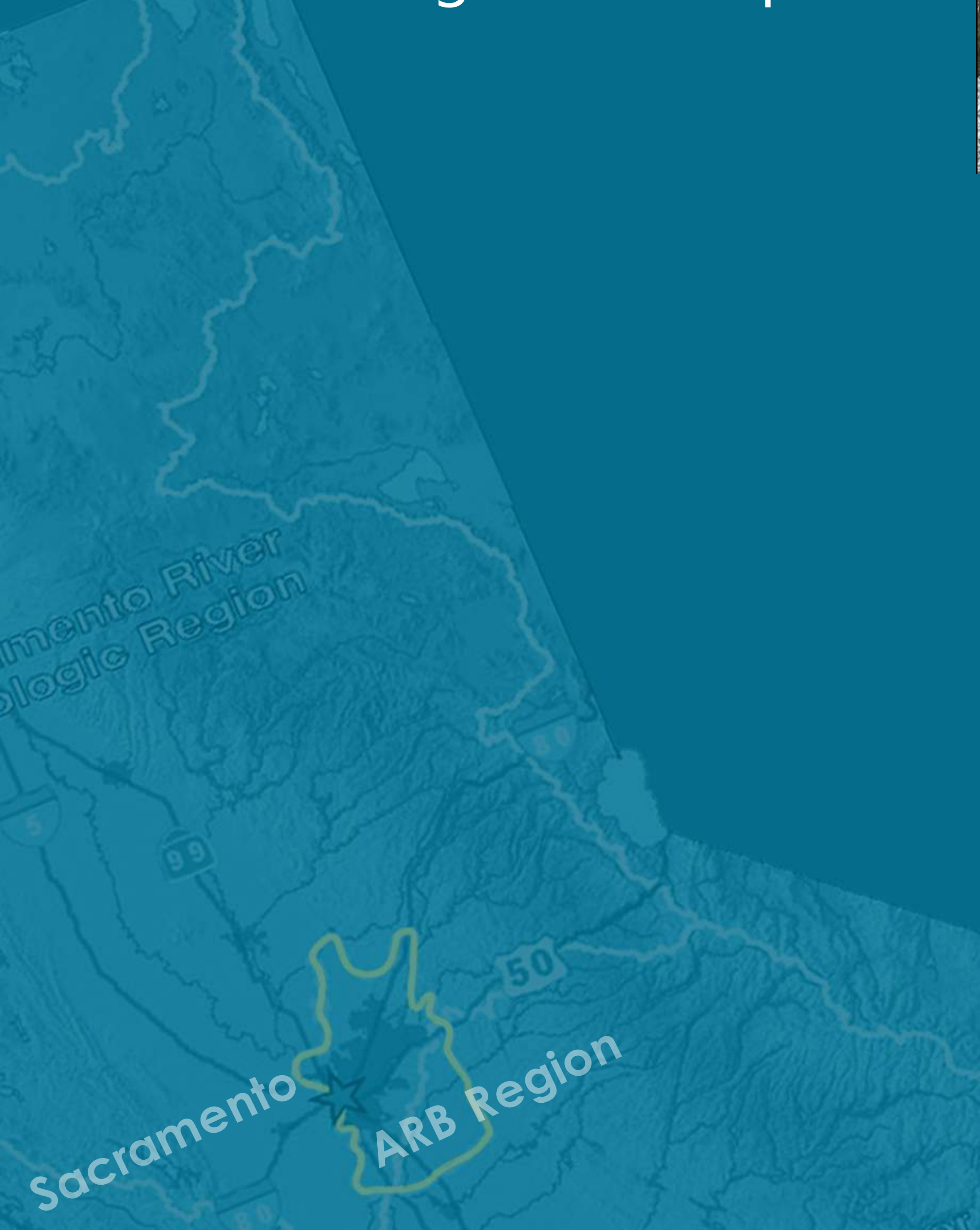
Section 2
Region Description



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Abbreviations and Acronyms

°C	degrees Celsius
°F	degrees Fahrenheit
µg/L	micrograms per liter
ABCW	American Basin Council of Watershed
AC/CC	Auburn Ravine/Coon Creek
ADWF	average dry weather flow
Aerojet	Aerojet General Corporation
AF	acre-feet
AFB	air force base
AFY	acre-feet per year
ARB	American River Basin
ARFCD	American River Flood Control District
ASR	Aquifer Storage and Recovery
ATP	Antelope Transmission Pipeline
Auburn	City of Auburn
BMO	basin management objective
BMP	Best Management Practice
CABY	Cosumnes/American/Bear/Yuba
Cal-Am	California American Water
CALFED	CALFED Bay-Delta Program
CASGEM	California Statewide Groundwater Elevation Monitoring
CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
CFW	Camp Far West
CHWD	Citrus Heights Water District
CRP	Cosumnes River Preserve
CrVI	hexavalent chromium
CSA	Central Service Area
CTP	Cooperative Transmission Pipeline
CUWCC	California Urban Water Conservation Council
CVP	Central Valley Project
CVPPP	Central Valley Flood Protection Plan
CWC	California Water Code
CWD	Carmichael Water District
DAC	disadvantaged community
DDT	dichlorodiphenyltrichloroethane
Delta	Sacramento-San Joaquin River Delta
DMM	Demand Management Measure
DWR	California Department of Water Resources
E. coli	Escherichia coli
EBMUD	East Bay Municipal Utility District
EGWD	Elk Grove Water District
EID	El Dorado Irrigation District
Elk Grove	City of Elk Grove
EPA	U.S. Environmental Protection Agency
ERP	ecosystem restoration plan
FCWCD	Flood Control and Water Conservation District
FEMA	Federal Emergency Management Agency

FloodSAFE	FloodSAFE California
FMS	Flow Management Standard
Folsom	City of Folsom
FOWD	Fair Oaks Water District
FRWP	Freeport Regional Water Project
FVWC	Fruitridge Vista Water Company
Galt	City of Galt
GET	groundwater extraction and treatment
GHG	greenhouse gas
gpm	gallons per minute
GSA	groundwater sustainability agency
GSP	groundwater sustainability plan
GSWC	Golden State Water Company
GWTP	groundwater treatment plant
Handbook	Climate Change Handbook for Regional Water Planning
HCP	Habitat Conservation Plan
IPCC	Intergovernmental Panel on Climate Change
IRWM	integrated regional water management
IRWMP	Integrated Regional Water Management Plan
LID	low impact development
Lincoln	City of Lincoln
M&I	municipal and industrial
MCL	maximum contaminant level
MG	million gallons
mg/L	milligrams per liter
MGD	million gallons per day
MHI	median household income
MOU	Memorandum of Understanding
NAB RDCP	North American Basin Regional Drought Contingency Plan
NCMWC	Natomas Central Mutual Water Company
NDMA	n-nitrosodimethylamine
NID	Nevada Irrigation District
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NSA	North Service Area
OHWD	Omochumne-Hartnell Water District
OVWC	Orange Vale Water Company
PCB	polychlorinated biphenyl
PCE	tetrachlorethene
PCWA	Placer County Water Agency
PG&E	Pacific Gas and Electric
Placer Legacy	Placer County/Placer Legacy Program
POU	Place of Use
Rancho Cordova	City of Rancho Cordova
RD	Reclamation District
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
RFMP	Regional Flood Management Plan
RWMP	Regional Water Reliability Plan
SacIWRM	Sacramento Area Integrated Water Resources Model
SACOG	Sacramento Area Council of Governments

Sacramento	City of Sacramento
SAFCA	Sacramento Area Flood Control Agency
SARSAS	Save Auburn Ravine Steelhead and Salmon
SASD	Sacramento Area Sewer District
SB	Senate Bill
SCGA	Sacramento Central Groundwater Authority
SCWA	Sacramento County Water Agency
SD&FCC	storm drainage and flood control collection
SDAC	Severely Disadvantaged Communities
SGA	Sacramento Groundwater Authority
SGMA	Sustainable Groundwater Management Act
SJWD	San Juan Water District
SMD	Sewer Maintenance District
SMUD	Sacramento Municipal Utility District
SPFC	State Plan of Flood Control
SPMUD	South Placer Municipal Utilities District
SRA	Shaded Riverine Aquatic
SRCSD	Sacramento Regional County Sanitation District
SRWWTP	Sacramento Regional WWTP
SSA	South Service Area
SSMP	Sewer System Management Plan
SSQP	Sacramento Stormwater Quality Partnership
SSWD	Sacramento Suburban Water District
state	state of California
State Water Board	State Water Resources Control Board
SWMP	stormwater management plan
TAF	thousand acre-feet
TDS	total dissolved solids
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UV	ultraviolet
UWMP	urban water management plan
WD	Water District
WEP	Water Use Efficiency Program
WFA	Water Forum Agreement
WPC	Western Placer County Groundwater Management Plan Group
WRF	Water Reclamation Facility
WRPP	Water Recycling Pilot Program
WTP	Water Treatment Plant
WWTP	wastewater treatment plant
WWTRF	Wastewater Treatment and Reclamation Facility

2. REGION DESCRIPTION

This section describes the area encompassed by the American River Basin (ARB) Region, internal boundaries, and adjacent areas. Subsequently, the Region's economic trends and conditions are characterized with the discussion of trends in land use, demographics, and social and cultural makeup. An explanation of the water and environmental resources setting follows, which includes general information on climate; hydrology, water quality, habitat, and management of watersheds; and hydrogeology, water quality, and management characteristics of groundwater subbasins. This discussion is followed by stormwater and flood management systems; the discussion provides both a region-wide and local perspective on stormwater and floodwater management. The explanation of the water and wastewater systems lists the major water-related infrastructure, including water treatment and wastewater treatment plants of the Region. The following subsection on water demands and supplies first explores historic and projected demands as well as current demand management measures. The water supply description characterizes the Region's surface water, groundwater, and recycled water supplies, and explains water agencies' water supply portfolios and their projected future demands. The section ends with a discussion of the Region's vulnerabilities and adaptations to climate change.

The Region description section includes updated information from numerous local planning documents developed by government and local agencies within the Region, in addition to available descriptive data, such as population and hydrologic data. Examples of these documents include, for example, urban water management plans (UWMP), water master plans, and general plans. An explanation of technical analyses conducted in support of this section can be found in **Section 2.11**, and a list of references can be found in **Section 7**.

2.1. Regional Boundary

The Region encompasses Sacramento County and the lower watershed portions of Placer and El Dorado counties. **Figure 2-1** shows the Region along with the Water Forum Agreement (WFA) planning boundary and neighboring integrated regional water management (IRWM) regions. The Region boundary builds on this WFA history and boundary. Further, by designating the more urbanized portions of the greater Sacramento area within one IRWM region, the Region maximizes opportunities to integrate water resources management within areas facing relatively common challenges. The boundaries of the Region were defined by working directly with the organizations with water management authority to identify the most appropriate planning area.

In Sacramento County, nearly the entire county is included in the Region. At the recommendation of Sacramento County, the southeastern most portion of the county (referred to commonly as the "tail") was excluded. This area was excluded because it lies exclusively within the Sacramento-San Joaquin River Delta (Delta). This area has unique management issues that are beyond the scope of the ARB Integrated Regional Water Management Plan (IRWMP).

Previously, the western boundary of the Region was limited to the service area covered by the Placer County Water Agency (PCWA). This left a small area in western Placer County that was not covered by an IRWMP. In 2018, the Region boundary was extended west up to the boundary between Placer and Sutter Counties, incorporating the previously excluded western portion of Placer County. In eastern Placer County, PCWA recommended including its service area around the City of Auburn (Auburn), because of its proximity to Folsom Reservoir, the Sacramento Valley Groundwater Basin, and the Sacramento metropolitan area.

In El Dorado County, only the westernmost portion of the county is included. With the recommendation of El Dorado Irrigation District (EID), the area corresponding to the community of El Dorado Hills was included in the Region. This area was included because of its proximity to Folsom Reservoir, the Sacramento Valley Groundwater Basin, and the Sacramento metropolitan area.

2.2. Internal Boundaries

The Region includes numerous political subdivision boundaries, watershed boundaries, groundwater subbasin boundaries, groundwater sustainability agency boundaries, stormwater/floodwater management agency boundaries, water agency boundaries, and wastewater agency jurisdictional boundaries. Separate maps display each of these boundaries in the following subsections.

Table 2-1 below lists the various water management-related agencies in the Region. These agencies interact, cooperate, and occasionally have conflicting interests with one another, creating a complex water management landscape in the Region. **Table 2-1** presents organizations with at least one water management-related statutory authority and indicates the nature of that authority. Further information can be found in relevant subsections throughout **Section 2**. Most agencies and their general service areas can be located in at least one of the maps in **Figures 2-1** through **2-6**. Other nongovernmental water-related organizations exist in the Region, although they may not be listed here.

