110 (f). The State Plan of Flood Control Descriptive Document provides a detailed inventory and description of the levees, weirs, bypass channels, pumps, dams, and other structures included in the SPFC (DWR 2010).

Over the last century, the Central Valley, including large portions of the San Joaquin River Hydrologic Region, has experienced intensive development to meet the needs of a growing population. A complex water supply and flood risk management system supports and protects a vibrant agricultural economy, several cities, and numerous small communities.

Much of the Central Valley levee system was built over many years using the sands, silts, clays, and soils, including organic soils that were conveniently available and were often poorly compacted over permeable foundations. The system was designed to contain the record floods of the early 20th Century with the aim of fostering development of an agriculturally-oriented economy and promoting public safety. The subsequent construction of a series of multipurpose reservoirs with substantial flood control capability significantly augmented the capacity of the flood management system and contributed greatly to the State’s economic development and public safety objectives. These reservoirs constituted the principal response to the mid-century recognition that extreme floods that were much larger than those that guided design of the levee system were reasonably foreseeable.

Although the SPFC has prevented billions of dollars in flood damages since its construction, a better understanding of the risk assessment and engineering standards has made it clear that some SFPC facilities face an unacceptably high chance of failure. Combined with continued urbanization in the floodplains, this has increased the estimated level of flood risk. While the chance and frequency of flooding have decreased since construction of the SPFC and multipurpose reservoirs, the damages that would occur if a levee were to fail in one of the urban areas are much greater, resulting in a net long-term increase in cumulative damages if no action is taken to improve the flood management system and limit further development in these areas.

Water Quality

Salt management is the most serious long-term water quality issue in the San Joaquin River basin. (CVRWQCB 2011b) Water quality throughout the San Joaquin River basin varies dependent upon source, geologic influences, and land uses.

Flows from the west side of the river basin are dominated by agricultural return flows since west side streams are ephemeral and their downstream channels are used to transport agricultural return flows to the main river channel. Poorer quality (higher salinity) water is imported from the Delta for irrigation along the west side of the river to replace water lost through diversion of the upper San Joaquin River flows. Flows from the east side of the river basin originate with snowmelt and springs in the Sierra Nevada and therefore generally contain higher quality and volume of surface water. Water quality issues for the San Joaquin River Hydrologic Region include:

- Salinity.
- Boron.
- Selenium.
- Pesticides (chlorpyrifos, diazinon, pyrethroids, and organochlorine pesticides).
- Localized pesticide impairments identified for the following:
    - Dieldrin in Del Puerto Creek, Hospital Creek, Ingram Creek, Orestimba Creek, and San Creek.
    - Dimethoate in Ramona Lake, Del Puerto Creek, Hospital Creek, Ingram Creek, Orestimba Creek, and Westley Wasteway.
    - Diuron in Lone Tree Creek, Miles Creek, Del Puerto Creek, Orestimba Creek, and the San Joaquin River.
    - Simazine in Highline Canal, Mustang Creek and Newman Wasteway.
- Metals (mercury, copper and zinc).
- Nutrients (low dissolved oxygen.)
- Bacteria/E. Coli.
- Erosion and sediment.
- Temperature. (SWRCB 2010).

Since the 1940s, mean annual salt concentrations in the lower San Joaquin River at the Airport Way Bridge near Vernalis have doubled and boron levels have increased significantly. Water quality monitoring data collected by the Central Valley Region Water Quality Control Board and others indicates that water quality objectives for salinity and boron are frequently exceeded in the lower San Joaquin River during certain times of the year and under certain flow regimes. The salt and boron water quality impairment in the lower San Joaquin River has occurred, in large part, as a result of large-scale water development coupled with extensive agricultural land use and associated agricultural discharges in the watershed. Lower San Joaquin River flows have been severely diminished by the construction and operation of dams and diversions and the resulting consumptive use of water. Most of the natural flows from the upper San Joaquin River and its headwaters are diverted at the Friant Dam via the Friant-Kern Canal to irrigate crops outside the San Joaquin River Basin. Diverted natural-river flows have been replaced with poorer quality (higher salinity) imported water from the Sacramento-San Joaquin Delta that is primarily used to irrigate crops on the west side of the lower San Joaquin River basin. Surface and subsurface agricultural discharges are the largest sources of salt and boron loading to the lower San Joaquin River and river water quality is therefore heavily influenced by irrigation return flows during the irrigation season. Water quality generally improves downstream as higher quality flows from the Merced, Tuolumne, and Stanislaus rivers dilute salt and boron concentrations in the main channel of the lower San Joaquin River (CVRWQCB 2004).

Soils on the west side of the San Joaquin River Basin are derived from rocks of marine origin in the Coast Range that are high in selenium and salts. Dry conditions make irrigation necessary for nearly all crops grown commercially in the watershed. Irrigation of the soils derived from these marine sediments leaches selenium and salt into the shallow groundwater. Subsurface drainage is produced when farmers drain the shallow groundwater from the root zone to protect their crops. This subsurface agricultural drainage water is high in naturally occurring salts and selenium. The discharge of subsurface drainage from the west side has resulted in violations of water quality objectives in Salt Slough, the San Joaquin River, and other water bodies in the area (see Figure SJR-21). Selenium is a highly bioaccumulative trace element, which, under certain conditions can be mobilized through the food chain and cause both acute and chronic toxicity to waterfowl. Deformities and deaths of waterfowl have been linked to toxic concentrations of selenium (CVRWQCB 1999; CVRWQCB 2000; CVRWQCB 2001).

PLACEHOLDER Figure SJR-21 Salt Slough and Mud Slough

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Pesticides causing impairment of the San Joaquin River Hydrologic Region water ways are human-made chemicals used to control pests, insects, and undesirable vegetation in urban and agricultural landscapes. A fraction of the applied pesticides can enter waterways during rainfall or irrigation events when residual pesticides migrate in stormwater runoff or irrigation return water or migrate with sediment carried in stormwater runoff or irrigation return water and cause unintended toxicity to aquatic life.

Inorganic mercury enters waterways when soils erode, atmospheric dust falls to the ground, and mineral springs discharge. Another significant source is cinnabar ore (mercury sulfide) that was mined in the Inner Coast Ranges for elemental mercury (quicksilver). This liquid form of mercury was transported from the Coast Ranges to the Sierra Nevada for gold recovery where several million pounds of mercury were lost to the environment during the Gold Rush. In various aquatic environments, inorganic mercury can be converted to methylmercury, which is a potent neurotoxin. Methylmercury is readily absorbed from water and food and therefore concentrations multiply greatly between water and top predators of aquatic food chains. The production of methylmercury and uptake in the food chain is influenced by natural factors and by many human activities. Fish with elevated concentrations of methylmercury pose a risk to people and wildlife that eat the fish. Many streams and reservoirs in the San Joaquin River Hydrologic Region contain fish with elevated concentrations of methylmercury.

The “copper belt” in the lower Sierra Nevada foothills is an area with natural copper deposits and spans roughly from Amador County to Tuolumne County. Discharges from abandoned mines contain levels of copper, arsenic, pH, and salts, which are a concern for aquatic life.

Low dissolved oxygen and nutrient enrichment issues have been identified in the south and eastern Delta and in the upper Fresno River, Los Banos Creek, and Kellogg Creek., Low dissolved oxygen concentrations in the Delta may act as a barrier to upstream spawning migration of salmonids. In the Delta and elsewhere, low dissolved oxygen concentrations may stress and kill resident aquatic organisms. Oxygen-demanding substances are generally the likely cause of low dissolved oxygen impairments, although in the Deep Water Ship Channel portion of the San Joaquin River, channel geometry and reduced flows have also been identified as causes of the impairment (CVRWQCB 2005a).

High levels of indicator organisms were found in the south Delta and in various water bodies in the San Joaquin River watershed. Indicator organisms are used to infer the potential for the presence of disease-causing pathogens because pathogenic organisms are difficult to identify and isolate. High levels of the indicator organisms show an increased potential for human health risks. Water quality criteria have been established to protect for recreational use in ambient waters. (EPA 1986)

Erosion and sedimentation is a water quality concern in the San Joaquin River Hydrologic Region. Agricultural, forest management, mining, land development, and dredging activities can result in excessive erosion and discharge of sediments to surface waters. Sedimentation impairs fisheries and, by virtue of the characteristics of many organic and inorganic compounds to bind to soil particles, serves to distribute and circulate toxic substances through the riparian, estuarine, and marine systems (CVRWQCB 2011c).

Temperature impairments have been identified for the Lower Merced River, the Lower Stanislaus River, the Lower Tuolumne River, and the Lower San Joaquin River (SWRCB 2010). The activities of fish are controlled by temperatures in the aquatic environment. Extremes of temperature, whether hot or cold, produce adverse effects in fish. The tolerance of fish to temperature extremes varies with the life stage, whether it is egg, fry, fingerling, smolt, or adult. In addition to direct effects of temperature on fish, indirect effects due to temperature also occur that can limit fish populations. Such effects include altered food abundance and conversion efficiency, increased predation, temperature-mediated disease, dissolved oxygen, and increased toxicity of various compounds (DWR 1988). In the San Joaquin River basin, one critical factor limiting anadromous salmon and steelhead population abundance is high-water temperatures, which exist during critical life-stages in the tributaries and the mainstem. This results largely from water diversions, hydroelectric power operations, water operations and other factors. (Loudermilk 2007)

Drinking Water Quality

In general, drinking water systems in the region deliver water to their customers that meet federal and State drinking water standards. Nonetheless, local groundwater supplies have been found to be contaminated. Recently the SWRCB completed a draft statewide assessment of community water systems that rely on contaminated groundwater. This draft report identified 104 community drinking water systems in the region that rely on at least one contaminated groundwater well as a source of supply (see Table SJR-20). Common naturally occurring contaminants arsenic, gross alpha particle activity, and uranium are the most prevalent groundwater contaminants affecting community drinking water wells in the region. A number of community drinking water wells are also affected by nitrate and 1,2-Dibromo-3-chloropropane (DBCP) which are attributed to anthropogenic sources of contamination (see Table SJR-21). The majority of the affected systems are small water systems which often need financial assistance to construct a water treatment plant or alternate solution to meet drinking water standards.

PLACEHOLDER Table SJR-20 Summary of Community Drinking Water Systems in the San Joaquin River Hydrologic Region that Rely on One or More Contaminated Groundwater Wells that Exceed a Primary Drinking Water Standard

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PLACEHOLDER Table SJR-21 Summary of Contaminants Affecting Community Drinking Water Systems in the San Joaquin River Hydrologic Region

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Groundwater Quality

The following are the contaminants of concern in groundwater for this region:

- Salinity (CVRWQCB 2011b).
- Nitrate (Dubrovsky 1998; Burow 2008; SWRCB 2012b).
- Arsenic (SWRCB 2012b; and U.S. Geological Survey (USGS) 2012).
- Gross Alpha Particle Activity and Uranium (SWRCB 2012b; USGS 2012).
- Chromium 6 (SWRCB 2011b).
- Localized Contamination by tetrachloroethylene (PCE) and trichloroethylene (TCE) (SWRCB 2012b).

Salt management is the most serious long-term water quality issue in the San Joaquin River basin. The causes include increased urban and agricultural development, over allocation of surface water supplies, diversion of high quality flows to outside the basin, salty return flows from agriculture, and higher salinity water being imported into the basin. Approximately 600,000 tons of salt are imported annually into the western portion of the San Joaquin Basin (west of the San Joaquin River) for crop irrigation and wetland management via federal, State, and local water projects. An additional 160,000 tons are applied through irrigation from San Joaquin River diversions. Some of this salt is returned to the river through tail water return flows and some is stored in the soil. Most, however, is purposefully leached below the root zone to maintain salt balance in the root zone. Much of this leached salt ends up in the groundwater. Degradation of groundwater in the San Joaquin River basin by salts is unavoidable without a plan to remove salts from the basin (CVRWQCB 2011b).

Nitrate concentrations in 24 percent (21 of 88) of the domestic wells sampled during 1993-95 in the regional aquifer survey and land-use studies of the eastern San Joaquin Valley exceeded the drinking-water standard of 10 mg/L established by the EPA. Pesticides were detected in 61 of the 88 domestic wells sampled during 1993-95 (69 percent), but concentrations of most pesticides were low — less than 0.1 mg/L (Dubrovsky 1998). Concentrations of nitrate and pesticides in the shallow part of the aquifer system at depths of domestic wells in the study area have increased over time due to continued contributions of nitrates and current use pesticides in the recharge water. Also, concentrations of nitrates and pesticides in the shallow part of the aquifer are likely to move to deeper parts of the groundwater flow system (Burow 2008). Public supply wells with impacted source water are generally located on the valley floor (SWRCB 2012b).

Public supply wells with levels of arsenic in the raw and untreated water that exceed the maximum contaminant level (MCL) were found in the eastern portion of the valley floor and in the foothills of Madera County. Arsenic is generally considered to be naturally occurring (SWRCB 2012b; USGS 2012). Arsenic has been linked to cancer of the bladder, lungs, skin, kidney, nasal passages, liver, and prostate (EPA 2012a).

Gross alpha particle activity and uranium were found in raw and untreated water for many of the public water systems in the foothills and mountain parts of this hydrologic region. These radionuclides are typically naturally occurring but are a concern because of the potential for health effects (SWRCB 2012b; USGS 2012).

Chromium is a metal found in natural deposits of ores containing other elements, mostly as chrome-iron ore. It is also widely present in soil and plants. Recent sampling of drinking water throughout California suggests that hexavalent chromium may occur naturally in groundwater at many locations. Chromium may also enter the environment from human uses. Chromium is used in metal allows such as stainless steel, protective coatings on metal, magnetic tapes, and pigments for paints, cement, paper, rubber, composition floor covering, etc. Elevated levels (above the detection limit of 1 µg/l) of hexavalent chromium have been detected in many active and standby public supply wells along the west or valley floor portion of the Central Valley (SWRCB 2011b).

There were very few occurrences of organic compounds in public supply wells in the San Joaquin River Hydrologic Basin. Organic compounds of concern found at levels above the MCLs in raw and untreated water from public supply wells were tetrachloroethylene (PCE) and trichloroethylene (TCE) in one well in Madera County, two wells in San Joaquin County, and one well in Stanislaus County.

Land Subsidence

Land subsidence was first noted in the San Joaquin Valley in 1935 in the Delano area (Galloway et al. 1999). In 1955, about one-fourth of the total groundwater extracted for agricultural uses in the United States was pumped from the San Joaquin Valley and regional aquifer compaction was occurring at a rate of about 1-foot per year (Swanson 1995). As of 1960, water levels in the deep aquifer system were declining at a rate of about 10 feet per year. In western Fresno County, during the highest pumping years of the 1960s maximum subsidence exceeded 30 feet and the regional ground surface was sinking at rates of one to one-half feet per year. As shown in Figure SJR-22, by the late 1960s more than 5,000 square miles of farm land or one-half the entire San Joaquin Valley had subsided by at least one foot (Ireland 1986).

PLACEHOLDER Figure SJR-22 Land Subsidence in the San Joaquin Valley — 1926 to 1970

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Surface water deliveries from the State Water Project and other regional conveyance facilities in the 1970s and 1980s significantly reduced the demand for groundwater for agricultural water use. Between 1967 and 1974, groundwater levels in the deep aquifer recovered as much as 200 feet (Galloway et al. 1999). Although reduced groundwater pumping and imported surface water largely diminished the subsidence problem, subsidence still continued in some areas but at a slower rate, due to the time lag involved in the redistribution of pressures in the confined aquifers.

A combination of drought conditions, regulatory restrictions of imported surface water, increasing population, and agricultural trend towards the planting of more permanent crops has incrementally led to a renewed reliance on groundwater pumping in the San Joaquin River Hydrologic Region over the last few decades. Swanson (1995) conducted land subsidence update for the San Joaquin Valley and concluded that 1) subsidence is continuing in all subsidence areas but at lower rates than before the completion of the California Aqueduct; 2) subsidence centers have probably shifted to areas where groundwater pumping is concentrated; 3) subsidence rates are expected to increase in the near future as groundwater pumping replaces surface water diverted for environmental uses; and 4) subsidence may contribute to lost channel capacity and flooding in areas where these problems have been previously attributed entirely to different causes.

Beginning in 1987 and lasting through 1992, there was a surge in the number of new wells drilled due to the drought conditions. Wet years from 1995 to 1998 again provided sufficient surface water and fewer new wells were drilled. Beginning with the reduction in surface water supplies in 2007, farmers increased their use of groundwater to meet irrigation demand. This included increased pumping from existing deep wells and nearly tripling the number of new irrigation wells drilled. The consequences of additional on line groundwater pumping have been an intensification of declining water levels, a renewal of subsidence in areas where water levels declined below the historic low levels of 1967 and a spread of subsidence to areas formerly showing little or no subsidence. Results from recent land subsidence monitoring activities are discussed below.

California Aqueduct Elevation Surveys

DWR's California Aqueduct elevation survey conducted in Merced, Fresno, and Kings County for years 2000, 2006, and 2009 shows subsidence of as much as 0.8 feet from 2000 to 2009 (see Figure SJR-23). The survey also indicates an accelerated level of subsidence from 2006 to 2009.

PLACEHOLDER Figure SJR-23 Land Subsidence Along the California Aqueduct

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Borehole Extensometer Monitoring

There are currently seven active extensometers in the San Joaquin Valley being monitored for groundwater levels and land subsidence. The extensometer located in the Kern Water Bank and installed in 1966 and actively monitored by DWR, includes four groundwater level monitoring wells that are constructed to monitor various depth intervals within the aquifer system. The extensometer well cluster show relatively large changes in water levels as the water bank is recharged and extracted. The aquifer compaction and subsidence monitored by the extensometer show a small elastic response to changes in the water levels. Elastic subsidence is reversible and will typically not develop into inelastic (irreversible) subsidence until groundwater drop below a level that results in irreversible aquifer compaction.

USGS InSAR Monitoring

Preliminary results from USGS evaluation of 2007-2011 InSAR survey data show two areas of subsidence - an area in western Madera County (just to the north of the Tulare Lake Hydrologic Region) and a broad area in central Tulare Lake Hydrologic Region located in approximately west of Highway 99 within Kings and Tulare Counties. Additional information related to subsidence in the San Joaquin Valley is included in the Tulare Lake Hydrologic Region report. Data from the InSAR survey is currently being evaluated and the amount and rate of subsidence has not yet been determined.

Caltrans Highway 152 Elevation Monitoring

The 2004 survey by Caltrans of Highway 152 across the San Joaquin Valley from the San Luis Dam to State Route 99 shows that land subsidence at the western ends of the Highway 152 is negligible. However, moving towards the center of the valley near the San Joaquin River channel, a land subsidence trough of approximately 2.8 feet developed between 1972 and 1988. From 1988 to 2004, the rate of subsidence increased and the land in this area subsided by approximately another 3.1 feet. The cumulative decline in land surface elevation between 1972 and 2004 in the area was about 5.3 feet (see Figures SJR-24 and SJR-25).

PLACEHOLDER Figure SJR-24 Location of Caltrans Highway 152 Elevation Monitoring

PLACEHOLDER Figure SJR-25 Land Subsidence Results from Caltrans Highway 152 Elevation Monitoring, between San Luis Dam and Highway 99 (1972-2004)

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GPS Array Monitoring

The university-governed consortium for geosciences research using geodesy's (UNAVCO) continuously monitored precision GPS stations in western United States provide partial but important insight into the regional magnitude of subsidence in the Tulare Lake and San Joaquin River Hydrologic Regions (http://pbo.unavco.org). For example, many of the 13 land surface displacement summary graphs show a significant trend of declining land surface within the region (see Figure SJR-26). Similarly, Figure SJR-27 shows the obvious correlation between the post-2007 decline in groundwater levels beneath the Corcoran Clay and the decline in land surface elevations near the City of Mendota. Between 2007 and 2010, groundwater levels in the Mendota area have declined by approximately 30 feet, while the vertical displacement in the land surface has declined by about 0.2 feet.

PLACEHOLDER Figure SJR-26 UNAVCO GPS Land Subsidence Displacement Monitoring Stations and Station Data Summary Graphs

PLACEHOLDER Figure SJR-27 Depth to Groundwater Hydrograph and Vertical Land Surface Displacement at UNAVCO GPS site 304, Near the City of Mendota

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Groundwater Level Monitoring and Subsidence

The rate, extent, and type (elastic versus inelastic) of land subsidence is directly related to the rate and extent of declining groundwater levels. In areas of that have undergone historic subsidence, the threat for renewed subsidence is commonly considered to be minimized if current groundwater levels can me maintained above historic lows. Droughts in 2007 and 2008 and the court settlement of San Joaquin River water rights resulted in reduced surface water allocations for irrigation. The result was an increased reliance on groundwater to meet water needs including the reactivation of old wells and an increase to the number of new wells drilled. With renewed increase in groundwater pumping, it is anticipated that dropping groundwater levels would cause a recurrence in land subsidence.

Groundwater pumping to meet ever increasing agricultural water demand has led to a long-term economic boom for California's agriculture economy and allowed the San Joaquin Valley to become one of the world's most productive agricultural regions. However, the groundwater extraction far exceeds natural aquifer recharge in the region and the depleted system was not replenished by actively recharging the aquifer via conjunctive management practices. These economic benefits have not gone without a broader cost to the infrastructure affected by land subsidence, to the quantity and quality of groundwater resources, to the increased energy required to pump groundwater, and to the decline in ecosystem services provided by the interaction of groundwater-surface water systems. In water short regions, implementing effective groundwater management can be extremely challenging. Local water resource managers in the region currently utilize conjunctive management and water conservation measures to help reduce unsustainable stress on the aquifer systems; however, in many cases groundwater levels continue to decline and evidence of renewed land subsidence remains. It is very important for existing agricultural and urban development to critically evaluate the broader and longer-term costs associated with unsustainable groundwater pumping and take more aggressive actions to balance between water resource management and land use practices, and help mitigate against escalation of future grim consequences.

Additional information regarding the aquifers in the San Joaquin River Hydrologic Region is available online from Update 2013, Volume 4, Reference Guide, the article "California's Groundwater Update 2013."

Groundwater Conditions and Issues

Groundwater Occurrence and Movement

Aquifer conditions and groundwater levels change in response to varying supply, demand, and climate conditions. During dry years or periods of increased groundwater extraction, seasonal groundwater levels tend to fluctuate more widely and, depending on annual recharge conditions, may result in a long-term decline in groundwater levels, both locally and regionally. Depending on the amount, timing, and duration of groundwater level decline, nearby well owners may need to deepen wells or lower pumps to regain access to groundwater.

Lowering of groundwater levels can also impact the surface water–groundwater interaction by inducing additional infiltration and recharge from surface water systems, thereby reducing the groundwater discharge to surface water base flow and wetlands areas. Extensive lowering of groundwater levels can also result in land subsidence due to the dewatering, compaction, and loss of storage within finer grained aquifer systems.

During years of normal or above normal precipitation, or during periods of low groundwater extraction, aquifer systems tend to recharge and respond with rising groundwater levels. As groundwater levels rise, they reconnect to surface water systems, contributing to surface water base flow or wetlands, seeps, and springs. However, for some areas of the San Joaquin River Hydrologic Region, due to extensive pumping over the years the groundwater table has been disconnected from the surface water system for decades and provides no contribution to base flow. In 1980, DWR Bulletin 118-80 identified three of the seven southern San Joaquin Valley groundwater subbasins (Eastern San Joaquin, Chowchilla, and Madera), as being subject to conditions of critical overdraft. Thirty years later, things do not appear to have changed much. Although efforts have been made by local groundwater management agencies to reduce overdraft conditions in the region, a number of the groundwater management plans and more recent studies for key groundwater subbasins acknowledge that groundwater overdraft continues.

The movement of groundwater is from areas of higher hydraulic potential to areas of lower hydraulic potential, typically from higher elevations to lower elevations. Under predevelopment conditions, the occurrence and movement of groundwater in the region was largely controlled by the surface and the subsurface geology, the size and distribution of the natural surface water systems, the average annual hydrology, and the regional topography. However, decades of high-volume groundwater extraction to meet the region's agricultural and urban water uses has influenced the natural occurrence and movement of groundwater. Areas of high groundwater extraction tend to redirect and capture groundwater underflow that may otherwise have contributed to nearby surface water systems. Thousands of high-capacity wells screened over multiple aquifer zones also lend themselves to vertical aquifer mixing, which can result in further deviation from natural groundwater flow conditions. In addition, infiltration along miles of unlined water conveyance canals, percolation of applied irrigation water, and direct recharge programs create significant groundwater recharge areas where none previously existed.

Depth to Groundwater

The depth to groundwater has a direct bearing on the costs associated with well installation and groundwater extraction operations. Understanding the local depth to groundwater can also provide a better understanding of the local interaction between the groundwater table and the surface water systems, and the contribution of groundwater aquifers to the local ecosystem.

Figure SJR-28 is a spring 2010 depth to groundwater contour maps for the region. Groundwater contour maps were developed using groundwater level data that is available online from DWR's Water Data Library (http://www.water.ca.gov/waterdatalibrary/) and CASGEM system (http://www.water.ca.gov/groundwater/casgem/). The contour lines in the figure represent areas having similar spring 2010 depth to groundwater values. Precipitation for water year 2010 was 106 percent of the previous 30-year average; however, precipitation for the preceding three years averaged about 73 percent of average. Contour lines were developed for only those areas having sufficient groundwater level data and for only those aquifers characterized by unconfined to semi-confined groundwater conditions. Depth to groundwater contours were not developed for Yosemite Valley or Los Banos Creek Valley due to a lack of groundwater level data.

PLACEHOLDER Figure SJR-28 Spring 2010 Depth to Groundwater Contours for the San Joaquin River Hydrologic Region

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Figure SJR-28 shows that the depth to groundwater in the western half of the region is shallowest along the valley floor adjacent to the San Joaquin River and its associated tributaries, and deepest along the eastern side of the valley where it abuts the lower foothills of the Sierra Nevada. On the east side of the region, wide spread agriculture and a lack of surface water supplies have resulted in significant declines to the water table and cones of depression exceeding 250 feet in the northeastern Madera subbasin, 200 feet in the eastern Turlock subbasin, and up to 150 feet in the northeastern Cosumnes subbasin. The declines are more pronounced in the southern portion of the region due to multiple factors including higher annual temperatures and less annual precipitation, which results in more groundwater pumping for crop irrigation.

Moving west, the groundwater elevation rises and ranges between five to 20 feet below ground surface adjacent to the San Joaquin River throughout the region. While intensive agricultural practices are predominant in this area as well, the volume of water transported by the tributaries of the San Joaquin River (Merced, Tuolumne, and Stanislaus Rivers) has resulted in a higher water table that is near surface due to the recharging of the shallow aquifers.

Groundwater Elevations

Groundwater elevation contours can help estimate the direction of groundwater movement and the gradient, or rate, of groundwater flow. Figure SJR-29 is a spring 2010 groundwater elevation contour map for the region. Groundwater movement direction is shown as a series of arrows along the groundwater flow path; these flow direction arrows do not provide information regarding vertical flow within the aquifer system. Similar to the spring 2010 depth to groundwater contours, groundwater elevation contours were developed for only those areas having sufficient groundwater level data and for only those aquifers characterized by unconfined to semi-confined aquifer conditions. Groundwater elevation contours were not developed for Yosemite Valley or Los Banos Creek Valley due to a lack of groundwater level data in the area.

PLACEHOLDER Figure SJR-29 Spring 2010 Groundwater Elevation Contours for the San Joaquin River Hydrologic Region

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Figure SJR-29 shows that the spring 2010 groundwater movement is generally from the eastern and western edges of the basins to the axis of the valley and then flows north following the San Joaquin River. Groundwater pumping and recharge activities tend to alter the spacing, pattern, and overall variability of groundwater elevation contours for some areas. In areas receiving little or no surface water, large pumping centers have developed cones-of-depression, reducing water levels to near sea level. A good example is the large pumping depression that has formed in the eastern Madera and Chowchilla subbasins, where historic groundwater flow directions have been altered and now groundwater flows toward the cone formed around the area. Although of lesser scope and size, similar cones have formed around the eastern Cosumnes and eastern Eastern San Joaquin subbasins. Figure SJR-29 also illustrates several patterns of groundwater recharge associated with key surface water systems flowing into the region. Recharge areas can be seen along the larger rivers such as the San Joaquin, Merced, and Tuolumne Rivers.

Groundwater Level Trends

Plots of depth-to-water measurements in wells over time (groundwater level hydrographs) allow analysis of seasonal and long-term groundwater level variability and trend over time. Because of the highly variable nature of the physical aquifer systems within each groundwater basin, and because of the variable nature of annual groundwater availability, recharge, and surrounding land use practices, the hydrographs presented herein do not attempt to illustrate or depict average aquifer conditions over a broader region. Rather, the selected hydrographs are intended to help tell a story about how the local aquifer systems respond to changing groundwater pumping quantity and to the implementation of resource management practices. The hydrographs are designated according to the State Well Number System (SWN), which identifies each well by its location using the public lands survey system of township, range, section, and tract.

<u>Hydrograph 05S09E07B001M</u>

Hydrograph 05S09E07B001M (Figure SJR-GW-30A) is from an irrigation well located on the west side of the Turlock groundwater subbasin, approximately four miles east of the San Joaquin River. Groundwater at the well site is shallow, occurring at a depths ranging from 5 to 10 feet below ground surface, which is typical for groundwater levels on the western portion of the groundwater basin. The well is believed to be screened in an unconfined to semi-confined aquifer, although exact depth and construction details of the well are unknown. The area surrounding the well is predominantly agricultural land use and is sparsely populated. Groundwater levels have been relatively stable during the monitoring period, varying in depth by no more than about 10 feet. Similar to many wells in the San Joaquin Valley, groundwater levels respond to wet and dry hydrology. Although for this well, the response is subdued. During a highly wet year (1983), water levels rose near the ground surface at a depth of 2.5 feet. The drought years of 1987 to 1992 resulted in a 10 foot drop in water level but it returned to the average level during subsequent wet years. The Turlock groundwater subbasin is designated a CASGEM high priority basin.

PLACEHOLDER Figure SJR-30 Groundwater Level Trends in Selected Wells in the San Joaquin River Hydrologic Region

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Hydrograph 05S10E04D001M

Hydrograph 05S10E04D001M (Figure SJR-30B) is from an irrigation well located immediately northeast of the City of Turlock in Stanislaus County within the Turlock groundwater subbasin. Groundwater at the well site has been in a gradual decline associated with urban growth in City of Turlock. The well is believed to be screened in an unconfined to semi-confined aquifer, although exact depth and construction details of the well are unknown. Turlock Irrigation District has an active conjunctive management program using surface water from the Tuolumne River during wet years and relying on groundwater pumping during dry years (Turlock Irrigation District, personal communication). Drought in 1987 to 1992 resulted in a 20 foot drop in groundwater levels due to an increased reliance on pumping and a decreased availability of surface water supplies from the Tuolumne River. Water levels stabilized and underwent a multiyear rise during a period of increased precipitation and resumption of surface water supplies between 1992 and 1998. Declining water levels beginning in 1999 have been associated with an increase in urban land development, in addition to the influence of the previously referenced cone of depression in the Turlock subbasin to the east. The cone of depression is created by groundwater pumping in areas east of the Turlock Irrigation District where irrigated lands do not have access to surface water and solely rely on groundwater for their supply. A conservation effort combined with slowing economic growth stabilized water levels beginning in 2009. The Turlock groundwater subbasin is designated a CASGEM high priority basin.

Hydrograph 05S12E11G001M

Hydrograph 05S12E11G001M (Figure SJR-30C) is from an irrigation well located in the Eastside Water District, approximately 10 miles east of the City of Turlock, in the Turlock groundwater subbasin. The well is believed to be screened in an unconfined to semi-confined aquifer, although exact depth and construction details of the well are unknown. Agricultural development in the water district intensified in the area starting in the 1970s. Eastside Irrigation District has no surface water allocations, thus the increased agriculture resulted in increased groundwater pumping for irrigation water which led to a steady decline in water levels. A shift in irrigation practices from sprinkler to drip and micro irrigation stabilized water levels from 1990 to 2002. Declining water levels in 2003 and 2004 are attributed to the increased agricultural development in areas that were previously non-irrigated rangeland. The 90 foot drop in water levels from 1970 to 2011 may likely require the deepening of existing wells and installation of new, deeper wells in the recently developed farmlands. The Turlock groundwater subbasin is designated a CASGEM high priority basin.

Hydrograph 13S13E16E001M

Hydrograph 13S13E16E001M (Figure SJR-30D) is from an irrigation well located in Fresno County, approximately 10 miles west of the San Joaquin River in the Delta-Mendota groundwater subbasin. The well is believed to be screened in an unconfined to semi-confined aquifer, although exact depth and construction details of the well are unknown. The well is located in an agricultural area of predominantly permanent crops. Although the land in the area was for many decades considered too salty for crop production, decades of farming lower value crops such as hay, cotton and sugar beets over time developed the soil into use for permanent crops such as grapes and almonds. Flushing of salt from the soil combined with recharge of fresh San Joaquin River water has produced a variable water quality with the lowest salt content groundwater being generally located closer to the river. Wells for agricultural irrigation penetrated the Corcoran Clay, the regionally extending confining layer discussed previously. Rapidly falling water levels resulted in broad areas of land subsidence. Well 13S13E16E001M is located in an area that experienced 16 feet of subsidence from 1926 to 1970. The California Aqueduct was constructed in partial response to the land subsidence problem. Farms in the area were provided surface water and groundwater pumping was substantially reduced. The hydrograph shows groundwater level recovery of more than 150 feet after completion of the State Water Project and beginning of water deliveries in the early 1960s. Dry years in 1992 and 2007 to 2009 and reduced water supplies have resulted in falling water levels and renewed impacts from subsidence have been observed in a number of areas. The Delta-Mendota groundwater subbasin is designated a CASGEM high priority basin.

Hydrograph 11S16E35H001M

Hydrograph 11S16E35H001M (Figure SJR-30E) is from an irrigation well located about five miles southwest of the City of Madera in Madera County within the Madera subbasin. Groundwater conditions in the area around the well site are in a persistent and growing groundwater depression. The well is believed to be screened in an unconfined to semi-confined aquifer, although exact depth and construction details of the well are unknown. The area surrounding the well is predominantly agricultural land use. The area has a mix of undeveloped range land, permanent crops (vines and tree fruit) and forage crops. There are no surface water supplies available and irrigation is dependent on groundwater to meet area's water use. Water levels were more or less stable through the 1930s. After World War II, agricultural development intensified and water levels began a steady decline. Groundwater is replenished by subsurface inflow from surrounding areas, recharge from rainfall and infiltration of applied irrigation water. The hydrograph shows the imbalance between recharge from subsurface inflow and groundwater extraction with water levels declining approximately 90 feet since 1940. The Madera groundwater subbasin is designated a CASGEM high priority basin.

Change in Groundwater Storage

Change in groundwater storage is the difference in stored groundwater volume between two time periods. Examining the annual change in groundwater storage over a series of years helps identify the aquifer response to changes in climate, land use, or groundwater management over time. If the change in storage is negligible over a period represented by average hydrologic and land use conditions, the basin is considered to be in equilibrium under the existing water use scenario and current management practices. However, declining storage over a period characterized by average hydrologic and land use conditions does not necessarily mean that the basin is being managed unsustainably or subject to conditions of overdraft. Utilization of groundwater in storage during years of diminishing surface water supply, followed by active recharge of the aquifer when surface water or other alternative supplies become available, is a recognized and acceptable approach to conjunctive water management.

Additional information regarding the risks and benefits of conjunctive management can be found online from Update 2013, Volume 3, Chapter 9, "Conjunctive Management and Groundwater Storage."

Annual and cumulative change in groundwater storage for the San Joaquin River Hydrologic Region was calculated between 2005 and 2010 using spring groundwater elevation data, a range of specific yield values for the aquifer, and a Geographic Information Systems (GIS) analytical tool. Groundwater level data from the spring 2005 was used instead of 2006 because the hydrology for 2005 more closely approximated long term average conditions than that of 2006. Beginning the change in storage calculation in 2005, approximately an average water year, yields a more realistic assessment of the annual and cumulative change in storage values in subsequent years.

Based on published literature, minimum and maximum specific yield (Sy) values of 0.07 and 0.17 were determined to be a good approximation of the range of regional aquifer storage parameters. For depth to water and groundwater elevation contour maps discussed previously, groundwater basins having insufficient data to contour and compare year-to-year changes in groundwater elevations were identified as "non-reporting" areas. Change in storage was also not estimated for these "non-reporting" areas.

Spring 2005 to Spring 2010 Change in Aquifer Storage

Figure SJR-31 shows an overall decline in groundwater levels for much of the region. Groundwater level declines up to 40 feet are seen mostly in the southeastern portion of the region in the Madera, Chowchilla, and Merced subbasins. Groundwater level declines from 10 to 20 feet are also seen along the eastern edge of the region which includes the Merced, Stanislaus, and San Joaquin subbasins, where the alluvial basins about the Sierra Nevada. Additionally, groundwater elevation declines ranging up to 30 feet are observed along some areas in the western portion of the region in the Delta-Mendota subbasin.

Table SJR-22 and Figure SJR-32 show that the average annual change in groundwater elevation and related change in groundwater storage generally follow the annual precipitation or water year type. Figure SJR-32 shows that the annual variability in groundwater storage change for the region is large. The spring 2005 – spring 2010 cumulative groundwater level decline over the region is estimated at about six feet with corresponding changes in storage. For example, the single year maximum increase in groundwater storage occurred during the 2005-2006 period and ranged between approximately 185 and 450 taf. The maximum single year decline in groundwater storage occurred during the 2008-2009 period and ranged between 610 and 1480 taf. The 2008-2009 decline in groundwater storage is estimated to be between approximately 20 and 45 percent of the average annual groundwater extraction for the region (see Table SJR-16). The cumulative change in groundwater storage over the 2005-2010 period is estimated between approximately one and two and a half-million acre feet. These numbers represent between approximately 30 and 80 percent of the average annual groundwater extraction for the region. The large annual variation in groundwater storage changes points to high reliance on groundwater in the region.

PLACEHOLDER Figure SJR-31 Spring 2005 – Spring 2010 Change in Groundwater Elevation Contour Map for the San Joaquin River Hydrologic Region

PLACEHOLDER Table SJR-22 Spring 2005 – Spring 2010 Annual Change in Groundwater Storage for the San Joaquin River Hydrologic Region

PLACEHOLDER Figure SJR-32 Spring 2005 – Spring 2010 Annual Change in Groundwater Storage for the San Joaquin River Hydrologic Region

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Additional information regarding the methods and assumptions for calculating change in groundwater storage is available online from Update 2013, Volume 4, Reference Guide, the article "California's Groundwater Update 2013."

Flood Management

Traditionally, the approach to flood management was to develop narrowly focused flood infrastructure projects. This infrastructure often altered or confined natural watercourses, which reduced the chance of flooding thereby minimizing damage to lives and property. This traditional approach looked at floodwaters primarily as a potential risk to be mitigated instead of as a natural resource that could provide multiple societal benefits.

Today, water resources and flood planning involves additional demands and challenges, such as multiple regulatory processes and permits, coordination with multiple agencies and stakeholders, and increased environmental awareness. These additional complexities call for an integrated water management (IWM) approach that incorporates natural hydrologic, geomorphic, and ecological processes to reduce flood risk by influencing the cause of the harm, including the probability, extent, or depth of flooding (flood hazard). Some agencies are transitioning to an IWM approach. IWM changes the implementation approach based on the understanding that water resources are an integral component for sustainable ecosystems, economic growth, water supply reliability, public health and safety, and other interrelated elements. Additionally, IWM acknowledges that a broad range of stakeholders might have interests and perspectives that could positively influence planning outcomes.

Damage Reduction Measures

Flood exposure in the San Joaquin River Hydrologic Region occurs primarily along the San Joaquin River. However, significant flooding has also occurred on the Fresno, Merced, Mokelumne, and Stanislaus rivers. Floods within the San Joaquin River Hydrologic Region originate principally from melting of the Sierra snowpack and from rainfall. Most flood events occur in December and January as a result of multiple storms and saturated soil conditions, but floods can occur in October and November or during the late winter or early spring months.

In the San Joaquin River Hydrologic Region, more than 535,000 people and around $40 billion in structures are exposed to the 500-year flood event. There is also more than $1.9 billion in agriculture crop value exposed in the region. Figures SJR-33 and SJR-34 provide a snapshot of people, structures, crops, infrastructure exposed to flooding in the region. Over 260 State and federal threatened, endangered, listed, or rare plant and animal species exposed to flood hazards are distributed throughout the San Joaquin River Hydrologic Region.