Table 2-1. Water-Related Agencies in the Region

Agency	Water-Related Activities			
	Water Supply/ Groundwater	Wastewater/ Recycled Water	Stormwater/ Flood Management	Land-Use Planning
American River Flood Control District			X	
California American Water*	X			
Carmichael Water District*	X			
Citrus Heights Water District*	X			
City of Auburn		X	X	X
City of Citrus Heights			X	X
City of Elk Grove			X	X
City of Folsom*	X	X	X	X
City of Galt	X	X	X	X
City of Lincoln*	X	X	X	X
City of Rancho Cordova			X	X
City of Rocklin			X	X
City of Roseville*	X	X	X	X
City of Sacramento*	X	X	X	X
Clay Water District	X			
Del Paso Manor Water District*	X			
El Dorado County	X		X	X
El Dorado Irrigation District*	X	X		
Elk Grove Water District*	X			
Fair Oaks Water District*	X			
Florin County Water District	X			
Freeport Regional Water Authority	X			
Fruitridge Vista Water Company*	X			
Galt Irrigation District	X			
Golden State Water Company*	X			
Natomas Central Mutual Water Company	X			
Omochumne-Hartnell Water District	X			
Orange Vale Water Company*	X			
Placer County*	X	X	X	X
Placer County Flood Control & Water Conservation District			X	
Placer County Resource Conservation District				X
Placer County Water Agency*	X			
Rancho Murieta Community Services District*	X	X	X	X
Reclamation District 1000			X	
Rio Linda/Elverta Community Water District*	X			
Sacramento Area Council of Governments				X
Sacramento Area Flood Control Agency			X	
Sacramento Area Sewer District		X		
Sacramento Central Groundwater Authority	X			

Table 2-1. Water-Related Agencies in the Region (contd.)

Agency	Water-Related Activities			
	Water Supply/ Groundwater	Wastewater/ Recycled Water	Stormwater/ Flood Management	Land-Use Planning
Sacramento County			X	X
Sacramento County Water Agency*	X		X	
Sacramento Groundwater Authority	X			
Sacramento Regional County Sanitation District*		X		
Sacramento Suburban Water District*	X			
San Juan Water District*	X			
South Area Water Council	X			
South Placer Utility District		X		
South Sutter Water District	X			
Southeast Sacramento County Agricultural Water Authority	X			
Tokay Park Water District	X			
Town of Loomis			X	X

Note:
* Agency is a member or an associate member of the RWA.
- City of West Sacramento and the City of Yuba are also associate members of the Regional Water Authority (RWA), whereas El Dorado County Water Agency and the Sacramento Municipal Utility District are associate members.

2.2.1. Municipality and County Boundaries

Figure 2-1 shows county, city, and town boundaries in the Region. Counties and municipalities are often involved in providing water supply, wastewater, and stormwater management services for their citizens. In cases where these services are not provided by these entities, special service districts assume these roles. During development of the ARB IRWMP, representatives from each of the municipalities or of special districts providing these services were engaged to ensure broad representation of water planning interests.

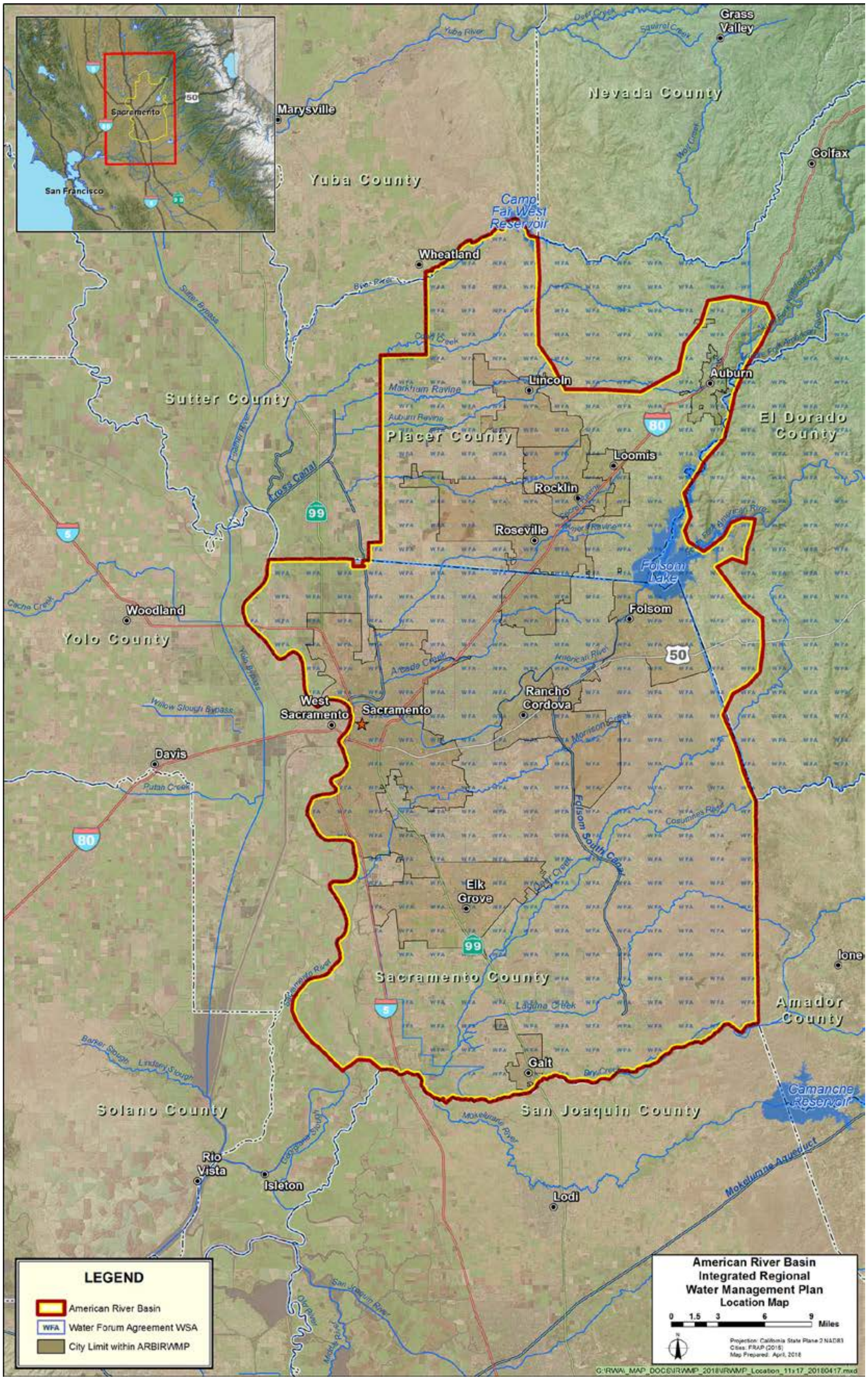


Figure 2-1. Municipal and County Boundaries in the Region

2.2.2. Watershed Boundaries and Surface Water Features

The Region lies in both the Sacramento and San Joaquin hydrologic regions and includes portions of six watersheds, as delineated by U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) datasets (see **Figure 2-2**). These watershed characteristics are described in **Section 2.6.2**. Key surface water bodies of the Region include Folsom Reservoir, the American River, the Sacramento River, and the Cosumnes River. These water bodies were integral in defining the Region, as they provide a substantial portion of the Region's water supply. These and other surface water bodies are shown in **Figure 2-2**. The portion of the Sacramento River that runs by the City of Sacramento (Sacramento) and Sacramento County acts as the western boundary of the Region. Also shown in **Figure 2-2** is the California Department of Water Resources (DWR) boundary between the Sacramento and San Joaquin hydrologic regions. The Region is part of both of these hydrologic regions, primarily because of past interaction with Sacramento County and the Water Forum.

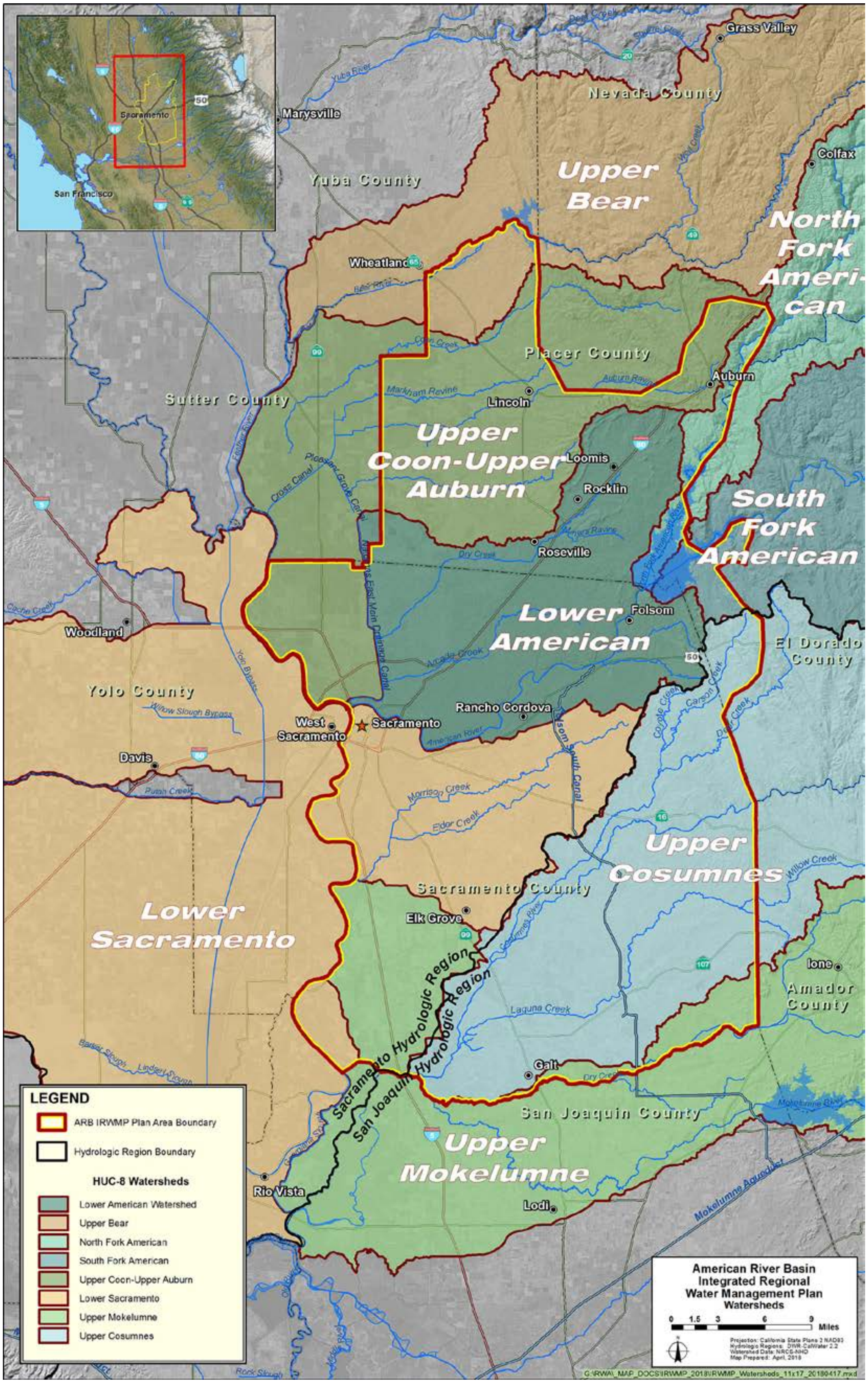


Figure 2-2. Watersheds and Surface Water Bodies

2.2.3. Groundwater Subbasin and Groundwater Sustainability Agency Boundaries

Most of the Region overlies the North American, South American, and the Cosumnes groundwater subbasins, as defined by DWR. The Sustainable Groundwater Management Act (SGMA) was adopted by California lawmakers in 2014. SGMA required, by June 30, 2017, the formation of locally-controlled groundwater sustainability agencies (GSA) in groundwater basins and subbasins (basins) designated as medium or high priority by DWR. The North American and South American subbasins are designated as high priority basins; the Cosumnes Subbasin is designated as medium priority. **Table 2-2** lists the twenty-six GSAs that have formed in the three subbasins.

Table 2-2. Groundwater Sustainability Agencies in the Region

Basin	Groundwater Sustainability Agencies
North American Subbasin	Sacramento Groundwater Authority West Placer Groundwater Sustainability Agency Sutter County** South Sutter Water District* Reclamation District 1001**
South American	Sloughhouse Resource Conservation District #1 Sloughhouse Resource Conservation District #2 Sacramento Central Groundwater Authority #1 Sacramento Central Groundwater Authority #2 Sacramento Central Groundwater Authority #3 Omochumne-Hartnell Water District County of Sacramento Reclamation District No. 2110** Reclamation District No. 551 Reclamation District No. 755 Reclamation District No. 744 Reclamation District No. 813 Reclamation District No. 369** Franklin Drainage District
Cosumnes	Galt Irrigation District Omochumne-Hartnell Water District Sloughhouse Resource Conservation District – Cosumnes Clay Water District Amador County Groundwater Management Authority** County of Sacramento City of Galt Groundwater Sustainability Agency

Notes:
*Partial overlap with ARB Region
**Outside of the ARB Region

Each GSA is responsible for developing and implementing a groundwater sustainability plan (GSP) or alternative to a GSP. These GSPs or alternative GSPs will assist groundwater basins in meeting sustainability goals. The primary goal is to maintain sustainable yields without causing undesirable results. Critically-overdrafted high- and medium-priority groundwater basins must be managed under a

GSP by January 31, 2020. All other basins designated as high- or medium-priory must be managed under a GSP by January 31, 2021.

A portion of the North American Subbasin extends outside the Region. As described in **Section 2.1**, the Region's boundary was modified in 2018 to incorporate the western area of Placer County that overlies the North American Subbasin (see **Figure 2-3**). The portion of the North American Subbasin within Sutter County is still outside of the Region. The Region recognizes the importance of coordinating with the GSAs and land use agencies to ensure that the North American Subbasin is sustainably managed. Therefore, the remaining area of the North American Subbasin outside the Region boundary has been identified as an "IRWM Coordination Zone." GSAs throughout the North American Subbasin will work together to monitor groundwater levels, collect data and assess the health of the Subbasin. Participating Agencies in the North American Subbasin will also consider the effect a project or program may have on the whole Subbasin and work with GSAs in the IRWM Coordination Zone to identify actions that contribute to the Subbasin's sustainability.

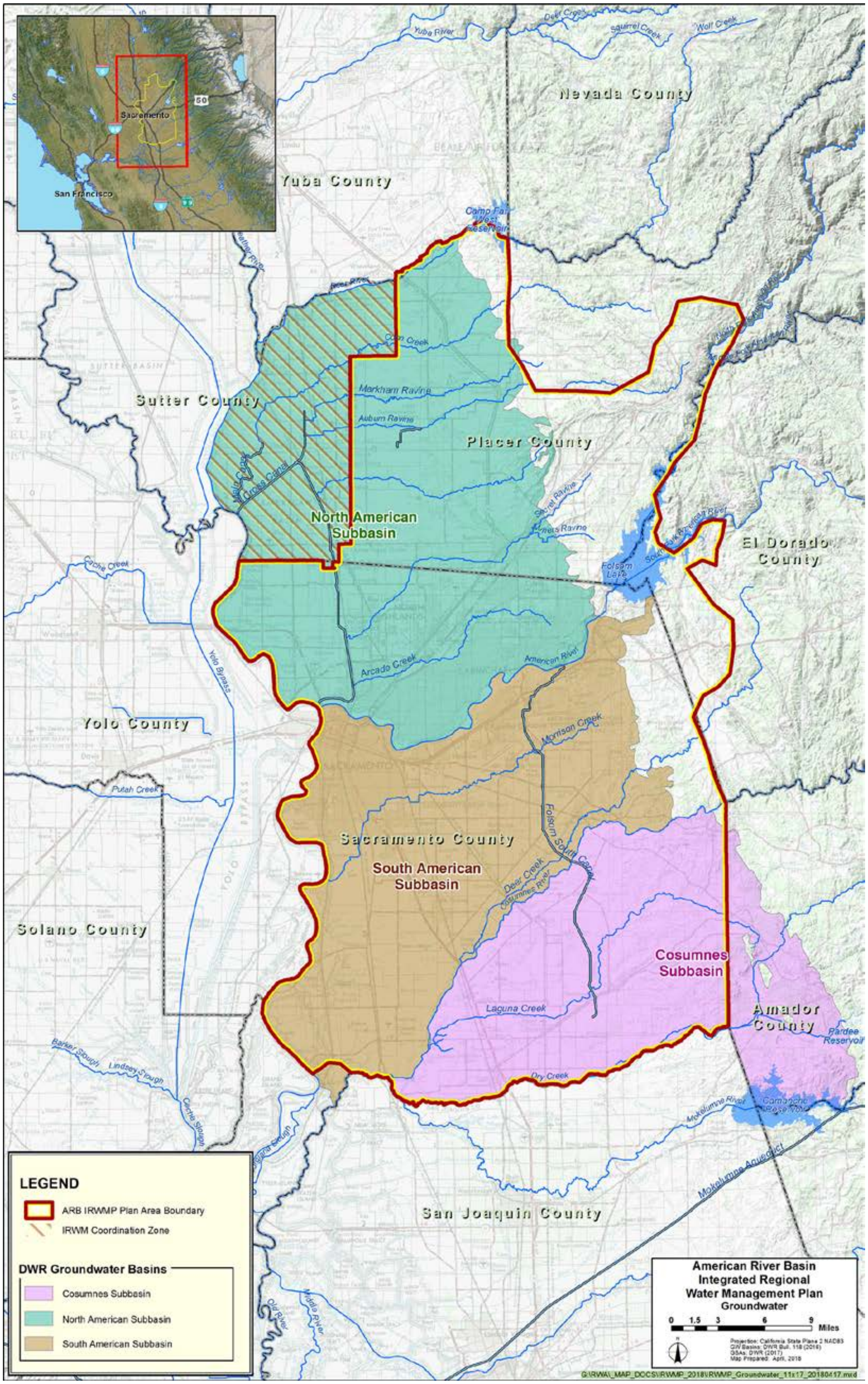


Figure 2-3. Groundwater Subbasins

2.2.4. Stormwater and Flood Management Agency Boundaries

Stormwater and flood management boundaries follow both city boundaries and flood-specific agency boundaries. Flood agencies in the Region include Reclamation District (RD) 1000, the American River Flood Control District (ARFCD), and the multiagency Sacramento Area Flood Control Agency (SAFCA). SAFCA boundaries include Sacramento and Sacramento County, but also include agricultural areas outside of the Region boundaries such as the Natomas Basin and Sutter County. Cities in the Region are responsible for their respective stormwater management systems. **Figure 2-4** shows stormwater and flood management agency jurisdictional boundaries as well as the Federal Emergency Management Agency (FEMA) 100-year floodplain.

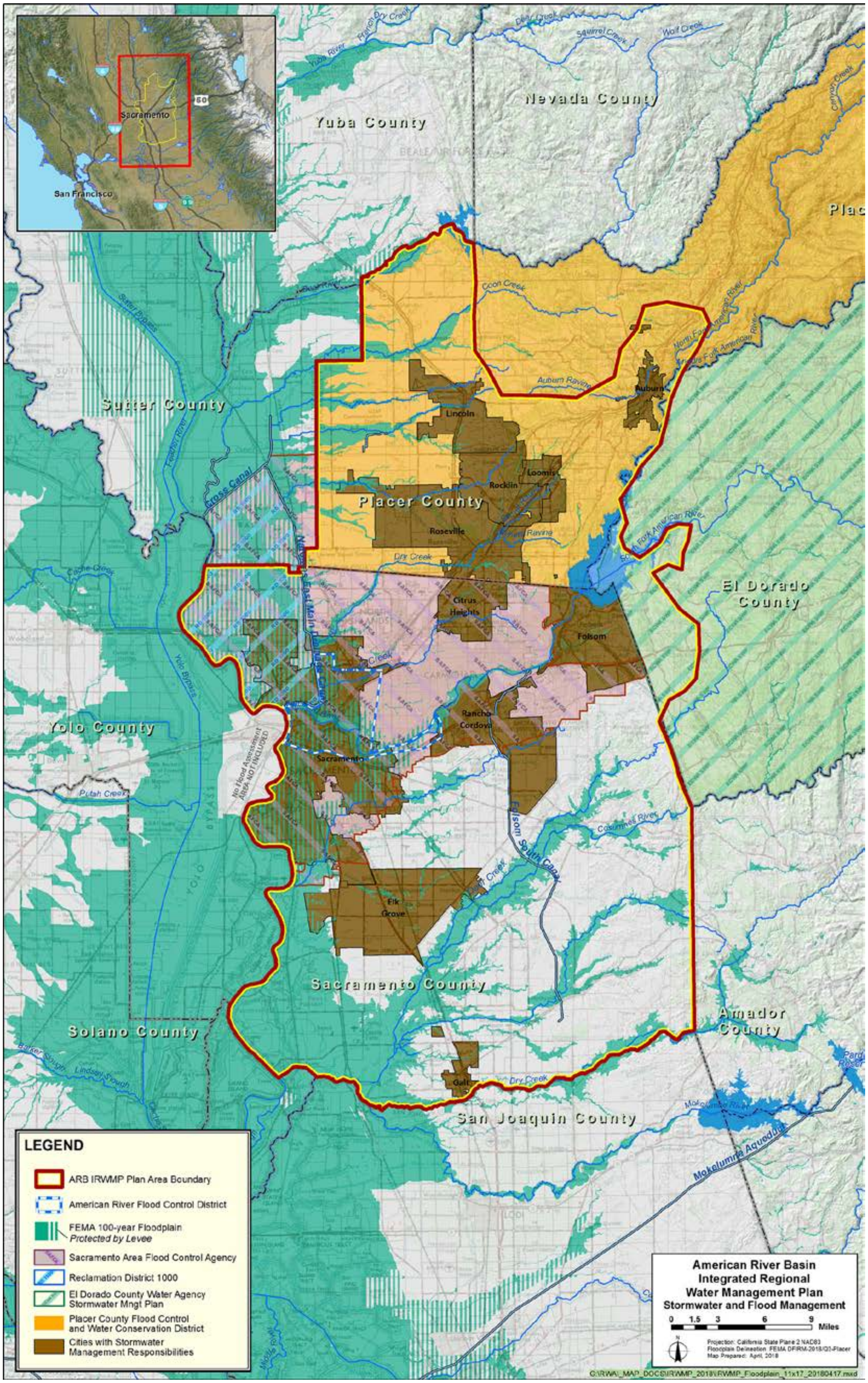


Figure 2-4. Stormwater and Flood Management Areas

2.2.5. Water Agency Boundaries

Each water agency in the Region is identified in **Figure 2-5**. As illustrated in **Figure 2-5**, there are 28 agencies with water delivery authority identified in the vicinities of Sacramento County, western Placer, and El Dorado counties. One agency identified, South Sutter Water District (WD), has part of its service area included in the Region, including Camp Far West (CFW) Reservoir, owned and operated by South Sutter WD, on the northernmost Region border. Of the agencies shown on the map, 21 are primarily public water suppliers, five are primarily agricultural irrigation districts, two (PCWA and EID) supply both public supply and raw water supply for agriculture, and one (Sacramento Municipal Utility District [SMUD]) provides water for nonpotable uses at the former Rancho Seco Nuclear Generating Station. This nuclear station has been decommissioned and is now operated as a regional recreational park, including a 160-acre lake.

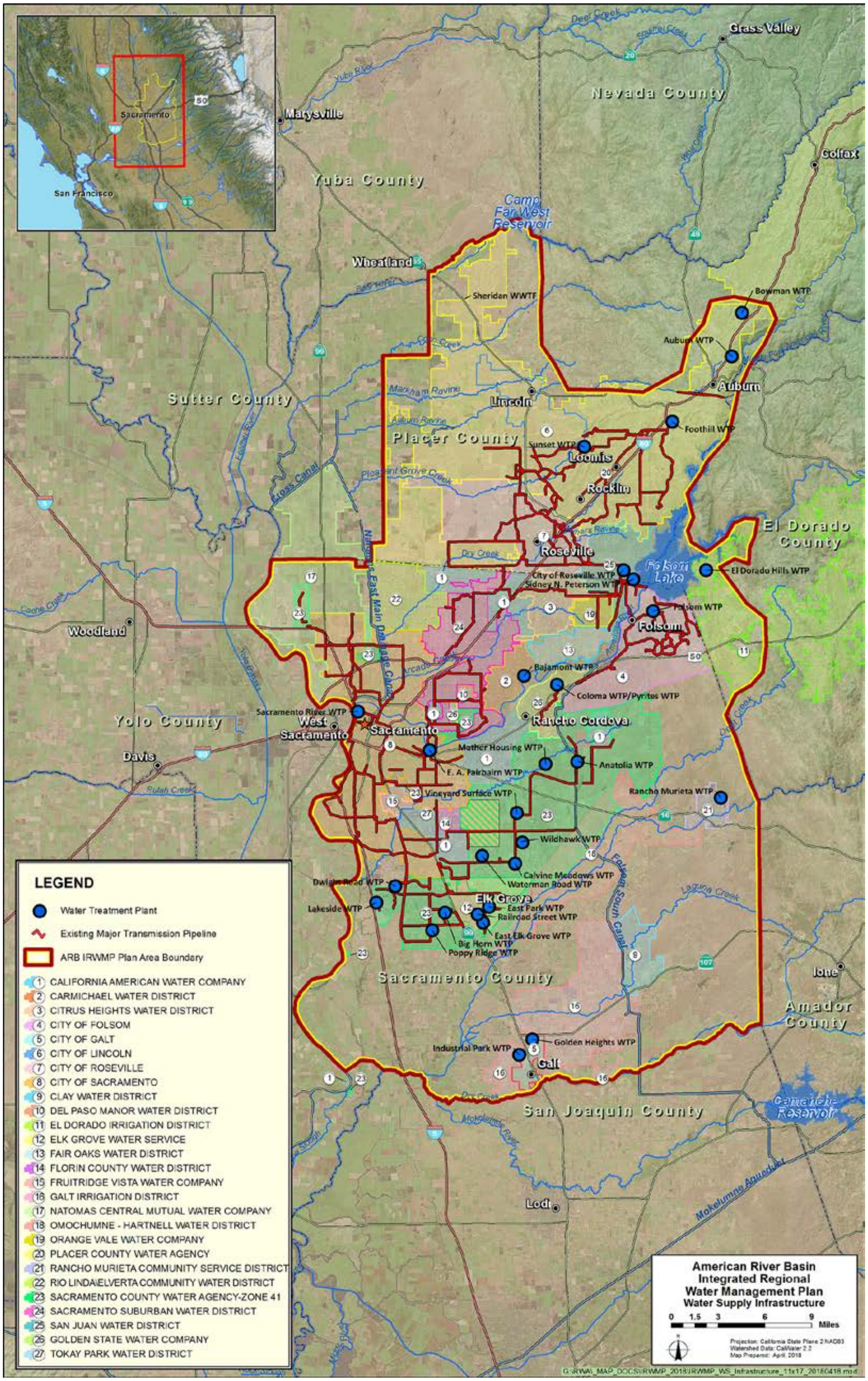


Figure 2-5. Water Agency Boundaries

2.2.6. Wastewater Agency Boundaries

Incorporated cities, the South Placer Utility District, and Placer County provide wastewater sewer systems as well as wastewater treatment plants (WWTP) in Placer County. Sacramento Regional County Sanitation District (SRCSD) collects and treats wastewater regionally, and from most of the urbanized areas in and immediately surrounding Sacramento County. El Dorado Hills in El Dorado County is served by EID and its WWTP. These boundaries are shown in **Figure 2-6**.