PLACEHOLDER Figure SJR-33 Flood Exposure to the 100-Year Floodplain, San Joaquin River Hydrologic Region

PLACEHOLDER Figure SJR-34 Flood Exposure to the 500-Year Floodplain, San Joaquin River Hydrologic Region

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Levee Performance and Risk Studies

Flood hazard mitigation planning is an important part of emergency management planning for floods and other disasters. Hazard mitigation is defined as any sustained action taken to reduce or eliminate long-term risk to human life and property from hazards. Hazard mitigation planning is the process through which natural hazards that threaten communities are identified, likely impacts of those hazards are determined, mitigation goals are set, and appropriate strategies that would lessen the impacts are determined, prioritized, and implemented. Hazard mitigation planning is required for State and local governments to maintain their eligibility for certain federal disaster assistance and hazard mitigation funding programs.

Multi-Hazard Mitigation Plans (MHMPs) are required by the Federal Emergency Management Agency (FEMA) as a condition of pre- and post-disaster assistance. The Stafford Act, as amended by the Disaster Mitigation Act of 2000, provides for States, tribes, and local governments to undertake a risk-based approach to reducing risks to natural hazards through mitigation planning. The National Flood Insurance Act reinforced the need and requirement for mitigation plans linking flood mitigation assistance programs to State, tribal and local mitigation plans. FEMA-approved MHMPs were on file for a number of counties in this hydrologic region. Other risk assessment studies were prepared by various entities including USACE, FEMA, and the State Reclamation Board of California. For a complete list of studies, see *California's Flood Future Report* Attachment G: Risk Information Inventory Technical Memorandum.

One specific study, the CVFPP was developed to address flood risk. The Central Valley Flood Protection Act of 2008 directed DWR to prepare this report. The CVFPP is a flood management planning effort that addresses flood risks and ecosystem restoration opportunities in an integrated manner while concurrently improving ecosystem functions, operations and maintenance practices, and institutional support for flood management. It specifically proposes a systemwide approach to flood management for the areas currently protected by facilities of the State Plan of Flood Control (SPFC). Under this approach, California will prioritize investments in flood-risk reduction projects and programs that incorporate ecosystem restoration and multi-benefit projects. The CVFPP was adopted by the Central Valley Flood Control Board on June 29, 2012. It is expected that the CVFPP will be updated every 5 years thereafter. The CVFPP proposes a systemwide approach to address the following issues:

- Physical improvements in the Sacramento and San Joaquin River basins.
- Urban flood protection.
- Small community flood protection.
- Rural/agricultural area flood protection.
- System improvements.
- Non-SPFC levees.
- Ecosystem restoration opportunities.
- Climate change considerations.

In the San Joaquin River Hydrologic Region 54 local flood management projects or planned improvements were identified. The local flood management projects can be found in *California's Flood Future Report*. Of this total, 47 projects have identified costs totaling about $735 million while the remaining projects do not have costs associated with them at this time. Twenty-four local planned projects implement IWM approach. Example projects include the Big Bend Floodplain Protection and Restoration Project, the Farmington Groundwater Recharge and Seasonal Habitat Program, and the Lower San Joaquin River Flood Bypass Project. For a complete list of projects, see *California's Flood Future Report* Attachment G: Risk Information Inventory Technical Memorandum.

Water Governance

The San Joaquin River Hydrologic Region's water management activities are generally governed by counties, cities, and special districts created to perform specific water-related functions. Federal entities within the region with water management responsibilities include the USBR and the USACE.

The interregional water conveyance systems of the CVP and SWP are operated by federal and State governments, respectively. The Madera Canal is part of the Friant Division of the USBR and is operated by the Friant Water Authority, while the Delta-Mendota Canal is part of the Delta Division of the USBR and operated by the SLDMWA. The San Luis Canal/California Aqueduct (a joint federal-State project), which runs from the O`Neill Forebay to Kettleman City is operated by the San Luis Unit of the USBR.

Local developed surface water systems include the Calaveras River waterworks for the Calaveras County Water District; Mokelumne River diversion points/canals for North San Joaquin WCD, Amador WA, and Calaveras County WD; Stanislaus River diversion points/canals for Calaveras County WD, Tuolumne UD, Oakdale Irrigation District, and South San Joaquin ID; Tuolumne River waterworks for the Turlock ID, Modesto ID, and TUD; Fresno River diversion points/canals for Madera ID; Chowchilla River diversion points/canals for the Chowchilla WD; Merced River diversion points for Merced ID; and San Joaquin River diversion points/canals for Patterson WD, West Stanislaus ID and the San Joaquin River Exchange Contractors (CCID, San Luis Canal Co., Firebaugh Canal Co., and Columbia Canal Co.).

Table SJR-23 lists a selection of organizations involved in water governance in the region. A list of regional flood management participants is included in the Flood Management section, and an IRWM discussion can be found in the IRWM section.

PLACEHOLDER Table SJR-23 Selection of Organizations in the San Joaquin River Hydrologic Region in Water Governance

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Changes to IRWM within the San Joaquin River Hydrologic Region since Update 2009 include the following:

- The conditionally-approved Central California IRWM group (which once included the Merced and Madera IRWM Regions) dissolved, re-organized, and re-formed as the Yosemite-Mariposa IRWM group, receiving full approval as an IRWM Region in round 2 of the Region Acceptance Process (RAP) in 2010-2011.

- The Madera, Merced, and Southern Sierra IRWM groups moved from conditionally-approved to fully approved IRWM Regions during round 2 RAP 2010-2011.
- The East Stanislaus IRWM group formed and was approved as an IRWM region during round 2 RAP 2010-2011.

State Funding Received

IRWM is divided into four main grant programs from three propositions: Prop. 50 Planning Grants, Prop. 84 Planning Grants, Prop. 84 Implementation Grants, and Prop. 1E Stormwater Flood Management Grants. Table SJR-24 lists those groups that received grant funds in the San Joaquin River region.

PLACEHOLDER Table SJR-24 Integrated Regional Water Management Grants Awarded in the San Joaquin River Hydrologic Region

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Flood Governance

California's water resource development has resulted in a complex, fragmented, and intertwined physical and governmental infrastructure. Although primary water management responsibility might be assigned to a specific local entity, aggregate responsibilities are spread among 280 agencies and cities in the San Joaquin River Hydrologic Region with many different governance structures. For a list of agencies, see *California's Flood Future Report* Attachment E: Information Gathering Technical Memorandum. Agency roles and responsibilities can be limited by how the agency was formed, which might include enabling legislation, a charter, a memorandum of understanding with other agencies, or facility ownership.

The San Joaquin River Hydrologic Region contains floodwater storage facilities and channel improvements funded and/or built by the State and federal agencies. Flood management agencies are responsible for operating and maintaining water management facilities, including more than 4,750 miles of levees, more than 260 dams and reservoirs, and other facilities in the hydrologic region. For a list of major infrastructure, see *California's Flood Future Report*.

CWC Division 5, Sections 8,000-9,651 have special significance to flood management activities in the Delta and are summarized in *California's Flood Future Report* Attachment E: Information Gathering Technical Memorandum.

Groundwater Governance

California does not have a statewide management program or statutory permitting system for groundwater. However, one of the primary vehicles for implementing local groundwater management in California is a groundwater management plan (GWMP). Some agencies utilize their local police powers to manage groundwater through adoption of groundwater ordinances. Groundwater management also occurs through other avenues such as basin adjudication, IRWMPs, Urban Water Management plans, and Agriculture Water Management plans.

Groundwater Management Assessment

Figure SJR-35 shows the location and distribution of the GWMPs within the San Joaquin River Hydrologic Region based on a GWMP inventory developed through a joint DWR/Association of

California Water Agencies (ACWA) online survey and follow-up communication by DWR in 2011-2012. Table SJR-25 furnishes a list of the same. GWMPs prepared in accordance with the 1992 AB 3030 legislation, as well as those prepared with the additional required components listed in the 2002 SB 1938 legislation are shown. Information associated with the GWMP assessment is based on data that was readily available or received through August 2012. Requirements associated with the 2011 AB 359 (Huffman) legislation, related to groundwater recharge mapping and reporting, did not take effect until January 2013 and are not included in the current GWMP assessment.

PLACEHOLDER Figure SJR-35 Location of Groundwater Management Plans in the San Joaquin River Hydrologic Region

PLACEHOLDER Table SJR-25 Groundwater Management Plans in the San Joaquin River Hydrologic Region

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The GWMP inventory indicates that 21 groundwater management plans exists within the region. Collectively, the 21 GWMPs cover 4,600 square miles or 79 percent of the Bulletin 118-2003 alluvial groundwater basin area in the region. Thirteen of the 21 GWMPs have been developed or updated to include the SB 1938 requirements and are considered active for the purposes of the Update 2013 GWMP assessment. The active GWMPs cover 3,100 square miles or 67 percent of the Bulletin 118-2003 alluvial groundwater basin area in the region. As of August 2012, all seven of the San Joaquin Valley groundwater subbasins in the San Joaquin River Hydrologic Region are identified as high priority under the CASGEM Basin Prioritization (see Table SJR-3). These seven high priority basins account for about 82 percent of the population and about 92 percent of groundwater supply in the region.

Based on the information compiled through inventory of the GWMPs, an assessment was made to understand and help identify groundwater management challenges and successes in the region, and provide recommendations for improvement. Information associated with the GWMP assessment is based on data that were readily available or received through August 2012 by DWR. The assessment process is briefly summarized below.

The California Water Code §10753.7 requires that six components be included in a groundwater management plan for an agency to be eligible for state funding administered by DWR for groundwater projects, including projects that are part of an IRWM program or plan (see Table SJR-26). Three of the components also contain required subcomponents. The requirement associated with the 2011 AB 359 (Huffman) legislation, applicable to groundwater recharge mapping and reporting, did not take effect until January 2013 and was not included in the current GWMP assessment.

In addition to the six required components, Water Code §10753.8 provides a list of twelve components that may be included in a groundwater management plan (Table SJR-26). Bulletin 118-2003, Appendix C provides a list of seven recommended components related to management development, implementation, and evaluation of a GWMP, that should be considered to help ensure effective and sustainable groundwater management plan (Table SJR-26).

As a result, the GWMP assessment was conducted using the following criteria:

- How many of the post SB 1938 GWMPs meet the six required components included in SB 1938 and incorporated into California Water Code §10753.7?
- How many of the post SB 1938 GWMPs include the twelve voluntary components included in California Water Code Section10753.8?
- How many of the implementing or signatory GWMP agencies are actively implementing the seven recommended components listed in DWR Bulletin 118 - 2003?

PLACEHOLDER Table SJR-26 Assessment for SB 1938 GWMP Required Components, SB 1938 GWMP Voluntary Components, and Bulletin 118-03 Recommended Components

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

In summary, assessment of the groundwater management plans in the San Joaquin Hydrologic Region indicates the following:

- Three of the 13 active GWMPs adequately address all of the required components listed under Water Code Section 10753.7. These three GWMPs cover only 16 percent of the Bulletin 118-2003 alluvial groundwater basin area in the region. Of the rest, eight plans do not identify activities to evaluate surface water and groundwater interaction. These same eight plans also do not develop sufficient monitoring protocols that would help ensure correctness and consistency when measuring, recording, and presenting field data. Four of these plans fail to provide monitoring protocols for the surface and groundwater interaction and do not sufficiently establish Basin Management Objectives (BMOs) or identify the necessary management actions that would be implemented in the event that BMOs are exceeded. The plans that fail to meet all the required components, does not address the BMO and Monitoring Protocol subcomponents for surface water-groundwater interaction. Analysis of the GWMPs for other regions also reveals that when a plan lacks BMO details for surface water and groundwater interaction, it generally lacks details for Monitoring Protocols as well.
- Six of the 13 active GWMPs incorporate the 12 voluntary components listed in Water Code Section 10753.8; the remaining plans incorporate eleven or fewer of the voluntary components.
- Six of the 13 active GWMPs include all seven components, two plans include most of the components while partially including one or more components, and one plan includes none of the seven components recommended in Bulletin 118-03; the remaining four plans do not provide the necessary detail for one or more of the components.

The DWR/ACWA survey asked respondents to identify key factors that contributed to the successful implementation of the agency's GWMP. Five agencies from the region participated in the survey. All five respondents identified data collection and sharing, understanding of common interest, sharing of ideas and information, and water budgets as key factors for successful GWMP implementation while four of the five respondents also identified other components as key factors. The responses to the survey are furnished in Table SJR-27.

PLACEHOLDER Table SJR-27 Factors Contributing to Successful Groundwater Management Plan Implementation in the San Joaquin River Hydrologic Region

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Survey participants were also asked to identify factors that impeded implementation of the GWMP. Five survey participants responded. Overall, respondents pointed to a lack of adequate funding as the greatest impediment to GWMP implementation. Funding is a challenging factor for many agencies because implementation and operation of groundwater management projects typically are expensive and because the sources of funding for projects typically are limited to either locally raised monies or to grants from State and federal agencies. Lack of surface storage and conveyance capacity and data collection and sharing were also considered key limiting factors by three of the five respondents. Unregulated pumping, groundwater supply, participation, and governance were also identified as factors that impede successful implementation of GWMPs. The responses to the survey are furnished in Tables SJR-28.

Finally, the survey asked if the respondents were confident in the long-term sustainability of their current groundwater supply. Four out of five respondents felt long-term sustainability of their groundwater supply was not feasible.

More detailed information on the DWR/ACWA survey and assessment of the GWMPs are available online from Update 2013, Volume 4, Reference Guide, the article "California's Groundwater Update 2013."

PLACEHOLDER Table SJR-28 Factors Limiting Successful Groundwater Management Plan Implementation in the San Joaquin River Hydrologic Region

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Groundwater Ordinances

Groundwater ordinances are laws adopted by local authorities, such as cities or counties, to manage groundwater. In 1995, the California Supreme Court declined to review a lower court decision (Baldwin v. Tehama County) that says that State law does not occupy the field of groundwater management and does not prevent cities and counties from adopting ordinances to manage groundwater under their police powers. Since 1995, the Baldwin v. Tehama County decision has remained untested; thus the precise nature and extent of the police power of cities and counties to regulate groundwater is still uncertain.

There are a number of groundwater ordinances that have been adopted by counties in the region (Table SJR-29). The region includes all or parts of Alameda, Alpine, Amador, Calaveras, Contra Costa, El Dorado, Fresno, Madera, Mariposa, Merced, Sacramento, San Joaquin, Stanislaus, and Tuolumne Counties. The most commonly adopted ordinances pertain to well abandonment and destruction and well construction policies. Several counties also have ordinances related to export permits. San Joaquin County has an additional ordinance regarding guidance committees while Madera County has an additional ordinance for recharge. However, none of the ordinances provide for comprehensive groundwater management.

PLACEHOLDER Table SJR-29 Groundwater Ordinances that Apply to Counties in the San Joaquin River Hydrologic Region

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Special Act Districts

Greater authority to manage groundwater has been granted to a few local agencies or districts created through a special act of the Legislature. The specific authority of each agency varies, but the agencies can be grouped into two general categories: (1) agencies having authority to limit export and extraction (upon evidence of overdraft or threat of overdraft) or (2) agencies lacking authority to limit extraction, but having authority to require reporting of extraction and to levy replenishment fees.

Court Adjudication of Groundwater Rights

Another form of groundwater management in California is through the courts. Of the 24 groundwater adjudications in California, none is in the San Joaquin River Hydrologic Region.

Other Groundwater Management Planning Efforts

Groundwater management also occurs through other avenues such as IRWMPs, Urban Water Management plans, and Agriculture Water Management plans. Box SJR-2 summarizes these other planning efforts.

PLACEHOLDER Box SJR-2 Other Groundwater Management Planning Efforts in the San Joaquin River Hydrologic Region

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Current Relationships with Other Regions and States

Interregional and Interstate Planning Activities

The San Joaquin River Hydrologic Region provides water to other regions and receives water as well. CVP water is brought in from the Delta and distributed to San Joaquin River Exchange Contractors. This makes water available at Friant Dam for distribution in the Friant Unit of the CVP. State water is brought into the region through the SWP's California Aqueduct. The existence of major water project transport facilities traversing the region enhances the potential for water exchanges and transfers. Water for the federal San Felipe Project is transported through the west side of San Luis Reservoir to coastal areas. During periods of high runoff, San Joaquin River water can be transported to the Tulare Lake Hydrologic Region in the Friant-Kern Canal to the Kern River. From the Kern River water can be placed into the California Aqueduct via the Kern River Intertie.

During periods of high flows, Kings River water may be diverted from the Tulare Lake Hydrologic Region into the San Joaquin River via Fresno Slough and the James Bypass. At these times, the Kings River Water Association coordinates closely with USACE and operators of the reservoirs on San Joaquin River tributaries. All parties participate in daily operators' conferences sponsored by DWR's Flood Operations Center.

The regional map in Figure SJR-15 above depicts these regional imports and exports.

The Folsom South Canal originates at Lake Natoma near Folsom Dam, originally part of the USBR's CVP intended to transport American River water nearly to Stockton. Approximately 14.5 taf of tail water per year flows through the facility into the region to Galt Irrigation District. The southern portion of the canal will be used in the Freeport Regional Water Project to transport water in dry years to EBMUD.

The San Francisco Bay Hydrologic Region receives surface water that originates in the San Joaquin River Hydrologic Region. EBMUD serves communities on the east side of San Francisco Bay with water from the Mokelumne River via the Mokelumne Aqueduct. The Mokelumne River supplies more than 96 percent of the water supply to EBMUD, serving almost 1.3 million people. The San Francisco Water Department provides water from the Tuolumne River through the Hetch Hetchy Aqueduct. This is the sole source water supply for 1.3 million people and a partial source for an additional 1.4 million people. Nearly four million Bay Area people receive water from these two San Joaquin River Hydrologic Region watersheds/projects.

In November 2004, DWR and the California Department of Parks and Recreation reviewed the many Hetch Hetchy Valley restoration studies prepared during the previous 20 years. Hetch Hetchy Valley is inundated by the waters of the Tuolumne River behind O'Shaughnessy Dam in Yosemite National Park, Tuolumne County. The review included local, State, and federal resource plans to assist in the evaluation of water supply and quality, operational considerations, flood and drought impacts, and environmental and energy issues. The review concluded that many other aspects of restoration needed in-depth study. These included a replacement water supply, public input, other stakeholder interests, a dam removal plan, and public use and benefits evaluation. Although no recommendation was made as to the restoration, cost estimates (making broad assumptions) ranged from $3 billion to $10 billion. The results were documented in the Hetch Hetchy Restoration Study (CNRA 2006).

In 1998, Contra Costa Water District completed Los Vaqueros Reservoir, which can store 100 thousand af. This is an offstream reservoir in the northwest corner of the San Joaquin River Hydrologic Region. The reservoir stores Contra Costa Water District water that has been diverted from the Delta in winter and spring. Water is typically withdrawn from Los Vaqueros Reservoir in the summer and fall to improve the quality of water delivered to the district's service areas. The reservoir also provides emergency storage. A portion of the Contra Costa Water District service area is in the San Francisco Bay Hydrologic Region. The reservoir area provides recreational opportunities such as multi-use trails (hiking, bicycling, and equestrian), animal and bird sighting, fishing, and rental boating.

In December 2010, Contra Costa Water District contracted to expand the reservoir to 160 taf by raising the dam by 34 feet. Construction began in April 2011 and the expanded reservoir/dam was dedicated in July 2012.

Regional Water Planning and Management

Water agencies, cities and counties, utility organizations, and other stakeholders are planning individually and collectively to address growth, water supply, flood management, water management, and ecosystem issues. Efforts to increase effective use of groundwater storage, surface storage, and conveyance facilities are apparent in planning documents throughout the region. Conjunctive management, increased efficiency, conservation, reclamation, recycling, and reuse are themes throughout urban and agricultural water management plans.

The San Joaquin Valley Water Coalition was established in 1998 to promote the water interests of its valley members. Among its major members were counties within the San Joaquin Valley. Much of the counties' efforts have been shifted to the San Joaquin Valley Regional (SJVR) Blueprint Planning Process and the San Joaquin Valley Regional water plan. The SJVR Blueprint Planning Process was started by the Councils of Government from each of the San Joaquin Valley's counties including Merced, Madera, San Joaquin, and Stanislaus in the San Joaquin River Hydrologic Region. One of its aims is to provide a comprehensive and integrated decision-making tool that combines separate and distinct data sets into a single set. This will allow for scenario planning, more efficient use of resources, and an understanding of regional impacts and solutions. The SJVR Water Plan was initiated by valley lawmakers who were interested in creating a comprehensive, integrated plan for the valley's water resources. The California Water Institute (CWI) at California State University, Fresno was tasked with coordinating the eight-county planning effort. The CWI developed the Framework for the Implementation of Water Planning (Framework) for long-term San Joaquin Valley water management. The effort is critical to identify the valley water needs and determine water management solutions for a 50-year planning horizon. The framework was unanimously adopted by the California Partnership for the San Joaquin Valley Board of Directors on October 22, 2009.

California Partnership for the San Joaquin Valley was established in 2005 to identify potentially effective projects and programs, identify critical needs, review State policies and regulations, and make recommendations to the governor. The partnership includes eight State government members, eight local government members, and eight private sector members. The partnership was extended for one additional year by an executive order in December 2008. Then in July 2010, Executive Order S-10-10 extended the Partnership indefinitely and established governance guidelines. For more information see http://sjvpartnership.org/.

The Grasslands Bypass Project is an ongoing activity and example of planning and implementation of a program dealing with water quality, environmental concerns, and San Joaquin River conditions. Prior to 1996, agricultural drainage water passed through wetland areas in western Merced County. The drainage water contains constituents harmful to wildlife. Subsequently, this drainage water has been routed around the Grasslands wetlands into Mud Slough and discharged into the San Joaquin River upstream of the Merced River. The water is monitored for constituents to meet discharge requirements considering the assimilative capacity of the river.

The San Joaquin River Parkway and Conservation Trust was created in 1988. One purpose of the trust was to create a 22-mile parkway along the San Joaquin River in the Fresno/Madera area. The trust restores, preserves, and maintains the ecological, scenic, and historic aspects of the area. It also provides educational and recreational opportunities and experiences in the parkway. For more information, see http://riverparkway.org/index.php.

Integrated Regional Water Management Coordination and Planning

The IRWM Planning Act, signed by the governor as part of SB 1 in 2008, provides a general definition of an IRWM plan as well as guidance to DWR as to what IRWM program guidelines must contain (CWC Sections 10530 et seq.). The act states that the guidelines shall include standards for identifying a region for the purposes of developing or modifying an IRWM plan. The first RAP spanned 2008-2009. Final decisions were released in fall 2009. The RAP is used to evaluate and accept an IRWM region into the IRWM grant program. Many IRWM regions have been proposed, some have been approved and some were conditionally approved. Figure SJR-36 shows RAP regions in this hydrologic region. Table SJR-30 lists strategies from earlier IRWM efforts.

PLACEHOLDER Table SJR-30 Strategies of Integrated Water Management Efforts in the San Joaquin River Hydrologic Region

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

PLACEHOLDER Figure SJR-36 Integrated Regional Water Management Regions in the San Joaquin River

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Implementation Activities (2009-2013)

Surface Water Quality and Central Valley Region Water Quality Control Board Implementation

The Regional Water Quality Control Boards are responsible for protecting the water quality of the waters of the state and have regulatory and non-regulatory programs that can address the water quality concerns of this area. The individual Regional Water Quality Control Boards adopt water quality control plans or basin plans that lay out the framework for how the board will protect water quality in each region. The basin plans designate the beneficial uses of surface and groundwater in the region, water quality objectives to meet the beneficial uses, and establish an implementation program to achieve the water quality objectives and protect the beneficial uses. The implementation program describes how the board will coordinate its regulatory and non-regulatory programs to address specific water quality concerns.

Overarching all the Central Valley Region Water Quality Control Board's programs and activities is the development of a comprehensive salt and nitrate management plan for the Central Valley. The Central Valley Region Water Quality Control Board and the SWRCB, as part of a stakeholder coalition, are working on Salinity Alternatives for Long-Term Sustainability (CV-SALTS), which is a strategic initiative to address problems with salinity and nitrates in the surface waters and ground waters of the Central Valley. The long-term plan developed under CV-SALTS will identify and require discharger implementation of management measures aimed at the reduction and/or control of major sources of salt and nitrate as well as support activities that alleviate known impairments to drinking water supplies. The eventual salt and nitrate management plan will provide guidance across all the Central Valley Region Water Quality Control Board's regulatory and non-regulatory programs on how to address salinity and nitrate concerns. As this issue impacts all users (stakeholders) of water within the San Joaquin River Hydrologic Region, it is important that all stakeholders participate in CV-SALTS to be part of the development and have input on the implementation of salt and nitrate management within the San Joaquin River Hydrologic Region., The only acceptable process to develop the salt and nutrient management plans that are required under State policy for the Central Valley is through CV-SALTS (SWRCB 2009).

CV-SALTS will include basin plan amendments that establish regulatory structure and policies to support basin-wide salt and nitrate management. The regulatory structure will have four key elements: (1) refinement of the agricultural supply (AGR), municipal and domestic supply (MUN) and groundwater recharge (GWR) beneficial uses, (2) revision of water quality objectives for these uses, (3) establishment of policies for assessing compliance with the beneficial uses and water quality objectives, and (4) establishment of management areas where there are large scale differences in baseline water quality, land use, climate conditions, soil characteristics and existing infrastructure and where short and long-term salt and/or nitrate management is needed. CV-SALTS plans to implement pilot projects to demonstrate revision of water quality objectives for salt and boron in the San Joaquin River, and evaluate beneficial uses and water quality objectives for agricultural water bodies. (CV-SALTS 2012a; CV-SALTS 2012b)

Surface Water

The Central Valley Region Water Quality Control Board has adopted basin plan implementation programs (that include total maximum daily load (TMDLs) to address salt and boron in the San Joaquin River at Vernalis; selenium in the San Joaquin River that also addresses impairments in Salt Slough and the Grasslands Marshes; diazinon and chlorpyrifos in the San Joaquin River and the Delta; mercury in the Delta and dissolved oxygen in the Stockton Deep Water Ship Channel(CVRWQCB 2004; CVRWQCB 1999; CVRWQCB 2000; CVRWQCB; 2001; CVRWQCB 2005b; CVRWQCB 2006; CVRWQCB 2010; CVRWQCB 2005a). Outside of the basin plan, the Central Valley Region Water Quality Control Board has adopted a TMDL for pathogens in the Stockton urban water bodies (CVRWQCB 2008). The basin plan implementation programs describe how the Central Valley Region Water Quality Control Board will use its authority to regulate controllable factors to restore water quality.

The Central Valley Region Water Quality Control Board has regulatory programs to protect and restore the quality of surface waters. These programs include:

- The Irrigated Lands Regulatory Program, which regulates discharges from irrigated agriculture through surface water monitoring and the development and implementation of management plans to address water quality problems identified in the surface water monitoring. This program addresses materials used in agricultural production that may end up in surface water, such as pesticides as well as pollutants that may be concentrated or mobilized by agricultural activities such as salt. In this program, coalition groups representing growers monitor to identify constituents of concern. Management plans are developed which identify management practices that individual growers implement to reduce the concentrations of the constituents of concern in surface water. Follow-up monitoring is conducted to confirm that water quality standards are met. Growers work together under a coalition group to meet the program requirements (CVRWQCB 2011d).
- Water quality coalitions currently active in the San Joaquin River basin include the East San Joaquin Water Quality Coalition, San Joaquin County and Delta Water Quality Coalition, and Westside San Joaquin River Watershed Coalition. In addition to addressing the basin plan implementation programs for salt and boron, organophosphate pesticides and dissolved oxygen, management plans have been developed and implemented to address chlorpyrifos, diazinon, diuron, dimethoate, methyl-parathion, simazine, malathion, thiobencarb, water column and sediment toxicity, and e. coli (CVRWQCB 2011a; CVRWQCB 2012a).
- The Grasslands Bypass Project was established to implement the basin plan selenium control program for the San Joaquin River. The project routes subsurface agricultural drainage water with elevated levels of selenium, salts, and other constituents of concern away from wildlife refuges and wetlands. The goal is to reduce and reuse high selenium subsurface agricultural drainage to comply with the basin plan load limits for the San Joaquin River and its tributaries.
- The National Pollutant Discharge Elimination System (NPDES) permit program regulates the discharge of point-source wastewaters and urban runoff to surface waters. Point-source wastewater can contain elevated levels of salt and nitrates, pesticides, mercury and other metals, oxygen-demanding substances, and bacteria. Urban runoff can contain pesticides,

mercury and other metals, oxygen-demanding substances, bacteria, and sediment. Permits prevent the discharge of elevated concentrations of these constituents. In cases where elevated levels of constituents of concern are being discharged, permits require dischargers to develop and implement measures to reduce the levels of these constituents.

- The Discharge to Land Program oversees the investigation and cleanup of impacts of current and historic unauthorized discharges including discharges from historic mining activities. Historic mine impacts include mercury impairments from mercury mines found on the Coast Range side of the Central Valley and mercury impairments from the use of mercury to amalgamate gold in the mines on the Sierra side. Other metal impairments result from the copper mining that occurred in the foothills area of the Sierra. Sedimentation can be a problem in the construction and operation of many mines. The photos below are Calfed Mine in Amador County. These photos are also available at http://www.waterboards.ca.gov/centralvalley/water_issues/mining/region5_success_stories/calfed_copper_mine/index.shtml.

PLACEHOLDER Photo SJR-1 Mine Waste

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- The Timber Program provides review, oversight, and enforcement of timber harvest activities on both private and U.S. Forest Service lands. The primary responsibility of the program is review and inspection of harvest activities. Timber harvest activities pose a threat to water quality through the potential for sediment and herbicide discharges and temperature increases to surface waters. During the past five years, private timberland owners in the San Joaquin River Hydrologic Region have submitted 136 timber harvest plans that allow harvesting on over 53,000 acres.
- The Water Quality Certification Program evaluates discharges of dredge and fill materials to ensure that the activities do not violate State and federal water quality standards. One of the goals of the program is to protect wetlands and riparian areas from dredge and fill activities and to implement State and federal "no net loss" policies for wetlands. Constituents of concern addressed by this program are salts and nutrients, methylmercury, and temperature.
- The Nonpoint Source program supports local and regional watershed assessment, management, and restoration to enhance watershed conditions that provide for improved flow properties and water quality. Non-point-sources include agriculture, forestry, urban discharges, discharges from marinas and recreational boating, hydromodification activities, wetlands, riparian areas, and vegetated treatment systems. For some of these sources, such as irrigated agriculture and forestry, the Central Valley Region Water Quality Control Board has specific regulatory programs. The Nonpoint Source Program addresses sources where the Central Valley Region Water Quality Control Board has not developed a specific program. This program has assisted stakeholders obtain funding to address non-point-source pollution as well as conduct riparian and habitat restoration activities. Impacts from recreational activities, such as off-highway vehicle (OHV) use, fall under this program. In 2012, the Central Valley Region Water Quality Control Board found that sediment disturbed by recreational vehicle activity and transported in stormwater runoff to Corral Hollow Creek was a water quality problem at the Carnegie State Vehicle Recreation Area. The board also identified metals, such as copper and lead, as a

potential concern. To address these problems, the board issued a Cleanup and Abatement Order to the California Department of Parks and Recreation (State Parks). The order recognized that State Parks had developed a stormwater management plan that describes the best management practices that need to be implemented to address erosion and sedimentation. The Order required State Parks to update and implement the Storm Water Management Plan (CVRWQCB.2012b).

Monitoring of the San Joaquin River for flow and quality has been fairly regular over the past years but recently there has been a dramatic drop in the amount of monitoring occurring of the San Joaquin River watershed. However, the need for monitoring information remains as strong as ever. Entities involved in monitoring and the entities using the monitoring information agreed it would be useful to collaborate to achieve efficiencies in current and anticipated monitoring efforts to ensure that collected flow and water quality information satisfies both individual project needs as well as those mandated by State and federal agencies. An effort is underway to develop a regional monitoring program for the San Joaquin River watershed. Stakeholders that generate and/or use water quality monitoring data are encouraged to participate (SWRCB 2012a).

Groundwater

The Central Valley Region Water Quality Control Board has regulatory programs meant to prevent groundwater contamination by controlling the quality of discharges to land. In cases where groundwater quality has been affected, the Central Valley Region Water Quality Control Board's cleanup programs work with the entities responsible for the contamination to assess the extent of contamination and develop and implement a plan to clean up the contamination. The Central Valley Region Water Quality Control Board has developed programs that regulate specific discharge types when there are a large number of dischargers of that type and the water quality of the discharge is similar. The following are programs addressing specific discharge types (CVRWQCB 2010b):

- The Confined Animal Program regulates discharges from confined animal operations which are typically high in salt and nutrients. In 2007, the Central Valley Region Water Quality Control Board adopted Waste Discharge Requirements General Order for Existing Milk Cow Diaries (R5-2007-0035) which includes requirements for both the dairy production area and land application area and requires each dairy to fully implement their waste management plan by 2011 and a nutrient management plan by 2012. The requirements for the waste and nutrient management plans are designed to protect both surface and groundwater. In the San Joaquin River Hydrologic Region, there are 739 dairies with over 658 thousand cows regulated under this general order.
- The Irrigated Lands Regulatory Program, which has been focused on surface water, has been transitioning to a long-term program that will address both surface and groundwater. Irrigated lands may be a source of salt, nitrates, and pesticides going into groundwater.

- The SWRCB has adopted regulations for the operation of onsite wastewater treatment systems. (Resolution No. 2012-0032). Water quality concerns associated with individual disposal systems include salt, nitrates, and pathogens. The Central Valley Region Water Quality Control Board plans to update its guidelines and establish a program based on the new regulations. In the past, the Central Valley Region Water Quality Control Board has prohibited discharge in problematic service areas. In the San Joaquin River Hydrologic Region, the Central Valley Region Water Quality Control Board has adopted thirteen prohibitions of discharge from individual sewage disposal systems. Currently, all of these areas are served by community sewage systems.

Accomplishments

Recent Initiatives to Improve Water Quality

The Central Valley Region Water Quality Control Board recently adopted and implemented a basin plan control program that included TMDLs to address mercury in the Delta. The Central Valley Region Water Quality Control Board implemented previously adopted basin plan control programs to address salt and boron in the San Joaquin River at Vernalis, selenium in the San Joaquin River, diazinon and chlorpyrifos in the San Joaquin River and the Delta, and dissolved oxygen in the Stockton Deep Water Ship Channel. Improvements in water quality allowed for the CWA 303(d) de-listings for selenium for the San Joaquin River from Merced River to the Delta. The Central Valley Region Water Quality Control Board approved the Groundwater Quality Protection Strategy and Workplan to establish a long-term strategy that will identify high priority activities (CVRWQCB 2010b).

Through the Irrigated Lands Regulatory Program, dischargers have addressed pH, diazinon, and toxicity in Duck Slough, dieldrin in French Camp Slough, copper and lead in Grant Line Canal, dissolved oxygen and copper in the Mokelumne River, toxicity in Terminous Tract Drain, and diuron, oryzalin, EC and TDS in the Modesto Irrigation District (CVRWQCB 2012a). Also, the Irrigated Lands Program has made the transition from an interim program that imposes requirements on discharges from irrigated lands to surface waters of the State to the long-term program that addresses discharges to both surface and groundwaters of the State including increased enforcement for dischargers that create conditions of pollution or nuisance.

The Central Valley Region Water Quality Control Board has successfully implemented its general order for existing milk cow dairies and over 95 percent of the dairies in the San Joaquin River Hydrologic Region are in compliance with the general order.

In addition, the Central Valley Region Water Quality Control Board has successfully made improvements to its land discharge program to increase groundwater monitoring and reduce the backlog of waste discharge requirements.

- Under the South County Water Supply Program, South San Joaquin Irrigation District (SSJID) in cooperation with local cities built a treatment plant at Woodward Reservoir which was dedicated in 2005. Treated water from the Stanislaus River is delivered to Manteca, Tracy, and Lathrop. The water supply program is expanding under Phase 2 and treated water is anticipated for Escalon in 2012. SSJID intends to construct solar panels on 14 acres adjacent to the water treatment plant to provide power for the plant and other purposes.

- The Modesto Regional Water Treatment Plant was completed in 1994 and is operated by Modesto Irrigation District. Treated water from the Tuolumne River is delivered to the City of Modesto to supplement groundwater supplies. An expansion of the treatment plant is under way including storage and pipeline facilities for the City of Modesto.
- Turlock Irrigation District is proposing to build a surface water treatment plant. Its Regional Surface Water Supply Project would treat Tuolumne River water and deliver it in Stanislaus County to Ceres, Hughson, Keyes, South Modesto, and Turlock. The final environmental impact report is dated December 2006.
- The City of Stockton designed a project to treat Delta water for municipal supply. The Delta Water Supply Project takes surface water from the west side of Empire Tract and transports it approximately six miles eastward along Eight Mile Road to the new treatment plant. The project was completed in 2012. The Delta Water Supply Project Intake and Pump Station Facility is funded in part thanks to a $12.5 million Proposition 84 Grant from , DWR under the Safe Drinking Water, Water Quality and Supply, Flood Control, River, and Coastal Protection Bond Act of 2006.
- Yosemite Spring Park Utility Company's plan will make a number of improvements, which include replacing existing water meters with an automatic meter reading system to better record usages and identify water losses due to customer side leaks, replacing failing infrastructure to preserve the integrity and safety of the water supply and reduce the loss of water due to catastrophic failures in the distribution system, constructing a uranium removal system to recover well(s) lost due to detected uranium levels above the drinking water standard, and constructing a surface water treatment plant to provide alternate supply source for Yosemite Lakes Park.

Ecosystem Restoration

A host of other environmental water issues within the region require attention: water quality, water temperature, salinity, and dissolved oxygen sufficient for fish and habitat and other uses are of concern as is the availability of water to supply habitat areas. Environmental water issues and activities within the region include:

- Vernalis Adaptive Management Program.
- Central Valley Project Improvement Act.
- Anadromous Fish Restoration Program.
- Riparian Habitat Protection Program.
- Spawning Gravel Replenishment Program.
- Refuge Water Supply.
- Central Valley Joint Venture.
- San Joaquin River Restoration Program.

Vernalis Adaptive Management Program

Vernalis Adaptive Management Program (VAMP) is a large-scale, long-term (12-year), experimental/management program initiated in 2000 that is designed to protect juvenile Chinook salmon migrating from the San Joaquin River through the Delta. VAMP is also a scientifically recognized experiment to determine how salmon survival rates change in response to alterations in San Joaquin River flows and SWP/CVP exports with the installation of the Head of Old River Barrier. For more information, see http://www.sjrg.org/default.html.

Central Valley Project Improvement Act

The CVPIA, passed by Congress in 1992, requires the Secretary of the Interior to implement a wide variety of CVP operation modifications and structural repairs in the Central Valley for the benefit of the wildlife and anadromous fish resources including the goal of a sustainable level of natural anadromous fish production of at least twice the levels from 1967 to 1991. This is in addition to the Anadromous Fish Restoration Program and Anadromous Fish Screening Program. Provisions within the CVPIA address operational improvements to support fisheries restoration through a combination of timed increases in flows, water banking, conservation, and transfers, and modified operations and new or improved control structures.

One of the primary effects of the CVPIA was the dedication of project yield for fish and wildlife purposes. The combined total amount of water dedicated to the environment by the CVPIA suggests an annual amount of up to 1.2 million af including reallocation of 800 taf called (b)(2) water] and dedicated deliveries to wildlife refuges of about 250 taf (called Level 2 Refuge water. See Table SJR-9 above for CVP deliveries to refuges within the San Joaquin River region.

Central Valley Joint Venture

Formally organized in 1988, the Central Valley Joint Venture (CVJV) is one of the original six priority joint ventures formed under the North American Waterfowl Management Plan. It was formerly named the Central Valley Joint Venture Implementation Plan, and focuses on reversing the decline of California wetlands and works collaboratively to protect, restore, and enhance wetlands and associated habitats for waterfowl, shorebirds, water birds, and riparian songbirds. See http://www.centralvalleyjointventure.org/.

San Joaquin River Restoration Program

The San Joaquin River Restoration Program (SJRRP) is a comprehensive long-term effort to restore flows to the San Joaquin River from Friant Dam to the confluence of Merced River, ensure irrigation supplies to Friant Water Users, and restore a self-sustaining fishery in the river. SJRPP is a direct result of a settlement of an 18-year lawsuit reached in September 2006 to provide sufficient fish habitat in the San Joaquin River below Friant Dam (near Fresno) by the U.S. Department of the Interior, the U.S. Department of Commerce, the Natural Resources Defense Council, and the Friant Water Users Authority. Federal legislation was reintroduced on January 4, 2007 to authorize federal agencies to implement the settlement. Interim flows began October 1, 2009 and full restoration flows were scheduled to begin no later than January 2014. Initially, salmon were to be reintroduced in the upper reaches no later than December 31, 2012, but the timeline for introducing salmon into the river was extended by about three years to 2016. In the summer of 2012, the USBR estimated the cost of the program to be between $892 million and $2 billion. There is more information at the SJRRP Web site at http://www.restoresjr.net/.