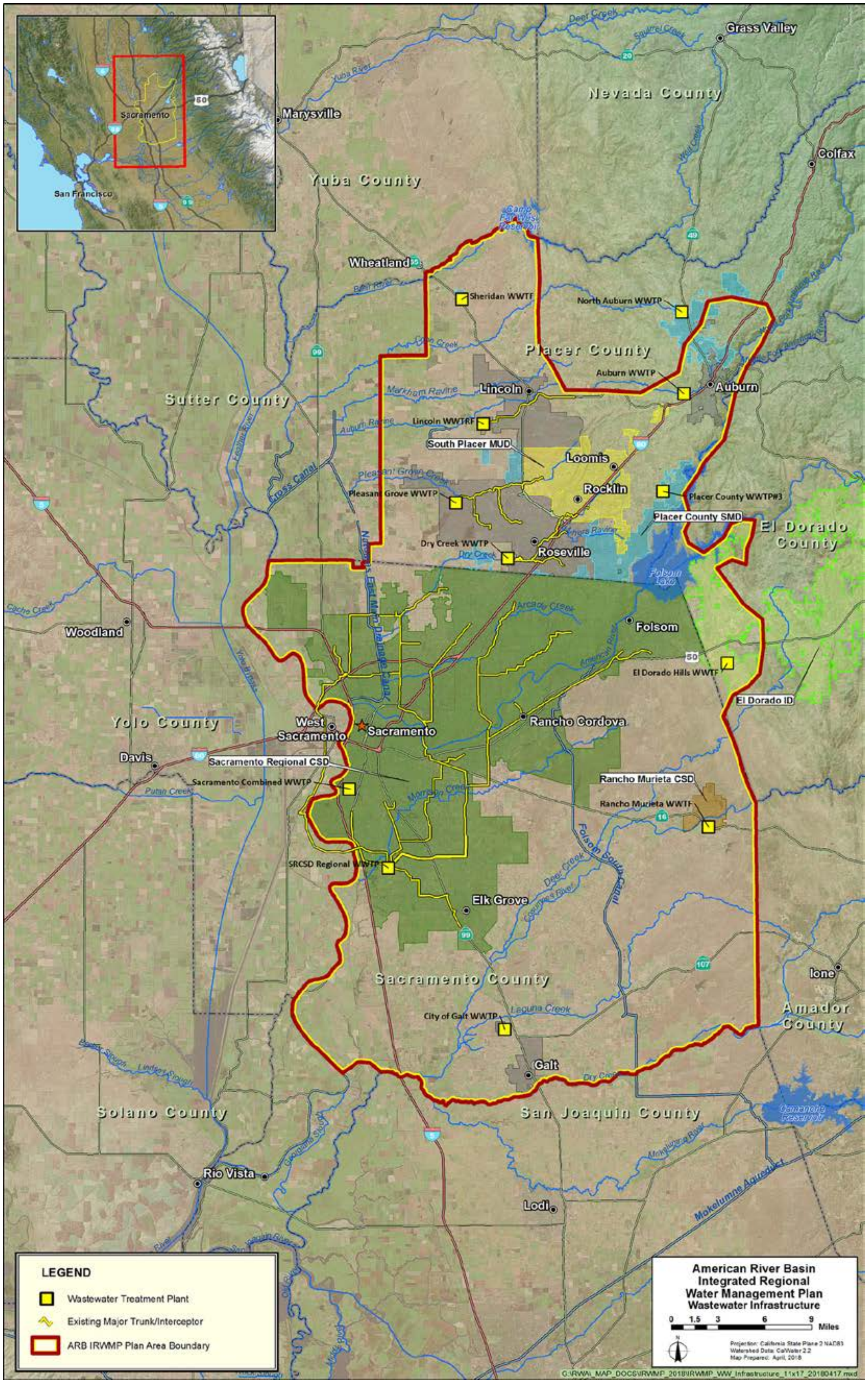


Figure 2-6. Wastewater Agency Jurisdictional Areas

2.3. Relationship to the Sacramento-San Joaquin Delta

A small portion of the Region's southwestern corner is in the legally-defined Delta, as shown in **Figure 2-7**. Approximately 66 square miles of the Delta are included in the ARB's overall 1,233-square-mile area. The vast majority of the Region does not receive water supplied from the Delta.

The single point of diversion in the Region located in the Delta is the intake facility for the Freeport Regional Water Project (FRWP) on the Sacramento River just south of the Pocket area of Sacramento, near the community of Freeport. The FRWP emerged as a collaborative and more environmentally sensitive solution for the delivery of water. A series of lawsuits dating back to 1972 prevented a diversion off the American River near Lake Natoma by East Bay Municipal Utility District (EBMUD). The controversy began in 1970 when U.S. Department of the Interior, Bureau of Reclamation (Reclamation), issued a water supply contract to EBMUD. After decades of litigation, Sacramento County Water Agency (SCWA) and EBMUD agreed to partner on a joint 185 million-gallon-per-day (MGD) intake at a location on the Sacramento River that would ensure critical flows to support habitat and species on the American River were preserved. EBMUD has 100 MGD of the intake capacity for use in dry years. SCWA has 85 MGD of the intake capacity.

Because the EBMUD portion of the project is an alternative diversion point for a water supply contract initially issued on the American River, this is not considered as receiving water supplied from the Delta. The nature of SCWA's water rights and uncertainty about future operations of the FRWP create less certainty as to whether this part of the project receives water that would be defined as being supplied from the Delta. To address this uncertainty, the ARB IRWMP has developed several strategies (as described in **Section 5**) that will both help reduce dependence on Delta water supply and provide other significant benefits to the Delta:

- Surface water treatment capacity, groundwater treatment capacity, and system interconnections in the Region will be increased. These actions will allow expansion of regional conjunctive use operations, using more groundwater in drier conditions and leaving more surface water in the system.

- Per capita water use in the Region will be reduced by 20 percent by year 2020.

- Recycled water use in the Region will be increased.

- Functional wetland and riparian habitat in the Region will be restored to help improve conditions for species dependent on the Delta.

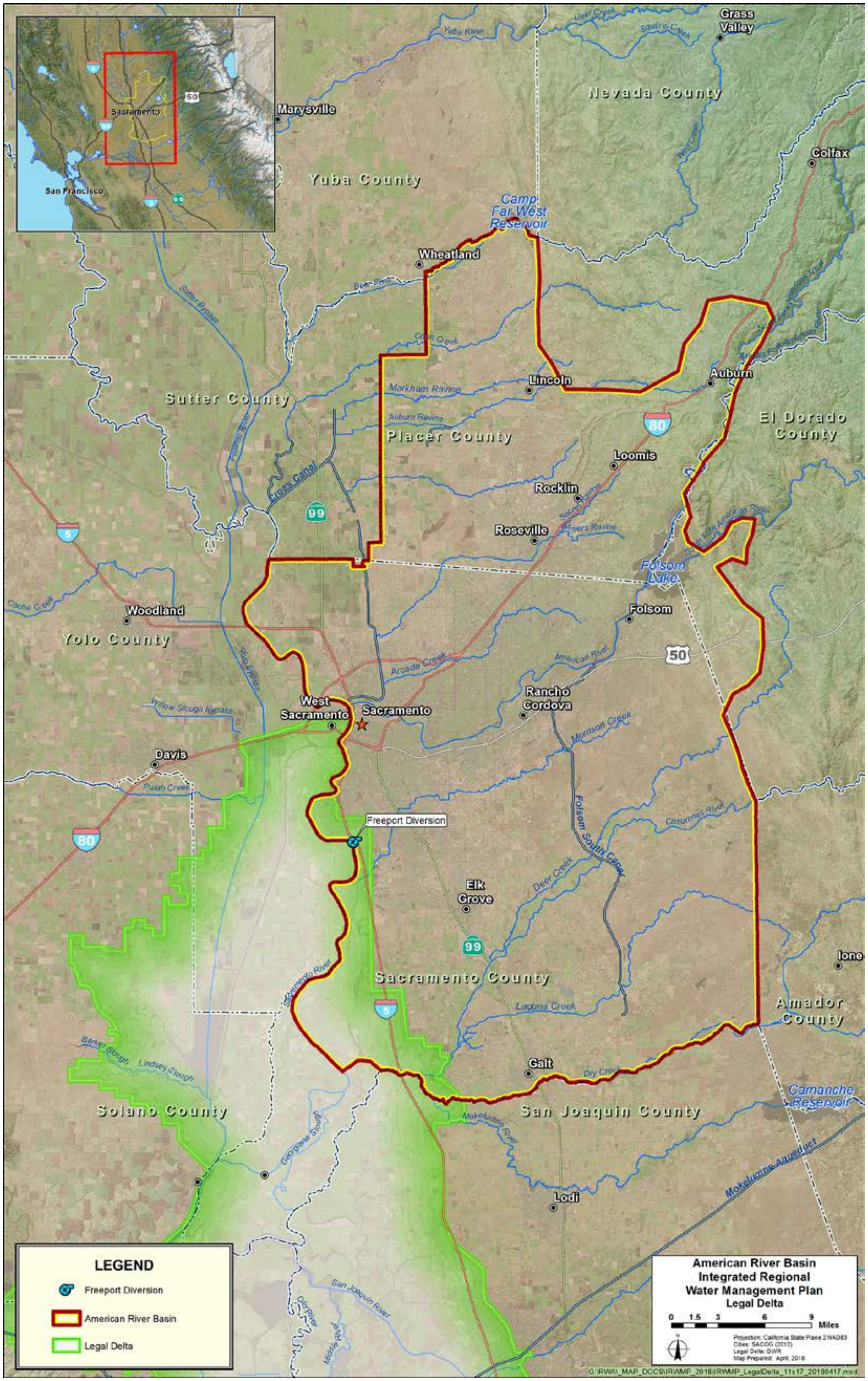


Figure 2-7. Legal Delta and Region

2.4. Adjacent Areas

The areas adjacent to the Region include Yolo, Sutter, Yuba, and San Joaquin counties. Adjacent IRWM regions include the Cosumnes/American/Bear/Yuba (CABY) Region, Westside (Yolo, Solano, Napa, Lake, Colusa) Region, North Sacramento Valley Region, Mokelumne/Amador/Calaveras Region, Yuba County Region, and Eastern San Joaquin Region. **Figure 2-8** displays the adjacent IRWM planning regions. Interregional coordination and relationships with these adjacent IRWM regions are described in **Section 3.4**.

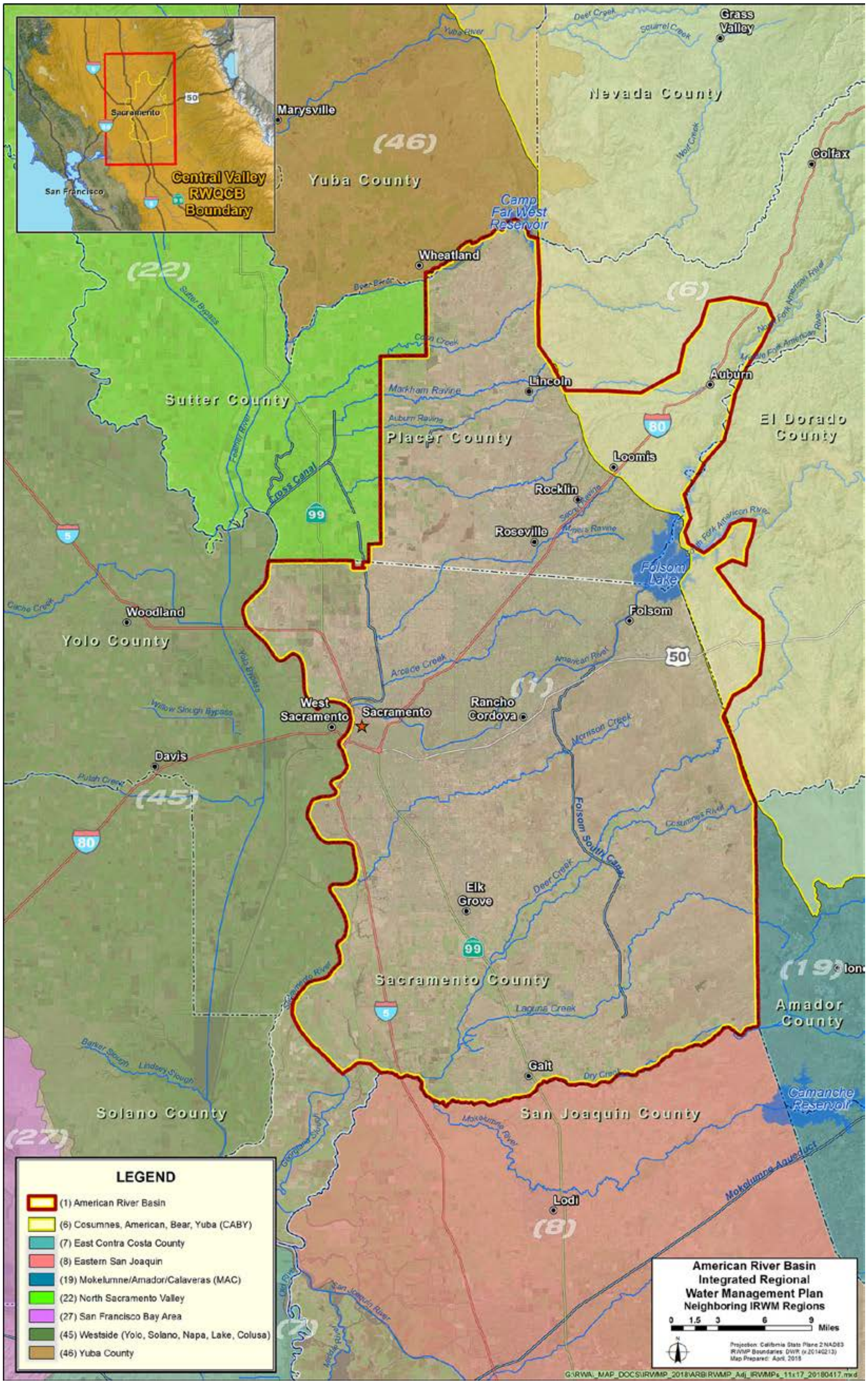


Figure 2-8. Neighboring IRWM Regions

2.5. Regional Economic Conditions and Trends

This subsection describes the economic, demographic, and development trends of the Region. These trends provide a context for and help portray and justify the water resources-specific needs and concerns, characterized in the remainder of **Section 2**.

This subsection reflects information gathered from a variety of sources and agencies. Land-use data are from the U.S. Department of Agriculture. Population and growth projection data are from Sacramento Area Council of Governments[1] (SACOG). Regional income, ethnic makeup, and disadvantaged communities (DAC) descriptions are derived from U.S. Census data. Employment data are from the California Employment Development Department, and housing and population data are from the Demographic Research Unit of the California Department of Finance, which is the official source of demographic data for State of California (state) planning and budgeting. Finally, agricultural and urban land-use and growth data are from California Department of Conservation.

The Region encompasses Sacramento County, the western portion of Placer County, and the El Dorado Hills portion of El Dorado County. There are multiple overlapping jurisdictional boundaries, primarily at the county level in the ARB. These data are included in this report when it refers to counties, unless otherwise noted. Data are disaggregated for the ARB-specific region, where possible. The higher elevation portions of Placer and El Dorado counties and other adjacent geographies are part of the CABY Region. The Region's working relationship and coordination efforts with CABY are described in **Section 3.4.2**.

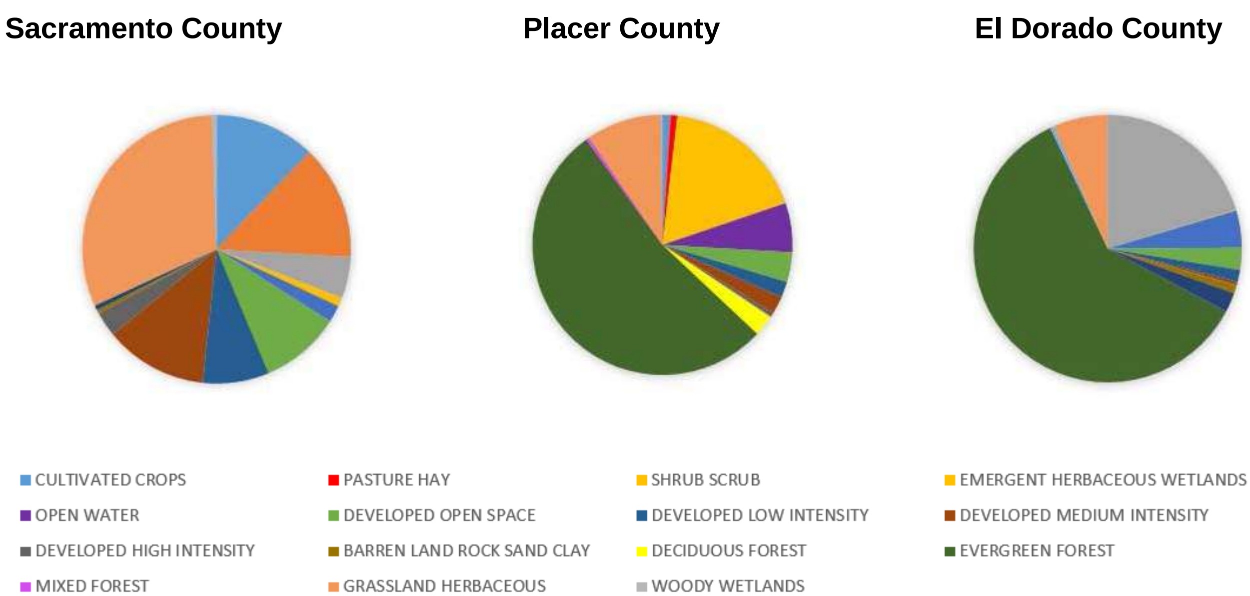
2.5.1. General Land-Use Information

The Region has historically supported agriculture, with the City of Sacramento located at the confluence of the American and Sacramento rivers serving as regional hub (and state capital) since the gold rush era. In the past several decades, urban and residential development have spread from Sacramento proper outward—upstream and easterly, along the American River toward Folsom and El Dorado Hills; north into the Natomas Basin and western Placer County, and south along Interstate 5 and Highway 99 through City of Elk Grove (Elk Grove) toward the City of Galt (Galt). The Region is defined in part by the extent of planned urban boundaries.

[1] SACOG demographic and land-use data and projections are cited in this subsection, as these are the data used by planning agencies in this region. An association of local governments, SACOG plans and funds regional transportation for the six-county Sacramento region, which includes Sacramento, Placer, El Dorado, Yuba, Sutter, and Yolo counties. SACOG data exclude the Tahoe Basin region of El Dorado and Placer counties.

Figure 2-9 shows the pattern of urban development in the Region. The land uses in Sacramento County are a mix of urban and agriculture. While Placer and El Dorado counties have significant urban areas in the lower elevations, agricultural and forest products are the predominant land uses in the remainder of these counties. The total land area encompassed by Sacramento, Placer, and El Dorado counties is approximately 2.7 million acres. The Region consists of the western, downstream, and more developed half of this area, as Sacramento County accounts for approximately 629 thousand acres—a fraction of the three-county area. While data for El Dorado and Placer counties are reported, Sacramento County's land-use breakdown is the most representative overall for the Region, given overlaps and land uses.

A more detailed discussion on the trends in farmland conversion in the Region can be found in **Section 2.5.6.2**.



Data Source: 2017 Cropland Data Layer, USDA National Agricultural Statistics Service

Figure 2-9. 2017 Land Use by County

2.5.2. Population

Following World War II, the population of California increased steadily and in some cases explosively, particularly in Southern California. Similarly for the Sacramento area, the Cold War era, the Korean War and Vietnam War brought employment opportunities in manufacturing and at nearby defense installations, attracting tens of thousands of people to the Region. The population of the Region continues to increase for many reasons, partially for economic opportunities, described in **Section 2.5.3**, available affordable housing, described in **Section 2.5.5**, quality of life, and recreational opportunities. **Table 2-3** summarizes the 2010 and 2016 population by county and highlights larger cities in the Region.

Table 2-3. 2010 and 2016 Population by Area

Area	2010 Population	2016 Population Estimates
El Dorado County	181,058	184,371
Placer County	348,432	376,203
City of Lincoln	42,819	47,268
City of Roseville	118,788	133,618
City of Rocklin	56,974	61,672
Town of Loomis	6,430	6,715
City of Auburn	13,330	14,066
Sacramento County	1,418,788	1,496,619
City of Sacramento	466,488	486,111
City of Citrus Heights	83,301	86,372
City of Elk Grove	153,015	168,118
City of Folsom	72,203	77,310
City of Rancho Cordova	64,776	72,267
Total (3-County Region)	1,948,278	2,057,193

Data Source: California Department of Finance (2018).

Based on data collected by SACOG in 2018 the Region's population is expected to continue growing significantly between 2012 and 2035. Sacramento County is expected to grow about 34 percent between 2012 and 2035, Placer County is expected to grow about 48 percent, and El Dorado County is expected to grow about 26 percent. As a whole, the three-county region (excluding the Tahoe Basin) is expected to grow about 35 percent. These overall projections apply directly to the Region. The projected increase in population demonstrates a continued and increasing need throughout the Region to examine and maintain reliable water resources, supporting infrastructure and management systems. The SACOG growth projections are presented in **Table 2-4**.

Table 2-4. SACOG Population Projections by County

Area	2012	2020	2035
Sacramento	1,402,302	1,517,200	1,879,302
Placer	346,984	397,250	512,043
El Dorado	151,639	165,523	191,549

Data Source: SACOG 2018.

2.5.3. Employment

Employment in the Region consists primarily of service sector employment, as shown in **Tables 2-5** through **2-7**. State and federal governments are also large employers in the Sacramento area. The number employed in Sacramento County is four times that of Placer County and thirteen times of that of El Dorado County. This pattern portrays that the greater Sacramento area serves as the hub for economic opportunities.

Sacramento, Placer, and El Dorado counties have experienced economic growth during the last five years. This growth is consistent with statewide and national trends in employment statistics following the economic recession and downturn. From 2010 to 2016, all three counties experienced annual decreases in unemployment rates, with 2016 employment rates in the single digits. The total number of jobs has increased by about 15 percent in the three counties since 2010. A description of employment and economic conditions of the Region is important for the public as a whole, but also for those agencies that serve them. After multiple years of increasing employment and corresponding housing demand, water-related projects in the Region have slowly increased.

Table 2-5. Sacramento County Employment Summary

Year	Total Jobs	Agriculture	Goods Production	Services	Unemployment Rate
2005	600,600	2,700	76,900	521,100	5.0%
2006	614,700	2,700	68,800	543,100	4.8%
2007	615,200	2,900	65,200	547,000	5.4%
2008	599,900	2,700	57,200	540,000	7.2%
2009	567,500	2,700	47,500	517,300	11.3%
2010	550,400	2,600	42,900	504,900	12.7%
2011	543,800	2,600	42,500	498,800	12.1%
2012	576,600	2,600	44,900	529,000	10.5%
2013	587,600	2,600	48,100	537,000	8.9%
2014	599,800	2,600	49,900	547,300	7.3%
2015	621,300	2,700	51,900	566,700	6.0%
2016	644,000	2,000	54,300	587,500	5.4%

Data Source: California Department of Employment Development 2018

Table 2-6. Placer County Employment Summary

Year	Total Jobs	Agriculture	Goods Production	Services	Unemployment Rate
2005	137,300	600	26,100	110,600	4.3%
2006	140,100	400	25,100	114,600	4.2%
2007	140,400	300	23,300	116,700	4.8%
2008	136,900	400	20,300	116,200	6.4%
2009	126,300	300	16,300	109,600	10.4%
2010	126,200	300	15,100	110,900	11.5%
2011	126,500	400	14,500	113,400	10.8%
2012	133,700	300	14,900	118,500	9.4%
2013	141,400	400	16,000	125,000	7.7%
2014	146,400	300	16,800	129,300	6.3%
2015	153,300	300	18,800	133,200	5.0%
2016	160,000	300	20,600	139,100	4.4%

Data Source: California Department of Employment Development 2018

Table 2-7. El Dorado County Employment Summary

Year	Total Jobs	Agriculture	Goods Production	Services	Unemployment Rate
2005	51,300	400	7,800	43,100	4.8%
2006	52,700	400	8,100	44,200	4.6%
2007	53,500	400	8,200	45,000	5.2%
2008	52,200	300	7,200	44,700	6.9%
2009	48,700	300	5,300	43,100	11.1%
2010	47,100	300	4,700	42,100	12.4%
2011	46,100	200	4,500	41,400	11.8%
2012	48,200	400	4,700	43,200	10.2%
2013	50,000	500	5,100	44,500	8.5%
2014	50,900	500	5,300	45,100	7.0%
2015	48,900	500	6,300	42,100	5.7%
2016	46,800	300	6,800	39,800	5.1%

Data Source: California Department of Employment Development 2018

2.5.4. Income

This subsection summarizes household income as it relates to economic conditions of the Region. Economic trends relating to household income are discussed, along with information about disadvantaged communities within the Region. Along with employment, household income is an indicator of the capacity of the local economy and local agencies to invest in necessary water resources, infrastructure, and services.

2.5.4.1. Regional Income Data

The median household income increased for all counties when compared to the median household income as reported in the 2010 U.S. Census (in 2010 dollars). **Table 2-8** shows the median household income for the three-county Region as reported in the U.S. Census 2000 report, 2010 report, and 2016 estimates.