Challenges

Flooding

Flood management challenges in the San Joaquin River Hydrologic Region include:

- Inadequate accurate and up-to-date FEMA maps.
- Inadequate agency alignment and inconsistent agency roles and responsibilities.
- Regulatory constraints that prevent maintenance of existing infrastructure.

- Undersized and outdated infrastructure.
- Inadequate assistance with developing and monitoring data including aerial images, mapping, and river gauges.

The identified issues were based upon interviews with 25 agencies of varying levels of flood management responsibilities in each county of the hydrologic region. For a list of agencies with flood management responsibility in the San Joaquin River Hydrologic Region that participated in these meetings, see *California's Flood Future Report*. The information gathered from local agencies was used to help improve the process and better understand the local needs throughout the state.

- Recurrent flooding is a problem in many places in the San Joaquin River Hydrologic Region. Providing better protection for lives and property remains the definitive flood management challenge. Some particularly vulnerable locations in the region are at Lathrop, Manteca, Merced, Modesto, Stockton, and at Interstate 5 crossings of Panoche Creek, Orestimba Creek, and Del Puerto Creek. Existing facilities are inadequate on the west side of the San Joaquin River from Orestimba Creek to the Delta and on North Fork Jackson Creek in Jackson. Capacity of leveed waterways of the Lower San Joaquin Levee Project has been reduced by regional subsidence.
- Throughout the state, including this region, urbanization continues which brings greater runoff due to increases of impervious areas and makes retention of flood protection levels a challenging issue. Urbanization often causes increases in erosion and sedimentation. In this hydrologic region, the embankments of irrigation canals that carry floodwaters through urban areas need to be strengthened.
- Completion of floodplain mapping, both the FEMA FIRMs and the State's complementary Awareness Floodplain Mapping, will provide much needed information for evaluating flood risk. In the San Joaquin River Hydrologic Region, a current need is improvement of high-water coordination for the San Joaquin River and tributaries including Kings River inflow, considering use of coordination agreements, forecast-coordinated operations, and reservoir reoperation.
- Local funding for flood maintenance and construction projects has become more difficult to implement. This is due, in large part, to new environmental restrictions/conditions and in the bigger picture, two particularly tough challenges in the region — overcoming the technical and environmental hurdles associated with increasing the capacity of the San Joaquin River from the Merced River into the Delta and removing Arundo donax and other invasive species that significantly restrict water flows.
- Wildfires, which are predicted to become more frequent due to climate change, may denude steep erodible slopes in canyons and upland areas that are located above urban developments in the foothills and mountainous areas of the region. Ensuing winter rains, which are also predicted to replace snow storms, may threaten these areas not only with high water, but also with debris flows.

Funding

Securing resources to complete local projects where funding and economic conditions are only sufficient to meet a small percentage of those projects.

Licensing and Infrastructure

- Federal Energy Regulatory Commission (FERC) relicensing of New Exchequer Dam on the Merced River and New Don Pedro Dam on the Tuolumne River.
- Finding resources to construct, repair, and maintain infrastructure.

Water Quality

A major challenge will be the development of the CV-SALTS basin plan amendments within the timeframe set by the State Recycled Water Policy. Without action to improve salts management for the Central Valley, the economic vitality of the region is threatened. A 2009 University of California, Davis study found that salts and nitrates are already costing Central Valley residents $544 million annually for treatment and lost production (Howitt et al. 2009). Freshwater supplies will be used more often to dilute salts, reducing supplies for people and the environment, especially during droughts. (CV-SALTS 2012a)

In the next five years, the Central Valley Region Water Quality Control Board expects to adopt TMDLs and control programs for chlorpyrifos, diazinon, and pyrethroid pesticides that will cover most valley floor waters. These TMDLs will address 100 current impairments and provide the framework for addressing future listings. In addition, the Central Valley Region Water Quality Control Board is taking the lead in coordinating a multi-region/SWRCB effort to develop a statewide mercury TMDL control program for reservoirs.

The dairy industry in the Central Valley has been affected by economic factors such as the variability in milk and feed prices. The cost of complying with the General Order for Existing Milk Cow Dairies can be a disproportionate burden on smaller, less economically competitive dairies. In response, the Central Valley Region Water Quality Control Board amended the General Order in April 2009 to allow an additional year for dairies to submit certain elements of the waste management plan. The Central Valley Region Water Quality Control Board also approved the Central Valley Dairy Representative Monitoring Program as an alternative to installing individual groundwater monitoring systems at each dairy facility (CVRWQCB 2011e).

As the irrigated lands program transitions to addressing groundwater quality, the most significant issues that will be addressed will include establishing the groundwater quality monitoring networks necessary to identify problem areas, assess trends, and evaluate effectiveness of practices (CVRWQCB 2011e).

There are thousands of abandoned mines in California and a significant portion is in the Central Valley. Remediation of abandoned mines is very costly and determining responsible parties is difficult. State agencies have insufficient staff resources to identify responsible parties. While any past or present owner of the site is a responsible party, some of the owners may never have mined the site or the owners are not financially viable and are not able to conduct investigations and cleanup activities. Mine waste may even be located on land that was not part of the mined property just because in the past mine waste was commonly discharged wherever it was convenient.

Due to the serious threat of both public safety and environmental hazards posed by abandoned mines, there are many volunteers (Good Samaritans) who are interested in helping restore watersheds impaired by abandoned mines. However, the threat of liability pursuant to the Clean Water Act (CWA) and/or the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) discourages such third party cleanups. A volunteer conducting a partial cleanup could become liable for the entire cleanup or could be obligated to obtain a discharge permit, which requires compliance with strict water quality standards in streams that are already in violation of these standards. Liability may occur even though the volunteer did not cause the pollution. (EPA 2012b)

Timber harvest activities may pose a threat to water quality due to the discharge of sediment, herbicides, petroleum products, and increases in surface water temperatures. There are currently several legislative measures and EPA policy decisions being considered that have the potential to add a substantial workload to the program. Pre-project and active operations field inspections by water quality regulatory staff allows for proactively locating sediment sources so that appropriate management measures may be taken to reduce or eliminate those threats though the life of the project. However, funding for State agency oversight has steadily decreased in recent years and further reductions are anticipated that will make implementation of this program challenging (CVRWQCB 2011e).

Off-highway vehicle (OHV) use is a popular form of recreation in California. State and federal agencies provide recreational areas for this purpose. These OHV recreation areas need to implement a range of stormwater best management practices to protect water quality. Additionally, unauthorized and unmanaged OHV areas can become erosion problems and discharge polluted stormwater. With limited resources, maintaining and policing these areas can be a challenge.

A major challenge is the ability of small communities to address water quality issues. Small communities with wastewater treatment plants face increasingly stringent wastewater requirements and have difficulty meeting these requirements due to the cost of compliance. The Central Valley has approximately 600,000 individual onsite disposal systems within its boundaries, which collectively discharge approximately 120 million gallons per day to the subsurface. Water quality impacts can occur if these systems are not properly sited or properly maintained. It can be difficult for owners of these systems to fund repairs if these systems fail.

Other water quality issues include:

- Coordinating upper watershed programs to maintain water quality and ecosystems, minimize harmful sedimentation and flooding, and equitably maintain the beneficial use of water.
- Maintaining or improving water quality, water temperature, and dissolved oxygen conditions sufficient for environmental needs.
- Combating saline water intrusion into confined aquifers and the movement of saline groundwater fronts encroaching into useable groundwater.
- Maintaining groundwater quality sufficient to meet rural domestic use.

Drought and Flood Planning

The San Joaquin Valley has traditionally used a combination of surface water and groundwater. The San Joaquin River region has significant surface water resources due to Sierra snowpack and reservoir storage on major eastside rivers. Imported surface water supplies may suffer the highest degree of variability. In years where surface water supplies are significantly reduced, additional groundwater is often used to fill the gap between needs and available surface water.

DWR’s Bulletin 118-80, Ground Water Basins in California, identifies eastern San Joaquin County, Chowchilla, and Madera subbasins as being in a critical condition of overdraft. In these subbasins and others, part of the drought preparedness philosophy is to maintain as much groundwater storage as possible. This can be achieved by intentional recharge, water banking, in-lieu recharge, water transfers, shifts to available surface water, etc. See discussions in Volume 3, *Resource Management Strategies*.

FloodSAFE California is a DWR strategic initiative that seeks a sustainable integrated flood management and emergency response system throughout California that improves public safety, protects and enhances environmental and cultural resources, and supports economic growth by reducing the probability of destructive floods, promoting beneficial floodplain processes, and lowering the damages caused by flooding. FloodSAFE is guiding the development of regional flood management plans, which will encourage regional cooperation in identifying and addressing flood hazards. Regional flood plans will include flood hazard identification, risk analyses, review of existing measures, and identification of potential projects and funding strategies. The plans will emphasize multiple objectives, system resiliency, and compatibility with State goals and IRWM plans.

FloodSAFE is responsible for the Central Valley Flood Management Planning Program. Its purpose is to improve integrated flood management in the Sacramento and San Joaquin Valleys. The program study area includes the watersheds of the Sacramento and San Joaquin rivers. The program is charged with the development of three documents: (1) the State Plan of Flood Control, describing the flood management facilities, land, programs, conditions, and modes of operation and maintenance for the State-federal flood protection system in the Central Valley, published in the spring of 2010, (2) the Flood Control System Status Report, which assesses the status of facilities in the State Plan of Flood Control, identifying deficiencies, and making recommendations for improvement, was completed in December 2011, and (3) the Central Valley Flood Protection Plan, approved by the Central Valley Flood Protection Board on June 29, 2012, describing a sustainable, integrated flood management plan that reflects a systemwide approach for protecting areas of the Central Valley currently receiving protection from flooding by the existing facilities of the State Plan of Flood Control. Updates of the Central Valley Flood Protection Plan are required every five years.

Drought Contingency Plans

CWC Sections 10601 et seq. require urban suppliers to prepare and update urban water management plans (UWMP) every five years and serve as a drought preparedness planning tool for the State’s larger water systems. As part of UWMP preparation, systems must provide a water shortage contingency analysis that addresses how they would respond to supply reductions of up to 50 percent, and must estimate supplies available to their systems in a single dry year and in multiple dry years. Implementing enhanced water conservation programs and calling for customers to achieve either voluntary or mandatory water use reduction targets are common urban agency drought response actions. For example, during the recent 2007-2009 drought, the City of Stockton urged voluntary conservation, instituted rate increases (surcharges) and restricted outdoor water use (California’s Drought of 2007-2009, An Overview, September 2010).

In 2002 the City of Modesto implemented Stage I of its Water Shortage Contingency Plan, which called for a 10 to 20 percent reduction in water use. The City has remained in Stage I since then. Some of the requested/mandated consumer actions include outdoor watering is prohibited from 12:00 noon to 7:00 p.m., identified water leaks must be repaired within 24 hours, and restaurants are encouraged to serve water only on request.

Looking to the Future

Already being implemented is the Friant Water Users Authority (FWUA)/Natural Resources Defense Council agreement to restore the San Joaquin River, the region's namesake. The agreement was reached in 2006, and on March 30, 2009, President Obama signed Public Law 111-11, the Omnibus Public Land Management Act of 2009 that contains the San Joaquin River Restoration Settlement Act. The act authorizes implementation of the San Joaquin River Restoration Program. Water deliveries to FWUA members could be reduced by about 15 percent on average, but the program has provisions for recapture of a portion of the water used for restoration. Interim flows began October 1, 2009, and full restoration flows were scheduled to begin no later than January 2014. Salmon were to be reintroduced in the upper reaches no later than December 31, 2012. However, the timeline for introducing salmon into the river was extended to 2016.

Many farmers in the San Joaquin River depend on the Delta for delivery of surface water supplies. In 2009, the governor and Legislature approved a comprehensive water package that included a Delta Governance/Delta Plan. It establishes the framework to achieve the coequal goals of providing a more reliable water supply to California and restoring and enhancing the Delta ecosystem. The coequal goals are to be achieved in a manner that protects the unique cultural, recreational, natural resource, and agricultural values of the Delta. In May 2012, the Delta Stewardship Council, charged with developing the Delta Plan, was given the last draft version of the document. After it is adopted by the council, it will require further public review before it can take regulatory effect.

Additional pressures on Delta deliveries will come from court decisions and new federal agency permits that will further limit how much water is sent south to the San Joaquin Valley and Southern California. In May 2007, U.S. District Judge Oliver W. Wanger found that rules governing the smelt (which is protected as a threatened species under the federal Endangered Species Act and was classified as an endangered species in March under the State ESA) in the Delta were flawed and needed to be rewritten. Both the State and federal water projects have been required to reduce pumping to aid the delta smelt.

The USFWS issued new biological opinion in December 2008. In a typical year, the new restrictions could cut SWP deliveries by about 20 to 30 percent. Westlands Water District joined forces with the San Luis and Delta-Mendota Water Authority in March 2009 in an attempt to stop the federal government from enforcing the new biological opinion. In December 2010, Judge Oliver Wanger ruled that while pumping from the Sacramento-San Joaquin Delta hurt the smelt, the restrictions set up to protect the fish were not justified. In May of 2011 Judge Wanger set a deadline of December 2013 for the USFWS to rewrite the biological opinion.

In April 2008, a federal judge rejected the federal government's biological opinion on the 2004 Operations Criteria and Plan for management of the State and federal water project for endangered winter-run Chinook salmon, spring-run Chinook salmon and Central Valley steelhead. New rules were due in March 2009, but the judge delayed the requirement for three months. In June 2009, the National Marine Fisheries Service (NMFS) released the final biological opinion. It estimated that it would reduce deliveries by the federal and State projects by 330,000 af. In September 2011, Judge Wanger invalidated parts of the biological opinion in a lawsuit brought by water users. The judge sent the biological opinion back for further review and analysis, leaving the biological opinion in force while federal water managers and wildlife agencies make the necessary fixes.

In 1996, in western Merced County in an area known as the Grasslands Drainage Area south of Los Banos, a group of growers led by the San Luis & Delta-Mendota Water Authority began an effort known as the Grasslands Bypass Project that would attempt to eliminate selenium tainted drainage water from entering the San Joaquin River upstream of the confluence with the Merced River. In the years since the project began, it has been able to remove 85 percent of selenium in the drainage water. The project was scheduled to end in 2009, but because selenium remains in the drainage water entering the river, the group requested a 10-year extension on the project, and on December 22, 2009, the Bureau of Reclamation signed a Record of Decision (ROD) for the Grassland Bypass Project to execute a new use agreement with the San Luis & Delta Mendota Water Authority for continued use of the San Luis Drain from January 1, 2010, through December 31, 2019.

This list provides a list of some of the priority areas and needs specific to the San Joaquin River Hydrologic Region from a DFW perspective for California, in relation to California water supply.

- Protect or restore fish habitat through the improvement of fish passage conditions, gravel augmentation, hydrology, fish screens, min/max flow, etc.
- Restoration of floodplain process, including hydrodynamic process, to benefit listed species.
- Restoration projects that facilitate the improvement of nesting and foraging habitat for listed and migratory bird species.
- Increase food web productivity.
- Development, collection and publication of instream flow data, including recommended instream flow levels and minimum instream flow requirements.
- Restoration of perennial grasslands.
- Reduce predation loss of juvenile fish, including fish entrapment.
- Restoration projects that facilitate the increase of populations and improvement of habitat for salmon, especially Coho.
- Restoration or modification to allow for a more natural regime of hydrology and hydraulics.
- Restoration of riparian habitat, including conservation of riparian corridors.
- Restoration projects that facilitate the improvement of aquatic habitat, including deep and shallow open water.
- Restoration of saline emergent wetlands and tidal marshes.
- Restoration of tributary creeks and streams.
- Improvements in coordination, management and implementation of watersheds.
- Water quality improvements (sediment, oxygen saturation, pollution, temperature, etc…) to support healthy ecosystems.
- Restoration projects that improve upon existing wetlands, or create new wetlands in appropriate areas.
- Restoration, preservation, and protection of wildlife corridors.

Future Conditions

Future Scenarios

For Update 2013, the California Water Plan (CWP) evaluates different ways of managing water in California depending on alternative future conditions and different regions of the state. The ultimate goal is to evaluate how different regional response packages, or combinations of resource management strategies from Volume 3, perform under alternative possible future conditions. The alternative future conditions are described as future scenarios. Together the response packages and future scenarios show what management options could provide for sustainability of resources and ways to manage uncertainty and risk at a regional level. The future scenarios are comprised of factors related to future population growth and factors related to future climate change. Growth factors for the San Joaquin River region are described below. Climate change factors are described in general terms in Volume 1, Chapter 5.

PLACEHOLDER Box SJR-3 Evaluation of Water Management Vulnerabilities — San Joaquin River Hydrologic Region

PLACEHOLDER Box SJR-3 Figure SJR-A Range of Urban and Agricultural Reliability Results across Scenarios for the San Joaquin River Region

PLACEHOLDER Box SJR-3 Figure SJR-B Range of Change in Groundwater Results across Scenarios for the San Joaquin River Region

PLACEHOLDER Box SJR-3 Figure SJR-C Range of Instream Flow Reliability for the San Joaquin River Region across Scenarios

PLACEHOLDER Box SJR-3 Figure SJR-D Climate Conditions Leading to Low Agricultural Reliability Results in the San Joaquin River Region

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the chapter.]

Water Conservation

The CWP scenario narratives include two types of water use conservation. The first is conservation that occurs without policy intervention (called background conservation). This includes upgrades in plumbing codes and end user actions such as purchases of new appliances and shifts to more water efficient landscape absent a specific government incentive. The second type of conservation expressed in the scenarios is through efficiency measures under continued implementation of existing best management practices in the Memorandum of Understanding (CUWCC 2004). These are specific measures that have been agreed upon by urban water users and are being implemented over time. Any other water conservation measures that require additional action on the part of water management agencies are not included in the scenarios, and would be represented as a water management response.

Growth Scenarios

Future water demand in the San Joaquin River hydrologic region is affected by a number of growth and land use factors, such as population growth, planting decisions by farmers, and size and type of urban landscapes. See Table SJR-31 for a conceptual description of the growth scenarios used in the CWP. The CWP quantifies several factors that together provide a description of future growth and how growth could affect water demand for the urban, agricultural, and environmental sectors in the San Joaquin River region. Growth factors are varied between the scenarios to describe some of the uncertainty faced by water managers. For example, it is impossible to predict future population growth accurately, so the CWP uses three different but plausible population growth estimates when determining future urban water demands. In addition, the CWP considers up to three different alternative views of future development density. Population growth and development density will reflect how large the urban landscape will become in 2050 and are used by the CWP to quantify encroachment into agricultural lands by 2050 in the San Joaquin River region.

PLACEHOLDER Table SJR-31 Conceptual Growth Scenarios

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

For Update 2013, DWR worked with researchers at the University of California, Davis, to quantify how much growth might occur in the San Joaquin region through 2050. The UPlan model was used to estimate a year 2050 urban footprint under the scenarios of alternative population growth and development density (see http://ice.ucdavis.edu/project/uplan for information on the UPlan model). UPlan is a simple rule-based urban growth model intended for regional or county-level modeling. The needed space for each land use type is calculated from simple demographics and is assigned based on the net attractiveness of locations to that land use (based on user input), locations unsuitable for any development, and a general plan that determines where specific types of development are permitted. Table SJR-32 describes the amount of land devoted to urban use for 2006 and 2050, and the change in the urban footprint under each scenario. As shown in the table, the urban footprint grew by about 160,000 acres under low population growth scenario (LOP) by 2050 relative to 2006 base-year footprint of about 410,000 acres. Urban footprint under high population scenario (HIP), however, grew by about 380,000 acres. The effect of varying housing density on the urban footprint is also shown.

PLACEHOLDER Table SJR-32 Growth Scenarios (Urban) – San Joaquin River

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Table SJR-33 describes how future urban growth could affect the land devoted to agriculture in 2050. Irrigated land area is the total agricultural footprint. Irrigated crop area is the cumulative area of agriculture, including multi-crop area, where more than one crop is planted and harvested each year. Each of the growth scenarios shows a decline in irrigated acreage over existing conditions, but to varying degrees. As shown in the table, irrigated crop acreage declines, on average, by about 130,000 acres by year 2050 as a result of low population growth and urbanization in the San Joaquin River region, while the decline under high population growth was higher by about 240,000 acres.

PLACEHOLDER Table SJR-33 Growth Scenarios (Agriculture) – San Joaquin River

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

San Joaquin River — 2050 Water Demands

In this section a description is provided for how future water demands might change under scenarios organized around themes of growth and climate change described earlier in this report. The change in water demand from 2006 to 2050 is estimated for the San Joaquin River region for the agriculture and urban sectors under nine growth scenarios and 13 scenarios of future climate change. The climate change scenarios included the 12 CAT scenarios described in Volume 1, Chapter 5, and a 13th scenario representing a repeat of the historical climate (1962-2006) to evaluate a “without climate change” condition.

Figure SJR-37 shows the change in water demands for the urban and agricultural sectors under nine growth scenarios, with variation shown across 13 climate scenarios. The nine growth scenarios include three alternative population growth projections and three alternative urban land development densities, as shown in Table SJR-31. The change in water demand is the difference between the historical average for 1998 to 2005 and future average for 2043 to 2050. Urban demand is the sum of indoor and outdoor water demand where indoor demand is assumed not to be affected by climate. Outdoor demand, however, depends on such climate factors as the amount of precipitation falling and the average air temperature. The solid blue dot in Figure SJR-37 represents the change in water demand under a repeat of historical climate, while the open circles represent change in water demand under 12 scenarios of future climate change.

PLACEHOLDER Figure SJR-37 Change in San Joaquin River Agricultural and Urban Demands for 117 Scenarios from 2006-2050 (thousand acre-feet per year)

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Urban demand increased under all 9 growth scenarios tracking with population growth. On average, it increased by about 450 taf under the three low population scenarios, 550 taf under the three current trend population scenarios and about 890 thousand acre-feet under the three high population scenarios when compared to historical average of about 590 taf. The results show change in future urban water demands are less sensitive to housing density assumptions or climate change than to assumptions about future population growth.

Agricultural water demand decreases under all future scenarios due to reduction in irrigated lands as a result of urbanization and background water conservation when compared with historical average water demand of about 6350 taf. Under the three low population scenarios, the average reduction in water demand was about 550 taf while it was about 900 taf for the three high population scenarios. For the three current trend population scenarios, this change was about 690 taf. The results show that low density housing would result in more reduction in agricultural demand since more lands are lost under low-density housing than high density housing.

Integrated Water Management Plan Summaries

Inclusion of the information contained in IRWMP's into the CWP Regional Reports has been a common suggestion by regional stakeholders at the Regional outreach meetings since the inception of the IRWM program. To this end the CWP has taken on the task of summarizing readily available IWMP in a consistent format for each of the regional reports. This collection of information will not be used to determine IRWM grant eligibility. This effort is ongoing and will be included in the final CWP updates and will include up to 4 pages for each IRWMP in the regional reports.

In addition to these summaries being used in the regional reports we intend to provide all of the summary sheets in one IRWMP Summary "Atlas" as an article included in Volume 4. This atlas will, under one cover, provide an "at-a-glance" understanding of each IRWM region and highlight each region's key water management accomplishments and challenges. The atlas will showcase how the dedicated efforts of individual regional water management groups (RWMGs) have individually and cumulatively transformed water management in California.

All IRWMPs are different in how are organized and therefore finding and summarizing the content in a consistent way proved difficult. It became clear through these efforts that a process is needed to allow those with the most knowledge of the IRWMPs, those that were involved in the preparation, to have input on the summary. It is the intention that this process be initiated following release of the Update 2013 and will continue to be part of the process of the update process for Update 2018. This process will also allow for continuous updating of the content of the atlas as new IRWMP's are released or existing IRWMPs are updated.

As can be seen in Figure SJR-36 there are 11 IRWM planning efforts ongoing in the San Joaquin River Hydrologic Region.

[Placeholder Text: At the time of the Public Review Draft the collection of information out of the IRWMP's in the region has not been completed. Below are the basic types of information this effort will summarize and present in the final regional report for each IRWMP available. An opportunity will be provided to those with responsibility over the IRWMP to review these summaries before the reports are final.

Region Description: This section will provide a basic description of the IRWM region. This would include location, major watersheds within the region, status of planning activity, and the governance of the IRWM. In addition, an IRWM grant funding summary will be provided.

Key Challenges: The top five challenges identified by the IRWM would be listed in this section.

Principal Goals/Objective: The top five goals and objectives identified in the IRWMP will be listed in this section.

Major IRWM Milestones and Achievements: Major milestones (Top 5) and achievements identified in the IRWMP would be listed in this section.

Water Supply and Demand: A description (one paragraph) of the mix of water supply relied upon in the region along with the current and future water demands contained in the IRWMP will be provided in this section.

Flood Management: A short (one paragraph) description of the challenges faced by the region and any actions identified by the IRWMP will be provided in this section.

Water Quality: A general characterization of the water quality challenges (one paragraph) will be provided in this section. Any identified actions in the IRWMP will also be listed.

Groundwater Management: The extent and management of groundwater (one paragraph) as described in the IRWMP will be contained in this section.

Environmental Stewardship: Environmental stewardship efforts identified in the IRWMP will be summarized (one paragraph) in this section.

Climate Change: Vulnerabilities to climate change identified in the IRWMP will be summarized (one paragraph) in this section.

Tribal Communities: Involvement with tribal communities in the IRWM will be described (one paragraph) in this section of each IRWMP summary.

Disadvantaged Communities: A summary (one paragraph) of the discussions on disadvantaged communities contained in the IRWMP will be included in this section of each IRWMP summary.

Governance: This section will include a description (less than one paragraph) of the type of governance the IRWM is organized under.]

Resource Management Strategies

Volume 3 contains detailed information on the various strategies which can be used by water managers to meet their goals and objectives. A review of the resource management strategies addressed in the available IRWMPs is summarized in Table SJR-34.

PLACEHOLDER Table SJR-34 Resource Management Strategies addressed in IRWMPs in the San Joaquin River Hydrologic Region

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Conjunctive Management and Groundwater Storage

Conjunctive management, or conjunctive use, refers to the coordinated and planned use and management of both surface water and groundwater resources to maximize the availability and reliability of water supplies in a region to meet various management objectives. Managing both resources together, rather than in isolation, allows water managers to use the advantages of both resources for maximum benefit.

A survey undertaken in 2011-2012 jointly by DWR and ACWA to inventory and assess conjunctive management projects in California is summarized in Box SJR-4.

More detailed information about the survey results and a statewide map of the conjunctive management projects and operational information, as of July 2012, is available online from Update 2013, Volume 4, Reference Guide, the article "California's Groundwater Update 2013."

PLACEHOLDER Box SJR-4 Statewide Conjunctive Management Inventory Effort in California

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

<u>Conjunctive Management Inventory Results</u>

Of the 89 conjunctive management programs identified in California as part of the DWR/ACWA survey, five projects are in the San Joaquin River Hydrologic Region - Stockton East Water District, Northeastern San Joaquin County Groundwater Banking Authority, Madera Ranch Water Bank, Madera Irrigation District, and Root Creek Water District.

Stockton East Water District (SEWD) began the Farmington Groundwater Recharge Program in 2003 in the Eastern San Joaquin Groundwater Subbasin. The Farmington Program has a recharge capacity of approximately 35,000 acre-feet per year using surface spreading basins for direct percolation. SEWD also has an in-lieu groundwater recharge program. SEWD receives approximately 50,000 acre-feet of water from the CVP and approximately 31,500 acre-feet of water from local surface water sources. SEWD recharges 5,500 acre-feet of surface water annually with a total possible capacity of about 50,000 acre-feet. The extraction volume is estimated to be 300 acre-feet annually, with dry-year take up to 3,500 acre-feet. In-lieu recharge is estimated to be 76,000 acre-feet annually and 630,000 acre-feet cumulatively, while cumulative extraction volume from SEWD's in-lieu program is estimated to be 1.26 million acre-feet. SEWD indicates that the goals and objectives of their recharge program include reversing groundwater overdraft and salinity intrusion, addressing water quality protection, meeting climate change challenges, and providing a sustainable water supply. The most significant constraints identified by SEWD were regulatory and cost issues. Moderate constraints include political, legal and institutional issues, while limited aquifer storage and water quality were identified as minimal constraints.

The Northeastern San Joaquin County Groundwater Banking Authority partners with SEWD on their groundwater recharge programs.

The Madera Ranch Water Bank, operated by Madera Irrigation District, indicates that its program goals and objectives are to integrate groundwater recharge with flood management. The estimated capacity of the program's direct percolation and in-lieu recharge effort is 250,000 acre-feet.

Limited information was provided by Root Creek Irrigation District about their in-lieu groundwater recharge program; with only notable information included is their annual recharge volume of 6,000 acre-feet.

More details on the conjunctive management survey results is available online from Update 2013, Volume 4, Reference Guide, the article "California's Groundwater Update 2013" and DWR Bulletin 118-2003. Additional information regarding conjunctive management in California, as well as discussion of associated benefits, costs, and issues, can be found online from Update 2013, Volume 3, Chapter 9, "Conjunctive Management and Groundwater Storage."

Regional Resource Management Strategies

Central Valley Salinity Alternatives for Long-Term Sustainability

Throughout the Central Valley, participating in the development of salt and nitrate management plans is very important to improving water quality in the region and providing for a sustainable economic and environmental future. The Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) is a strategic initiative to address problems with salinity and nitrates in the surface and ground waters of the Central Valley. The long-term plan developed under CV-SALTS will identify and require discharger implementation of management measures aimed at the reduction and/or control of major sources of salt and nitrate as well as support activities that will alleviate known impairments to drinking water supplies. As this issue has a wide-ranging impact on the San Joaquin River Hydrologic Region, it is important that all stakeholders be part of the development and have input on the implementation of salt and nitrate management within the San Joaquin river area as part of the CV-SALTS program. For the Central Valley, the only available process to develop the salt and nutrient management plans that are required under State policy is through the CV-SALTS program (SWRCB 2009).

Groundwater Quality Protection Strategy

To protect groundwater quality, the CVRWQCB approved a strategy which recommends the following actions:

- Develop Salt & Nutrient Management Plan.
- Implement Groundwater Quality Monitoring Program.
- Implement Groundwater Protection Programs through IRWM Plan Groups.
- Broaden Public Participation in all programs.
- Coordinate with local agencies to implement a Well Design & Destruction Program.
- Creation of a Groundwater Database.
- Alternative Dairy Waste Disposal Methods.
- Develop individual and general orders for Poultry, Cattle Feedlots and other types of Concentrated Animal Feeding Operations (CAFOs).
- Implementation of Long-term Irrigated Lands Regulatory Program (ILRP)
- Coordinate with California Department of Food and Agriculture (CDFA) to identify methods to enhance fertilizer program
- Reduce Site Cleanup Backlog
- Draft waiver following new regulation adopted based on AB885 (passed in 2000 and requires the SWRCB to adopt regulations or standards for the operation of onsite wastewater treatment systems (OWTS))
- Update Guidelines for Waste Disposal for Land Developments consistent with the Water Quality Control Policy for Siting, Design, Operation and Maintenance of Onsite Wastewater Treatment Systems (State Water Board Resolution 2012-0032 adopted in compliance with CWC Section 13291)

Salt and Salinity Management

In March 2010, a memorandum of agreement (MOA) was finalized between Central Valley Regional Water Quality Control Board, Central Valley Salinity Coalition (a legal stakeholder entity), and the State Water Resources Control Board that documents the roles and responsibilities of the parties to coordinate salinity planning, management and regulation throughout the Central Valley in order to insure a sustainable future. The State Water Board provided $5-million in seed money that is being matched by stakeholder contributions. Some activities completed to date to help develop a sustainable salt and nitrate management plan include: pilot studies to document water balances and salt and nitrate source and fate (between 2009 and 2011), initiation of a management practices tool box that assists dischargers in identifying practices that will help reduce salt and nitrate impacts (2010); initiation of a conceptual model to prioritize management areas for detailed study and implementation plans (2012); and development of a long term funding plan (2012).

South of Delta SWP/CVP aqueduct intertie

A shared federal-State water system improvement project, the Intertie connects the Delta-Mendota Canals (DMC) (federal facility) and the California Aqueduct (CA) (State facility) and pumping station via two 108-inch-diameter pipes. Jones Pumping Plant and the DMC are the primary federal water delivery facilities that provide water to Central Valley Operations (CVP) contractors south of the Bay-Delta. The Intertie provides redundancy in the water distribution system, allows for maintenance and repair activities that are less disruptive to water deliveries, and provides the flexibility to respond to CVP and State Water

Project (SWP) emergencies. The contract was awarded in July 2010 and construction was completed in April 2012.

The Intertie will primarily be used in the fall and winter to fill the CVP's San Luis Reservoir earlier in the year to support South-of-Delta allocations. On a long-term annual average basis the Intertie is expected to provide a 35,000 acre-feet increase in CVP deliveries.

The Intertie cost $29 million which includes planning, design, permitting, mitigation, and construction management in addition to the pumping plant and transmission line construction cost. The Intertie was constructed using American Recovery and Reinvestment Act and other federally appropriated funds, as well as water user contributed funds. Federal costs are being recovered from benefitting water contractors according to Reclamation rate-setting policy. http://www.usbr.gov/mp/PA/docs/fact_sheets/Aquaduct_Delta_Mendota_Intertie.pdf.

Madera County water bank

Currently, farmers in MID's service area use a combination of groundwater and surface water. During dry years there is not adequate surface water to meet the water demand and groundwater pumping increases substantially. The amount of groundwater that has been pumped from the aquifer in the vicinity of Madera Ranch has exceeded the amount of water that has recharged the aquifer, resulting in groundwater overdraft. Even in wet years, the groundwater basin is in severe overdraft because groundwater pumping is steadily increasing for agricultural use as well as M&I use. This overdraft has caused the water table to decline and groundwater quality to degrade and has resulted in excess space in the aquifer that could be used to bank surface water (Madera Irrigation District Water, Supply Enhancement Project, Final Environmental Impact Statement, EIS-06-127).

In the vicinity of Madera Ranch, the water table has declined more than 90 feet over the last 60 years. These conditions have made it increasingly expensive for farmers to pump groundwater. Additionally, in many years, MID has been unable to deliver sufficient surface water to farmers because water is available primarily during the early months of the year when irrigation demand is low, and often water is available only for short periods of time during the growing season (Madera Irrigation District Water, Supply Enhancement Project, Final Environmental Impact Statement, EIS-06-127).

In 2005 MID acquired the 13,000 acre+ Madera Ranch property that will be used for groundwater banking. The Madera Ranch Water Bank will be able to store up to 250,000 af with recharge/recovery rates of up to 55,000 af per year. The majority of the recharge will be through natural swales and existing unlined canals. Only 323 acres of conventional recharge basins will be built for the project. The purposes of the project are to: enhance water supply reliability and flexibility, reduce groundwater overdraft, reduce groundwater pumping costs, improve groundwater quality, and encourage conjunctive use (Madera ID Press Release, 8/2/11).

Grasslands Bypass

The Grasslands Bypass Project was established to implement the Basin Plan selenium control program for the San Joaquin River. The Project routes subsurface agricultural drainage water with elevated levels of selenium, salts and other constituents of concern away from wildlife refuges and wetlands. The goal is to reduce and reuse high selenium subsurface agricultural drainage to comply with the Basin Plan load limits for the San Joaquin River and its tributaries.

Between 1998 and 2009, best management practices implemented by Grasslands Area Farmers prevented more than 22,300 pounds of selenium and 80,735 af of drainage from discharging to waters. These load reductions brought Salt Slough into compliance with the 2.0 micrograms per liter (μg/L) selenium monthly mean objective, and reduced selenium loading in the lower SJR below the four-day average of 5.0 μg/L. As a result, California removed several water bodies from its impaired waters list, including Salt Slough (10 miles) in 2008 and three segments (a combined 40.4 miles) of the SJR — Merced River to Tuolumne River (29 miles), Tuolumne River to Stanislaus River (8.4 miles), and Stanislaus River to the Delta Boundary (3 miles) — in 2010 (USEPA, Section 319, Nonpoint Source Program Success Story, California, Grasslands Bypass Project Reduces Selenium in the San Joaquin Basin, September 2011).

Although the GBP has made significant progress, additional work is required to achieve the ultimate project goal of zero discharge. To this end, Bureau of Reclamation signed an ROD on December 22, 2009, for the Grassland Bypass Project to execute a new use agreement with the San Luis & Delta Mendota Water Authority for continued use of the San Luis Drain from January 1, 2010, through December 31, 2019.

Climate Change

For over two decades, the State and federal governments have been preparing for climate change effects on natural and built systems with a strong emphasis on water supply. Climate change is already impacting many resource sectors in California, including water, transportation and energy infrastructure, public health, biodiversity, and agriculture (USGRCP 2009; CNRA 2009). Climate model simulations based on the Intergovernmental Panel on Climate Change's 21st Century scenarios project increasing temperatures in California, with greater increases in the summer. Projected changes in annual precipitation patterns in California will result in changes to surface runoff timing, volume, and type (Cayan 2008). Recently developed computer downscaling techniques indicate that California flood risks from warm-wet, atmospheric river type storms may increase beyond those that we have known historically, mostly in the form of occasional more-extreme-than-historical storm seasons (Dettinger 2011).

Currently, enough data exist to warrant the importance of contingency plans, mitigation (i.e., reduction) of greenhouse gas (GHG) emissions, and incorporating adaptation strategies (i.e., methodologies and infrastructure improvements that benefit the region at present and into the future). While California is taking aggressive action to mitigate climate change through reducing emissions from greenhouse gases and implementing other measures (CAR 2008), global impacts from carbon dioxide and other GHGs that are already in the atmosphere will continue to impact climate through the rest of the century (IPCC 2007).

Resilience to an uncertain future can be achieved by implementing adaptation measures sooner rather than later. Due to the economic, geographical and biological diversity of the state, vulnerabilities and risks due to current and future anticipated changes are best assessed on a regional basis. Many resources are available to assist water managers and others in evaluating their region-specific vulnerabilities and identifying appropriate adaptive actions (EPA/DW 2011; Cal-EMA/CNRA 2012).

Observations

The region’s observed temperature and precipitation vary greatly due to complex topography. Regionally-specific temperature observations can be retrieved through the Western Regional Climate Center (WRCC).Three WRCC regions overlap with the San Joaquin River Hydrologic Region - the Sierra, Sacramento-Delta, and San Joaquin Valley regions. Temperatures in the WRCC Sacramento-Delta region during the period of record indicate that a mean increase of about 1.5-2.4 °F (0.8 -1.3 °C) has occurred, with minimum values increasing more than maximums [2.1-3.1 °F (1.2-1.7 °C) and 0.7-1.9 °F (0.4-1.1 °C), respectively]. Temperatures in the WRCC San Joaquin Valley region show a similar trend. A mean increase of 0.9-1.9 °F (0.5-1.0 °C) was recorded, with minimum temperatures increasing 2-3 °F (1.1-1.6 °C) compared to the mean maximum temperature trend, which was relatively stable. The WRCC Sierra region also had an increasing mean temperature trend of 0.8-1.9 °F (0.4-1.1 °C), and again more warming was observed at night than in daytime [1.7-2.7 °F (0.9-1.5 °C) compared to -0.3-1.3 °F (-0.2-0.7 °C)].

The San Joaquin River Hydrologic Region also is currently experiencing impacts from climate change through changes in statewide precipitation and surface runoff volumes, which in turn affect availability of local and imported water supplies. During the last century, the average early snowpack in the Sierra Nevada decreased by about ten percent, which equates to a loss of 1.5 million acre-feet of snowpack storage (DWR 2008).

Projections and Impacts

While historic data is a measured indicator of how the climate is changing, it can't project what future conditions may be like under different GHG emissions scenarios. Current climate science uses modeling methods to simulate and develop future climate projections. A recent study by Scripps Institution of Oceanography uses the most sophisticated methodology to date, and indicates that by 2060-2069, temperatures will be 3.4 -4.9 ^{o}F (1.9 -2.7 ^{o}C) higher across the state than they were from 1985 to1994 (Pierce et al. 2012). By 2060-29, the annual mean temperature in the San Joaquin River region is projected to increase by 4.1 °F (2.3 °C) for the annual mean, with an increase of 3.2 °F (1.8 °C) in mean winter temperatures and 5.2 °F (2.9 °C) in summer. Two or three additional heat waves, defined as five days over 102 °F, are expected annually by 2050, with five to eight more by 2100 (Cal-EMA/CNRA 2012). Climate projections for the San Joaquin region from Cal-Adapt indicate that the temperatures between 1990 and 2100 are projected to increase 7-10°F (3.9 - 5.6°C) during winter and 9 -11°F (5-6.1°C) during summer (Cal-EMA and CNRA 2012b).