Table 2-8. Regional Median Income Data

Year	El Dorado	Placer	Sacramento
2000 (1999 dollars)	$51,484	$57,535	$43,816
2010 (2010 dollars)	$66,129	$67,884	$52,709
2016 (2016 dollars)	$72,586	$76,926	$57,509

Source: U.S. Census Bureau 2000, 2010b, 2016c

2.5.4.2. Disadvantaged Communities

A DAC is defined as a community with an annual median household income (MHI) less than 80 percent of the statewide annual MHI. According to data from the American Community Survey for the years 2010-2014, $49,191 is 80 percent of the statewide MHI. In addition, those census geographies having an annual MHI that is less than 60 percent of the statewide annual MHI are shown as "Severely Disadvantaged Communities" (SDAC). Region census tracts are small, relatively permanent statistical subdivisions of a given county that are designed to be relatively homogeneous units with respect to population characteristics, economic status, and living conditions.

The downloaded data are presented in **Figure 2-10** and summarized in **Table 2-9**. Census tracts do not precisely coincide with the Region boundary. The data presented in **Table 2-9** include all tracts that overlap the Region, and thus slightly overestimate the total population. The data show that slightly less than 30 percent of the population lives in DACs. See Appendix E, for information on the demographics of DACs and how the Region involved DACs in developing this IRWMP.

Table 2-9. Disadvantaged Community Data

Total Population of Census Tracts Overlapping the Region	Total Population of DAC Census Tracts	Percentage of Population Living in DACs
1,738,876	502,938	28.9

Source: U.S. Census Bureau 2010 as presented by DWR 2013a

Key
DAC = disadvantaged community

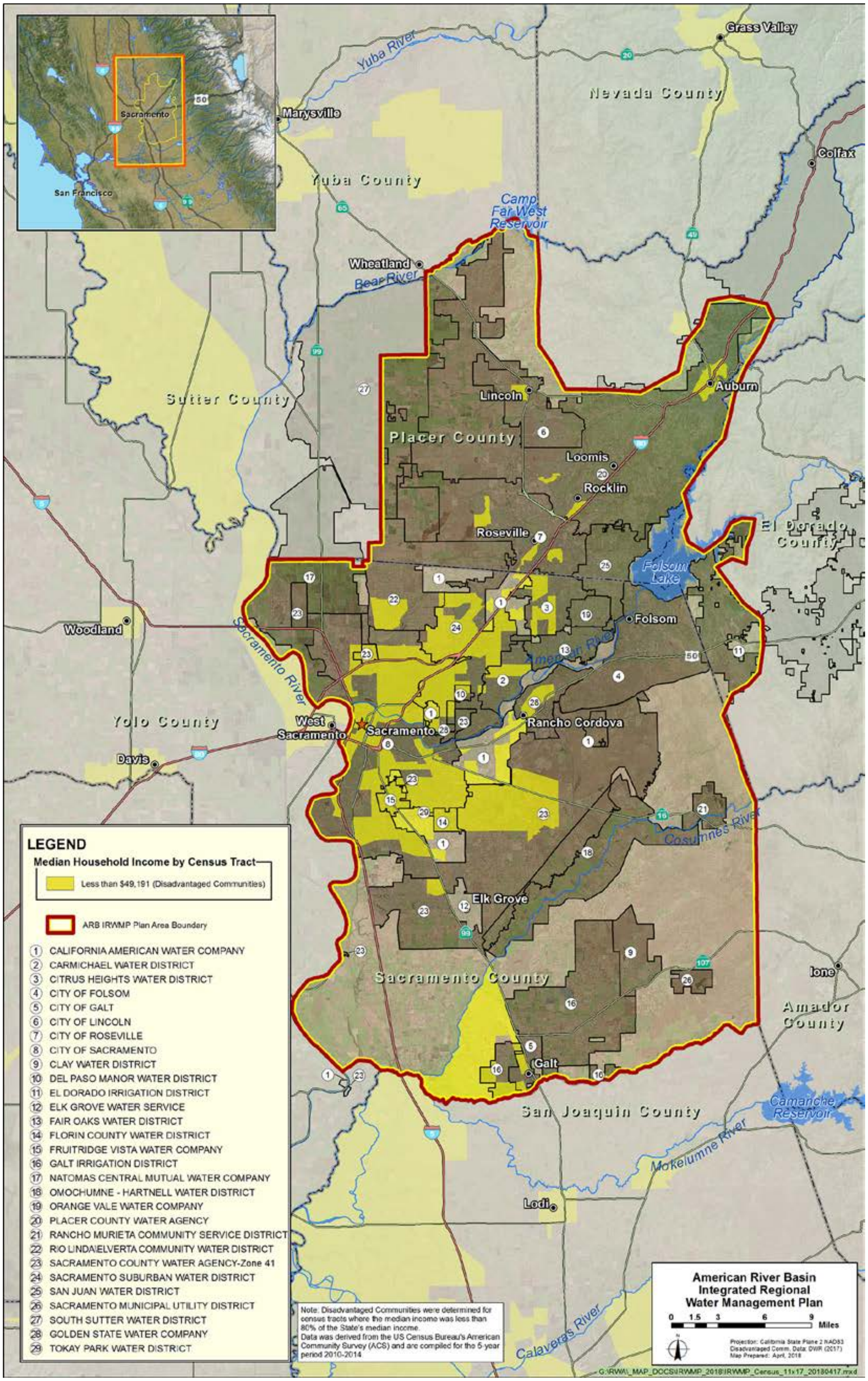


Figure 2-10. Disadvantaged Communities in the Region

2.5.5. Housing

The number of housing units has grown significantly in the Region over the last several decades with urbanization occurring in undeveloped areas within commuting distance to Sacramento. As described previously, population growth, economic opportunities, and affordable housing interact and can complement one another. Growth in the housing units has steadily increased since 2012. All housing categories showed an increase between 2010 and 2017, with the biggest increase in single family homes, as shown below in **Table 2-10**.

Table 2-10. Housing Units Estimates–2017

Area	Single Family	Multi-Unit 2–4	Multi-Unit 5 +	Mobile
Sacramento County	401,222	45,019	106,177	14,863
Placer County	131,146	8,421	18,652	4,270
El Dorado County	75,645	4,873	5,730	4,105
3-County Region Total	608,013	58,313	130,559	23,238
Change from 2012	***3%***	***0.3%***	***1.8%***	***0.4%***

Data Source: California Department of Finance 2018

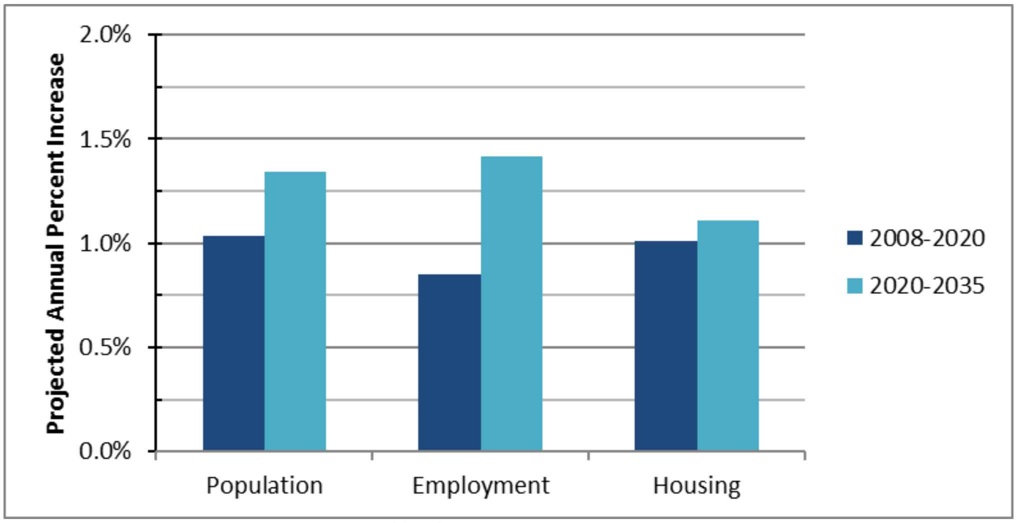
The California Association of Realtors reported that the housing market was expected to show a small increase in 2017, with a one percent increase in home sales in 2018. The organization cites supply shortages and affordability constraints as the main causes hampering marketing activity.

2.5.6. Regional Growth Trends

This subsection discusses regional growth trends that mostly affect water management. Expected population, employment, and housing growth are discussed, followed by a discussion of farmland conversion.

2.5.6.1. Population, Employment and Housing Growth Summary

According to the California Department of Finance's 2014 estimates, the population of the American River Basin portions of El Dorado, Placer, and Sacramento counties will rise to nearly 3 million – a 47 percent increase – by 2060. Population, employment, and housing all have grown and will continue to grow in the near future. **Figure 2-11** is a summary of SACOG's projection for growth trends in population, employment, and housing for the Region. Although growth trends do not reach 2 percent, which was the growth during the late 1990s and the first half of the 2000s, growth rates for both population and employment are projected to increase into 2035. Housing growth rates show a slight increase from 2020 to 2035, compared to the first 12 years (from 2008 to 2020) that were modeled. Continued growth in the Region with constrained natural resources signifies a continued need for increasingly efficient and effective water resources projects to serve more people in larger land areas more efficiently.



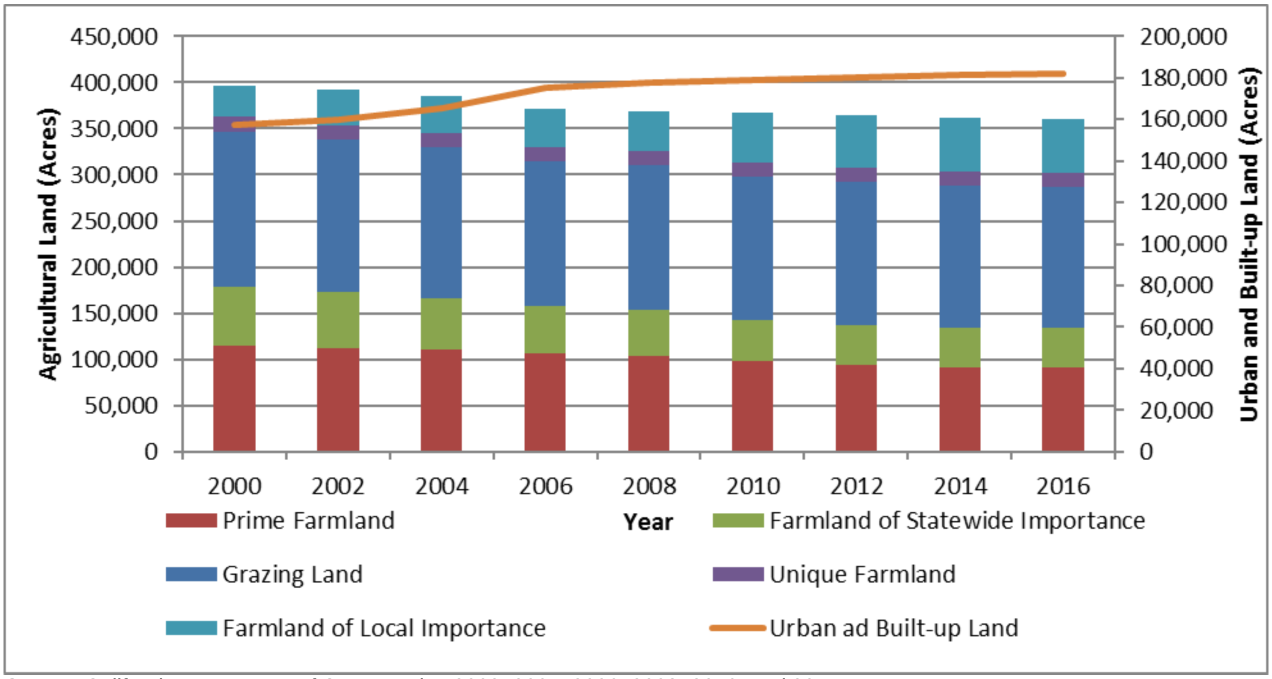
Data Source: SACOG 2012 as presented by the 2013 ARB IRWMP

Figure 2-11. Regional Growth Trends in Population, Employment and Housing

2.5.6.2. Farmland Conversion

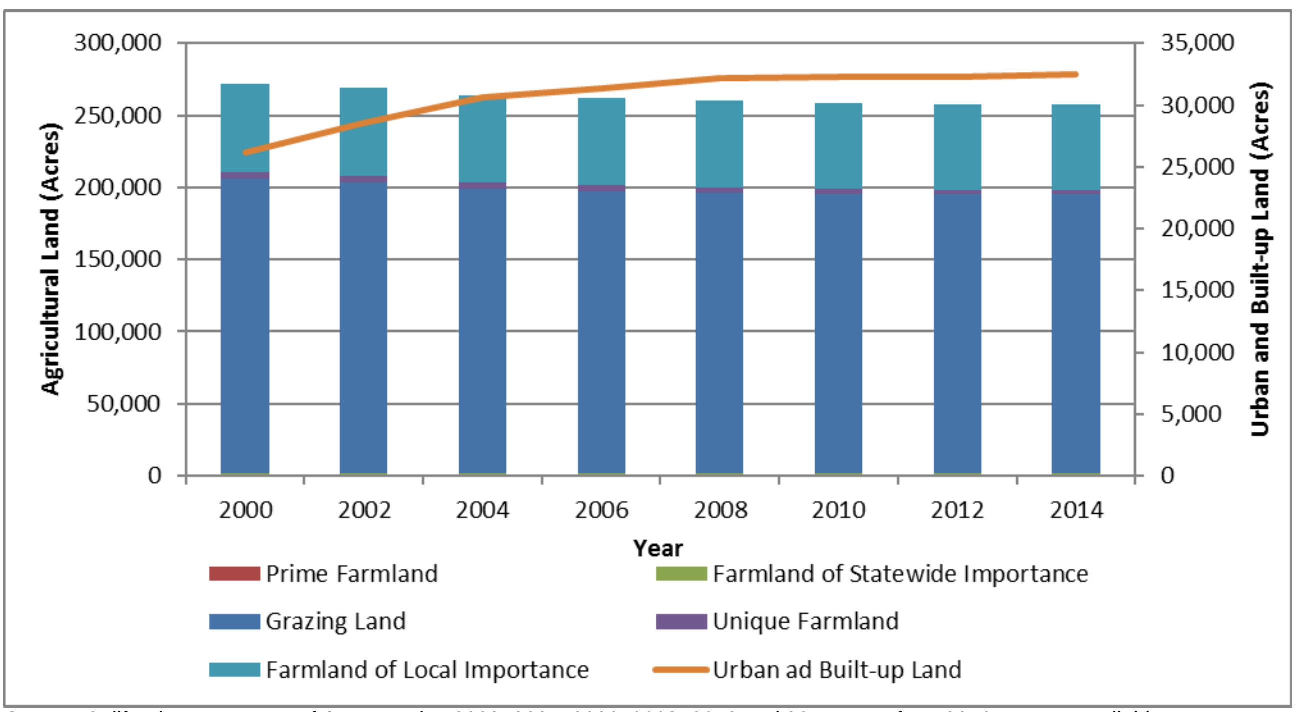
Historically, agricultural operations have been economically important to the vitality of the Region. Fertile soils and a semiarid climate allow for cultivation of a variety of crops (row crops, tree crops, irrigated grains) and raising of livestock (fowl and dairies). In 2015, the aggregated gross crop value for the counties of Sacramento, El Dorado, Placer, and Sutter was over $1.14 billion. Crops grown in the Region include wine grapes, apples, walnuts, timber, rice, and pears. In El Dorado County, commonly grown crops include wine grapes (2,420 acres in 2015), apples (852 acres), pears (107 acres) and timber (181,460 acres).

Economic markets and technological advancements have impacted agricultural markets and farming practices in the Region in recent decades. Spurred by employment and population growth, property once zoned agricultural land has been re-zoned and developed into housing, commercial, and industrial developments. **Figures 2-12** through **2-14** show total acreage for agricultural land (left ordinate) and urban and built-up land (right ordinate) in Sacramento, El Dorado, and Placer counties. Sacramento and Placer counties data are shown for every 2 years from 2000 to 2016. El Dorado County data are from 2000 to 2014 because the 2016 data are still under development.



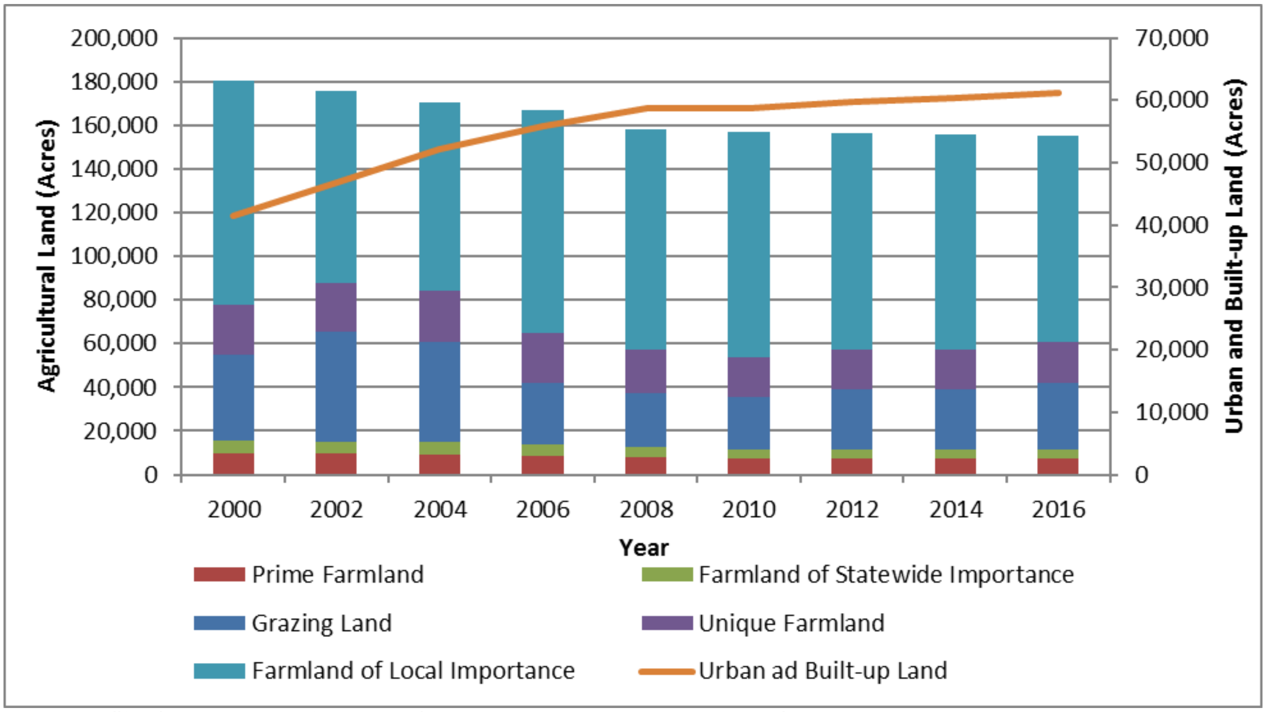
Source: California Department of Conservation 2002, 2004, 2006, 2008, 2010, and 2015.

Figure 2-12. Sacramento County Agricultural Land and Urban and Built-up Land from 2000 to 2016



Source: California Department of Conservation 2002, 2004, 2006, 2008, 2010 and 2015. Data from 2016 was not available.

Figure 2-13. El Dorado County Agricultural Land and Urban and Built-up Land from 2000 to 2014



Source: California Department of Conservation 2002, 2004, 2006, 2008, 2010, and 2015.

Figure 2-14. Placer County Agricultural Land and Urban and Built-up Land from 2000 to 2016

From 2000 to 2016, Sacramento County converted a total of approximately 35,418 acres of agricultural land. Urban and Built-Up Land increased from 2000 to 2006, but has remained steady from 2006 to 2016, likely due to the completion of already approved development. Agricultural land in Placer and El Dorado counties has also been steadily decreasing since 2000. Approximately 14,404 acres of agricultural land have been lost in El Dorado County from 2000 to 2016, and approximately 25,098 acres of agricultural land have been lost in Placer County from 2000 to 2016. From 2000-2014 in El Dorado County, approximately 6,353 acres of Urban and Built-up Land were added whereas from 2000-2016 approximately 19,768 acres of Urban and Built-up Land were added in Placer County.

As population growth and urban development continue in the future, the density or efficiency of development (as measured by people per urban acre developed) is a key factor identified in limiting impacts to existing agricultural land. The recent trend in all three counties is increasingly dense and efficient development relative to existing and previously urbanized lands (American Farmland Trust 2007).

2.5.7. Social and Cultural Makeup of the Regional Community

This subsection describes the social and cultural makeup of the regional community, including cultural resources, ethnic makeup of the regional community, and important cultural and social values. These values play a critical role in how the Region approaches water management issues.

2.5.7.1. Cultural Resources

Cultural resources include physical resources and intangible cultural values pertaining to paleontology, prehistoric and historic archaeology, history, and Native American ethnography. Paleontological resources include fossil animals and plants of scientific value. Archaeological resources include evidence of past human activities, both prehistoric and historic. Historic resources also include extant structures. Ethnographic resources may include natural or cultural resources, landscapes, or natural environmental features that are linked by a community, or group of communities, to the traditional practices, values, beliefs, history, and/or ethnic identity of that community or wider social group.

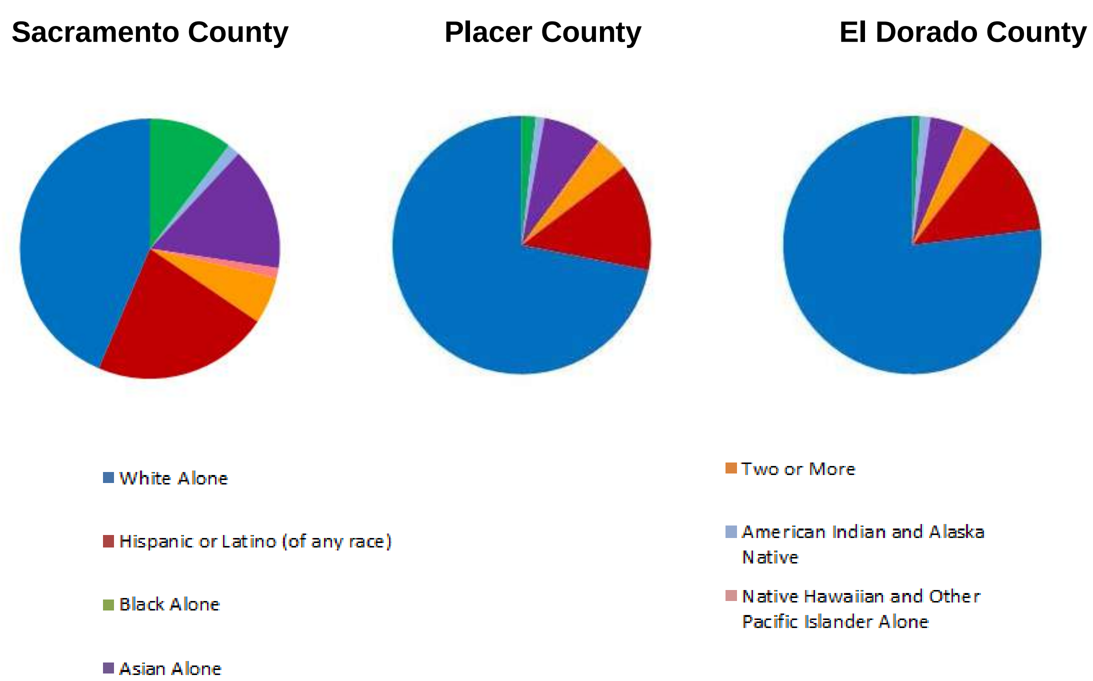
Several dozen prehistoric sites have been identified along the lower American and lower Sacramento rivers. These include village sites, bedrock milling stations, lithic scatters, and small campsites. More than a hundred prehistoric sites have been identified within the Folsom Reservoir Basin. Of particular concern are sites located within reservoir inundation areas. Such sites are subject to degradation due to reservoir siltation, erosion from fluctuating surface water elevations, and vandalism when exposed by low surface water elevations.

Historic sites along the lower American River and lower Sacramento River include placer mining districts, railroad-related structures, irrigation and hydroelectric facilities, and historic residential structures.

Ethnographic resources include historic Nisenan (southern Maidu) village sites located along the lower Sacramento and lower American rivers. Many archaeological sites in the area contain burials, and human remains are of substantial concern to contemporary Native Americans. Two federally recognized tribes are located within the Region. These are the United Auburn Indian Community of the Auburn Rancheria in Placer County and the Wilton Rancheria in Sacramento County according to the U.S. Department of Health and Human Services. See **Section 3.1** for details on the outreach process to Native American tribes.

2.5.7.2. Ethnic Makeup of the Regional Community

The ethnic makeup of the Region and included communities is summarized in **Figure 2-15**. Based on information from the U.S. Census for 2016, Sacramento County is one of the most diverse jurisdictions, with significant populations of white, black, Asian, and Hispanic ethnicities.



Source: U.S. Census Bureau 2016

Figure 2-15. Ethnic Makeup of the Regional Community

Multiple languages are spoken in the Region, especially in Sacramento County. English and Spanish are the prominent languages spoken in Sacramento County. While communication materials in English may be suitable for a majority of residents, alternate languages are often advisable for a large number of potential stakeholders. For instance, public health outreach materials produced by Sacramento County are translated into five languages and some Sacramento area community service providers provide language assistance for up to 10 languages.

2.5.7.3. Important Cultural and Social Values

Identifying and articulating a common understanding of the cultural and social values of the Region were important in developing the IRWMP. **Section 5.4** includes a discussion on how the ARB stakeholders developed and agreed to a list of principles, which are statements that articulate shared organizational values, underlie strategic vision and mission, and serve as a basis for integrated decision making. When agencies or project proponents adopt this ARB IRWMP Update, they are committing to adhere to the spirit of these core values of the Region, as written in the "Resolution of Adoption" (**Section 4.3**). The list of adopted principles is found in **Section 5.4**.