Changes in annual precipitation across California, either in timing or total amount, will result in changes to the type of precipitation (rain or snow) in a given area and to the timing and volume of surface runoff. Precipitation projections from climate models for California are not all in agreement, but most anticipate drier conditions in the southern part of California, with heavier and warmer winter precipitation in the north (Pierce et al. 2012). Because there is less scientific detail on localized precipitation changes, there exists a need to adapt to this uncertainty at the regional level (Qian et al. 2010).

The Sierra Nevada snowpack is expected to continue to decline as warmer temperatures raise the elevation of snow levels, reduce spring snowmelt, and increase winter runoff. Based upon historical data and modeling, researchers at Scripps Institution of Oceanography project that, by the end of this century, the Sierra snowpack will experience a 48 to 65 percent loss from its average at the end of the previous century (van Vuuren et al. 2011). In addition, earlier seasonal flows will reduce the flexibility in how the State manages its reservoirs to protect communities from flooding while ensuring a reliable water supply.

A recent study that explores future climate change and flood risk in the Sierra using downscaled simulations (computer projections refined to a scale smaller than global models), from three global climate models (GCMs) under a GHG scenario which is reflective of current trends, indicates a tendency toward increased 3-day flood magnitude. By the end of the 21st Century, all three projections yield larger floods for both the moderate elevation northern Sierra Nevada watershed and for the high elevation southern Sierra Nevada watershed, even for GCM simulations with 8 percent to 15 percent declines in overall precipitation. The increases in flood magnitude are statistically significant for all three GCMs for the period 2051–2099. By the end of the 21st century, the magnitudes of the largest floods increase to 110 percent to 150 percent of historical magnitudes. These increases appear to derive jointly from increases in heavy precipitation amount, storm frequencies, and days with more precipitation falling as rain and less as snow. (Das et al. 2011)

Changes in climate and runoff patterns may create increased competition among sectors that utilize water. Currently, Delta pumping restrictions are in place to protect endangered aquatic species. Climate change is likely to further constrain the management of these endangered species and the State's ability to provide water for other uses. The region is economically dependent on the thriving agricultural industry, which will be affected by a more variable hydrologic regime, reduced chill-hours in winter, increased evapotranspiration, and other indirect effects of rising temperatures. In some instances a longer growing season will be beneficial, but productivity of stone-fruit and nut trees may decline. The dairy industry will be affected by an anticipated increase in extreme heat days and reduced water availability (CNRA 2012). Agricultural water use efficiency will become increasingly important under these conditions. Additional climate change impacts will occur in surrounding watersheds. Wildfires in the Sierra foothills may increase in number and intensity (Westerling 2008), impacting habitat and water quality in the San Joaquin River region.

Adaptation

Changes in climate have the potential to impact the region, upon which the State depends for its economic and environmental benefits. These changes will increase the vulnerability of natural and built systems in the region. Impacts to natural systems will challenge aquatic and terrestrial species by diminishing water quantity and quality and shifting eco-regions. Built systems will be impacted by changing hydrology and runoff timing, loss of natural snowpack storage, making the region more dependent on surface storage in reservoirs and groundwater sources. Preparing for increased future water demand for both natural and built systems may be particularly challenging with less natural storage and less overall supply.

The San Joaquin River Hydrologic Region contains a diverse landscape with different climate zones, making it difficult to find one-size-fits-all adaptation strategies. Water managers and local agencies must work together to determine the appropriate planning approach for their operations and communities. While climate change adds another layer of uncertainty to water planning, it does not fundamentally alter the way water managers already address uncertainty (USEPA and DWR 2011). However, stationarity (the idea that natural systems fluctuate within an unchanging envelope of variability) can no longer be assumed, so new approaches will likely be required (Milly et al. 2008).

IRWM planning is a framework that allows water managers to address climate change on a smaller, more regional scale. Climate change is now a required component of all IRWM plans (DWR 2010). IRWM regions must identify and prioritize their specific vulnerabilities, and identify adaptation strategies that are most appropriate for sub-regions. Planning strategies to address vulnerabilities and adaptation to climate change should be both proactive and adaptive, starting with strategies that benefit the region in the present-day while adding future flexibility and resilience under uncertainty.

Local agencies, as well as federal and State agencies, face the challenge of interpreting climate change data and determining which methods and approaches are appropriate for their planning needs. The *Climate Change Handbook for Regional Water Planning* (EPA/DWR 2011) provides an analytical framework for incorporating climate change impacts into a regional and watershed planning process and considers adaptation to climate change. This handbook provides guidance for assessing the vulnerabilities of California's watersheds and regions to climate change impacts, and prioritizing these vulnerabilities.

The State has developed additional tools and resources to assist resource managers and local agencies in adapting to climate change, including:

- *California Climate Adaptation Strategy (2009)* - California Natural Resources Agency (CNRA) at http://www.climatechange.ca.gov/adaptation/strategy/index.html.
- *California Climate Change Adaptation Planning Guide (2012)* - California Emergency Management Agency (Cal-EMA) and CNRA at http://resources.ca.gov/climate_adaptation/local_government/adaptation_planning_guide.html.
- *Cal-Adapt website* at http://cal-adapt.org/.
- *Urban Forest Management Plan (UFMP) Toolkit* - sponsored by the California Department of Forestry and Fire Management at http://ufmptoolkit.com/.
- *California Climate Change Portal* at http://www.climatechange.ca.gov/.
- *DWR Climate Change* website at http://www.water.ca.gov/climatechange/resources.cfm.
- *The Governor's Office of Planning and Research (OPR)* website at http://www.opr.ca.gov/m_climatechange.php.

Many of the Resource Management Strategies from Update 2009 (Volume 3) provide benefits for adapting to climate change in addition to meeting water management objectives. These include:

- Agricultural/Urban Water Use Efficiency.
- Conveyance – Regional/local.
- System Reoperation.
- Conjunctive Management and Groundwater.
- Precipitation Enhancement
- Surface Storage – Regional/Local.
- Pollution Prevention
- Agricultural Land Stewardship.
- Ecosystem Restoration.
- Forest Management.
- Land Use Planning and Management.
- Recharge Area Protection.
- Watershed Management.
- Flood Management.

The myriad of resources and choices available to managers can seem overwhelming, and the need to take action given uncertain future conditions is daunting. However, there are many actions that water managers in the San Joaquin River region can take to prepare for climate change, regardless of the magnitude of future warming. These actions often provide economic and public health co-benefits. Water and energy conservation are examples of strategies that make sense with or without the additional pressures of climate change. Promoting healthy urban forests can reduce the urban heat island effect by decreasing ambient air temperature. Restoration of flood control and riparian corridors is an important adaptation strategy for both water management flexibility and ecosystem protection. Conjunctive management projects that manage surface and groundwater in a coordinated fashion could provide a buffer against variable annual water supplies. Forecast-coordinated operations would provide flexibility for water managers to respond to weather conditions as they unfold.

Regardless of the specific strategies selected, increased coordination across sectors will be imperative for successful climate adaptation. Water managers will need to consider both the natural and built environments as they plan for the future. Stewardship of natural areas and protection of biodiversity are critical for maintaining ecosystem services important for human society such as carbon sequestration, pollution remediation, and habitat for pollinators. Increased cross-sector collaboration between water managers, land use planners and ecosystem managers provides opportunities for identifying common goals and actions needed to achieve resilience to climate change and other stressors.

Mitigation

California's water sector has a large energy footprint, consuming 7.7 percent of statewide electricity (CPUC 2010). Energy is used in the water sector to extract, convey, treat, distribute, use, condition, and dispose of water. Figure 3-26, Water-Energy Connection in Volume 1, California Water Today shows all of the connections between water and energy in the water sector; both water use for energy generation and energy use for water supply activities. The regional reports in the 2013 Update 2013 are the first to provide detailed information on the water-energy connection, including energy intensity (EI) information at the regional level. This EI information is designed to help inform the public and water utility managers about the relative energy requirements of the major water supplies used to meet demand. Since energy usage is related to greenhouse gas (GHG) emissions, this information can support measures to reduce GHG's, as mandated by the State.

Figure SJR-38 shows the amount of energy associated with the extraction and conveyance of 1 acre-foot of water for each of the major sources in this region. The quantity used is also included, as a percent. For reference, Figure 3-26, Water-Energy Connection in California Water Today, Volume 1 highlights which water-energy connections are illustrated in Figure SJR-38; only extraction and conveyance of raw water. Energy required for water treatment, distribution, and end uses of the water are not included. Not all water types are available in this region. Some water types flow by gravity to the delivery location and therefore do not require any energy to extract or convey (represented by a white light bulb).

Recycled water and water from desalination used within the region are not show in Figure SJR-38 because their energy intensity differs in important ways from those water sources. The energy intensity of both recycled and desalinated water depend not on regional factors but rather on much more localized, site, and application specific factors. Additionally, the water produced from recycling and desalination is typically of much higher quality than the raw (untreated) water supplies evaluated in Figure SJR-38. For these reasons, discussion of energy intensity of desalinated water and recycled water are included in Volume 3, *Resource Management Strategies*.

Energy intensity, sometimes also known as embedded energy, is the amount of energy needed to extract and convey (extraction refers to the process of moving water from its source to the ground surface. Many water sources are already at ground surface and require no energy for extraction, while others like groundwater or sea water for desalination require energy to move the water to the surface. Conveyance refers to the process of moving water from a location at the ground surface to a different location, typically but not always a water treatment facility. Conveyance can include pumping of water up hills and mountains or can occur by gravity) an acre-foot of water from its source (e.g. groundwater or a river) to a delivery location, such as a water treatment plant or a State Water Project (SWP) delivery turnout. Energy intensity should not be confused with total energy — that is, the amount of energy (e.g., kWh) required to deliver all of the water from a water source to customers within the region. Energy intensity focuses not on the total amount of energy used to deliver water, but rather the energy required to deliver a single unit of water (in kWh/acre-foot). In this way, energy intensity gives a normalized metric which can be used to compare alternative water sources.

In most cases, this information will not be of sufficient detail for actual project level analysis. However, these generalized, region-specific metrics provide a range in which energy requirements fall. The information can also be used in more detailed evaluations using tools such as WeSim (http://www.pacinst.org/publication/wesim/) which allows modeling of water systems to simulate outcomes for energy, emissions, and other aspects of water supply selection. It's important to note that water supply planning must take into consideration a myriad of different factors in addition to energy impacts; costs, water quality, opportunity costs, environmental impacts, reliability and other many other factors.

Energy intensity is closely related to greenhouse gas (GHG) emissions, but not identical, depending on the type of energy used (see California Water Today, Water-Energy, Volume 1). In California, generation of 1 megawatt-hour (MWh) of electricity results in the emission of about 1/3 of a metric ton of GHG, typically referred to as carbon dioxide equivalent or CO2e (eGrid 2012). This estimate takes into account the use of GHG-free hydroelectricity, wind, and solar and fossil fuel sources like natural gas and coal. The GHG emissions from a specific electricity source may be higher or lower than this estimate.

Reducing GHG emissions is a State mandate. Water managers can support this effort by considering energy intensity factors, such as those presented here, in their decision making process. Water use efficiency and related best management practices can also reduce GHGs (see *Volume 3, Resource Management Strategies*).

Accounting for Hydroelectric Energy

Generation of hydroelectricity is an integral part of many of the State's large water projects. In 2007, hydroelectric generation accounted for nearly 15 percent of all electricity generation in California. The State Water Project, Central Valley Project, Los Angeles Aqueduct, Mokelumne Aqueduct, and Hetch Hetchy Aqueducts all generate large amounts of hydroelectricity at large multi-purpose reservoirs at the heads of each system. In addition to hydroelectricity generation at head reservoirs, several of these systems also generate hydroelectric energy by capturing the power of water falling through pipelines at in-conduit generating facilities. (In-conduit generating facilities refer to hydroelectric turbines that are placed along pipelines to capture energy as water runs downhill in a pipeline [conduit].) Hydroelectricity is also generated at hundreds of smaller reservoirs and run-of-the-river turbine facilities.

Hydroelectric generating facilities at reservoirs provide unique benefits. Reservoirs like the State Water Project's Oroville Reservoir are operated to build up water storage at night when demand for electricity is low, and release the water during the day time hours when demand for electricity is high. This operation, common to many of the state's hydropower reservoirs, helps improve energy grid stabilization and reliability and reduces GHG emissions by displacing the least efficient electricity generating facilities. Hydroelectric facilities are also extremely effective for providing back-up power supplies for intermittent renewable resources like solar and wind power. Because the sun can unexpectedly go behind a cloud or the wind can die down, intermittent renewables need back up power sources that can quickly ramp up or ramp down depending on grid demands and generation at renewable power installations.

Despite these unique benefits and the fact that hydroelectric generation was a key component in the formulation and approval of many of California's water systems, accounting for hydroelectric generation in energy intensity calculations is complex. In some systems like the SWP and CVP, water generates electricity and then flows back into the natural river channel after passing through the turbines. In other systems like the Mokelumne aqueduct water can leave the reservoir by two distinct out flows, one that generates electricity and flows back into the natural river channel and one that does not generate electricity and flows into a pipeline flowing into the East Bay Municipal Utility District service area. In both these situations, experts have argued that hydroelectricity should be excluded from energy intensity calculations because the energy generation system and the water delivery system are in essence separate (Wilkinson 2000).

DWR has adopted this convention for the energy intensity for hydropower in the regional reports. All hydroelectric generation at head reservoirs has been excluded from Figure SJR-38. Consistent with Wilkinson (2000) and others, DWR has included in-conduit and other hydroelectric generation that occurs as a consequence of water deliveries, such as the Los Angeles Aqueduct's hydroelectric generation at San Francisquito, San Fernando, Foothill and other power plants on the system (downstream of the Owens River Diversion Gates). DWR has made one modification to this methodology to simplify the display of results: energy intensity has been calculated at each main delivery point in the systems; if the hydroelectric generation in the conveyance system exceeds the energy needed for extraction and conveyance, the energy intensity is reported as zero (0), i.e., no water system is reported as a net producer of electricity, even though several systems do produce more electricity in the conveyance system than is used (e.g., Los Angeles Aqueduct, Hetch Hetchy Aqueduct). (For detailed descriptions of the methodology used for the water types presented, see *Technical Guide*, Volume 5).

PLACEHOLDER Figure SJR-38 Energy Intensity of Raw Water Extraction and Conveyance in the San Joaquin Hydrologic Region

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

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Table SJR-1 Alluvial Groundwater Basins and Subbasins within the San Joaquin River Hydrologic Region

Basin/Subbasin		Basin Name
5-22		San Joaquin Valley
	5-22.01	Eastern San Joaquin
	5-22.02	Modesto
	5-22.03	Turlock
	5-22.04	Merced
	5-22.05	Chowchilla
	5-22.06	Madera
	5-22.07	Delta-Mendota
	5-22.15	Tracy
	5-22.16	Cosumnes
5-69		Yosemite Valley
5-70		Los Banos Creek Valley

Table SJR-2 Number of Well Logs by County and Use for the San Joaquin River Hydrologic Region (1977-2010)

County	Total Number of Well Logs by Well Use						Total Well Records
	Domestic	Irrigation	Public Supply	Industrial	Monitoring	Other	
Amador	3,415	83	40	6	206	17	3,767
Calaveras	4,514	217	79	14	237	37	5,098
Contra Costa	1,911	620	72	22	5,773	1,355	9,753
San Joaquin	6,193	980	229	76	2,894	528	10,890
Stanislaus	6,715	1,520	269	39	657	1,452	10,652
Merced	5,513	2,032	87	22	718	1,301	9,673
Tuolumne	4,575	124	215	14	260	145	5,333
Mariposa	4,977	74	74	1	76	164	5,366
Madera	9,986	1,630	396	31	210	662	12,915
Total Well Records	47,789	7,280	1,461	225	11,031	5,661	73,447

Table SJR-3 CASGEM Groundwater Basin Prioritization for the San Joaquin River Hydrologic Region

Basin Prioritization	Count	Basin/Subbasin Number	Basin Name	Subbasin Name	2010 Census Population
High	1	5-22.05	SAN JOAQUIN VALLEY	CHOWCHILLA	15,820
High	2	5-22.06	SAN JOAQUIN VALLEY	MADERA	116,919
High	3	5-22.01	SAN JOAQUIN VALLEY	EASTERN SAN JOAQUIN	582,662
High	4	5-22.02	SAN JOAQUIN VALLEY	MODESTO	294,872
High	5	5-22.07	SAN JOAQUIN VALLEY	DELTA-MENDOTA	107,879
High	6	5-22.04	SAN JOAQUIN VALLEY	MERCED	173,731
High	7	5-22.03	SAN JOAQUIN VALLEY	TURLOCK	197,605
Medium	1	5-22.15	SAN JOAQUIN VALLEY	TRACY	268,175
Medium	2	5-22.16	SAN JOAQUIN VALLEY	COSUMNES	59,163
Very Low	1	5-69	YOSEMITE VALLEY		1,016
Very Low	2	5-70	LOS BANOS CREEK VALLEY		
Total	**11**		**Population of Groundwater Basin Area**		**1,817,842**

Table SJR-4 Groundwater Level Monitoring Wells by Monitoring Entity in the San Joaquin River Hydrologic Region

State and Federal Agencies	Number of Wells
DWR	117
USGS	38
USBR	227
Total State and Federal Wells	**382**
Monitoring Cooperators	**Number of Wells**
Central California Irrigation District	41
Chowchilla Water District	147
Fresno Irrigation District	1
James Irrigation District	5
Madera Irrigation District	189
Merced Irrigation District	146
Modesto Irrigation District	87
City of Modesto	74
Sacramento County	3
San Joaquin County	8
San Luis Canal Company	21
Total Cooperator Wells	**722**
CASGEM Monitoring Entities	**Number of Wells**
Diablo Water District	20
Madera-Chowchilla Basin Regional Monitoring Group (see note)	26
Merced Area Groundwater Pool Interests (see note)	34
San Joaquin County Flood Control and Water Conservation District (see note)	257
San Luis and Delta Mendota Water Authority (see note)	85
Westlands Water District	6
Total CASGEM Monitoring Entities	**428**
Grand Total	**1,532**

Notes:

Table includes groundwater level monitoring wells having publicly available online data.

Designation as CASGEM Monitoring Entity pending for Madera-Chowchilla Basin Regional Monitoring Group, Merced Area Groundwater Pool Interests, San Joaquin County Flood Control and Water Conservation District, and San Luis and Delta Mendota Water Authority.

Table SJR-5 Sources of Groundwater Quality Information

Agency	Links to Information
State Water Resources Control Board	Groundwater • Communities that Rely on a Contaminated Groundwater Source for Drinking Water • Nitrate in Groundwater: Pilot Projects in Tulare Lake Basin/Salinas Valley • Hydrogeologically Vulnerable Areas • Aquifer Storage and Recovery • Central Valley Salinity Alternatives for Long-Term Sustainability (CV-Salts) GAMA • GeoTracker GAMA (Monitoring Data) • Domestic Well Project • Priority Basin Project • Special Studies Project • California Aquifer Susceptibility Project Contaminant Sites • Land Disposal Program • Department of Defense Program • Underground Storage Tank Program • Brownfields
California Department of Public Health	Division of Drinking Water and Environmental Management • Drinking Water Source Assessment and Protection (DWSAP) Program • Chemicals and Contaminants in Drinking Water • Chromium-6 • Groundwater Replenishment with Recycled Water
Department of Water Resources	Groundwater Information Center • Bulletin 118 Groundwater Basins • California Statewide Groundwater Elevation Monitoring (CASGEM) • Groundwater Level Monitoring • Groundwater Quality Monitoring • Well Construction Standards • Well Completion Reports
Department of Toxic Substances Control	• EnviroStor
Department of Pesticide Regulation	Groundwater Protection Program • Well Sampling Database • Groundwater Protection Area Maps
U.S. Environmental Protection Agency	US EPA STORET Environmental Data System
United States Geological Survey	USGS Water Data for the Nation

Table SJR-6 Critical Species in the San Joaquin River Hydrologic Region

Category	Common name	Scientific name	Federal status [a]	State status [a]
Invertebrates	Lange's metalmark butterfly	*Apodemia mormo langei*	FE	
	Conservancy fairy shrimp	*Branchinecta conservatio*	FE	
	Longhorn fairy shrimp	*Branchinecta longiantenna*	FE	
	San Bruno elfin butterfly	*Callophrys mossii bayensis*	FE	
	Vernal pool tadpole shrimp	*Lepidurus packardi*	FE	
Fish	Delta smelt	*Hypomesus transpacificus*	FT	SE
Amphibians	Sierra Nevada yellow-legged frog	*Rana sierrae*	FC	SCE
Reptiles	Blunt-nosed leopard lizard	*Gambelia sila*	FE	SE
Birds	Golden eagle	*Aquila chrysaetos*		FP
	Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	FC	SE
	White-tailed kite	*Elanus leucurus*		FP
	Willow flycatcher	*Empidonax traillii*		SE
	American peregrine falcon	*Falco peregrinus anatum*		FP
	Bald eagle	*Haliaeetus leucocephalus*		SE, FP
	Great gray owl	*Strix nebulosa*		SE
	Least Bell's vireo	*Vireo bellii pusillus*	FE	SE
Mammals	Giant kangaroo rat	*Dipodomys ingens*	FE	SE
	Fresno kangaroo rat	*Dipodomys nitratoides exilis*	FE	SE
	Riparian (=San Joaquin Valley) woodrat	*Neotoma fuscipes riparia*	FE	
	Salt-marsh harvest mouse	*Reithrodontomys raviventris*	FE	SE
	Riparian brush rabbit	*Sylvilagus bachmani riparius*	FE	SE
	San Joaquin kit fox	*Vulpes macrotis mutica*	FE	ST

Note:

[a] State and federal Designations:

SE = State-listed as Endangered
ST = State-listed as Threatened
FP = Fully Protected under the California Department of Fish and Wildlife
FE = Federally-listed as Endangered
FT = Federally-listed as Threatened
SCE = Candidate for State Listing as Endangered
FC = Candidate for Federal Listing

Table SJR-7 Critical Plant Species Endemic to the San Joaquin River Hydrologic Region

Common Name	Scientific Name	Federal Status [a]	State Status [a]	CNPS Rank [b]
Antioch Dunes buckwheat	*Eriogonum nudum var. psychicola*			1B.1
Chinese Camp brodiaea	*Brodiaea pallida*	FT	ST	1B.1
Contra Costa wallflower	*Erysimum capitatum var. angustatum*	FE	SE	1B.1
Delta button-celery	*Eryngium racemosum*			1B.1
El Dorado bedstraw	*Galium californicum ssp. sierrae*	FE	SR	1B.2
Ione buckwheat	*Eriogonum apricum var. apricum*	FE	SE	1B.1
Irish Hill buckwheat	*Eriogonum apricum var. prostratum*	FE	SE	1B.1
Large-flowered fiddleneck	*Amsinckia grandiflora*	FE	SE	1B.1
Lime Ridge navarretia	*Navarretia gowenii*			1B.1
Mariposa pussypaws	*Calyptridium pulchellum*	FT		1B.1
Merced clarkia	*Clarkia lingulata*		SE	1B.1
Pine Hill ceanothus	*Ceanothus roderickii*	FE	SR	1B.2
Red Hills vervain	*Verbena californica*	FT	ST	1B.1
Sacramento Orcutt grass	*Orcuttia viscida*	FE	SE	1B.1
Stebbins' lomatium	*Lomatium stebbinsii*			1B.1
Succulent owl's-clover	*Castilleja campestris ssp. succulenta*	FT	SE	1B.2

Notes:

[a] State and federal Designations:
SE = State-listed as Endangered
ST = State-listed as Threatened
SR = State-listed as Rare
FE = Federally-listed as Endangered
FT = Federally-listed as Threatened

[b] California Native Plant Society (CNPS) Ranks:
1A = Plants Presumed Extinct in California
1B.1 = Plants Rare, or Seriously Threatened or Endangered in CA and elsewhere
1B.2 = Plants Rare, or Fairly Threatened or Endangered in CA and elsewhere

Table SJR-8 San Joaquin River Hydrologic Region Population by County for 2005 and 2010

County	2005 population	2010 population
Alameda	412	403
Contra Costa	191,096	211,304
San Joaquin	651,625	685,306
Amador	37,632	38,030
Calaveras	44,773	45,578
Sacramento	43,326	45,409
Alpine	129	121
El Dorado	59,224	65,212
Tuolumne	56,452	55,365
Madera	139,868	150,865
Merced	240,600	255,793
Stanislaus	498,020	514,453
Mariposa	18,057	18,251
Fresno	17,794	18,116
Total	1,999,008	2,104,206

Table SJR-9 Top 10 Most Populous Cities within the San Joaquin River Hydrologic Region

City	Population
Stockton	291,707
Modesto	201,165
Antioch	102,372
Tracy	82,922
Merced	78,958
Turlock	68,549
Manteca	67,096
Lodi	62,134
Pittsburg	63,264
Madera	61,416

Table SJR-10 Federally Recognized Tribes in the San Joaquin River Hydrologic Region

Name of Tribe	Acres	Cultural Affiliation	County of Location
Shingle Springs Rancheria	160	Maidu, Miwok	El Dorado
Jackson Rancheria	331	Mewuk (Miwok)	Amador
Buena Vista Rancheria	67	Miwok (Mewuk)	Amador
Tuolumne Rancheria	335	Me-Wuk, Miwok, Yokut	Tuolumne
Chicken Ranch Rancheria	3	Me-Wuk	Tuolumne
Picayune Rancheria	160	Chukchansi	Madera
North Fork Rancheria	80	Western Mono	Madera
Big Sandy Rancheria	228	Western Mono (Monache) Indians	Fresno
Table Mountain Rancheria	61	Yokuts	Fresno
California Valley Miwok Tribe	Unknown	Miwok	Calaveras
Ione Band of Miwok Indians of California	228	Miwok	Amador

Note:
As per data taken from the San Diego State University's online library and information access (http://infodome.sdsu.edu/research/guides/calindians/calinddict.shtml#a) and Wikipedia.org.

Table SJR-11 Tribes within Integrated Regional Water Management Regions in the San Joaquin River Hydrologic Region

Map No.	IRWM	Tribe
1	American River	Wilton Rancheria
4	Yosemite-Mariposa	No Tribes in this IRWM Region
6	Cosumnes American Bear Yuba (CABY)	Shingle Springs Band of Miwok Indians
7	East Contra Costa County	No Tribes in this IRWM Region
8	Eastern San Joaquin	No Tribes in this IRWM Region
16	Madera	Picayune Rancheria of Chukchansi Indians
17	Merced	No Tribes in this IRWM Region
19	Mokelumne/Amador/Calaveras	Buena Vista Rancheria Me-Wuk Indians of California
		California Valley Miwok Tribe
		Ione Band of Miwok Indians
33	Southern Sierra	Big Sandy Rancheria of Mono Indians of California
		Table Mountain Rancheria of California
36	Tuolumne-Stanislaus	Chicken Ranch Rancheria of Me-wuk
		Tuolumne Band of Me-Wuk Indians
44	Westside-San Joaquin	No Tribes in this IRWM Region
47	East Stanislaus	No Tribes in this IRWM Region

Table SJR-12 Disadvantaged Communities (Cities) within the San Joaquin River Hydrologic Region

City	Population	Median Household Income
Firebaugh	7,373	$30,000
Sonora	4,914	$30,893
Plymouth	903	$31,250
Merced	77,080	$36,269
Chowchilla	18,090	$39,902
Dos Palos	4,904	$40,121
Angels	3,790	$40,690
Gustine	5,438	$40,818
Madera [a]	59,006	$40,889
Atwater	27,587	$42,226
Livingston	12,733	$46,198
Jackson	4,625	$46,932
Newman	9,806	$47,416
Sutter Creek	2,827	$47,909
Stockton	287,377	$47,946
Lodi	62,225	$48,695

Note:

[a] Madera city excluding Bonadelle Ranchos-Madera Ranchos.

Table SJR-13 Poorest 20 Census Designated Places within the San Joaquin River Hydrologic Region with Populations Greater Than 2,000

Census Place	Population	MHI
Shackelford	3,748	$19,302
South Dos Palos	2,271	$28,931
Winton	11,103	$29,586
Firebaugh [a]	7,373	$30,000
August	8,332	$30,469
West Modesto	6,222	$30,767
Sonora [a]	4,914	$30,893
Empire	3,763	$32,198
Columbia	2,504	$33,494
Jamestown	3,684	$33,988
Bystrom	4,010	$34,464
Keyes	5,079	$35,130
Oakhurst	3,263	$35,155
Kennedy	3,293	$35,450
Planada	4,295	$35,880
Merced [a]	77,080	$36,269
Bethel Island	2,191	$36,515
Parkwood	2,025	$37,208
Bret Harte	5,102	$38,087
Parksdale	2,977	$38,895

Note:

[a] All are Census Designated Places, except Firebaugh, Sonora, and Merced, which are cities.

Table SJR-14 Central Valley Project Supplies for Select Wildlife Refuges in the San Joaquin River Region

Refuge	CVP Deliveries (acre-feet)				
	2005	**2006**	**2007**	**2008**	**2009**
Grassland WD	154,456	191,821	162,907	150,284	134,287
Los Banos WA	3,542	21,798	24,171	18,255	19,025
North Grasslands WA	8,008	22,191	24,540	21,550	18,984
San Luis NWR	14,808	48,364	55,466	53,039	56,958
Volta WMA	47,057	11,164	13,129	10,501	10,896
Total SJR	228,863	296,273	281,065	254,341	241,125

Table SJR-15 South of Delta Central Valley Project and State Water Project Deliveries (Percentage of Contract Amounts)

Year	Ag	Urban	Wildlife	SWP
1998	100	100	0	100
1999	70	95	0	100
2000	65	90	0	90
2001	49	77	100	39
2002	70	77	100	70
2003	75	100	100	90
2004	70	95	100	65
2005	85	100	100	90
2006	100	100	100	100
2007	50	75	100	60
2008	40	75	100	35
2009	10	60	100	40
2010	45	75	100	50

Table SJR-16 San Joaquin River Hydrologic Region Average Annual Groundwater Supply by Planning Area (PA) and by Type of Use (2005-2010)

San Joaquin River Hydrologic Region		Agriculture Use Met by Groundwater		Urban Use Met by Groundwater		Managed Wetlands Use Met by Groundwater		Total Water Use Met by Groundwater	
PA Number	**PA Name**	**TAF**	**%**	**TAF**	**%**	**TAF**	**%**	**TAF**	**%**
601	Upper West Side Uplands	5.4	17%	7.5	10%	0.0	0%	12.9	12%
602	San Joaquin Delta	0.8	0%	37.8	35%	0.0	0%	38.6	4%
603	Eastern Valley Floor	426.8	58%	49.7	41%	0.1	17%	476.6	56%
604	Sierra Foothills	1.6	8%	2.7	6%	0.0	0%	4.3	6%
605	West side Uplands	0.0	0%	0.2	100%	0.0	0%	0.2	100%
606	Valley West Side	554.7	34%	27.8	88%	178.1	41%	760.6	36%
607	Upper Valley East Side	121.9	14%	103.0	69%	1.4	13%	226.3	22%
608	Middle Valley East Side	330.3	32%	74.9	100%	0.0	0%	405.2	37%
609	Lower Valley East Side	1,146.7	57%	95.4	100%	11.1	25%	1,253.1	58%
610	East Side Uplands	3.1	100%	15.3	97%	0.0	0%	18.4	98%
2005-10 Annual Average HR Total		**2,591.3**	**36%**	**414.1**	**58%**	**190.7**	**38%**	**3,196.1**	**38%**

Notes:

TAF = thousand acre-feet

Percent use is the percentage of the total water supply that is met by groundwater, by type of use.

2005-10 precipitation equals 97 percent of the 30-year average for the South Coast Region.

Table SJR-17 San Joaquin River Hydrologic Region Average Annual Groundwater Supply by County and by Type of Use (2005-2010)

San Joaquin River Hydrologic Region	Agriculture Use Met by Ground-water		Urban Use Met by Ground-water		Managed Wet-lands Use Met by Ground-water		Total Water Use Met by Ground-water	
County	**TAF**	**%**	**TAF**	**%**	**TAF**	**%**	**TAF**	**%**
Amador	3.0	20%	1.8	17%	0.0	0%	4.8	19%
Calaveras	1.3	16%	1.6	13%	0.0	0%	2.8	14%
Contra Costa	0.8	1%	25.0	9%	0.0	0%	25.8	6%
Madera	673.1	66%	40.7	100%	0.0	0%	713.7	68%
Mariposa	3.1	0%	4.6	1%	0.0	0%	7.7	0%
Merced	764.6	38%	84.6	97%	189.2	40%	1,038.3	40%
San Joaquin	354.1	22%	79.9	42%	0.0	0%	434.0	24%
Stanislaus	512.4	30%	162.8	85%	1.4	13%	676.6	36%
Tuolumne	0.4	7%	1.3	10%	0.0	0%	1.7	9%
2005-10 Annual Ave. Total	**2,312.8**	**36%**	**402.1**	**48%**	**190.6**	**39%**	**2,905.5**	**37%**

Notes:

TAF = thousand acre-feet

Percent use is the percentage of the total water supply that is met by groundwater, by type of use.

2005-10 precipitation equals 97 percent of the 30-year average for the South Coast region.

4) Total Supply = Groundwater + Surface Water + Reuse

Table SJR-18 Drinking Water Systems in the San Joaquin River Hydrologic Region

Water System Size by Population	Number of Community Systems	Percent of Community Systems in Region	Population Served	Percent of Population Served
Large (> 10,000)	29	7	1,501,338	82
Medium (3301-10,000)	35	8	186,402	10
Small (500-3300)	72	16	96,257	5
Very Small (< 500)	297	68	44,133	2
CWS that Primarily Provide Wholesale Water	5	1		
Total	438	100	1,828,130	

Table SJR-19 San Joaquin River Hydrologic Region Water Balance for 2001-2010

Table SJR-X San Joaquin River Hydrologic Region water balance for 2001-2010 (in TAF)

San Joaquin River (TAF)	Water Year (Percent of Normal Precipitation)									
	2001 (79%)	2002 (82%)	2003 (84%)	2004 (85%)	2005 (126%)	2006 (133%)	2007 (59%)	2008 (73%)	2009 (86%)	2010 (106%)
Water Entering the Region										
Precipitation	16,120	18,069	18,469	18,695	27,903	29,259	13,082	16,009	18,965	23,328
Inflow from Oregon/Mexico	0	0	0	0	0	0	0	0	0	0
Inflow from Colorado River	0	0	0	0	0	0	0	0	0	0
Imports from Other Regions	4,572	6,527	7,460	7,216	7,739	6,770	5,686	3,170	3,060	6,601
Total	**20,692**	**24,596**	**25,929**	**25,911**	**35,642**	**36,029**	**18,768**	**19,179**	**22,025**	**29,929**
Water Leaving the Region										
Consumptive Use of Applied Water * (Ag, M&I, Wetlands)	4,983	5,234	4,941	5,367	4,512	4,861	5,715	5,822	5,641	4,942
Outflow to Oregon/Nevada/Mexico	0	0	0	0	0	0	0	0	0	0
Exports to Other Regions	4,496	6,349	7,492	7,085	10,733	14,579	6,876	4,785	4,550	7,297
Statutory Required Outflow to Salt Sink	0	1,120	318	1,427	2,890	2,630	694	768	1,104	1,244
Additional Outflow to Salt Sink	218	276	276	282	263	273	290	295	290	291
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows	13,690	13,445	13,894	14,726	15,722	15,467	10,760	11,508	12,209	16,893
Total	**23,387**	**26,424**	**26,921**	**28,887**	**34,119**	**37,810**	**24,335**	**23,178**	**23,793**	**30,667**
Change in Supply										
[+] Water added to storage [-] Water removed from storage										
Surface Reservoirs	-1,435	-166	760	-977	2,774	164	-2927	-970	1189	1148
Groundwater **	-1,260	-1,662	-1,752	-1,999	-1,251	-1945	-2640	-3029	-2957	-1886
Total	**-2,695**	**-1,828**	**-992**	**-2,976**	**1,523**	**-1781**	**-5567**	**-3999**	**-1768**	**-738**
Applied Water * (Ag, Urban, Wetlands) (compare with Consumptive Use)	7,817	8,190	7,636	8,167	7,212	7,682	8,860	8,973	8,721	7,786

* Definition: Consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is greater than consumptive use because it includes consumptive use, reuse, and outflows.

** Definition: Change in Supply: Groundwater – The difference between water extracted from and water recharged into groundwater basins in a region. All regions and years were calculated using the following equation:

change in supply: groundwater = intentional recharge + deep percolation of applied water + conveyance deep percolation and seepage - withdrawals

This equation does not include unknown factors such as natural recharge and subsurface inflow and outflow. For further details, refer to Volume 4, Reference Guide – *California's Groundwater Update 2013* and Volume 5 Technical Guide.

n/a = not applicable

Table SJR-20 Summary of Community Drinking Water Systems in the San Joaquin River Hydrologic Region that Rely on One or More Contaminated Groundwater Well That Exceeds a Primary Drinking Water Standard

Community Drinking Water Systems and Groundwater Wells Grouped by Water System Population	No. of Affected Community Drinking Water Systems	No. of Affected Community Drinking Water Wells
Small System ≤ 3,300	80	119
Medium System 3,301-10,000	8	18
Large System ≥ 10,000	16	91
Total	104	228

Source: Water Boards 2012 Draft Report, *Communities that Rely on Contaminated Groundwater*

Table SJR-21 Summary of Contaminants Affecting Community Drinking Water Systems in the San Joaquin River Hydrologic Region

Principal Contaminant (PC)	Community Drinking Water Systems where PC exceeds the Primary MCL	No. of Community Drinking Water Wells where PC exceeds the Primary MCL
Arsenic	58	120
Gross alpha particle activity	38	76
Uranium	23	40
Nitrate	17	26
1,2-Dibromo-3-chloropropane (DBCP)	12	28
Tetrachloroethylene (PCE)	4	4

Source: Water Boards 2012 Draft Report on "Communities that Rely on Contaminated Groundwater"

Notes:

Only the 6 most prevalent contaminants are shown.

Wells with multiple contaminants:

40 wells are affected by gross alpha particle activity & Uranium.

13 wells are affected by arsenic and gross alpha particle activity/Uranium.

6 wells are affected by nitrate and gross alpha particle activity/Uranium.

6 wells are affected by both arsenic and nitrate.

Table SJR-22 Spring 2005 — Spring 2010 Annual Change in Groundwater Storage for the San Joaquin River Hydrologic Region

San Joaquin River Hydrologic Region Spring 2005-2010 Change in Storage Estimates			
Reporting Area (Acres):	2,535,865		
Non-Reporting Area (Acres):	1,180,392		
Period Spring - Spring	**Average Change in GW Elevation (feet)**	**Estimated Change in Storage in TAF**	
		Assuming Specific Yield = 0.07	**Assuming Specific Yield = 0.17**
2005-2006	1.0	186.4	452.6
2006-2007	-2.7	-487.6	-1,184.2
2007-2008	-0.3	-56.7	-137.6
2008-2009	-3.4	-610.7	-1,483.2
2009-2010	-0.5	-86.9	-211.0
2005-2010 (total)	-5.9	-1,055.5	-2,563.4

Note: Changes in groundwater elevation and storage are calculated for reporting area only.

Table SJR-23 Selection of Organizations in the San Joaquin River Hydrologic Region Involved in Water Governance

Entity	Role/Responsibilities	Federal, State, or Local
Madera Canal (CVP)	Provide regional water supply	Federal
US Bureau of Reclamation	Operation of Friant Dam, Delta Mendota and San Luis canals	Federal
US Army Corps of Engineers	Operation of New Hogan, Burns, Owens, Buchanon, Bear, Mariposa, and Hidden dams	Federal
State Water Project	Interregional water supply	State
Madera Irrigation District	Deliver CVP supplies from Friant Dam, as well as local supplies	Local
Chowchilla Water District	Deliver CVP supplies from Friant Dam, as well as local supplies	Local
Cities of Madera, Merced, Turlock, Modesto & Stockton	Municipal water supplies	Local
Merced Irrigation District	Deliver Merced River supplies	Local
Turlock Irrigation District	Deliver Tuolumne River supplies	Local
Modesto Irrigation District	Deliver Tuolumne River supplies	Local
Friant Water Authority	Madera Canal CVP deliveries	Local
San Luis & Delta Mendota Water Authority	Maintain and operate DMC	Local
Patterson Water District	Deliver San Joaquin River supplies	Local
West Stanislaus Irrigation District	Deliver San Joaquin River supplies	Local
Grasslands Water District	Distribute CVP supplies to area wildlife refuges	Local
San Joaquin River Exchange Contractors	Deliver San Joaquin River supplies	Local
Oakdale Irrigation District	Deliver Stanislaus River supplies	Local
South San Joaquin Irrigation District	Deliver Stanislaus River supplies	Local
South Delta WA	Charged with protecting the in-channel water supply for Delta-area farmers	Local
Central Delta WA	Charged with protecting the in-channel water supply for Delta-area farmers	Local
North San Joaquin WCD	Deliver Mokelumne River supplies	Local
Amador WA	Deliver Mokelumne River municipal supplies, as well as provide wastewater services	Local
Calaveras Co. WD	Deliver Mokelumne, Stanislaus, and Calaveras rivers municipal supplies, as well as provide wastewater services	Local
Tuolumne Utilities District	Deliver Tuolumne River supplies, as well as provide wastewater services	Local

Table SJR-24 Integrated Regional Water Management Grants Awarded in the San Joaquin River Hydrologic Region

Grant Program	Applicant/IRWM Group	Award
Prop. 50 Planning	San Luis and Delta Mendota Water Authority/Westside San Joaquin	$25,000,000
	Contra Costa Water District/East Contra Costa Co	$12,500,000
Prop. 84 Planning	CABY - Regional Water Management Group	$647,593
	Contra Costa Water District/East Contra Costa Co	$449,843
	Merced Area Groundwater Pool Interests (MAGPI)	$719,010
	Northeastern San Joaquin County Groundwater Banking Authority/Eastern San Joaquin	$545,925
	Regional Water Authority/American River Basin	$403,848
	Tuolumne Utilities District/Tuolumne - Stanislaus	$636,380
	Upper Mokelumne River Watershed Authority/Mokelumne/Amador/Calaveras	$250,909
Prop. 84 Implementation	East Contra Costa County	$1,775,000
	Madera	$9,413,947
	American River Basin	$1,895,806
	Mokelumne/Amador/Calaveras	$2,298,000
Prop. 1E SWFM	Contra Costa Water District/East Contra Costa Co.	$10,000,000
	Contra Costa Flood Control & Water Conservation District/East Contra Costa Co.	$2,000,000
	City of Antioch/East Contra Costa Co.	$2,997,300
	Total	$71,533,561

Table SJR-25 Groundwater Management Plans in the San Joaquin River Hydrologic Region

Map Label	Agency Name	Date	County	Basin Number	Basin Name
SJ-1	**Calaveras County Water**	2007	Calaveras	5-22.01	Eastern San Joaquin Subbasin
	No signatories on file				
SJ-2	**Chowchilla Water District-Red Top Resource Conservation District Joint Powers Authority**	1997	Madera	5-22.05	Chowchilla Subbasin
	No signatories on file		Merced	5-22.04	Merced Subbasin
SJ-3	**City of Tracy**	2007	San Joaquin	5-22.15	Tracy Subbasin
	Banta Carbona Irrigation Dis-				
	Del Puerto Water District				
	Patterson Water District				
	Plain View Water District				
	West Stanislaus Irrigation				
	Westside Irrigation District				
	San Joaquin County Flood Control & Water Conservation District				
SJ-4	**Diablo Water District**	2007	Contra Costa	5-22.15	Tracy Subbasin
	City of Brentwood				
	Town of Discovery Bay				
	East Contra Costa Irrigation District				
SJ-5	**Madera County**	1997	Madera	5-22.06	Madera Subbasin
	Chowchilla Water District-Red Top Resource Conservation District JPA				
	San Joaquin River Exchange Contractors Water Authority				
	Madera Irrigation District				
	Gravelly Ford Water District				
	Madera Water District				
	Aliso Water District				
	Root Creek Water District				
SJ-6	**Madera Irrigation District**	1999	Madera	5-22.06	Madera Subbasin
	No signatories on file				
SJ-7	**Madera Water District**		Madera	5-22.06	Madera Subbasin
	No signatories on file				
SJ-8	**Merced Area Groundwater**	2008	Merced	5-22.04	Merced Subbasin
	Stevinson Water District			5-22.05	Chowchilla Subbasin
SJ-9	**North San Joaquin Water Conservation District**	1995	San Joaquin	5-22.01	Eastern San Joaquin Subbasin
	No signatories on file			5-22.16	Cosumnes Subbasin

Map Label	Agency Name	Date	County	Basin Number	Basin Name
SJ-10	**Northeastern San Joaquin**	2004	San Joaquin	5-22.01	East San Joaquin Subbasin
	City of Lodi			5-22.16	Cosumnes Subbasin
	Woodbridge Irrigation District				
	North San Joaquin Water Conservation District				
	Central San Joaquin Water Conservation District				
	Stockton East Water District				
	Central Delta Water Agency				
	South Delta Water Agency				
	San Joaquin County Flood Control and Water Conserva-tion District				
	California Water Service				
	San Joaquin Farm Bureau				
SJ-11	**Root Creek Water District**	1997	Madera	5-22.06	Madera Subbasin
	No signatories on file				
SJ-12	**San Joaquin River Ex-**	2008	Madera	5-22.07	Delta-Mendota Subbasin
	Central California Irrigation District		Stanislaus		
	Firebaugh Canal Water Dis-		Merced		
	Columbia Canal Company		Madera		
	San Luis Canal Company				
SJ-13,	**San Luis & Delta Mendota**	2007	Merced	5-22.15	Tracy Subbasin
	Banta Carbona Irrigation		Stanislaus	5-22.07	Delta-Mendota Subbasin
	Del Puerto Water District		San Joaquin		Non-B118 Basin
	Patterson Irrigation District		Merced		
	Byron-Bethany Irrigation				
	West Stanislaus Irrigation District				
	Westside Irrigation District				
	City of Tracy				
	San Joaquin County Flood				
	Panoche Water District	2009			
	Eagle Field Water District				
	Oro Loma Water District				
	Widren Water District				
	Mercy Springs Water District				
	Broadview Water District				
	San Luis Water District				
SJ-15	**South San Joaquin Irriga-**	1994	San Joaquin	5-22.01	Eastern San Joaquin Subbasin
	No signatories on file				

Map Label	Agency Name	Date	County	Basin Number	Basin Name
SJ-16	**Southeast Sacramento**	2002	Sacramento		
	Clay Water District		San Joaquin	5-22.16	Cosumnes Subbasin
	Omochumne-Hartnell Water District			5-21.65	South American Subbasin
SJ-17	**Stanislaus and Tuolumne**	2005	Stanislaus	5-22.02	Modesto Subbasin
	Oakdale Irrigation District			5-22.01	East San Joaquin Subbasins
	Modesto Irrigation District				
	Stanislaus County				
	City of Riverbank				
	City of Modesto				
	City of Oakdale				
SJ-18	**Turlock Groundwater Basin**	2008	Stanislaus	5-22.03	Turlock Subbasin
	City of Turlock		Merced		
	City of Ceres				
	City of Modesto				
	Hilmar County Water District				
	Denair Community Services District				
	Eastside Water District				
	Ballico-Cortez Water District				
	Turlock Irrigation District				
	Keyes Community Services District				
	Delhi County Water District				
NL-1	**Alpine County**	2007	Alpine	6-6	Carson Valley Basin
	No signatories on file				Non-B118 Basin
TL-25	**Westlands Water District**	1996	Fresno	5-22.09	Westside Subbasin
	No signatories on file		Kings		
SR-24	**Sacramento Central County**	2006	Sacramento	5-21.65	South American Subbasin
	City of Elk Grove			5-22.16	Cosumnes
	City of Folsom				
	City of Rancho Cordova				
	City of Sacramento				
	County of Sacramento				

Table SJR-26 Assessment for SB 1938 GWMP Required Components, SB 1938 GWMP Voluntary Components, and Bulletin 118-03 Recommended Components

SB 1938 GWMP Required Components	Percent of plans that meet requirement
Basin Management Objectives	54%
BMO: Monitoring/Management Groundwater Levels	85%
BMO: Monitoring Groundwater Quality	85%
BMO: Inelastic Subsidence	77%
BMO: SW/GW Interaction & Affects to Groundwater Levels & Quality	62%
Agency Cooperation	92%
Map	69%
Map: Groundwater basin area	77%
Map: Area of local agency	77%
Map: Boundaries of other local agencies	77%
Recharge Areas (1/1/2013)	Not Assessed
Monitoring Protocols	31%
MP: Changes in groundwater levels	100%
MP: Changes in groundwater quality	100%
MP: Subsidence	69%
MP: SW/GW Interaction & Affects to Groundwater Levels & Quality	38%
SB 1938 Voluntary Components	**Percent of plans that include component**
Saline Intrusion	69%
Wellhead Protection & Recharge	92%
Groundwater Contamination	85%
Well Abandonment & Destruction	85%
Overdraft	85%
Groundwater Extraction & Replenishment	77%
Monitoring	85%
Conjunctive Use Operations	92%
Well Construction Policies	77%
Construction and Operation	54%
Regulatory Agencies	85%
Land Use	62%
Bulletin 118-03 Recommended Components	**Percent of plans that include component**
GWMP Guidance	92%
Management Area	92%
BMOs, Goals, & Actions	85%
Monitoring Plan Description	62%
IRWM Planning	62%
GWMP Implementation	85%
GWMP Evaluation	85%

Table SJR-27 Factors Contributing to Successful Groundwater Management Plan Implementation in the San Joaquin River Hydrologic Region

Key components	Respondents
Data collection and sharing	5
Outreach and education	4
Developing an understanding of common interest	5
Sharing of ideas and information with other water resource managers	5
Broad stakeholder participation	4
Adequate surface water supplies	4
Adequate regional and local surface storage and conveyance systems	4
Water budget	5
Funding	4
Time	4

Table SJR-28 Factors Limiting Successful Groundwater Management Plan Implementation in the San Joaquin River Hydrologic Region

Limiting Factors	Respondents
Funding for groundwater management projects	5
Funding for groundwater management planning	4
Unregulated Pumping	1
Groundwater Supply	1
Participation across a broad distribution of interests	1
Lack of Governance	1
Surface storage and conveyance capacity	3
Understanding of the local issues	-
Access to planning tools	-
Outreach and education	-
Data collection and sharing	3
Funding to assist in stakeholder participation	2

Table SJR-29 Groundwater Ordinances that Apply to Counties in the San Joaquin River Hydrologic Region

County	Groundwater Management	Guidance Committees	Export Permits	Recharge	Well Abandonment & Destruction	Well Construction Policies
Alameda	-	-	-	-	Y	Y
Alpine	-	-	Y	-	Y	Y
Amador	-	-	-	-	Y	Y
Calaveras	-	-	Y	-	Y	Y
Contra Costa	-	-	-	-	Y	-
El Dorado	-	-	-	-	Y	Y
Fresno	-	-	Y	-	Y	Y
Madera	-	-	Y	Y	Y	Y
Mariposa	-	-	-	-	Y	Y
Merced	-	-	-	-	Y	Y
Sacramento	-	-	Y	-	Y	Y
San Joaquin	-	Y	Y	-	Y	Y
Stanislaus	-	-	-	-	Y	Y
Tuolumne	-	-	Y	-	-	Y

Table SJR-30 Strategies of Integrated Regional Water Management Efforts in the San Joaquin River Hydrologic Region

Plan strategies	Westside IRWMP	American River Basin IRWMP	Cosumnes, American, Bear, Yuba Watershed IRWMP	Mokelumne/ Amador/ Calaveras IRWMP	Madera County IRWMP	Eastern San Joaquin IRWMP	East Contra Costa Co [a]
	May 2007	**June 2006**	**Dec 2006**	**Nov 2006**	**Apr 2008**	**Jul 2007**	**Jul 2007**
Agricultural and urban water management planning and water use efficiency			X		X	X	
Climate change			X				
Conjunctive management and groundwater storage		X		X	X	X	X
Conservation				X			
Conveyance			X			X	
Desalination							X
Economic incentives (Loans, grants, and water pricing)						X	
Environmental restoration and preservation; habitat protection and improvement	X	X	X	X	X	X	X
Flood management	X	X	X	X			X
Groundwater management	X	X	X	X		X	X
Groundwater monitoring					X	X	
Groundwater quality protection					X	X	
Imported water				X	X	X	X
Interregional cooperation					X		
Land use planning and coordination		X	X	X	X	X	X
Levee and channel restoration					X		
Matching water quality to water use						X	
Pollution monitoring, control, and prevention		X	X	X		X	X
Recharge areas protection					X	X	

Plan strategies	Westside IRWMP	American River Basin IRWMP	Cosumnes, American, Bear, Yuba Watershed IRWMP	Mokelumne/ Amador/ Calaveras IRWMP	Madera County IRWMP	Eastern San Joaquin IRWMP	East Contra Costa Co [a]
	May 2007	**June 2006**	**Dec 2006**	**Nov 2006**	**Apr 2008**	**Jul 2007**	**Jul 2007**
Recreation and public access	X	X	X			X	X
Reduce groundwater pumping and overdraft; increase surface water supplies			X	X	X	X	
Reduction of invasive species					X		
Resource mapping			X				
Storm water capture and management	X	X		X	X		X
System reoperation						X	
Water transfer and exchange					X	X	X
Water and wastewater treatment		X		X	X	X	X
Water conservation and recycling	X	X	X	X	X	X	X
Water quality protection and improvement	X	X	X	X			X
Water supply reliability	X	X	X	X	X	X	X
Watershed management and planning		X		X	X	X	X
Wetland enhancement and creation	X	X	X				X

Note:

[a] functionally equivalent plan

Table SJR-31 Conceptual Growth Scenarios

Scenario	Population Growth	Development Density
LOP-HID	Lower than Current Trends	Higher than Current Trends
LOP-CTD	Lower than Current Trend	Current Trends
LOP-LOD	Lower than Current Trends)	Lower than Current Trends
CTP-HID	Current Trends	Higher than Current Trends
CTP-CTD	Current Trends	Current Trends
CTP-LOD	Current Trends	Lower than Current Trends
HIP-HID	Higher than Current Trends	Higher than Current Trends
HIP-CTD	Higher than Current Trends	Current Trends
HIP-LOD	Higher than Current Trends	Lower than Current Trends

Source: California Department of Water Resources 2012.

Table SJR-32 Growth Scenarios (Urban) — San Joaquin River

Scenario [a]	2050 Population (thousand)	Population Change (thousand) 2006 [b] to 2050	Development Density	2050 Urban Footprint (thousand acres)	Urban Footprint Increase (thousand acres) 2006 [c] to 2050
LOP-HID	3,396.9 [d]	1,367.4	High	550.1	141.2
LOP-CTD	3,396.9	1,367.4	Current Trends	570.7	161.8
LOP-LOD	3,396.9	1,367.4	Low	591.4	182.5
CTP-HID	3,685.0 [e]	1,655.5	High	626.8	217.9
CTP-CTD	3,685.0	1,655.5	Current Trends	653.8	244.9
CTP-LOD	3,685.0	1,655.5	Low	681.0	272.1
HIP-HID	4,941.1 [f]	2,911.6	High	736.3	327.4
HIP-CTD	4,941.1	2,911.6	Current Trends	788.6	379.7
HIP-LOD	4,941.1	2,911.6	Low	841.6	432.7

Source: California Department of Water Resources 2012

Notes:

[a] See Table SJ-1X for scenario definitions

[b] 2006 population was 2.029.5 thousand.

[C] 2006 urban footprint was 408.9 thousand acres.

[d] Values modified by the California Department of Water Resources (DWR) from the Public Policy Institute of California.

[e] Values provided by the California Department of Finance.

[f] Values modified by DWR from the Public Policy Institute of California.

Table SJR-33 Growth Scenarios (Agriculture) — San Joaquin River

Scenario [a]	2050 Irrigated Land Area [b] (thousand acres)	2050 Irrigated Crop Area [c] (thousand acres)	2050 Multiple Crop Area [d] (thousand acres)	Change in Irrigated Crop Area (thousand acres) 2006 to 2050
LOP-HID	1831.9	1951.4	119.4	-117.0
LOP-CTD	1819.0	1937.6	118.6	-130.8
LOP-LOD	1806.7	1924.5	117.8	-143.9
CTP-HID	1791.5	1908.3	116.8	-160.1
CTP-CTD	1776.8	1892.6	115.8	-175.8
CTP-LOD	1762.6	1877.5	114.9	-190.9
HIP-HID	1740.3	1853.8	113.5	-214.6
HIP-CTD	1714.0	1825.7	111.7	-242.7
HIP-LOD	1686.5	1796.5	110.0	-271.9

Source: California Department of Water Resources 2012.

Notes:

[a] See Table SJ-1X for scenario definitions

[b] 2006 Irrigated land area was estimated by the California Department of Water Resources (DWR) to be 1943.3 thousand acres.

[c] 2006 Irrigated crop area was estimated by DWR to be 2068.4 thousand acres.

[d] 2006 multiple crop area was estimated by DWR to be 125.1 thousand acres.

Table SJR-34 Resource Management Strategies Addressed in IRWMP's in the San Joaquin River Hydrologic Region

Resource Management Strategy	IRWMP 1	IRWMP 2
Agricultural Water Use Efficiency		
Urban Water Use Efficiency		
Conveyance – Delta		
Conveyance – Regional/Local		
System Reoperation		
Water Transfers		
Conjunctive Management & Groundwater		
Desalination		
Precipitation Enhancement		
Recycled Municipal Water		
Surface Storage — CALFED		
Surface Storage — Regional/Local		
Drinking Water Treatment and Distribution		
Groundwater and Aquifer Remediation		
Match Water Quality to Use		
Pollution Prevention		
Salt and Salinity Management		
Agricultural Lands Stewardship		
Economic Incentives		
Ecosystem Restoration		
Forest Management		
Land Use Planning and Management		
Recharge Areas Protection		
Water-Dependent Recreation		
Watershed Management		
Flood Risk Management		
Flood Management		
Desalination (Brackish and Sea Water)		
Salt and Salinity Management		

Figure SJR-1 **San Joaquin River Hydrologic Region**

Figure SJR-2 San Joaquin River Hydrologic Region Watersheds

Figure SJR-3 Alluvial Groundwater Basins and Subbasins within the San Joaquin River Hydrologic Region

Source: Department of Water Resources, CWP 2013

Figure SJR-4 Number of Well Logs by County and Use for the San Joaquin River Hydrologic Region (1977-2010)

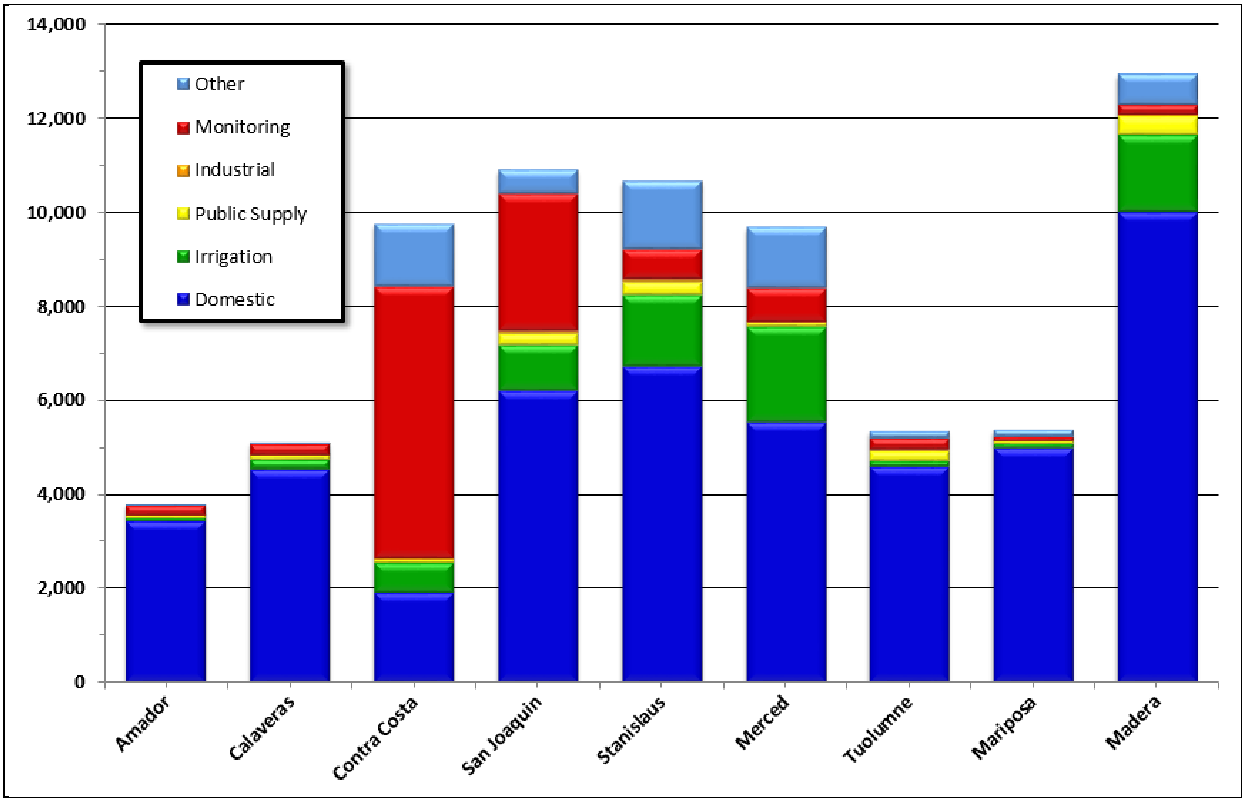


Figure SJR-5 Percentage of Well Logs by Use for the San Joaquin River Hydrologic Region (1977–2010)

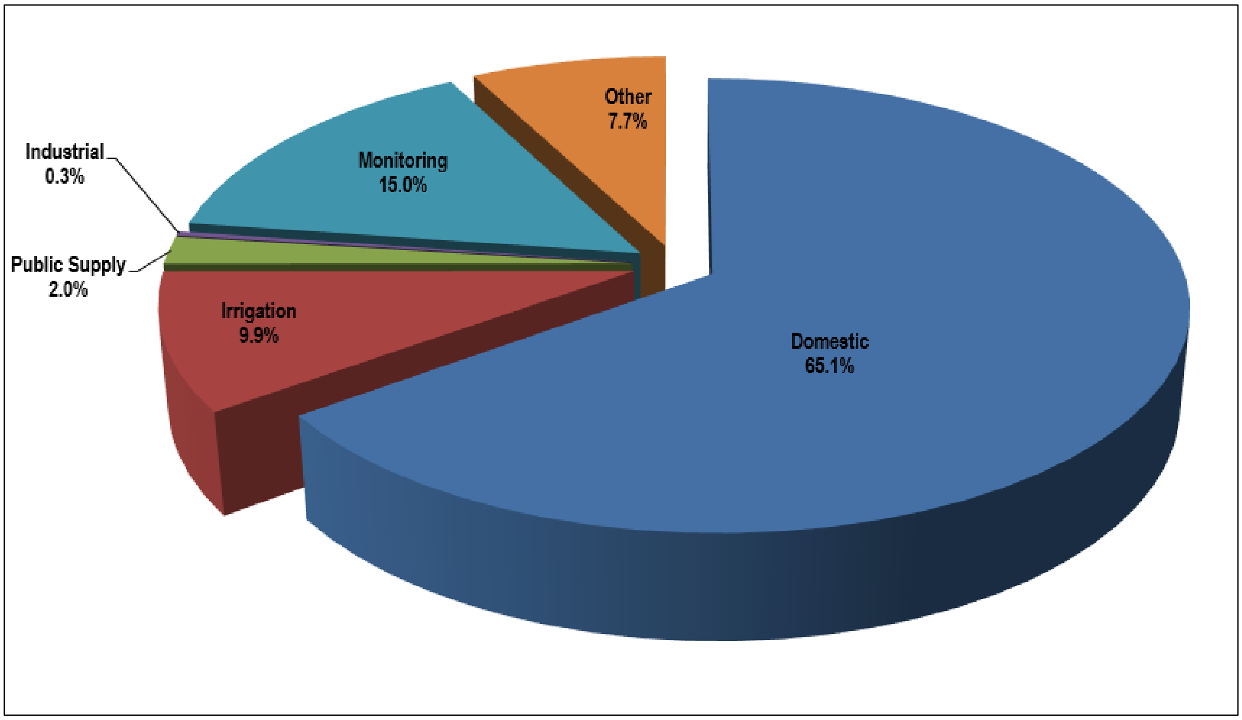


Figure SJR-6 Number of Well Logs Filed per Year by Use for the San Joaquin River Hydrologic Region (1977–2010)

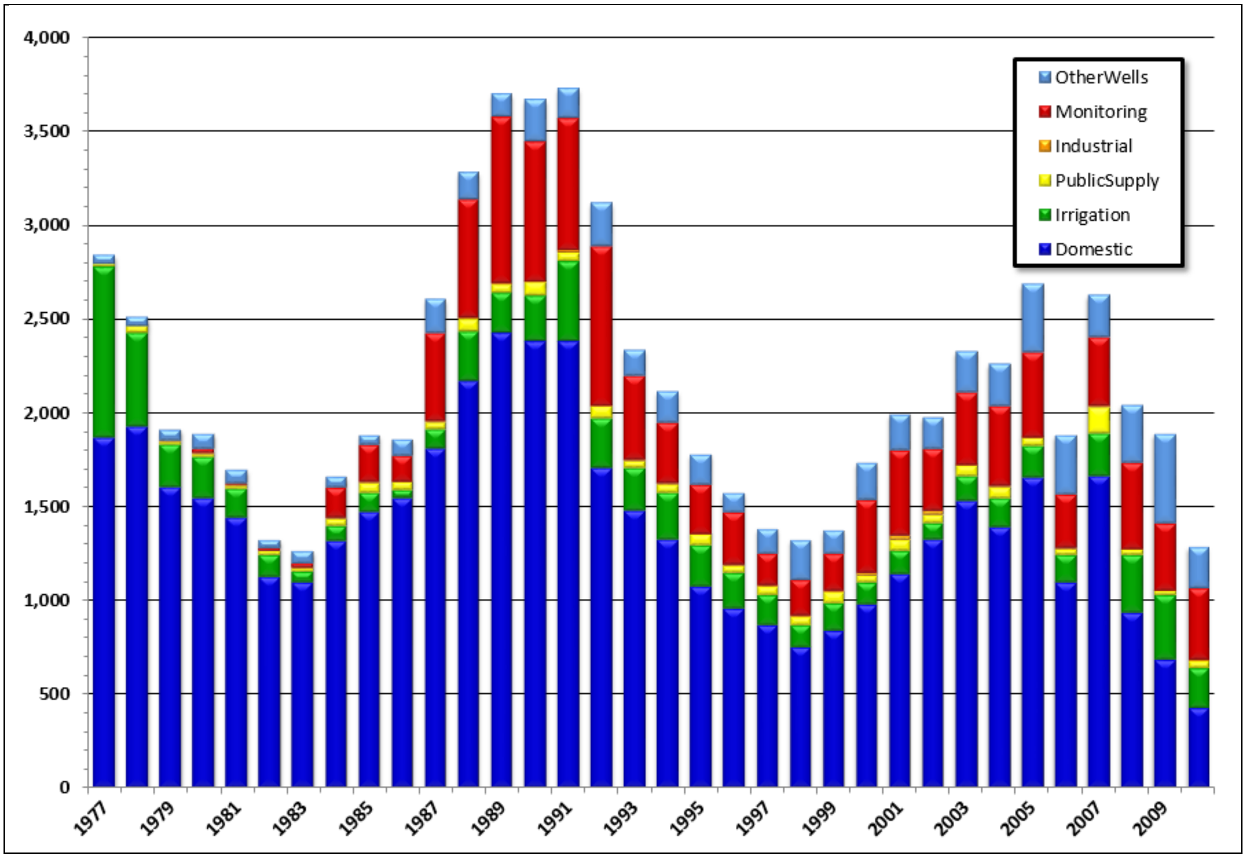


Figure SJR-7 CASGEM Groundwater Basin Prioritization for the San Joaquin River Hydrologic Region

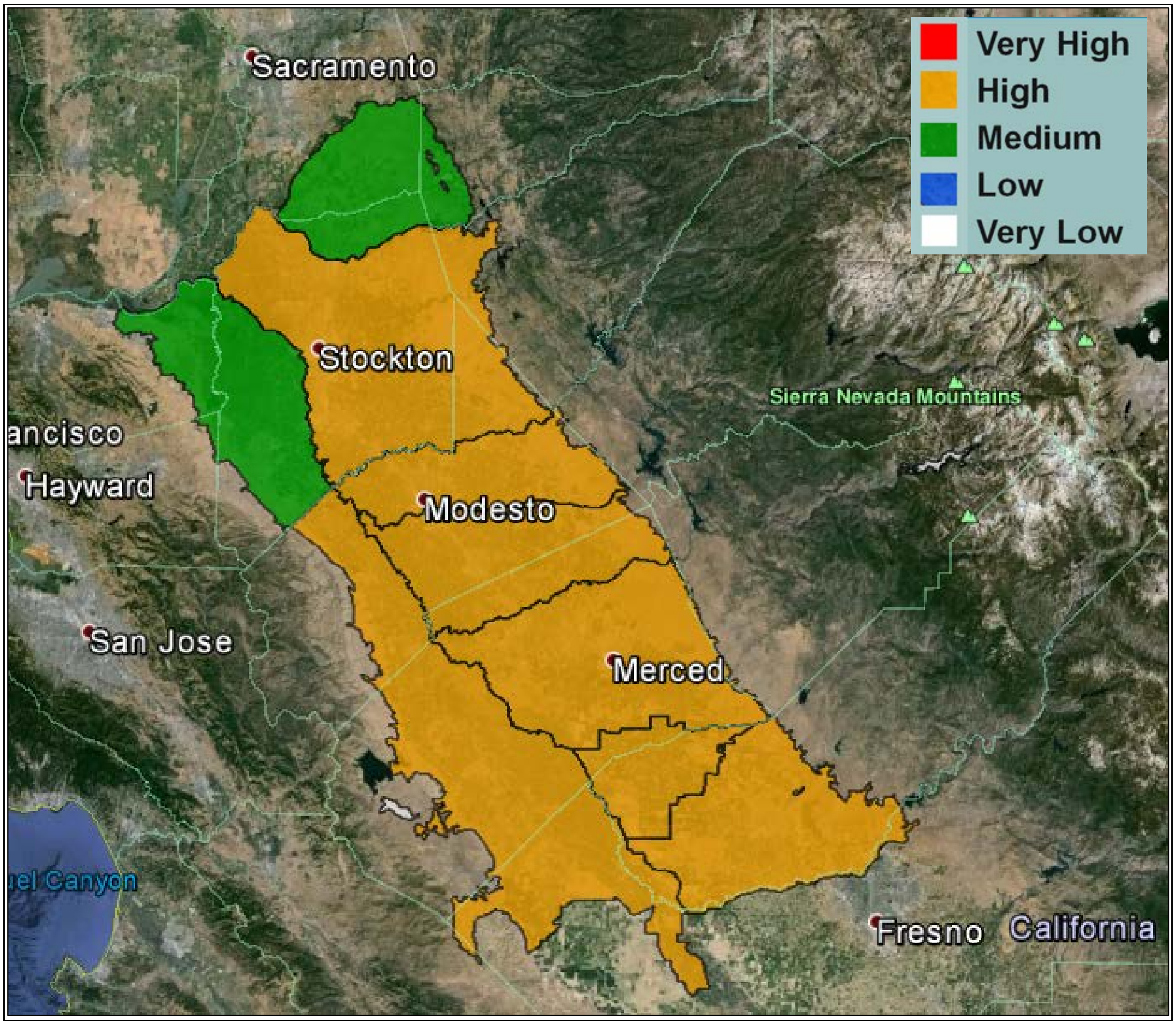
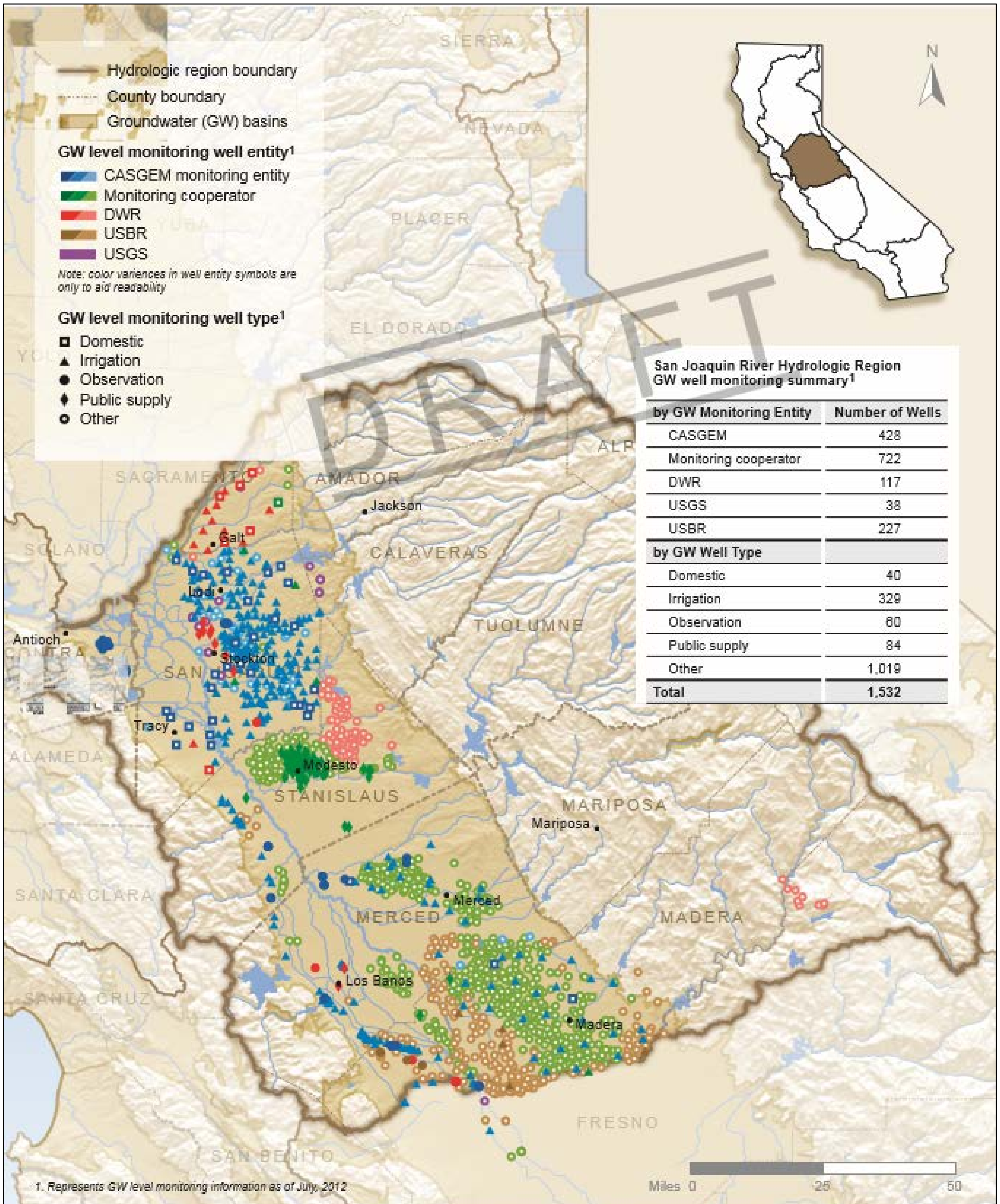


Figure SJR-8 Monitoring Well Location by Agency, Monitoring Cooperator, and CASGEM Monitoring Entity in the San Joaquin River Hydrologic Region



San Joaquin River Hydrologic Region GW well monitoring summary[1]

by GW Monitoring Entity	Number of Wells
CASGEM	428
Monitoring cooperator	722
DWR	117
USGS	38
USBR	227
by GW Well Type	
Domestic	40
Irrigation	329
Observation	60
Public supply	84
Other	1,019
Total	**1,532**

Source: Department of Water Resources, CWP 2013

Figure SJR-9 Percentage of Monitoring Wells by Use in the San Joaquin River Hydrologic Region

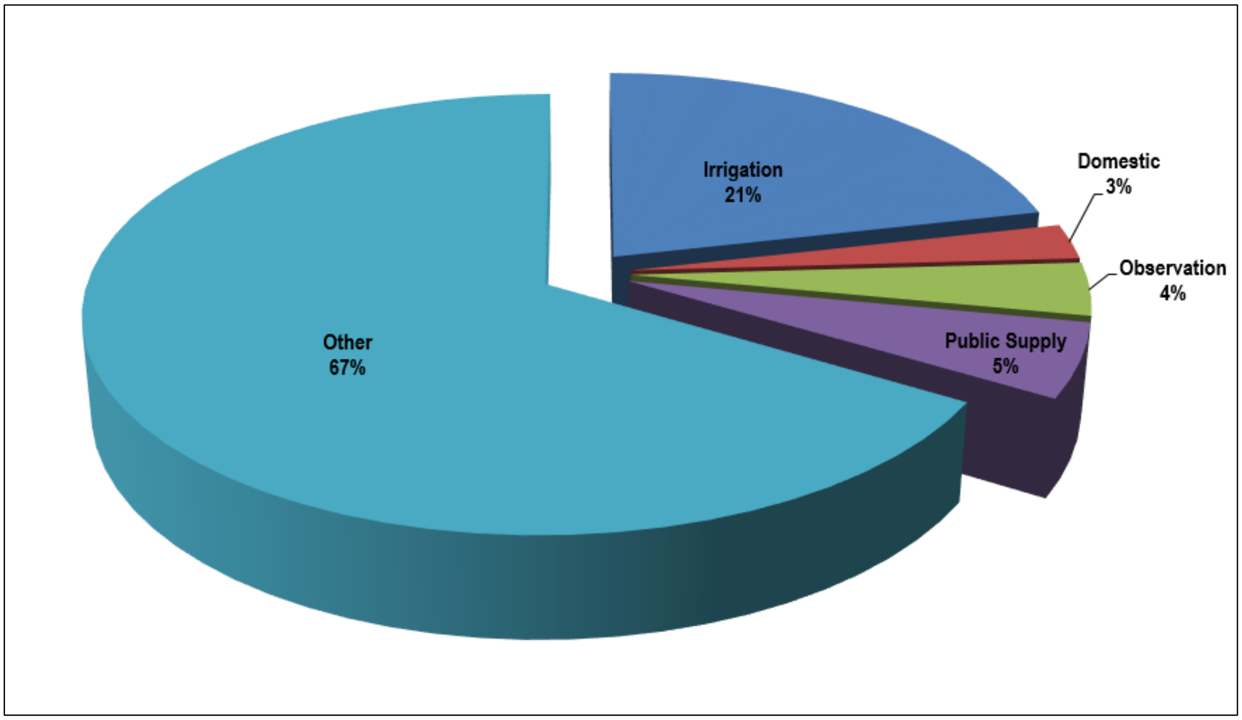


Figure SJR-10 Median Household Income (MHI) for Disadvantaged Communities (DACs) within the San Joaquin River Hydrologic Region Cities

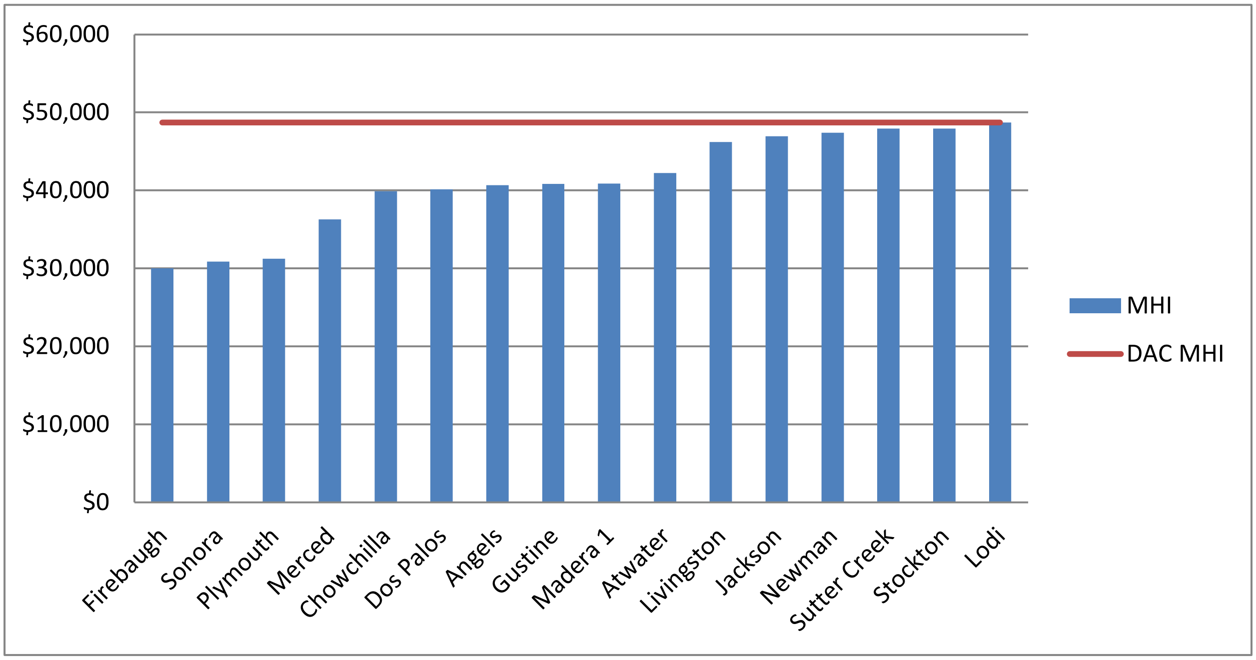


Figure SJR-11 Median Household Income (MHI) for Disadvantaged Communities (DACs) within the San Joaquin River Hydrologic Region: Poorest 20 Census Designated Places

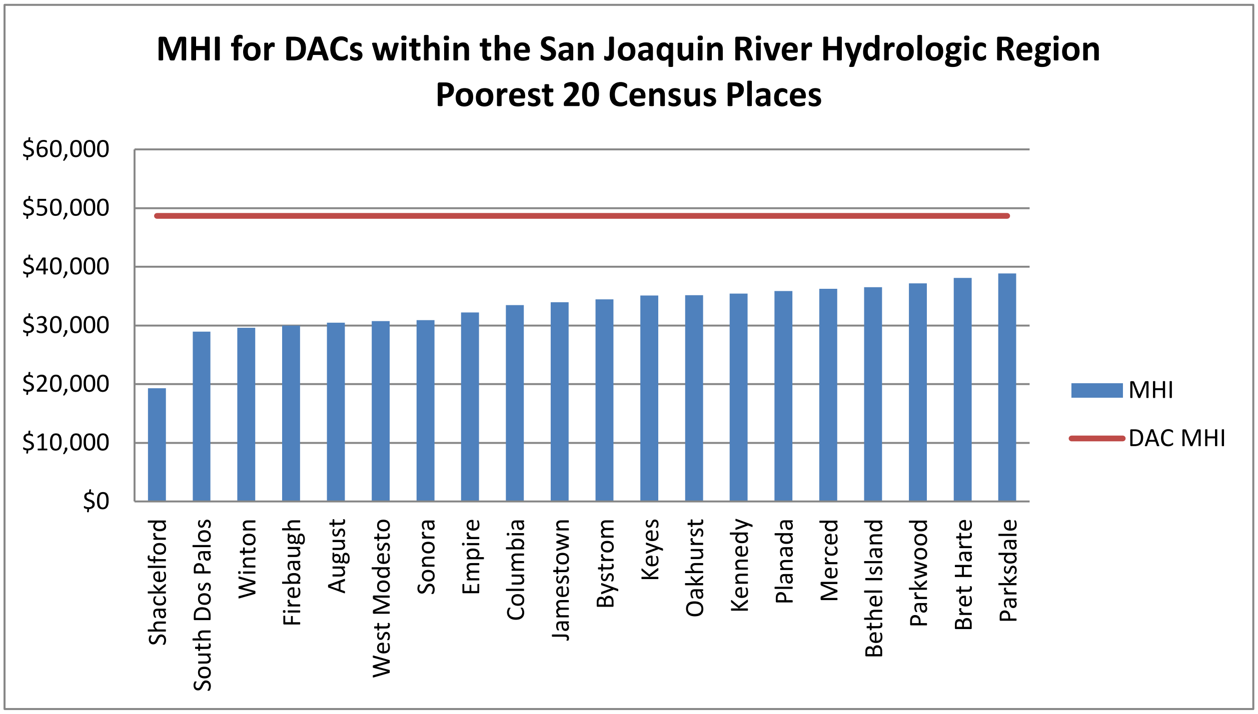


Figure SJR-12 San Joaquin River Hydrologic Region Gross Agricultural Value for 2005-2010, in Millions of Dollars

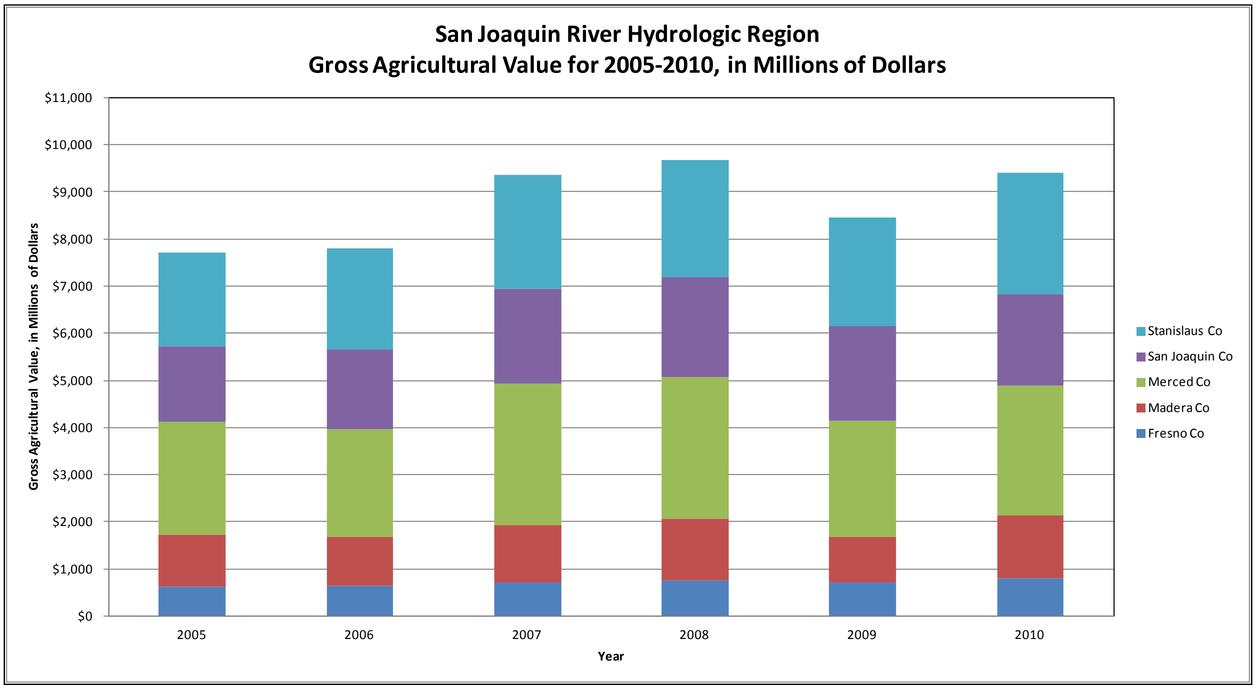
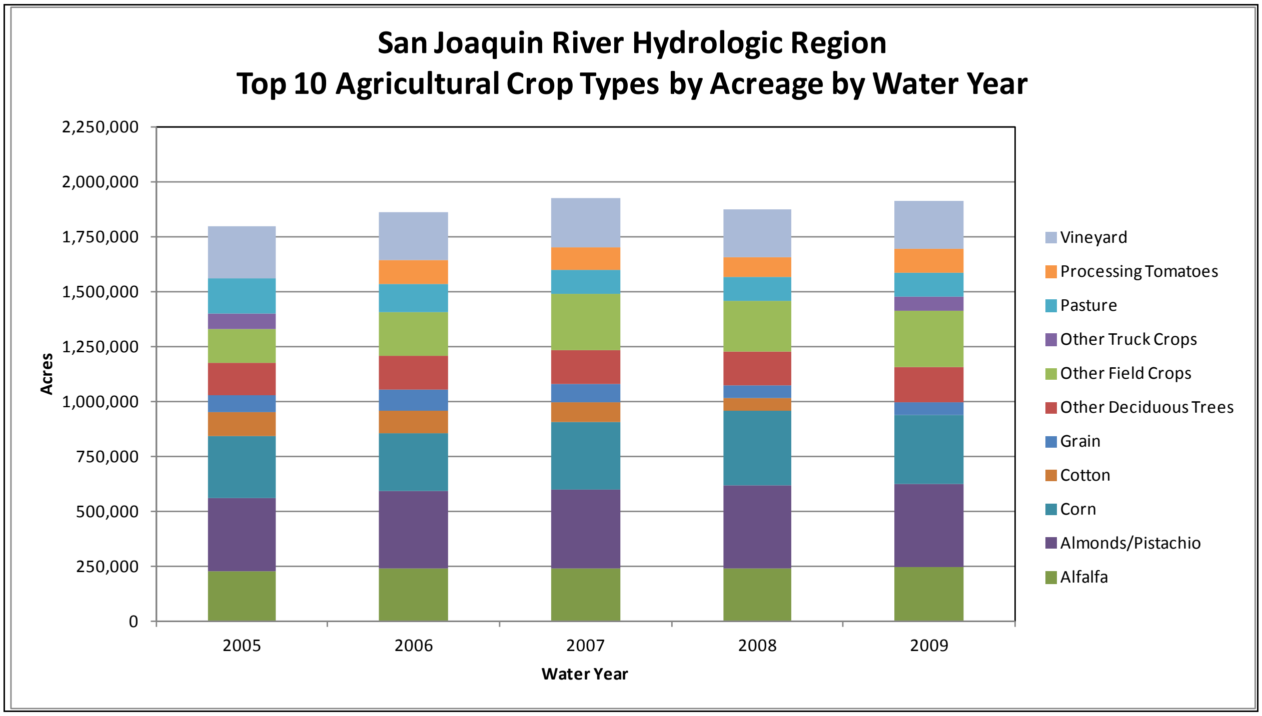


Figure SJR-13 Top 10 Crop Types by Acreage for the San Joaquin River Region for 2005-2009



Notes: *Other Field Crops*: Flax, hops, grain sorghum, sudan, castor beans, miscellaneous fields, sunflowers, hybrid sorghum/sudan, millet, and sugar cane. *Other Truck Crops*: Artichokes, asparagus, beans (green), carrots, celery, lettuce, peas, spinach, flowers nursery and tree farms, bush berries, strawberries, peppers, broccoli, cabbage, cauliflower, and Brussels sprouts. *Other Deciduous Trees*: Apples, apricots, cherries, peaches, nectarines, pears, plums, prunes, figs, walnuts, and miscellaneous deciduous.

Figure SJR-14 **San Joaquin River Hydrologic Region Water Supplies for Water Years 2005-2010**

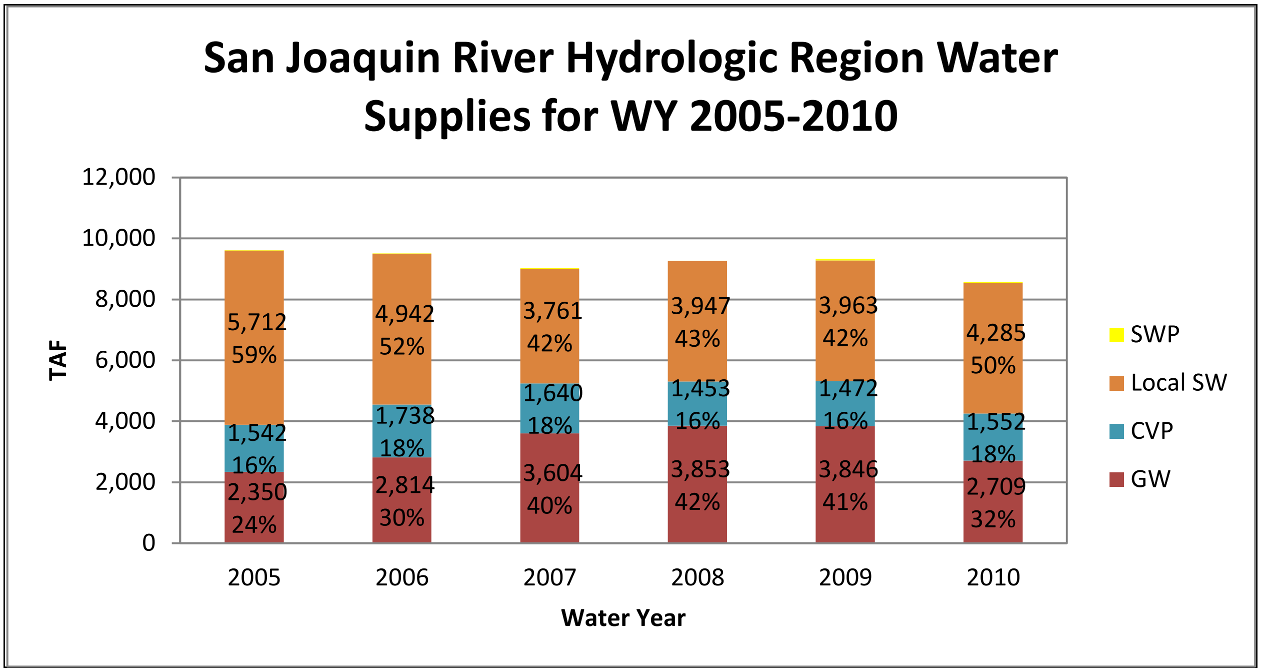


Figure SJR-15 San Joaquin River Hydrologic Region Inflows and Outflows in 2010

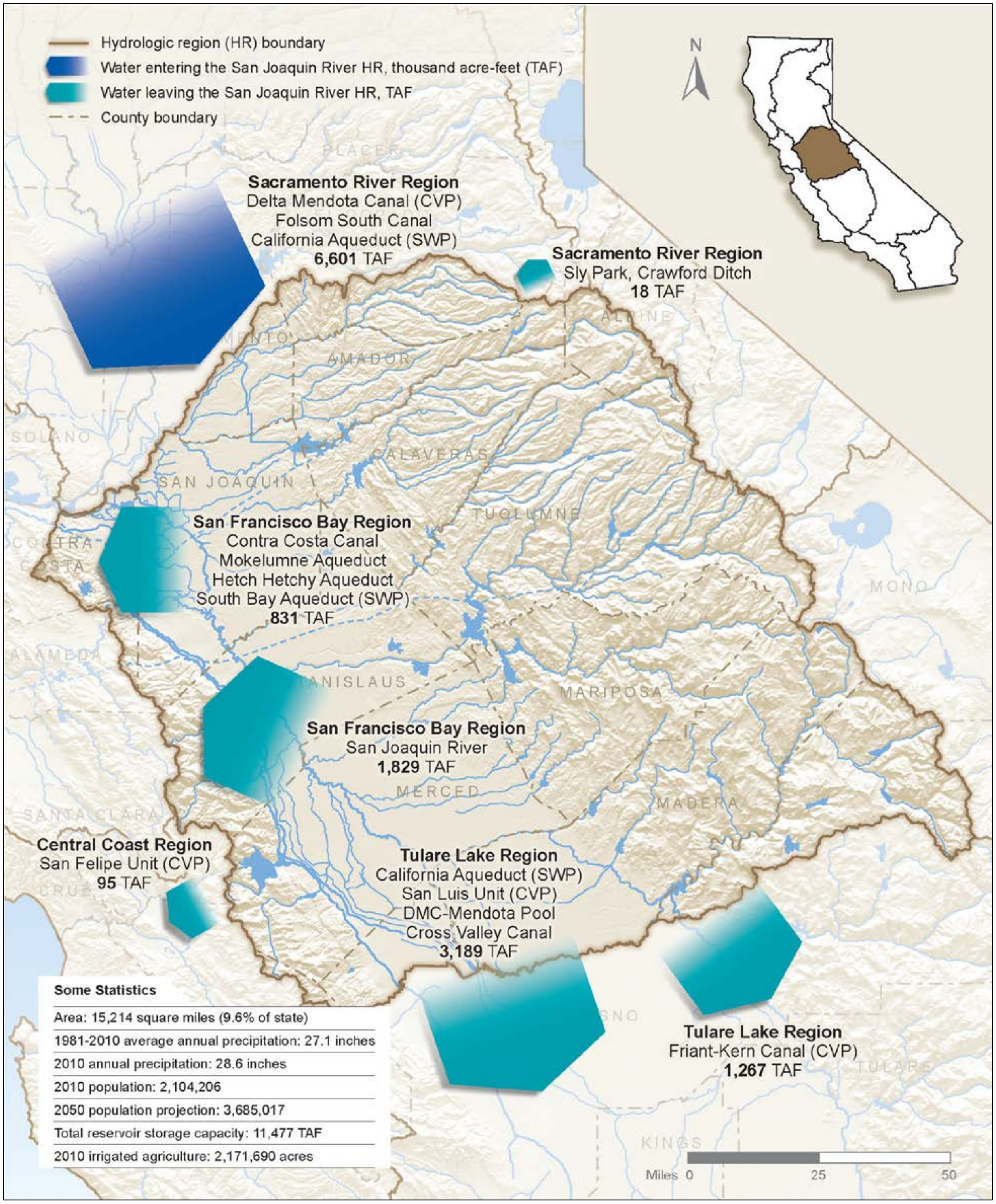


Figure SJR-16 South of Delta Central Valley Project and State Water Project Annual Deliveries (Percentage of Contracted Amount)

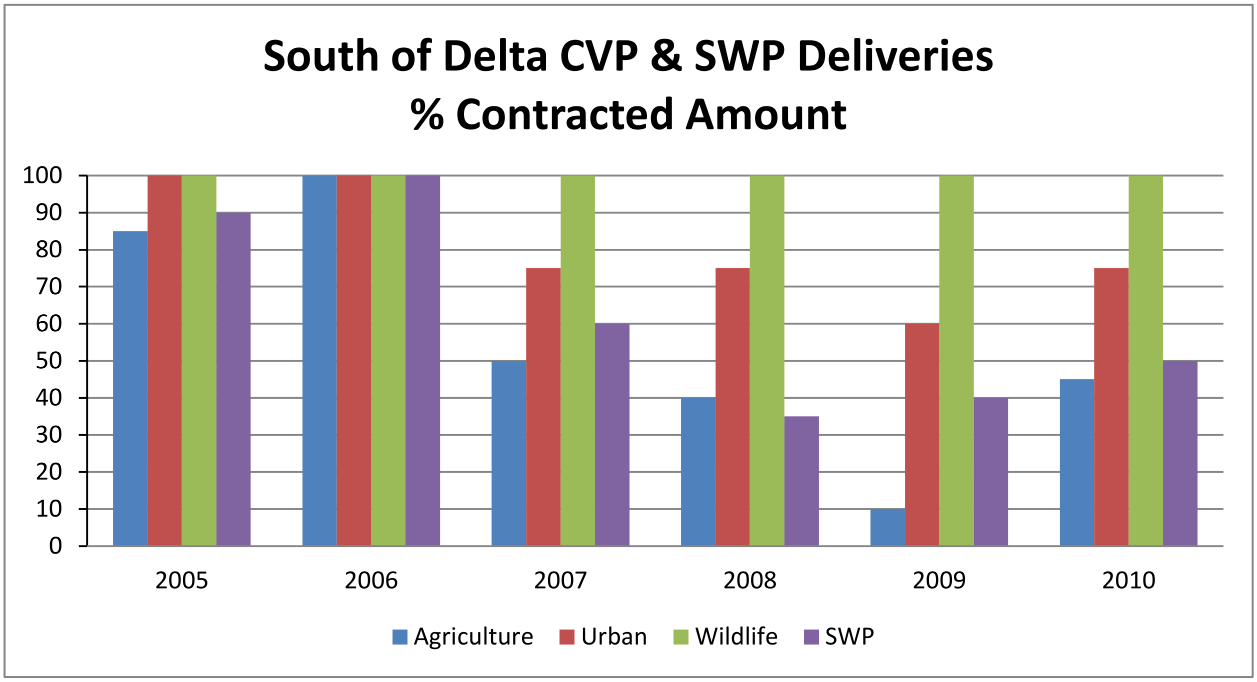
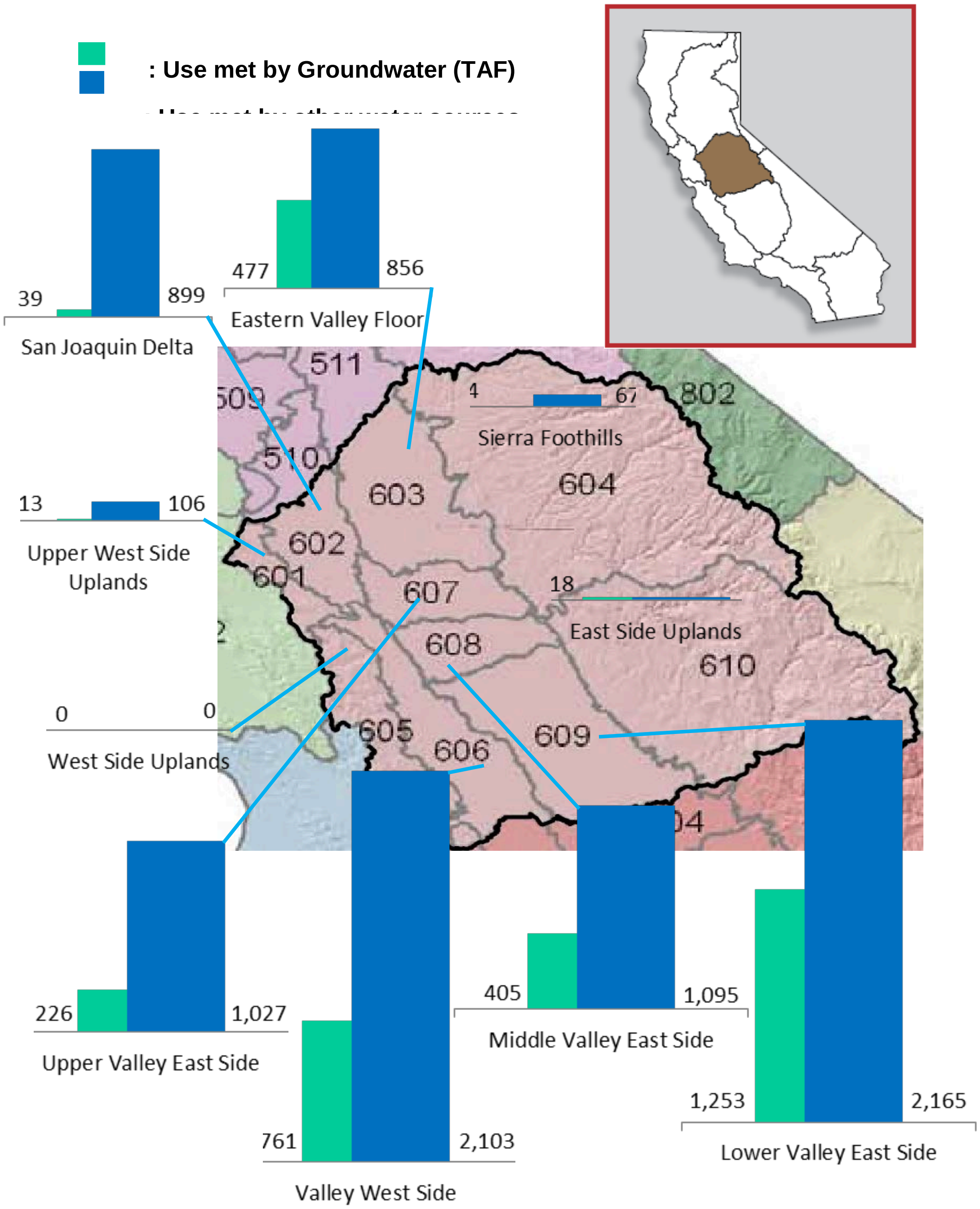


Figure SJR-17 Contribution of Groundwater to the San Joaquin River Hydrologic Region Water Supply by Planning Area (2005-2010)



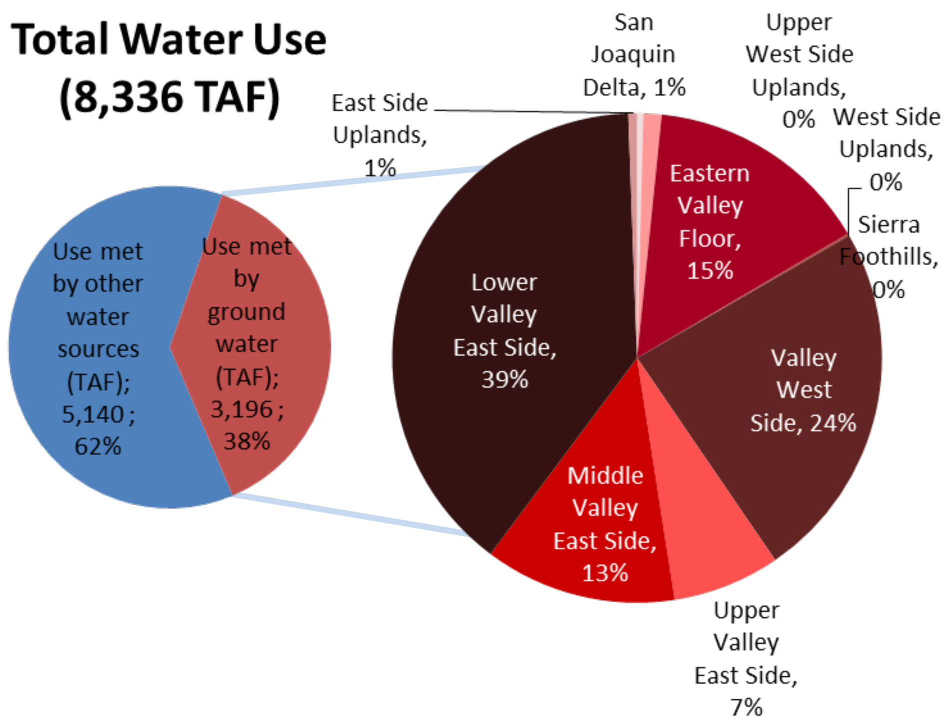

Total Water Use
(8,336 TAF)
Use met by other water sources (TAF); 5,140 ; 62%
Use met by ground water (TAF); 3,196 ; 38%
East Side Uplands, 1%
San Joaquin Delta, 1%
Upper West Side Uplands, 0%
West Side Uplands, 0%
Sierra Foothills, 0%
Eastern Valley Floor, 15%
Valley West Side, 24%
Upper Valley East Side, 7%
Middle Valley East Side, 13%
Lower Valley East Side, 39%

Figure SJR-18 San Joaquin River Hydrologic Region Annual Groundwater Water Supply Trend (2002-2010)

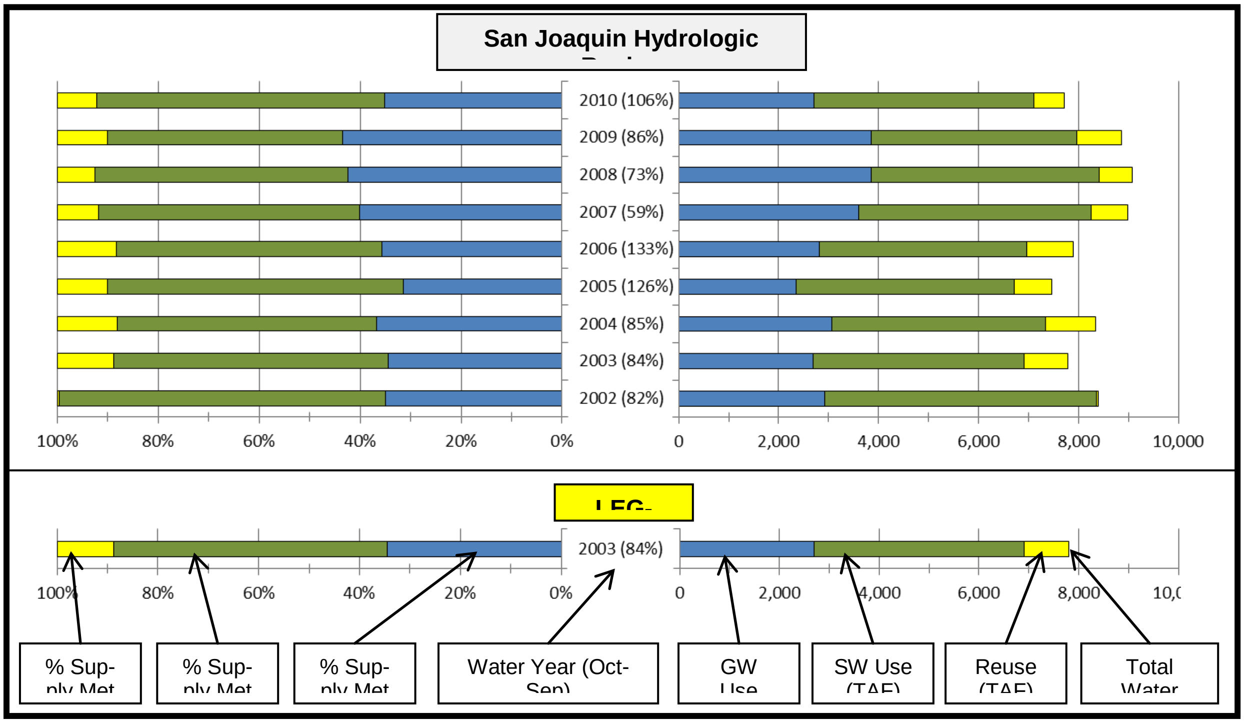


Figure SJR-19 San Joaquin River Hydrologic Region Annual Groundwater Supply Trend by Type of Use (2002-2010)

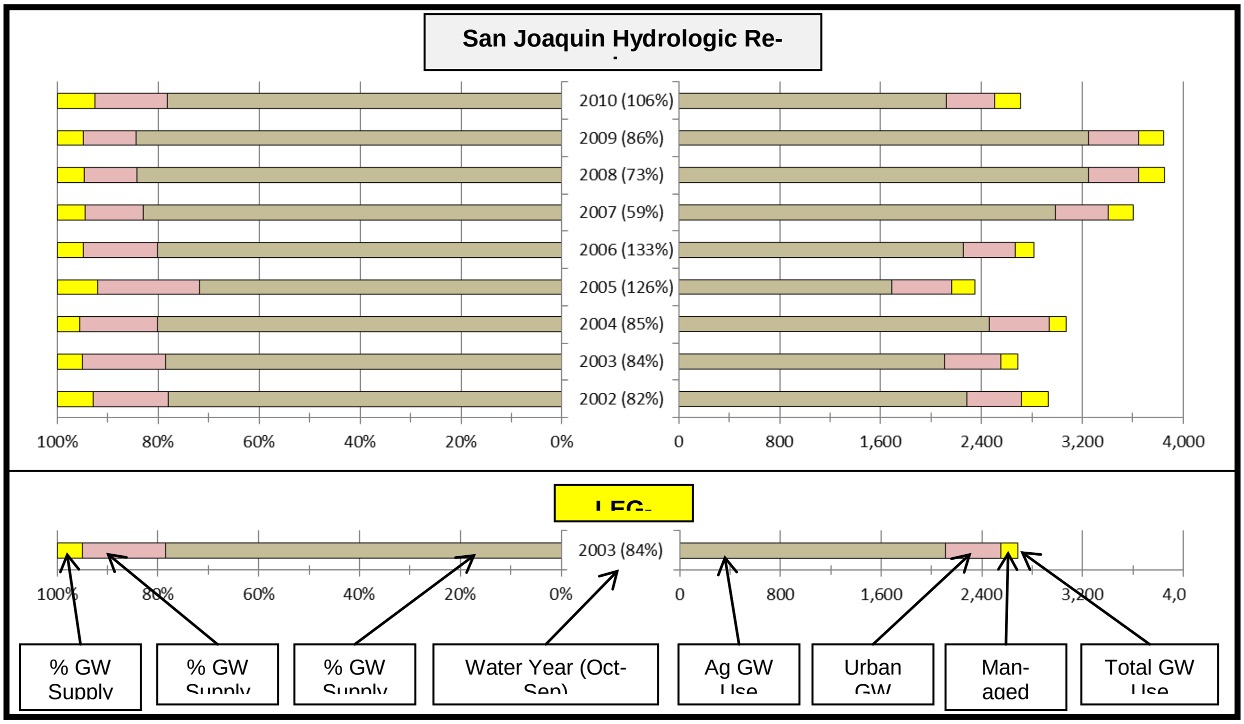
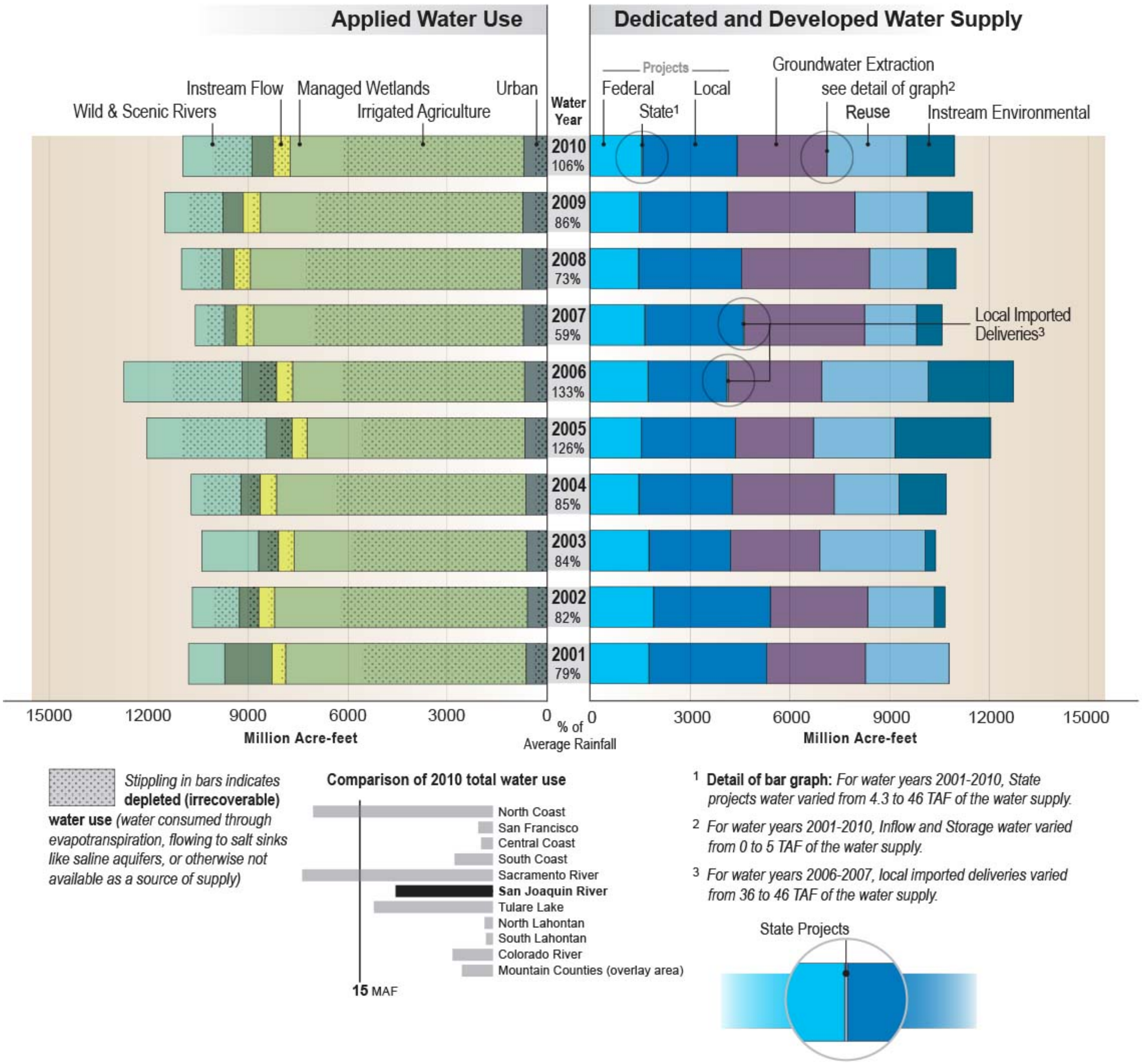


Figure SJR-20 San Joaquin River Hydrologic Region Water Balance by Water Year, 2001-2010

California's water resources vary significantly from year to year. Ten recent years show this variability for water use and water supply. Applied Water Use shows how water is applied to urban and agricultural sectors and dedicated to the environment and the Dedicated and Developed Water Supply shows where the water came from each year to meet those uses. Dedicated and Developed Water Supply does not include the approximately 125 million acre-feet (MAF) of statewide precipitation and inflow in an average year that either evaporates, are used by native vegetation, provides rainfall for agriculture and managed wetlands, or flow out of the state or to salt sinks like saline aquifers. Groundwater extraction includes annually about 2 MAF more groundwater used statewide than what naturally recharges – called groundwater overdraft. Overdraft is characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years.



Key Water Supply and Water Use Definitions

Applied water. The total amount of water that is diverted from any source to meet the demands of water users without adjusting for water that is depleted, returned to the developed supply or considered irrecoverable (see water balance figure).

Consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is greater than consumptive use because it includes consumptive use, reuse, and outflows.

Instream environmental. Instream flows used only for environmental purposes.

Instream flow. The use of water within its natural watercourse as specified in an agreement, water rights permit, court order, FERC license, etc.

Groundwater Extraction. An annual estimate of water withdrawn from banked, adjudicated, and unadjudicated groundwater basins.

Recycled water. Municipal water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur and is therefore considered a valuable resource.

Reused water. The application of previously used water to meet a beneficial use, whether treated or not prior to the subsequent use.

Urban water use. The use of water for urban purposes, including residential, commercial, industrial, recreation, energy production, military, and institutional classes. The term is applied in the sense that it is a kind of use rather than a place of use.

Water balance. An analysis of the total developed/dedicated supplies, uses, and operational characteristics for a region. It shows what water was applied to actual uses so that use equals supply.

San Joaquin River Water Balance by Water Year Data Table (MAF)

	2001 (79%)	2002 (82%)	2003 (84%)	2004 (85%)	2005 (126%)	2006 (133%)	2007 (59%)	2008 (73%)	2009 (86%)	2010 (106%)
Applied Water Use										
Urban	629	595	618	640	665	680	714	756	733	700
Irrigated Agriculture	7,243	7,612	6,998	7,505	6,559	6,982	8,124	8,177	7,899	7,045
Managed Wetlands	415	477	473	492	458	484	516	503	516	497
Req Delta Outflow	0	0	0	0	0	0	0	0	0	0
Instream Flow	1,424	583	600	582	772	1,046	361	345	614	644
Wild & Scenic R.	1,091	1,420	1,714	1,504	3,611	3,557	883	1,232	1,755	2,090
Total Uses	**10,802**	**10,687**	**10,403**	**10,723**	**12,065**	**12,750**	**10,598**	**11,013**	**11,517**	**10,977**
Depleted Water Use (stippling)										
Urban	400	294	311	337	347	331	346	375	393	376
Irrigated Agriculture	4,938	5,605	5,270	5,687	4,922	5,485	6,304	6,515	6,221	5,421
Managed Wetlands	138	190	186	207	155	206	242	472	241	474
Req Delta Outflow	0	0	0	0	0	0	0	0	0	0
Instream Flow	0	323	318	304	335	553	98	0	0	0
Wild & Scenic R.	0	797	0	1,123	2,555	2,077	532	708	1,044	1,184
Total Uses	**5,476**	**7,208**	**6,085**	**7,657**	**8,313**	**8,652**	**7,522**	**8,070**	**7,899**	**7,454**
Dedicated and Developed Water Supply										
Instream	0	323	318	1427	2890	2571	771	855	1358	1444
Local Projects	3,549	3,511	2,439	2,800	2,823	2,371	2,945	3,093	2,605	2,841
Local Imported Deliveries	0	0	0	0	0	36	46	0	0	0
Colorado Project	0	0	0	0	0	0	0	0	0	0
Federal Projects	1,764	1,904	1,765	1,461	1,542	1,738	1,640	1,453	1,472	1,552
State Project	4	9	17	14	5	7	24	10	46	30
Groundwater Extraction	2,969	2,930	2,688	3,073	2,351	2,814	3,604	3,853	3,846	2,709
Inflow & Storage	0	0	0	0	0	3	3	3	4	5
Reuse & Seepage	2,516	2,011	3,176	1,949	2,454	3,210	1,564	1,744	2,184	2,394
Recycled Water	2	0	0	0	0	2	2	2	2	1
Total Supplies	**10,802**	**10,687**	**10,403**	**10,723**	**12,065**	**12,750**	**10,598**	**11,013**	**11,517**	**10,976**

Figure SJR-21 Salt Slough and Mud Slough

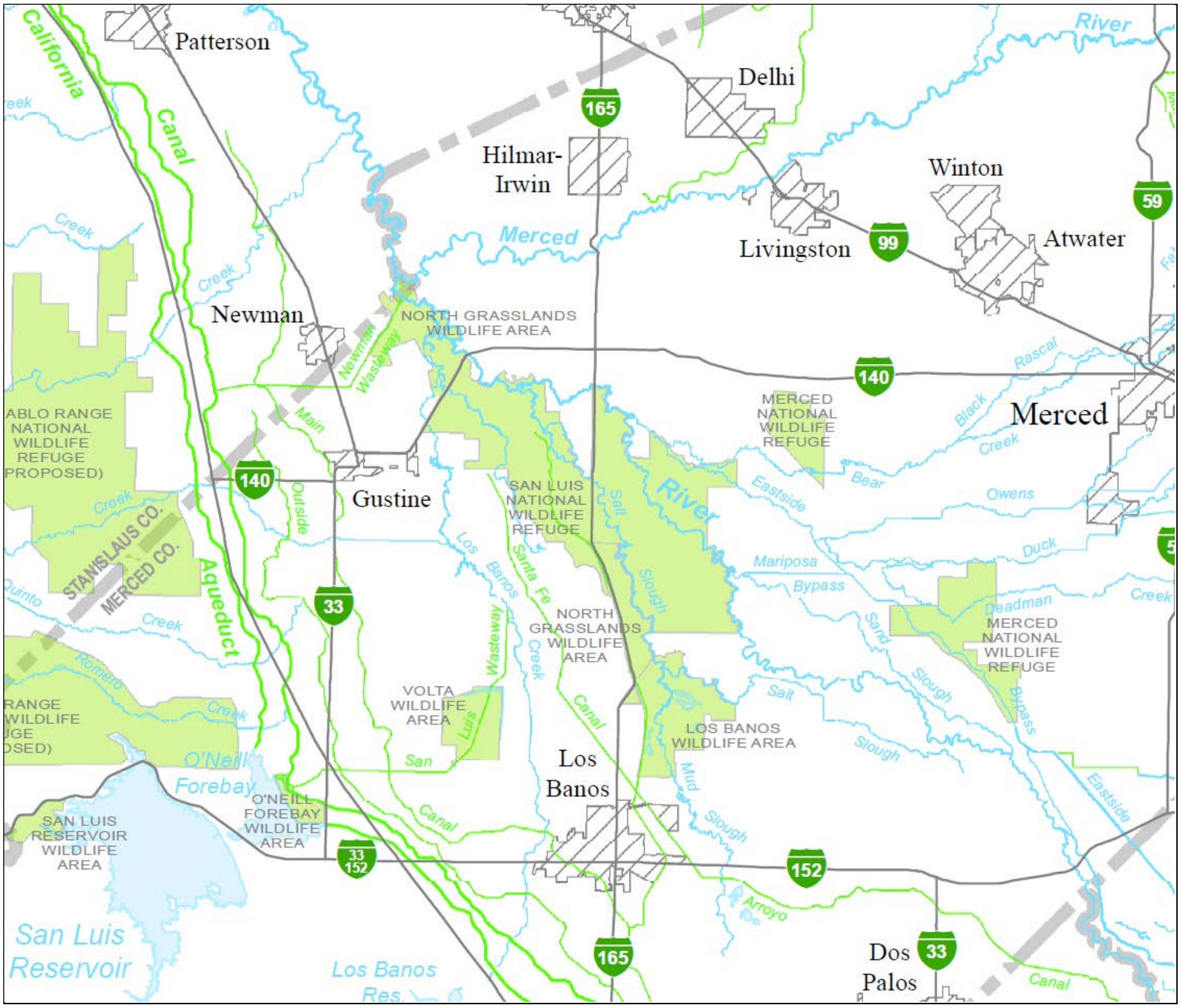


Figure SJR-22 Land Subsidence in the San Joaquin Valley — 1926 to 1970 (Adapted from Ireland, 1984)

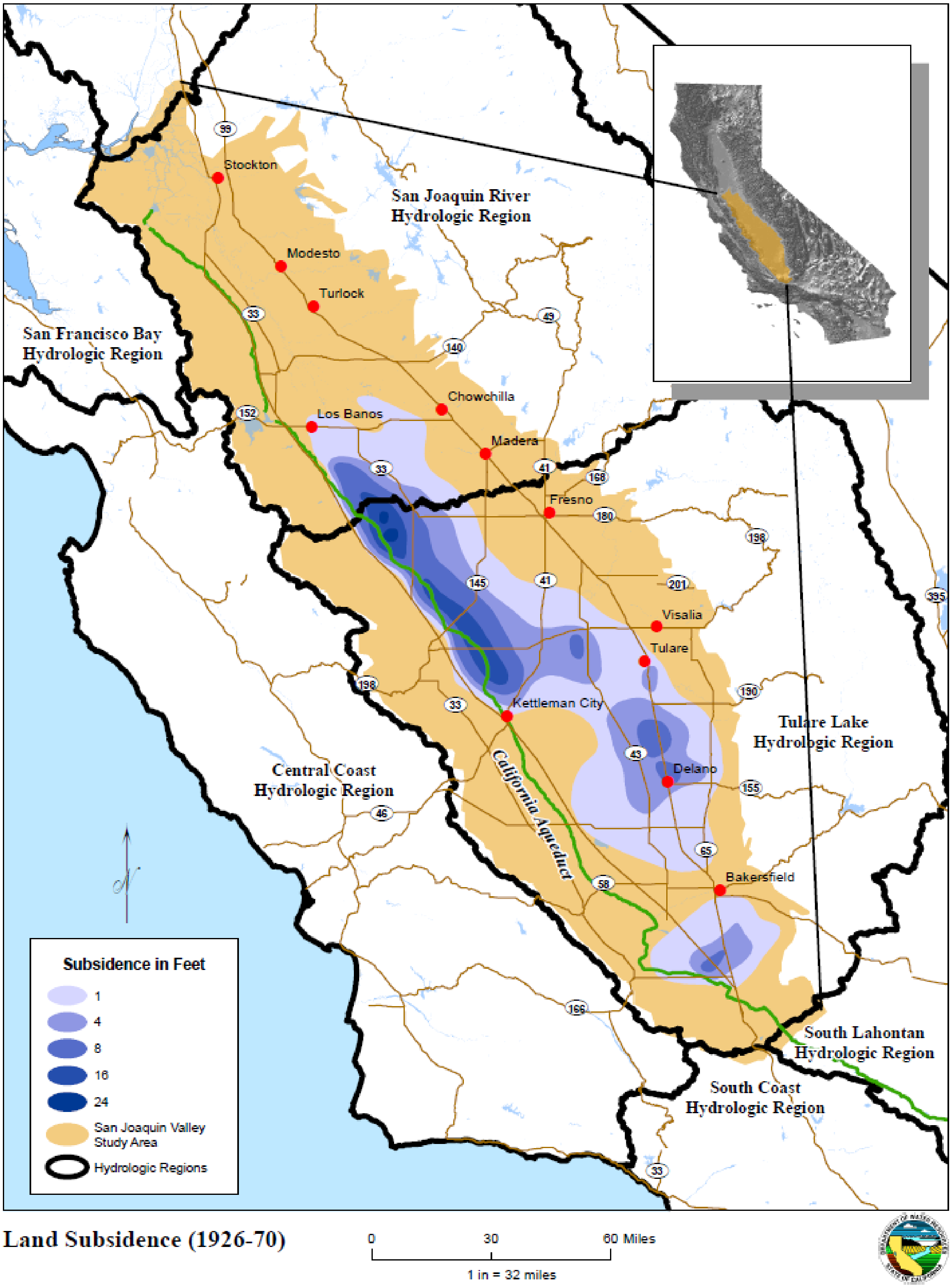


Figure SJR-23 Land Subsidence Along the California Aqueduct

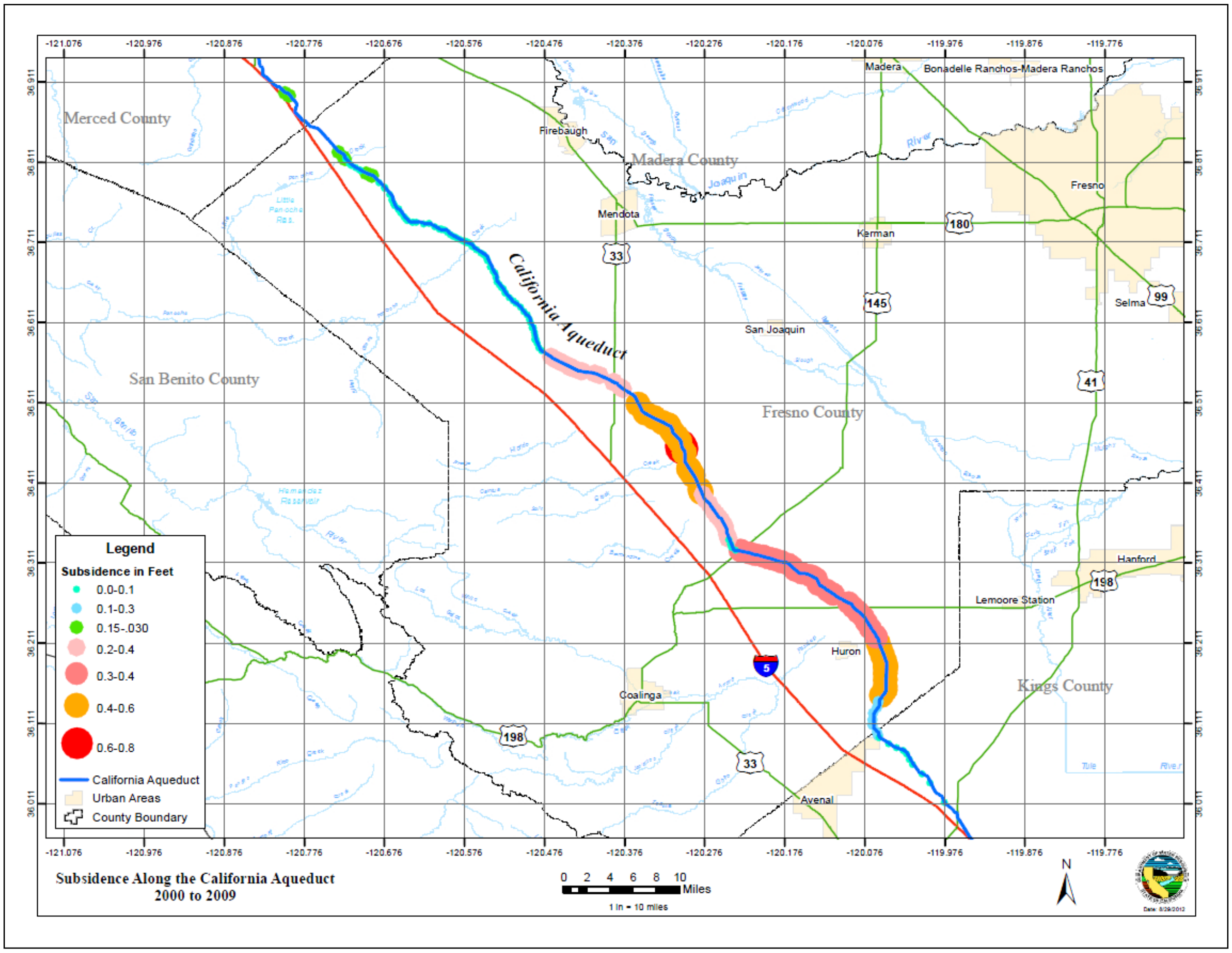


Figure SJR-24 Location of Caltrans Highway 152 Elevation Monitoring

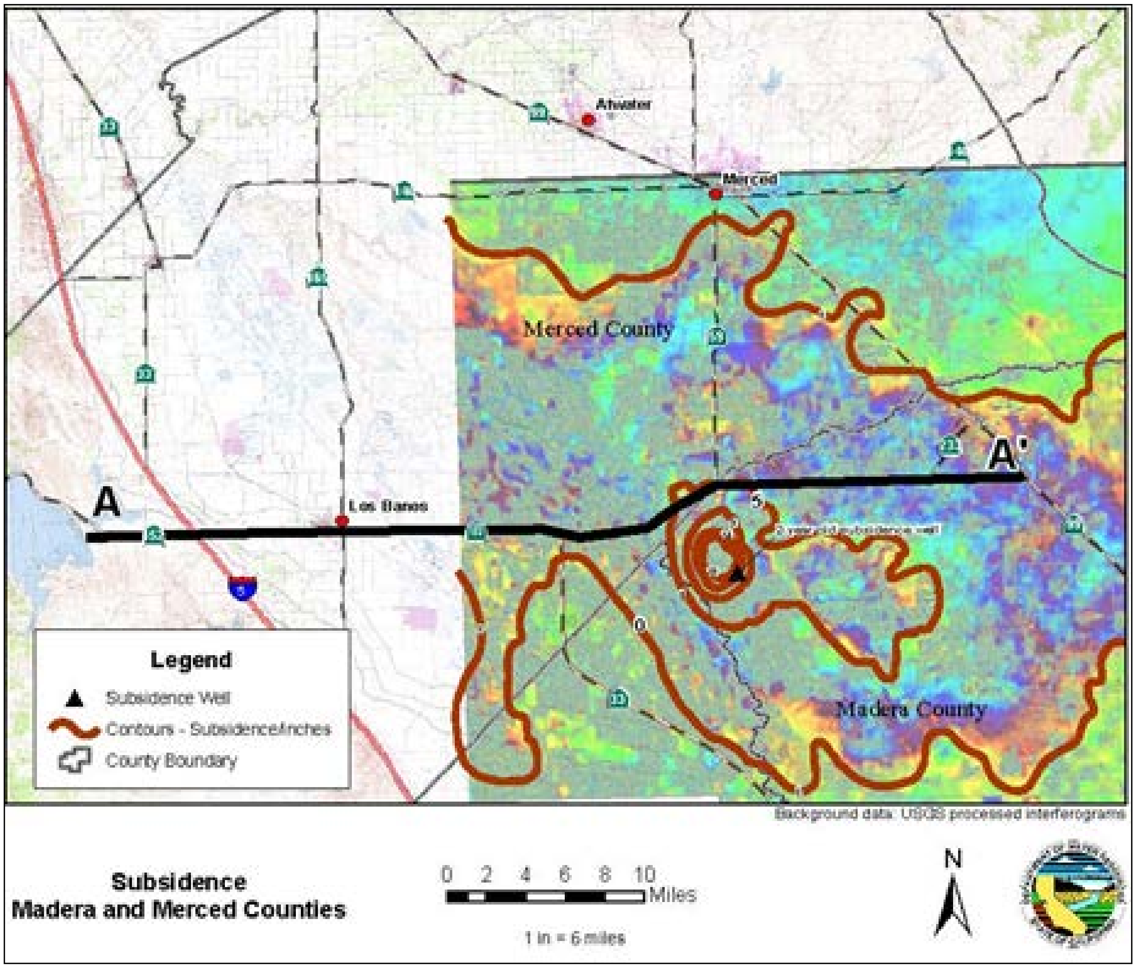


Figure SJR-25 Land Subsidence Results from Caltrans Highway 152 Elevation Monitoring, between San Luis Dam and Highway 99 (1972-2004)

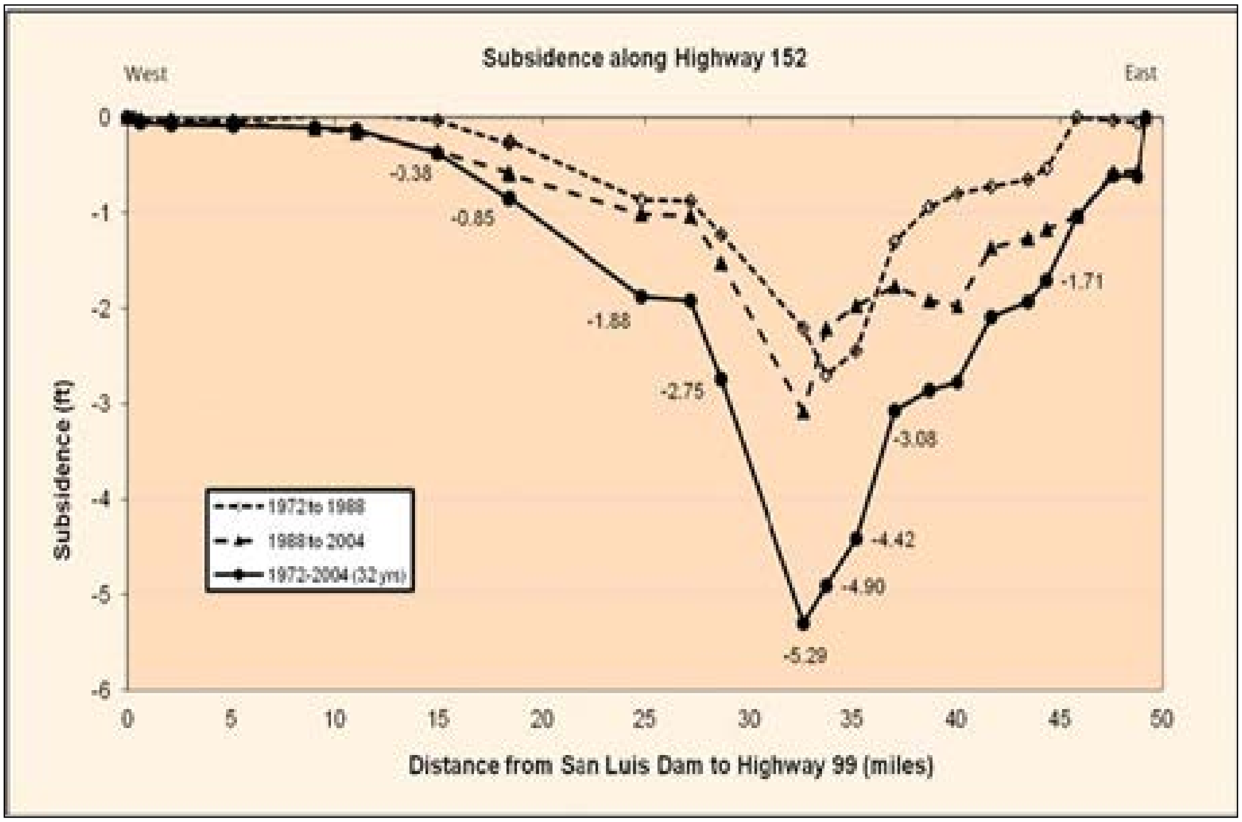


Figure SJR-26 UNAVCO GPS Land Surface Displacement Monitoring Stations and Station Data Summary Graphs

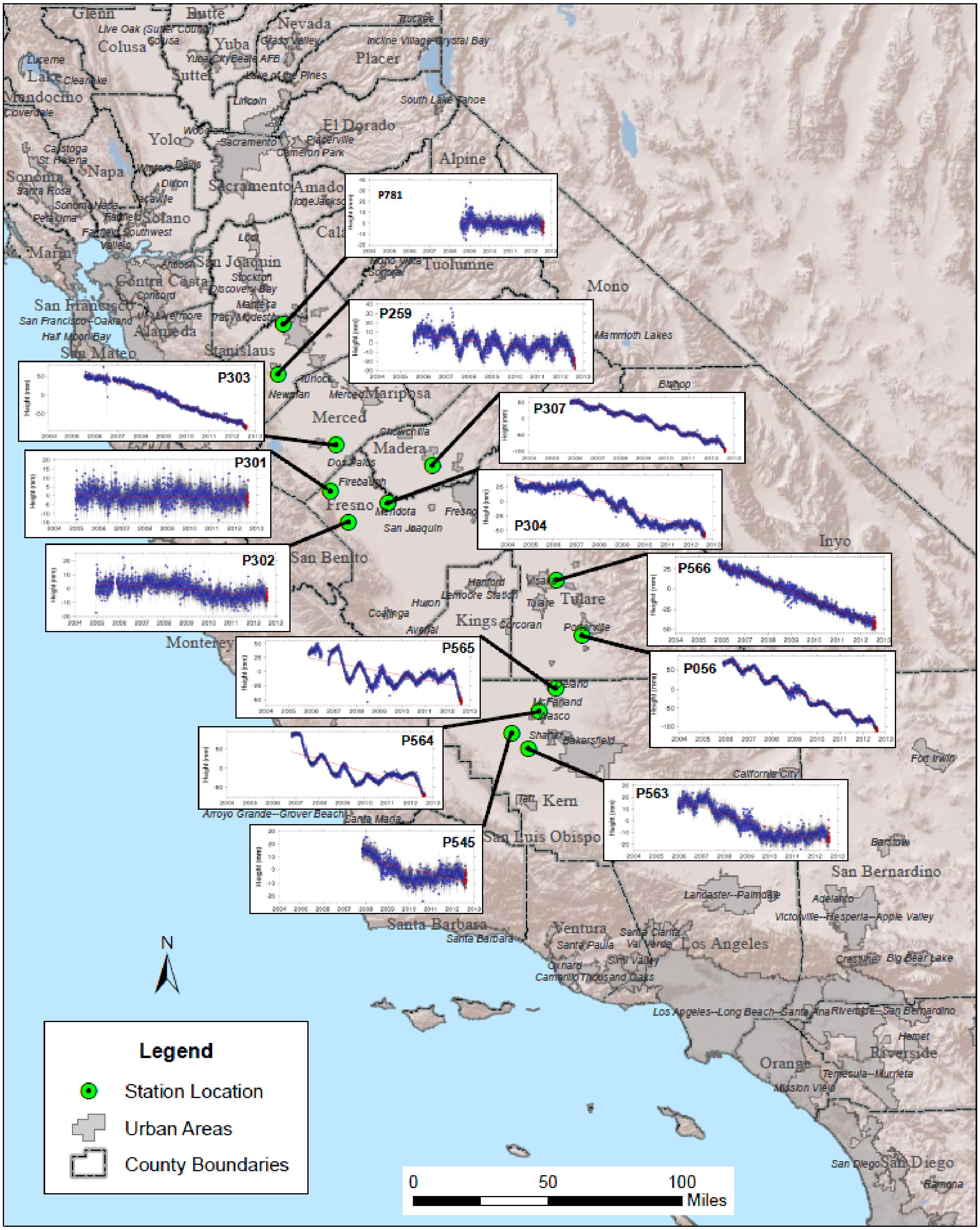
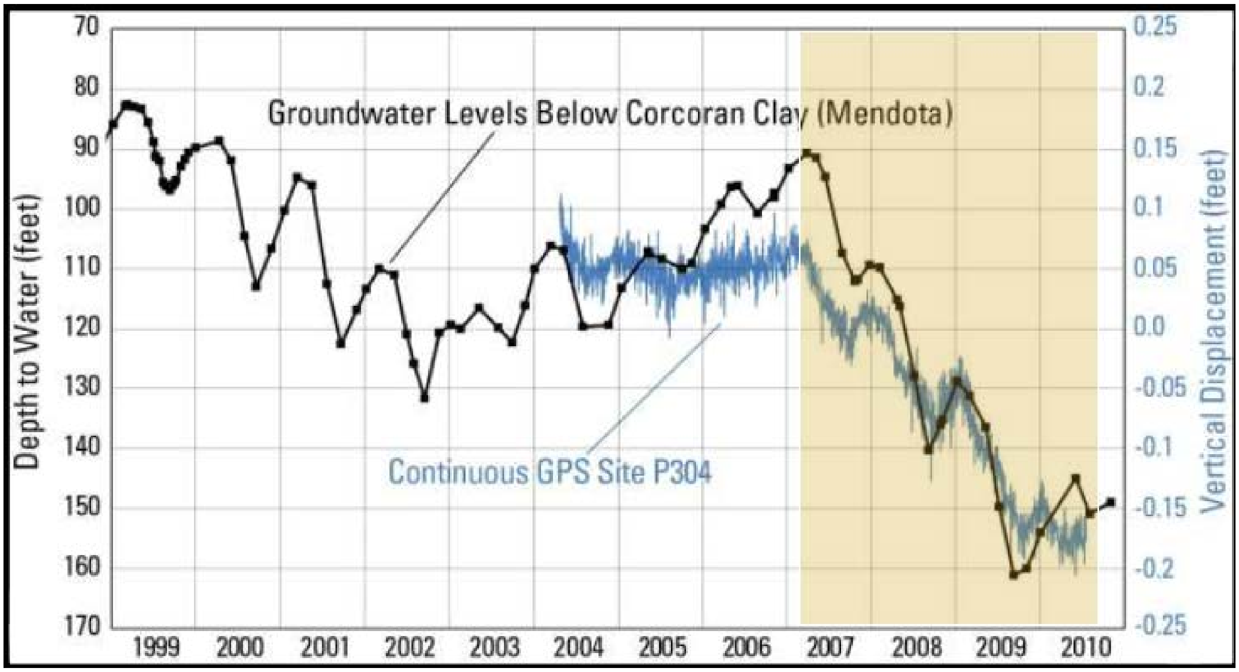


Figure SJR-27 Depth to Groundwater Hydrograph and Vertical Land Surface Displacement at UNAVCO GPS Site 304, near the City of Mendota



Source: USGS 2011 presentation on Central Valley subsidence. Land surface elevation data from UNAVCO Station 304; depth to water data provided by Luhdorff and Scalmanini Consulting Engineers)

Figure SJR-28 Spring 2010 Depth to Groundwater Contours for the San Joaquin River Hydrologic Region

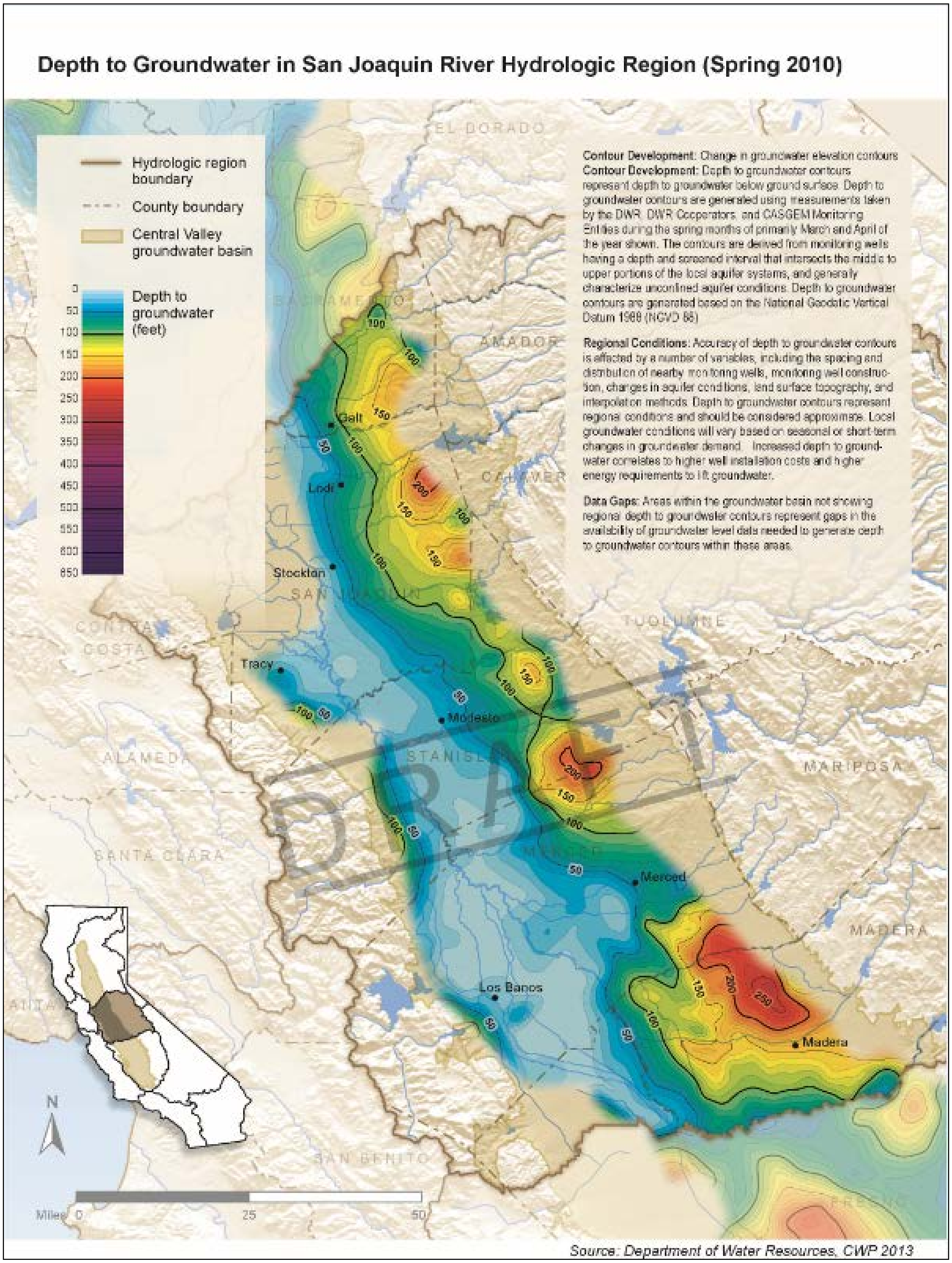


Figure SJR-29 Spring 2010 Groundwater Elevation Contours for the San Joaquin River Hydrologic Region

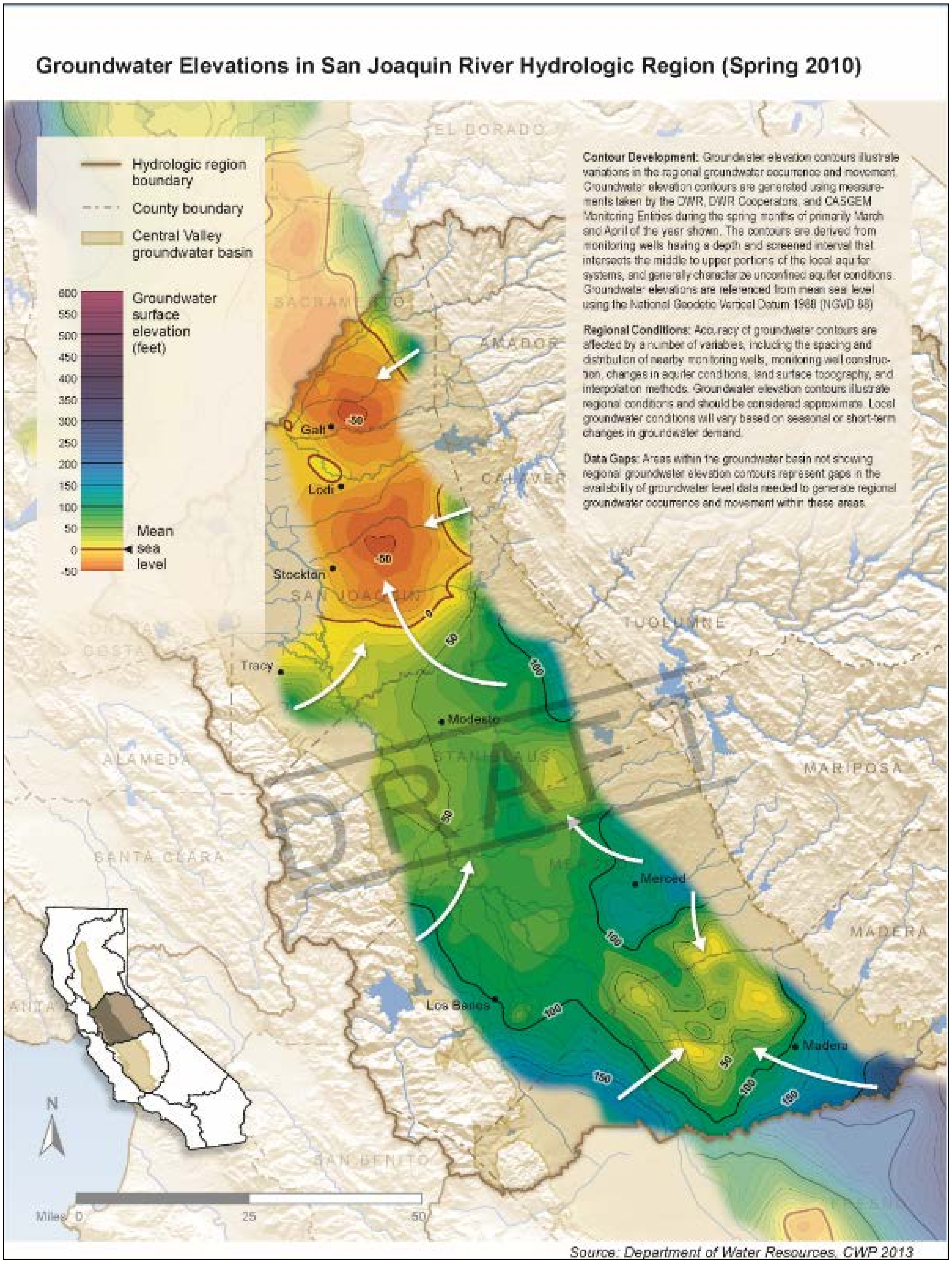
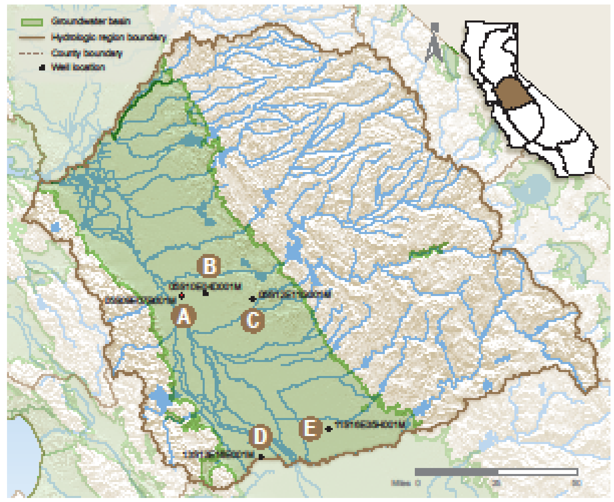


Figure SJR-30 Groundwater Level Trends in Selected Wells in the San Joaquin River Hydrologic Region

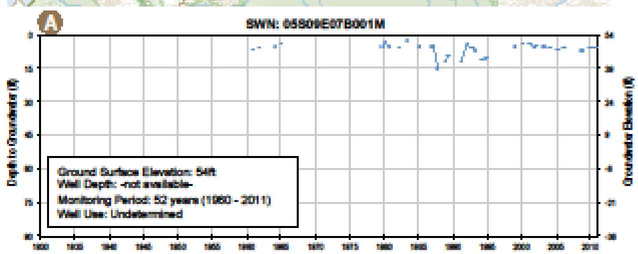
Aquifer response to changing demand and management practices

Hydrographs were selected to help tell a story of how local aquifer systems respond to changing groundwater demand and resource management practices. Additional detail is provided within the main text of the report.

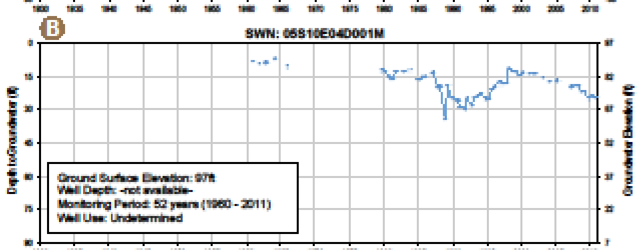
Regional locator map



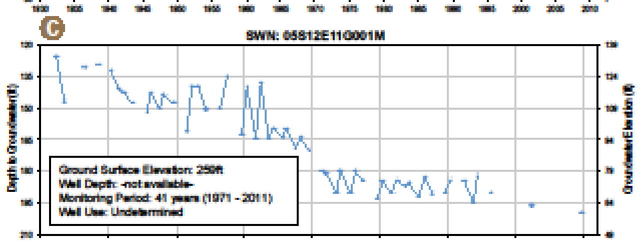
(A) Hydrograph 05S09E07B001M: illustrates an example of a typical well in the western portion of the Turlock Groundwater Basin: wells extracting water from shallow groundwater aquifers which readily respond to the local precipitation conditions.

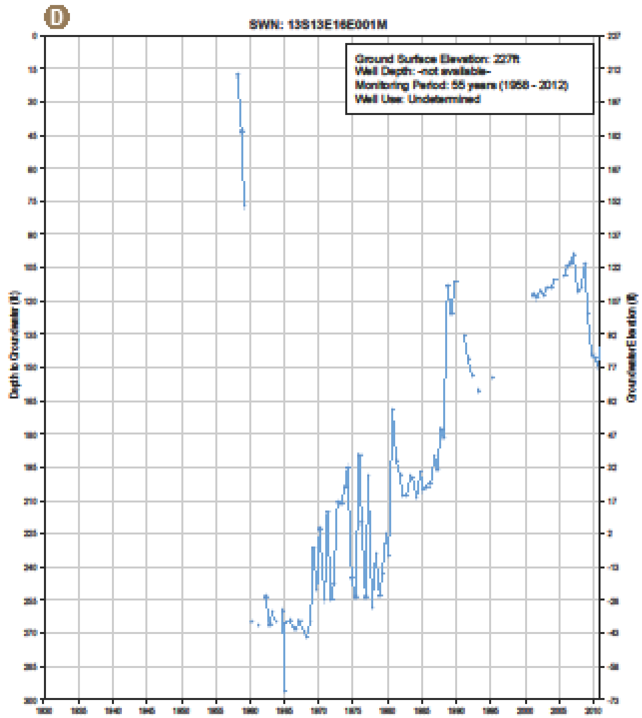


(B) Hydrograph 05S10E04D001M: highlights the successful role of an active in-lieu conjunctive management program in meeting the increasing urban water demands while keeping the long-term aquifer conditions stable.

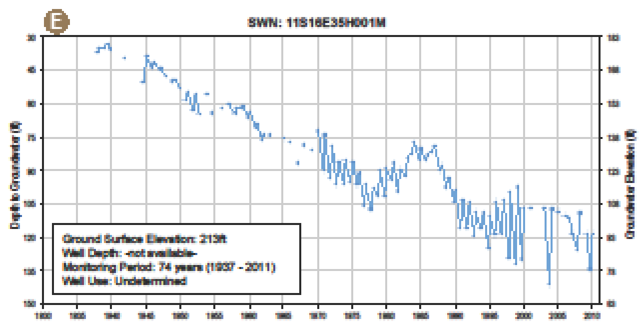


(C) Hydrograph 05S12E11G001M: shows a successful stabilization of declining groundwater levels resulting from adopting drip and micro irrigation system over the sprinkler system beginning 1990. The declining trend resumed, however, due to expansion of agricultural lands into previously non-irrigated lands.





D Hydrographs 13S13E16E001M: highlights the successful recovery of declining groundwater conditions and stabilization of subsiding land through the introduction of water deliveries from the SWP.



E Hydrographs 11S16E35H001M: shows the imbalance between recharge and groundwater extraction. There are no surface water supplies available in this region and irrigation is dependent on groundwater to meet area needs.

Figure SJR-31 Spring 2005 — Spring 2010 Change in Groundwater Elevation Contour Map for the San Joaquin River Hydrologic Region

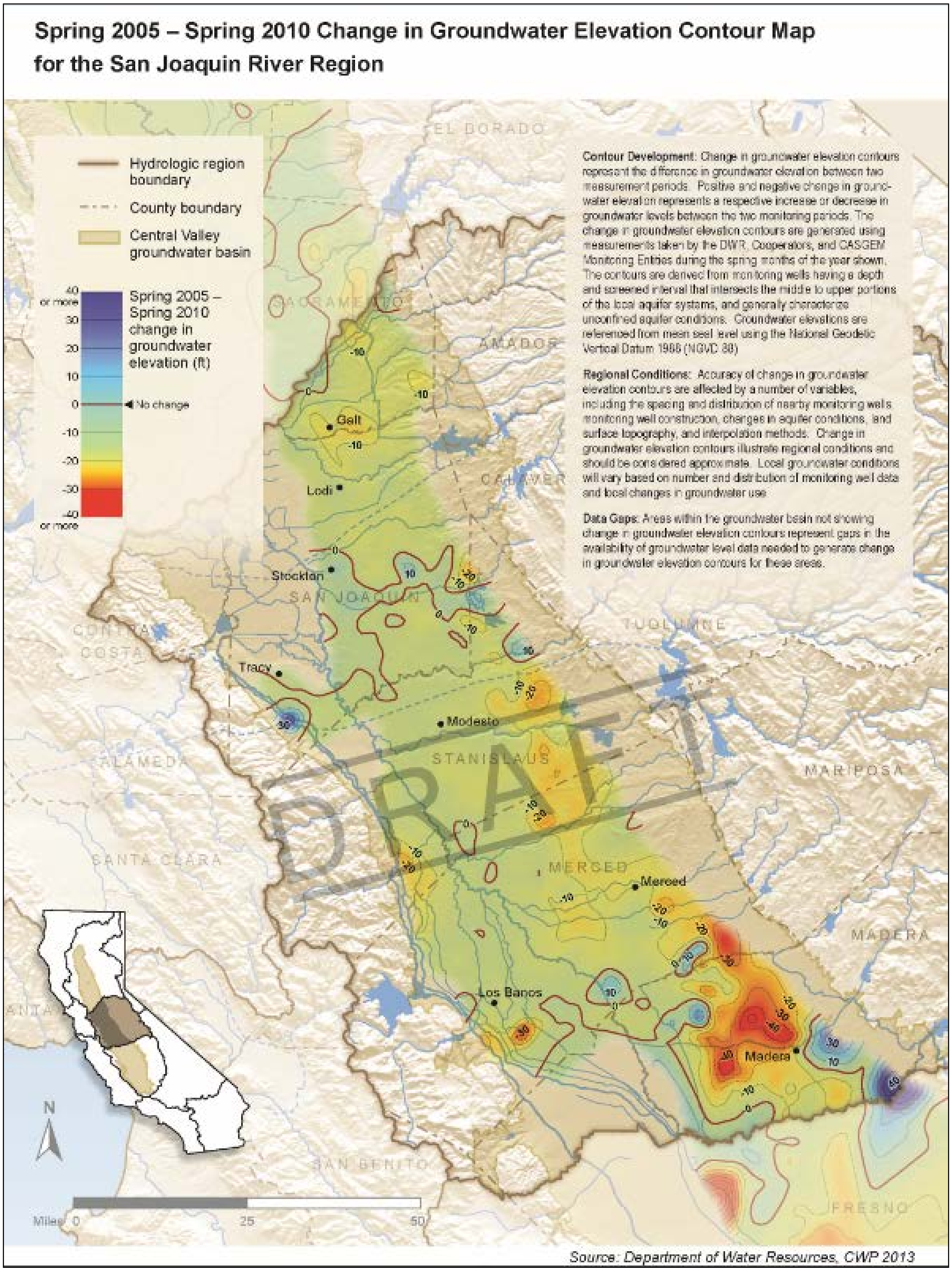


Figure SJR-32 Spring 2010 Annual Change in Groundwater Storage for the San Joaquin River Hydrologic Region

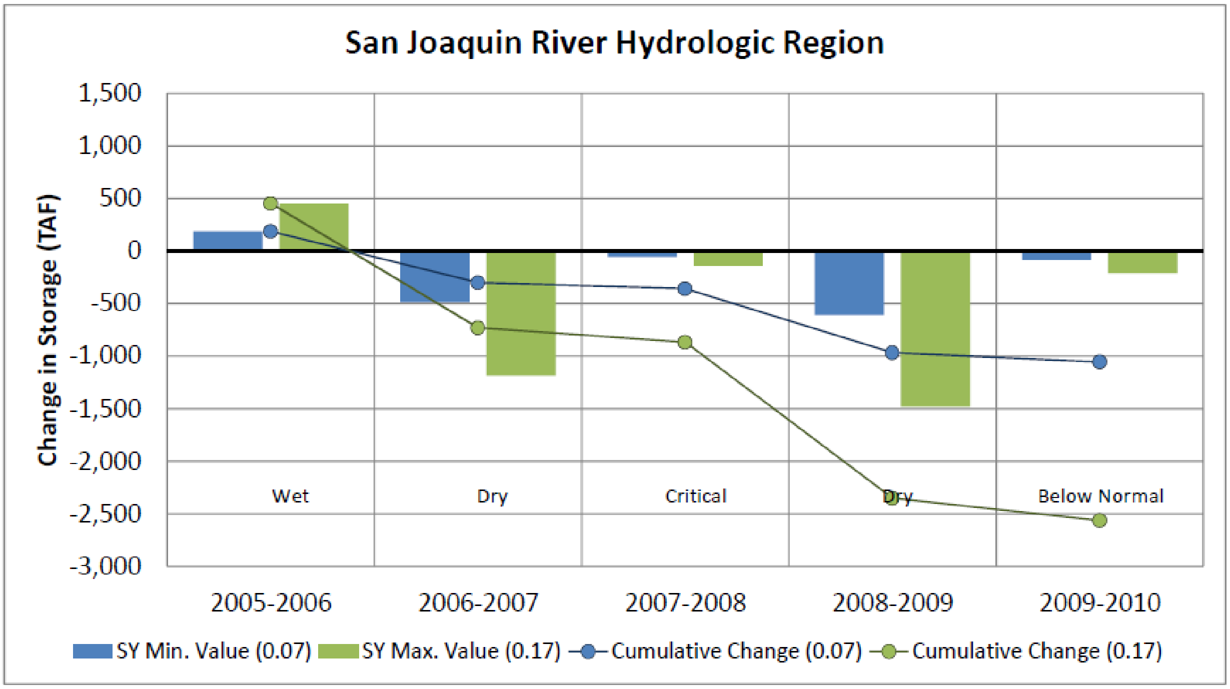
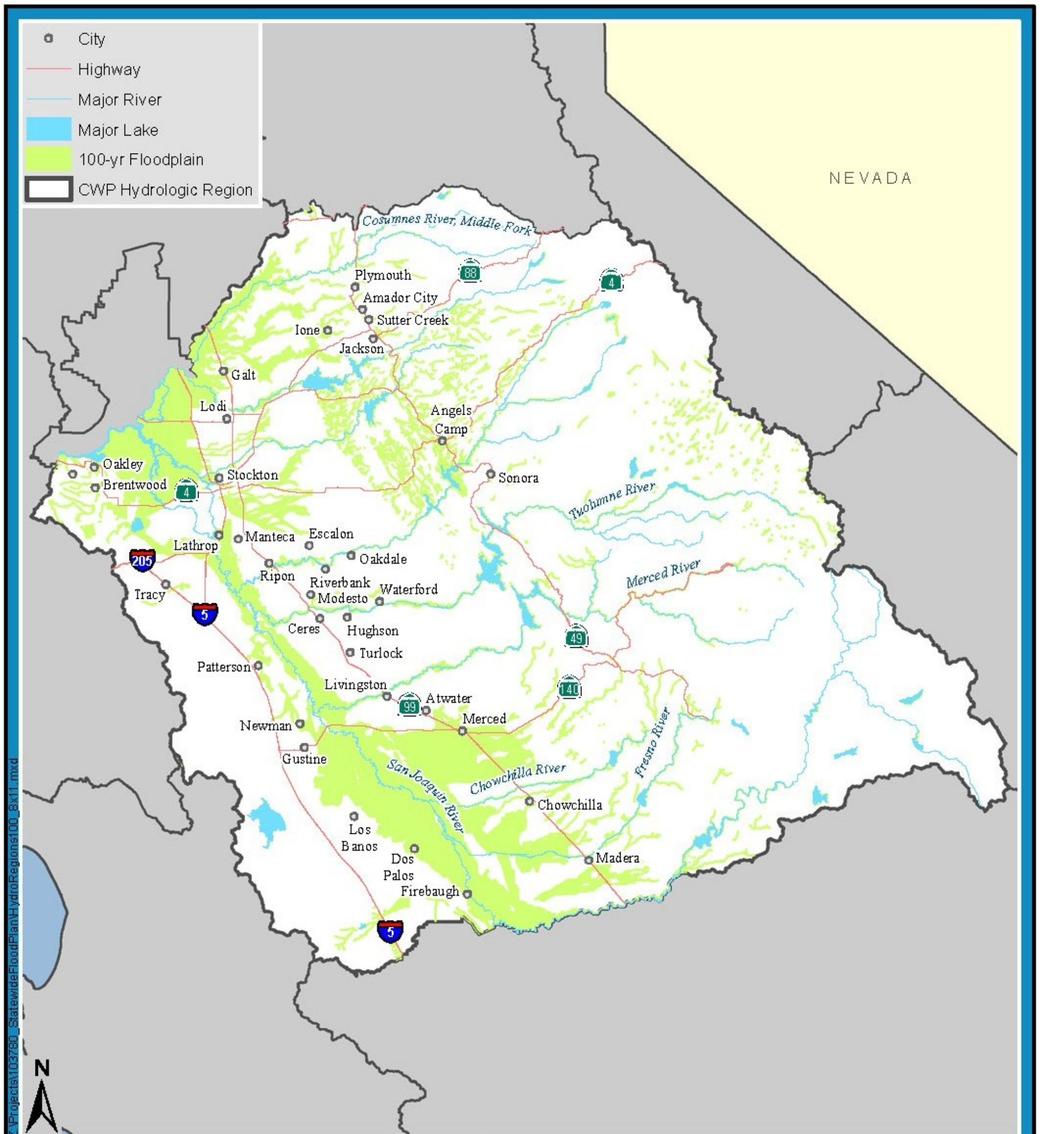


Figure SJR-33 Flood Exposure to the 100-Year Floodplain, San Joaquin River Hydrologic Region



San Joaquin River Key Results

Total Population:	1,752,400	Transportation Facilities:	646
Population Exposed:	157,100	Transportation Segments (miles):	428
Percent of Population Exposed:	9	Essential Facilities:	93
Exposed Structures:	54,200	Lifeline Utilities:	12
Value of Exposed Structure and Contents:	$11.3 Billion	Dept. of Defense Facilities:	2
Total Area (acres)	9.8 Million	Dept. of Defense Facilities (acres):	597
Exposed Area (acres)	1,149,200	High Potential Loss Facilities:	92
Percent of Area Exposed:	12	Native American Tribes:	1
Exposed Ag.Crops (acres):	682,100	Native American Tribal Lands (acres):	3
Percent of Ag. Crops Exposed:	32	Sensitive Animal Species Exposed:	131
Value of Exposed Ag. Crops:	$1.4 Billion	Sensitive Plant Species Exposed:	130

Statewide Flood Hazard Exposure Summary for the San Joaquin River Hydrologic Region 100-year Floodplain

STATEWIDE FLOOD MANAGEMENT PLANNING PROGRAM

FloodSAFE CALIFORNIA

Jan 28, 2013

Figure SJR-34 Flood Exposure to the 500-Year Floodplain, San Joaquin River Hydrologic Region

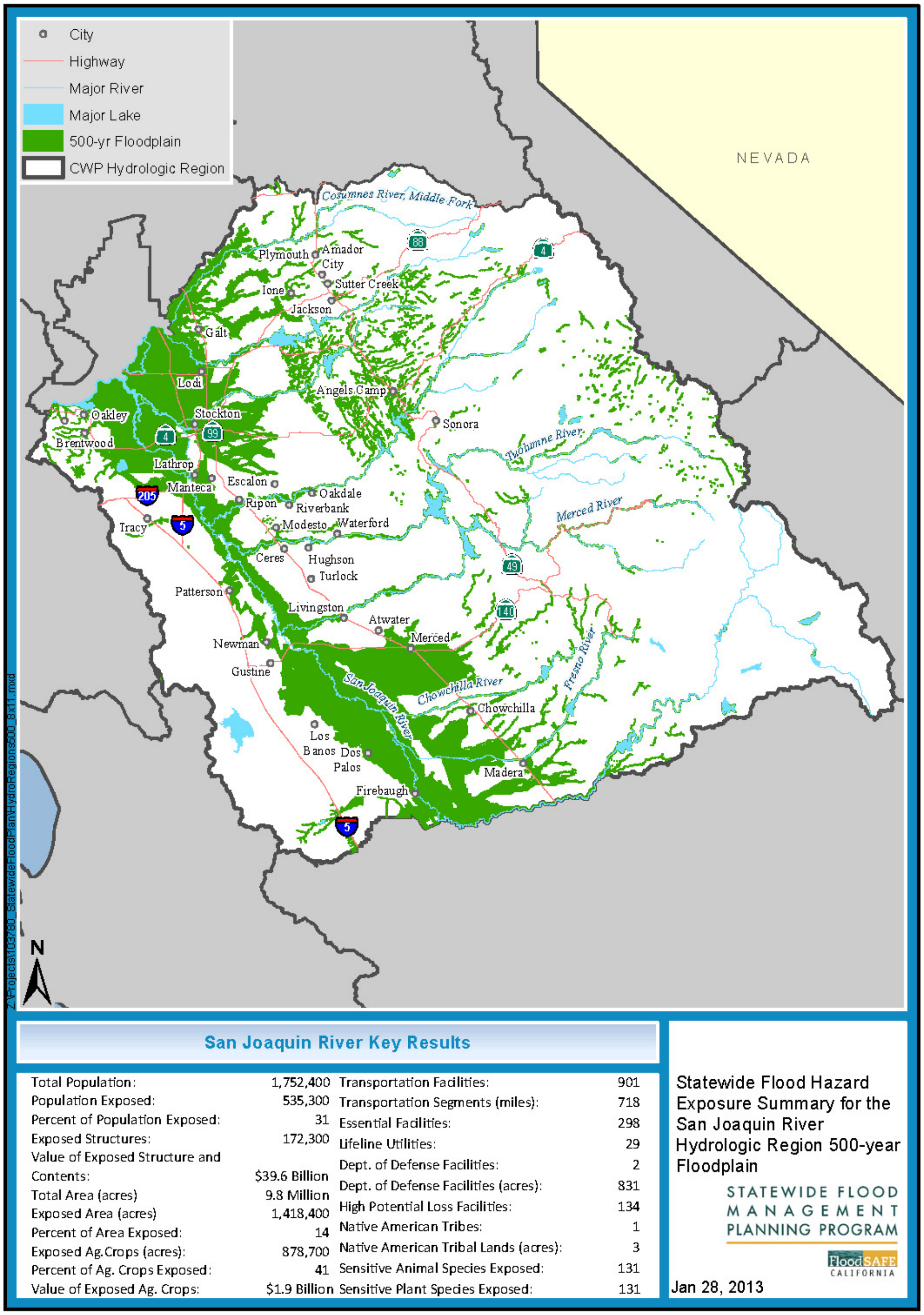


Figure SJR-35 Location of Groundwater Management Plans in the San Joaquin River Hydrologic Region

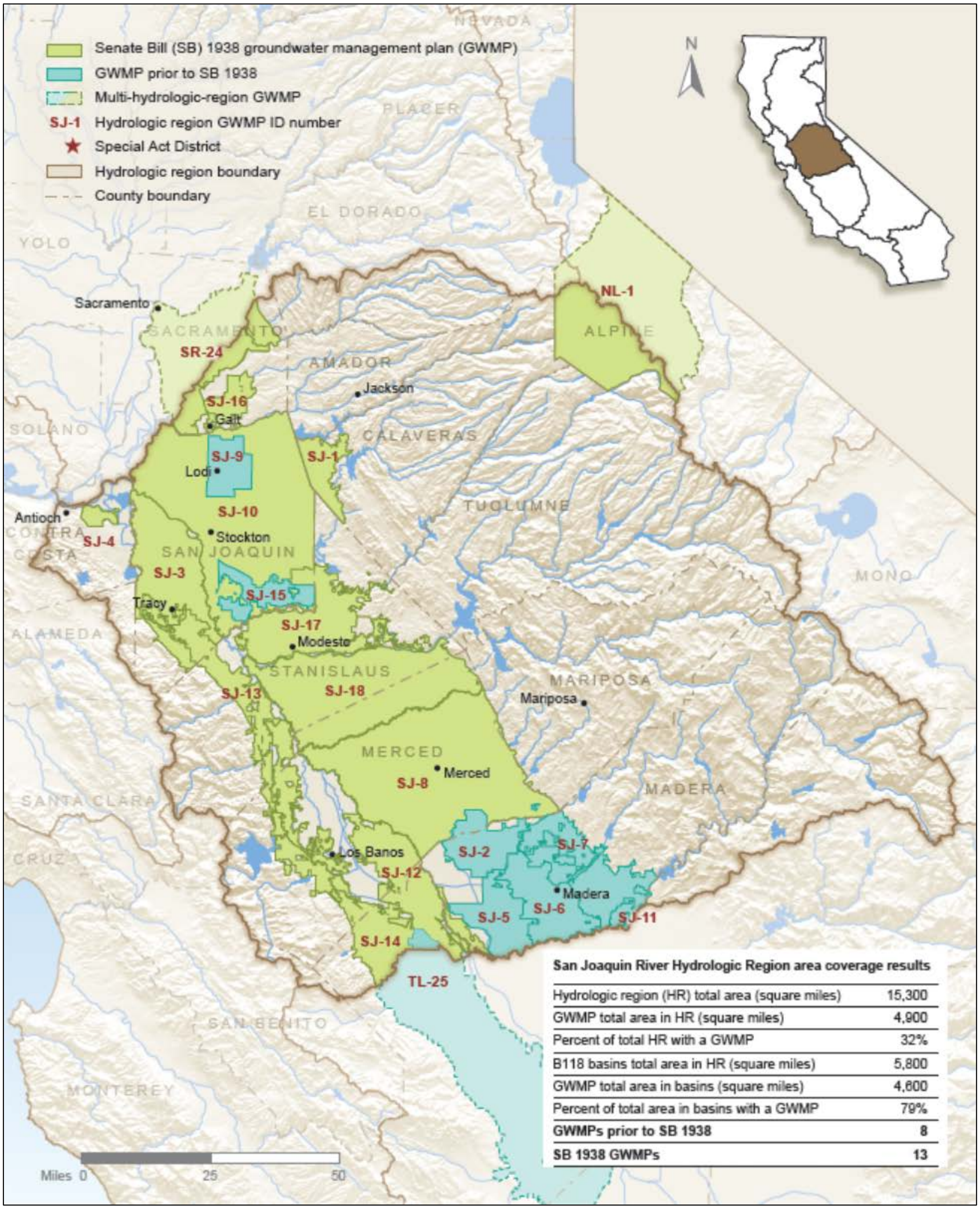
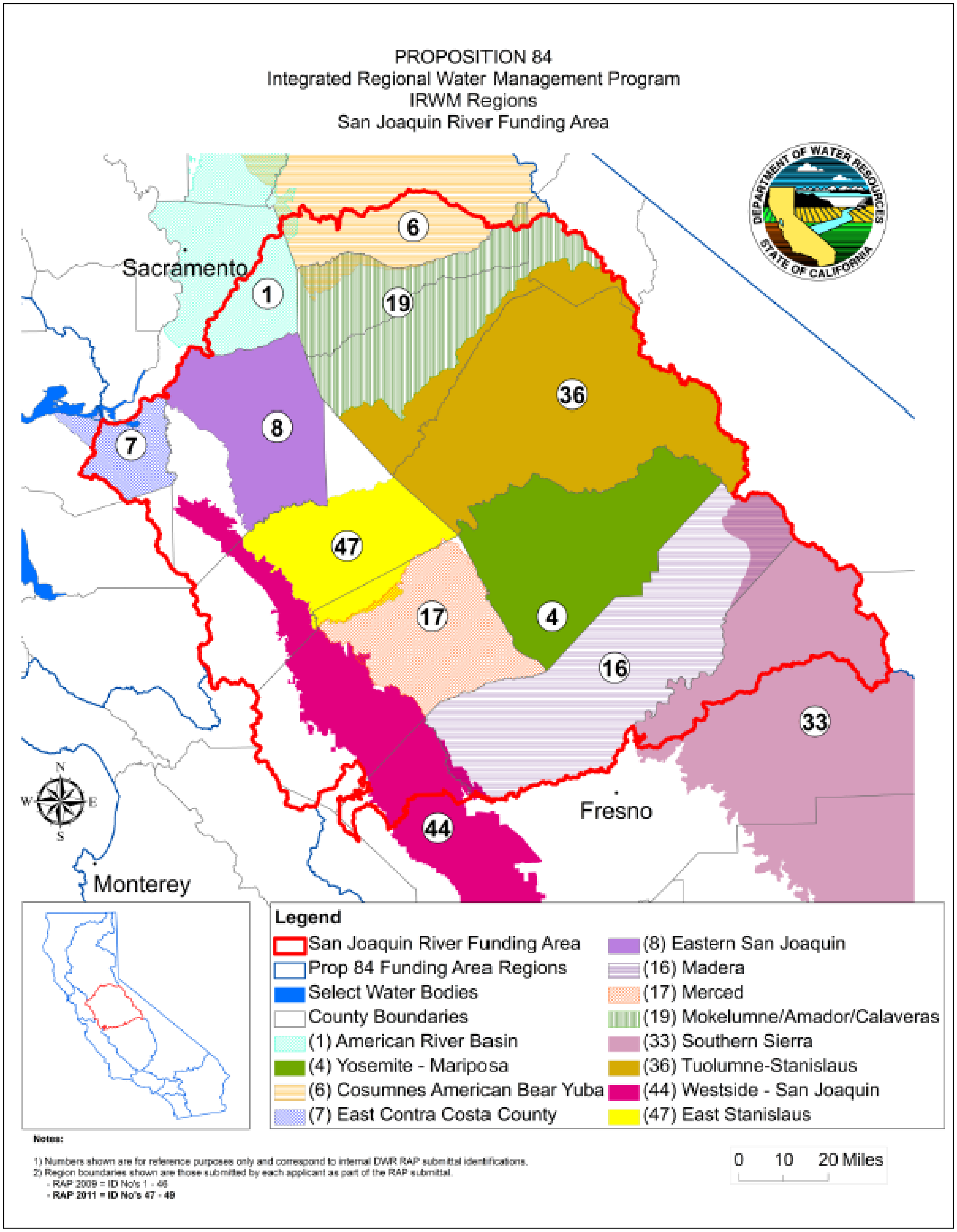


Figure SJR-36 Integrated Regional Water Management Regions in the San Joaquin River



http://www.water.ca.gov/irwm/grants/docs/FundingAreaContacts/SanJoaquinRiverFA2012_1016.pdf

Figure SJR-37 Change San Joaquin River Agricultural and Urban Demands for 117 Scenarios from 2006-2050 (thousand acre-feet per year)

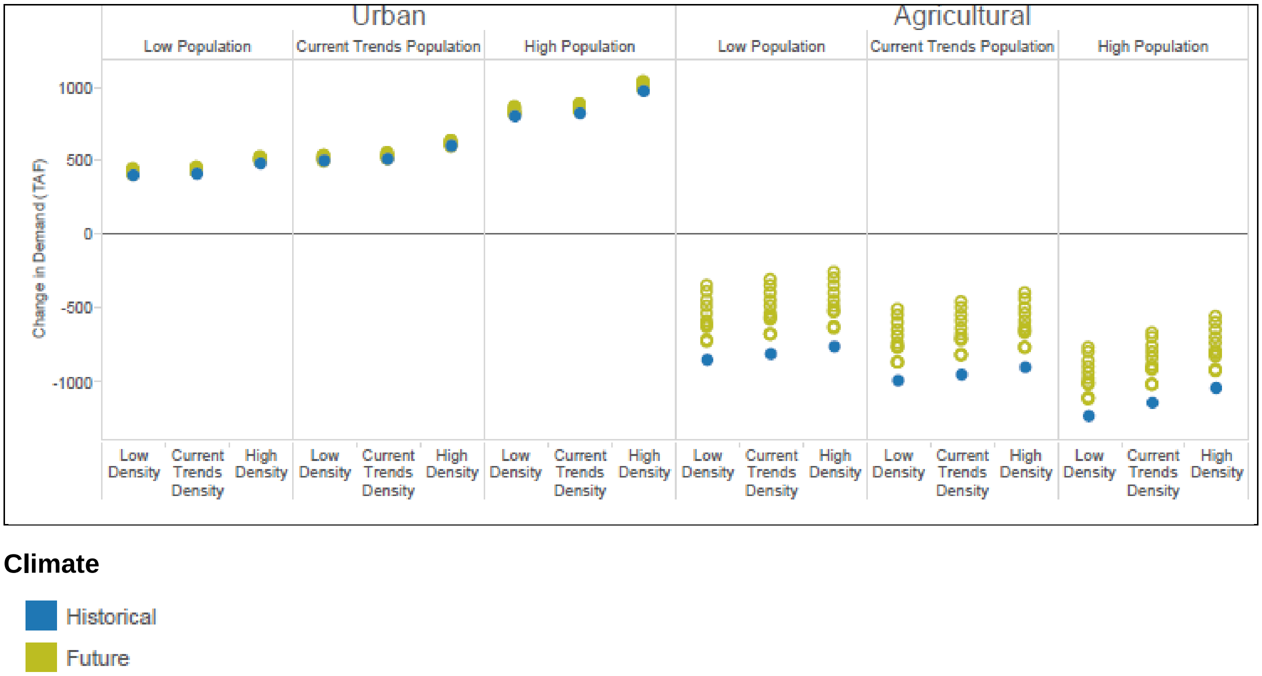


Figure SJR-38 Energy Intensity of Raw Water Extraction and Conveyance in the San Joaquin Hydrologic Region

Type of Water	Energy Intensity (yellow bulb = 1-500 kWh/AF)	% of regional water supply
Colorado (Project)	*This type of water not available*	0%
Federal (Project)	<250 kWh/AF	16%
State (Project)		0%
Local (Project)	<250 kWh/AF	29%
Local Imports	*This type of water not available*	0%
Groundwater	<250 kWh/AF	31%

Energy intensity per acre-foot of water

Energy intensity (EI) in this figure is the total amount of energy required for the extraction and conveyance of one acre-foot of water and does not include treatment, distribution to point of use, or end use energy (e.g., water heating). These figures should be seen as ranges within which the EI of different sources of each water type would likely fall i.e., a water type with four bulbs should be interpreted to mean that most sources of that water type in the region would have an EI of between 1,501-2,000 kWh/acre-ft of water. Smaller light bulbs represent an EI of greater than zero, and less than250 kWh/acre-ft. EI of desalinated and recycled water is not shown, but is covered in Resource Management Strategies #XX and #YY respectively, Volume 3. (For detailed description of the methodology used to calculate EI in this figure, see Volume 4, *Reference Guide*, or Volume 5, *Technical Guide*).

Photo SJR-1 Mine Waste

Improperly graded mine waste

Calfed Mine after grading

Box SJR-1 California Statewide Groundwater Elevation Monitoring (CASGEM) Basin Prioritization Data Considerations

Senate Bill 7x 6 (SBx7 6; Part 2.11 to Division 6 of the California Water Code § 10920 et seq.) requires, as part of the CASGEM program, DWR to prioritize groundwater basins to help identify, evaluate, and determine the need for additional groundwater level monitoring by considering available data listed below:.

1. The population overlying the basin,
2. The rate of current and projected growth of the population overlying the basin,
3. The number of public supply wells that draw from the basin,
4. The total number of wells that draw from the basin,
5. The irrigated acreage overlying the basin,
6. The degree to which persons overlying the basin rely on groundwater as their primary source of water,
7. Any documented impacts on the groundwater within the basin, including overdraft, subsidence, saline intrusion, and other water quality degradation, and
8. Any other information determined to be relevant by the DWR.

Using groundwater reliance as the leading indicator of basin priority, DWR evaluated California's 515 alluvial groundwater basins and categorized them into five groups:

- Very High
- High
- Medium
- Low
- Very Low

Box SJR-2 Other Groundwater Management Planning Efforts in the San Joaquin River Hydrologic Region

The Integrated Regional Water Management plans, Urban Water Management plans, and Agriculture Water Management plans in the San Joaquin River Hydrologic Region that also include components related to groundwater management are briefly discussed below.

Integrated Regional Water Management Plans

The San Joaquin River Hydrologic Region includes 12 of the 48 IRWM plans that have been accepted or conditionally accepted statewide. Five of the 12 IRWM plans are actively implemented, while seven are in various stages of implementation. One of the established plans extends northward into the Sacramento River Hydrologic Region and one southward into the Tulare Lake region.

Two of the active IRWM regions, Mokelumne/Amador/Calaveras and Westside, rely on local entities that actively manage groundwater resources and implement projects that help improve groundwater management in their respective areas. One IRWM region identifies groundwater management as one of its planning objectives while the other IRWM region states that its main goal is to minimize regional conflict by addressing problems such as water supply reliability, overdraft, drainage, and water quality.

The plan adopted by Eastern San Joaquin IRWM region was developed to define and integrate key water management strategies and establish protocols and course of actions for implementing conjunctive use programs. This followed the establishment of a groundwater banking authority and a groundwater management plan for the area. Individual agencies within the IRWM region that manage groundwater resources found it difficult to exert the political and financial power necessary to mitigate the conditions of overdraft in their groundwater basins. They concluded that a regional consensus based approach to water resources planning and conjunctive water management would increase their chance for success. The IRWM group developed Basin Management Objectives for groundwater levels, groundwater quality, and inelastic land subsidence. They also developed Basin Operations Criteria consisting of a series of groundwater levels triggers that correspond to basin condition levels to indicate the effectiveness of conjunctive use projects.

The Cosumnes, American, Bear, and Yuba Watersheds IRWM planning group states that groundwater in the IRWM region is poorly understood due to geological conditions dominated by faults and fractured rocks, and thus the IRWM group defers groundwater management to city and county agencies, and to irrigation districts. Among the objectives of the IRWM plan are to identify suitable groundwater management practices to prevent groundwater contamination, assure that groundwater recharge and extraction are balanced and support efforts to understand groundwater movement and quantities in the Sierra Nevada fractured rock systems through additional studies and analyses.

The American River Basin IRWM planning group relies on four local agencies or authorities with active groundwater management plans for groundwater management in the area. The IRWM plan states that groundwater management is important to reduce water rights disputes and conflicts due to heavy reliance on groundwater by agricultural and residential users. Among the IRWM plan's objectives are to identify and resolve issues connected with conjunctive use water management practices and groundwater contamination, and to evaluate effectiveness of regional groundwater monitoring systems and make recommendations to improve groundwater monitoring systems.

Urban Water Management Plans

Urban Water Management plans are prepared by California's urban water suppliers to support their long-term resource planning and to ensure adequate water supplies are available to meet existing and future water uses. Urban use of groundwater is one of the few uses that meter and report annual groundwater extraction volumes. The groundwater extraction data is currently submitted with the Urban Water Management plan and then manually translated by DWR staff into a database. Online methods for urban water managers to directly enter their water use along with their plan updates is currently under evaluation and review by DWR. Because of the time-line, the plans could not be reviewed for assessment for Water Plan Update 2013.

Agricultural Water Management Plans

Agricultural Water Management plans are developed by water and irrigation districts to advance the efficiency of farm water management while benefitting the environment. New and updated Agricultural Water Management plans addressing several new requirements were submitted to DWR by December 31, 2012 for review and approval. These new or updated plans provide another avenue for local groundwater management, but because of the time-line, the plans could not be reviewed for assessment for Water Plan Update 2013.

Box SJR-3 Evaluation of Water Management Vulnerabilities — San Joaquin River Region

The CWP is evaluating how implementing alternative mixes of resource management strategies could reduce the Central Valley vulnerabilities. Management response packages are each comprised of a mix of resource management strategies selected from Volume 3 and implemented at investment levels and locations, as described in the Plan of Study (see Volume 4, Reference Guide, the article "Evaluating Response Packages for the California Water Plan Update 2013, Plan of Study").

Results are presented here for the San Joaquin River region evaluated over 198 combinations of future population growth and climate scenarios. The growth scenarios are defined in Table SJR-31. Future climate conditions were evaluated over 22 alternative climate scenarios including five derived from historical temperature are precipitation estimates, five from historical conditions with an added temperature trend, and twelve downscaled global climate model estimates described in Chapter 5, Volume 1. For each scenario, an assessment of water supply, demand, and unmet demand in the urban and agricultural sectors was performed. The model also reported on changes in groundwater and how frequently instream flow requirements were met.

Reliability, defined as the percentage of years in which demand is sufficiently met by supply, is one of several different ways the CWP summarizes the projections of future urban and agricultural conditions. For the San Joaquin River region, urban reliability is defined as the percentage of years for a given simulation in which 98% of urban demand is met with supply. Agricultural reliability is defined as the percentage of years in which 85% of agricultural demand is met with supply. Figure SJ-A shows the range of reliability results for both sectors in the San Joaquin River hydrologic region. In the figure, each dot indicates the reliability for one of the 198 simulations, but many of the dots overlap. The vertical lines indicate the half way point of each distribution, and the shaded areas indicate the results that fall within the middle half of the distribution (between the 25th and 75th percentiles). The figure clearly shows that reliability in the urban sector is high—all futures lead to reliabilities of greater than 95%. For the agricultural sector, however, reliability is below 95% in about half of the futures evaluated.

PLACEHOLDER Figure SJ-A Range of urban and agricultural reliability results across scenarios for the San Joaquin River region

Groundwater resources and environmental flows were evaluated for performance under the plausible futures. Figure SJ-B shows the change in groundwater storage from the present to 2050 across the 198 scenarios. About 77% of scenarios show slight increases in groundwater. Declines of up to about 5% are seen in the other 23% of futures.

PLACEHOLDER Figure SJ-B Range of change in groundwater storage across scenarios for the San Joaquin River region

Figure SJ-C summarizes how frequently the two San Joaquin River region instream flow requirements are met across the scenarios. Reliability for the Merced flow requirement exceeds 90% in almost all scenarios whereas reliability for the San Joaquin River below Friant Dam is lower, with the majority of scenarios leading to reliability between 70 and 80%.

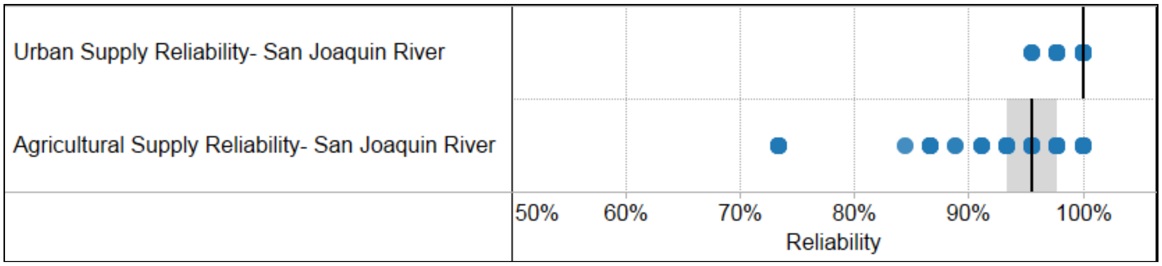
PLACEHOLDER Figure SJ-C Range of instream flow reliability for the San Joaquin River region across scenarios

The CWP next evaluated which future conditions would lead to low reliability in the San Joaquin River region. For the urban sector, reliability would exceed 95% in all of the scenarios evaluated. In the agricultural sector, however, 68 of the 198 scenarios (34%) would lead to low reliability. Using statistical analysis, the CWP identified that the most important factors driving low agricultural reliability outcomes is change in future precipitation and temperature. Futures in which the average precipitation in 2030-2050 is less than 4.8% of historical and average annual temperature from 2030-2050 is higher than 62.9 degrees Fahrenheit account for all the low reliability outcomes. Additionally, 84% of these futures would lead to low agricultural reliability. Figure SJ-D shows these results graphed against the temperature trend (vertical axis) and change from historical precipitation levels (horizontal axis) of each simulation. In this graph, Xs are those results that are less than 95% reliable and green Os are those that are more than 95% reliable. The color of the Xs indicates the reliability

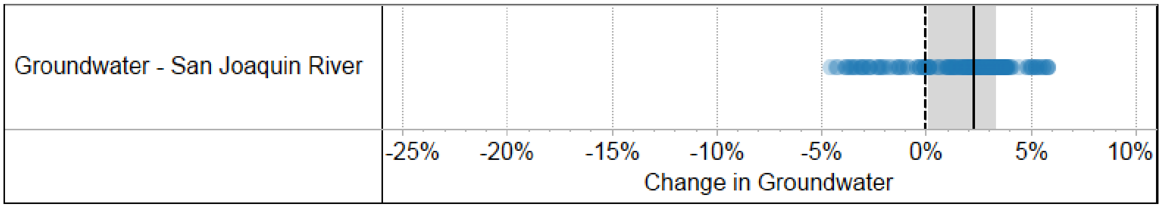
PLACEHOLDER Figure SJ-D Climate conditions leading to low agricultural reliability results in the San Joaquin River region

In summary, the San Joaquin River region is projected to be highly resilient to climate and demographic changes in the urban sector but less so in the agricultural sector. Groundwater storage is projected to change only modestly across the uncertain futures. Instream flows on the Merced River will maintain high reliability for most futures but be unreliable under all projections for the San Joaquin River. Supply in the agricultural sector will not reliably meet demand if future conditions are about 1 degree warmer than historical and more than 5% drier than historical.

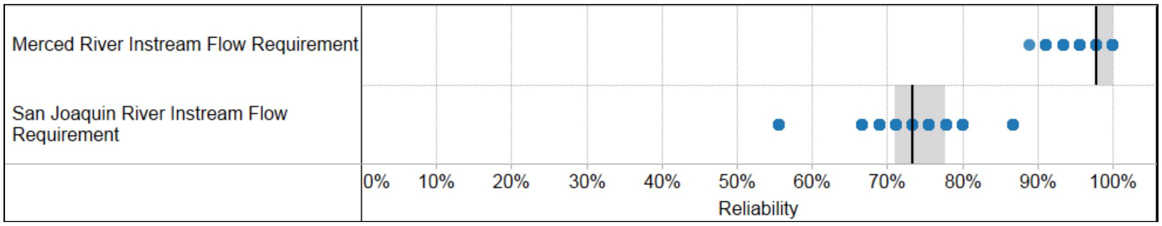
Box SJR-3 Figure SJR-A Range of Urban and Agricultural Reliability Results across Scenarios for the San Joaquin River Region



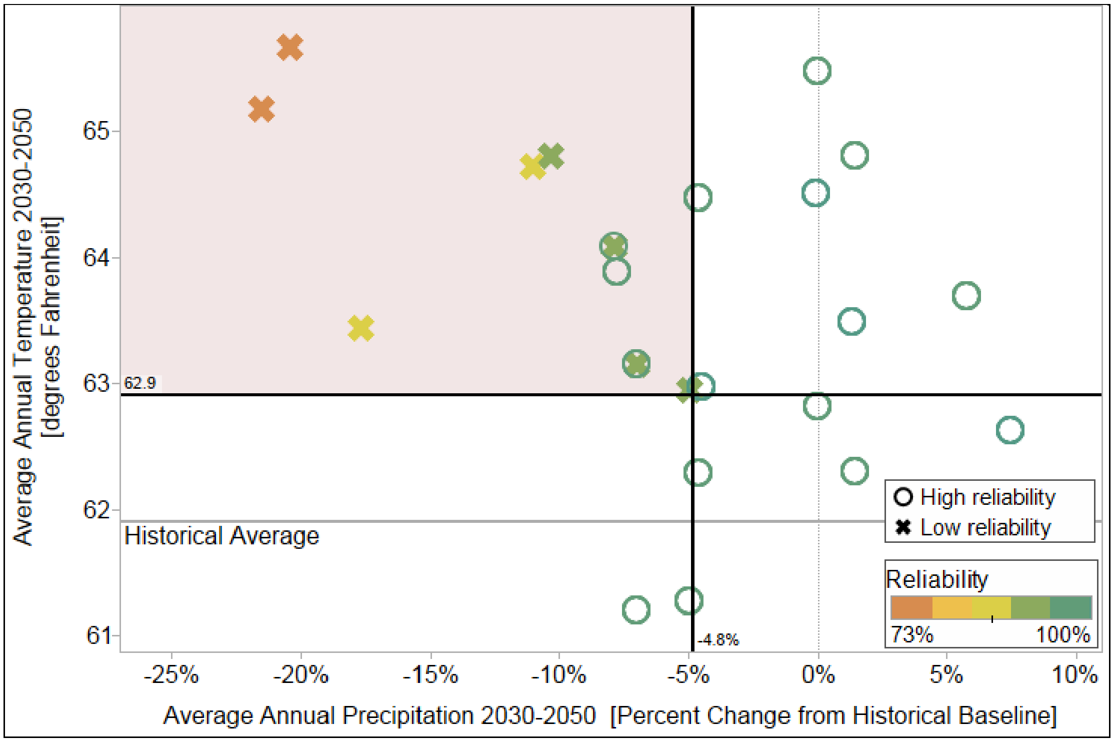
Box SJR-3 Figure SJR-B Range of Change in Groundwater Storage across Scenarios for the San Joaquin River Region



Box SJR-3 Figure SJR-C Range of Instream Flow Reliability for the San Joaquin River Region across Scenarios



Box SJR-3 Figure SJR-D Climate Conditions Leading to Low Agricultural Reliability Results in the San Joaquin River Region



Box SJR-4 Statewide Conjunctive Management Inventory Effort in California

The effort to inventory and assess conjunctive management projects in California was conducted through literature research, personal communication, and documented summary of the conjunctive management projects. The information obtained was validated through a joint DWR-ACWA survey. The survey requested the following conjunctive use program information:

1. Location of conjunctive use project;

2. Year project was developed;

3. Capital cost to develop the project;

4. Annual operating cost of the project;

5. Administrator/operator of the project; and

6. Capacity of the project in units of acre-feet.

To build on the DWR/ACWA survey, DWR staff contacted by telephone and email the entities identified to gather the following additional information:

7. Source of water received;

8. Put and take capacity of the groundwater bank or conjunctive use project;

9. Type of groundwater bank or conjunctive use project;

10. Program goals and objectives; and

11. Constraints on development of conjunctive management or groundwater banking (recharge) program.

Statewide, a total of 89 conjunctive management and groundwater recharge programs were identified. Conjunctive management and groundwater recharge programs that are in the planning and feasibility stage are not included in the inventory.