2.6. Water and Environmental Resources Setting

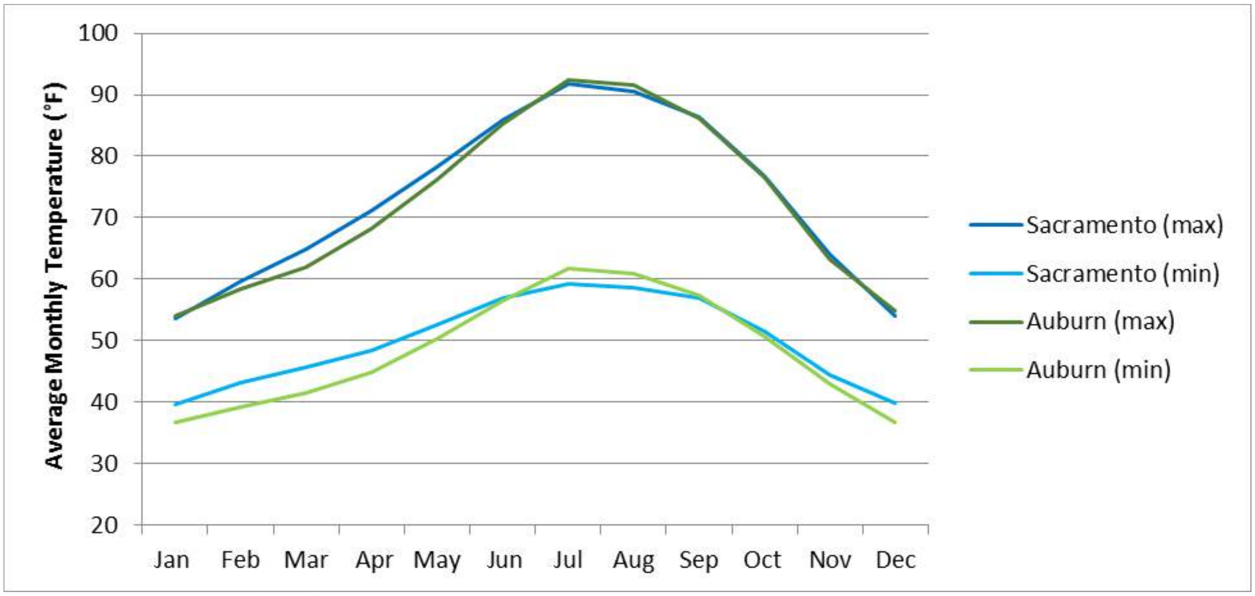
This subsection describes the water and environmental resources setting of the Region. It begins with a description of climate, then characterizes the Sacramento River and the Region's six main watersheds, and concludes with a description of the three underlying groundwater subbasins. For each watershed, the hydrology, water quality, habitat and species, and watershed management and stewardship are described. The groundwater discussion begins with the overall hydrogeology and water quality characteristics for the entire Region, and then describes each groundwater subbasin.

2.6.1. Climate

The Region has a Mediterranean climate, with hot, dry summers and cool, wet winters. In the winter, daily minimum temperatures average mid-to-upper 30 degrees Fahrenheit (°F) with daily maximum temperatures in the low-to-mid 50s (°F). On record-breaking days, daily minimum temperatures have been recorded below 20°F. In the summer, daily minimum temperatures average in the upper 50s (°F) with daily maximum temperatures in the low-to-mid 90s (°F); however, in some years daily maximum temperatures have exceeded 110°F.

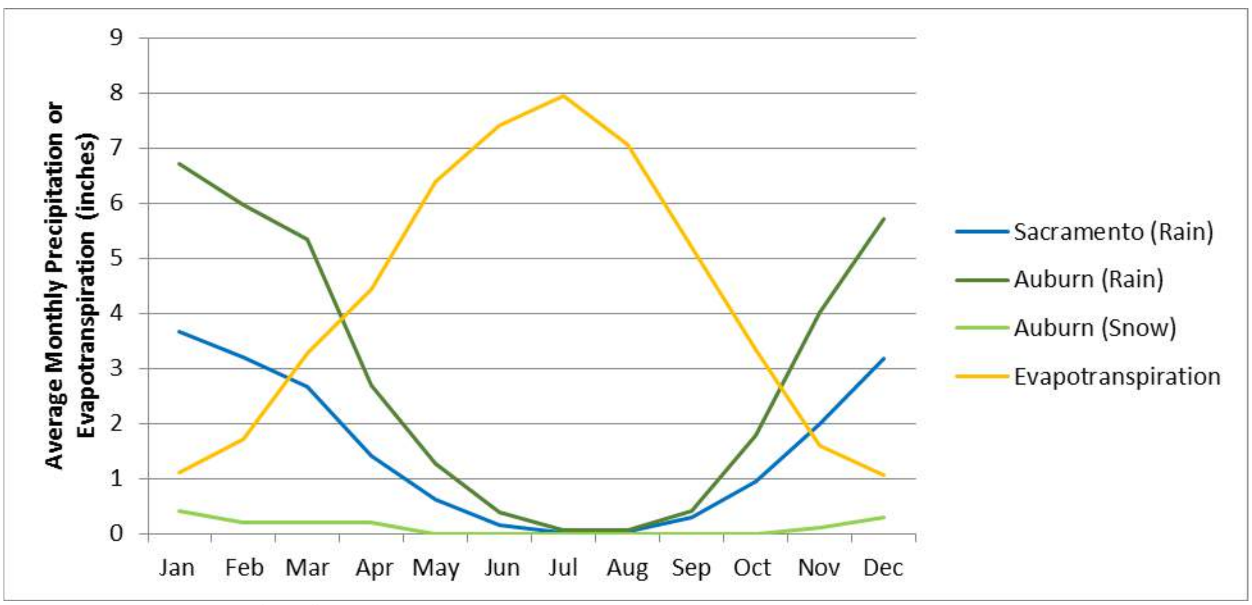
In the Region, the Pacific coastal influence decreases from west to east, causing slightly warmer summers and slightly cooler winters to the east. Average annual precipitation varies primarily with elevation, ranging from around 18.15 inches per year in Sacramento to 34.39 inches per year in Auburn (elevation approximately 1,227 feet above mean sea level). Precipitation also occurs seasonally, as most of the precipitation occurs from November through April. Evapotranspiration also varies seasonally with higher evapotranspiration during the drier and hotter summer months and lower evapotranspiration during the wetter and cooler winter months. The very distinctive cool and wet versus hot and dry seasons dictate much of the human and environmental water needs and concerns in the Region.

Figures 2-16 and **2-17** summarize and show trends for monthly climate data for Sacramento and Auburn and evapotranspiration data at Fair Oaks.



Data Source: Western Region Climate Center
Notes:
Sacramento 2016 https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca7633; Station No. 5 ESE (047633)
Period of Record: 7/11/1877 to 6/9/2016
Auburn 2016 https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca0383; Station No. 040383
Period of Record: 1/1/1905 to 6/10/2016

Figure 2-16. Average Monthly Maximum and Minimum Temperatures



Data Source: Western Region Climate Center
Notes:
Sacramento 2016 http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca7633; Station No. 5 ESE (047633)
Period of Record: 7/11/1877 to 6/9/2016
Auburn 2016 http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca0383; Station No. 040383
Period of Record: 1/1/1905 to 6/10/2016
Data Source: DWR/CIMIS
Station No. 131, 2018 Average data derived from CIMIS stations with a period of record: May 1997 – January 2018
Actual evapotranspiration values will vary, and presumably will be lower given the urban land use of the Region.

Figure 2-17. Average Monthly Precipitation and Evapotranspiration

2.6.2. Watershed Characteristics

Located near the Delta, the Region includes a large portion of the border between two of California's largest hydrologic regions as defined by DWR—the Sacramento River and the San Joaquin River. Approximately, the southern one-third of the Region is within the San Joaquin River Hydrologic Region, and the northern two-thirds is in the Sacramento River Hydrologic Region. **Figure 2-2** shows the watersheds and major hydrologic features of the Region.

The Region includes parts of six subbasins of these hydrologic regions as defined by USDA, NRCS. For purposes of this IRWMP, these subbasins are referred to as watersheds.[2] From north to south, the Region watersheds are:

1. Upper Bear
2. Upper Coon-Upper Auburn
3. Lower American
4. Lower Sacramento
5. Upper Cosumnes
6. Upper Mokelumne

The Region recognizes that watersheds are important from a natural hydrology, ecosystem, and pollution transport perspective. As low impact development (LID), stormwater runoff, and flood management considerations become increasingly a central issue, an understanding of the water and environmental resources setting from a watershed standpoint becomes critical.

In the following subsections, the Sacramento River, which defines the western border of the Region, is described first. Subsequently, the hydrology, water quality, habitat and species, and watershed management and stewardship of each of the six watersheds are described in detail. For clarity, **Figure 2-18** displays the rivers and streams in the Region in a simplified form. The rivers and creeks are grouped and numbered in the order that they are discussed. Arrows indicate those rivers and streams that receive inflows from watersheds or watershed areas outside the Region. Habitat and species information that applies to the entire Region are described in **Appendix B**. This appendix includes lists of sensitive plant

[2] This distinction is only made here because of common usage of the term watershed. These areas are subunits of much larger watersheds, but they are referred to locally as watersheds because they each include distinct drainage areas and tend to have other distinct characteristics.

and animal species and habitats that are candidates for, or listed as, rare, threatened, or endangered under the federal Endangered Species Act and/or the California Endangered Species Act. **Appendix B** also includes a list of invasive species of concern.

Figure 2-18 and the narrative descriptions of streams and creeks in the following subsections are not exhaustive; rather, only the larger and regionally important streams and creeks are discussed. Smaller, local creeks and streams are shown in figures under each watershed description below, which are more detailed views of the watersheds shown in **Figure 2-2**.

Discussions in **Sections 2.7** through **2.9** are organized by jurisdictional boundaries, because flood management, water delivery, and wastewater agency jurisdictions often do not follow watershed boundaries. Nonetheless, effects and influences of water management projects and programs span across both watershed and political/jurisdictional boundaries.

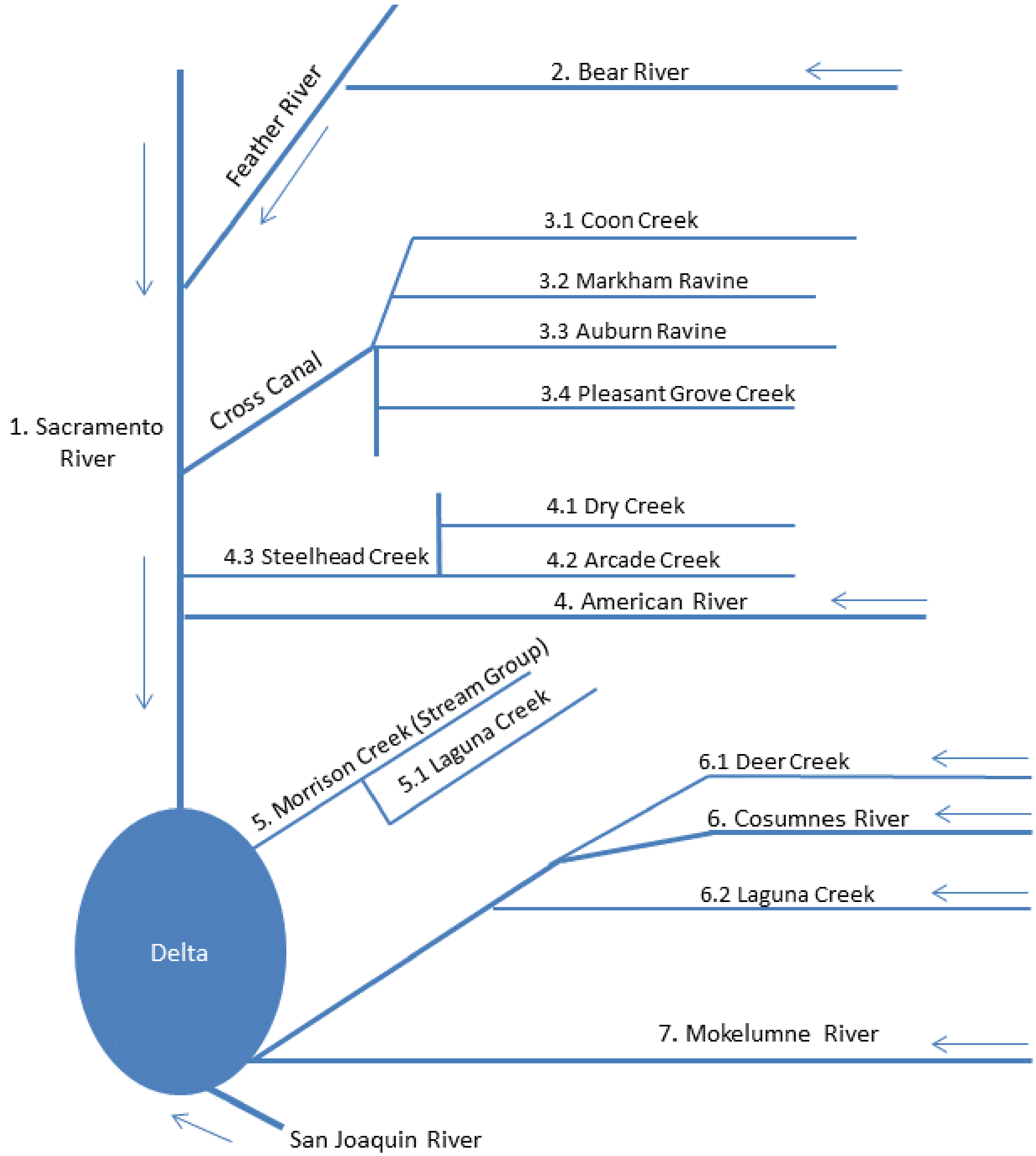


Figure 2-18. Outlines of Major Rivers and Streams in the Region

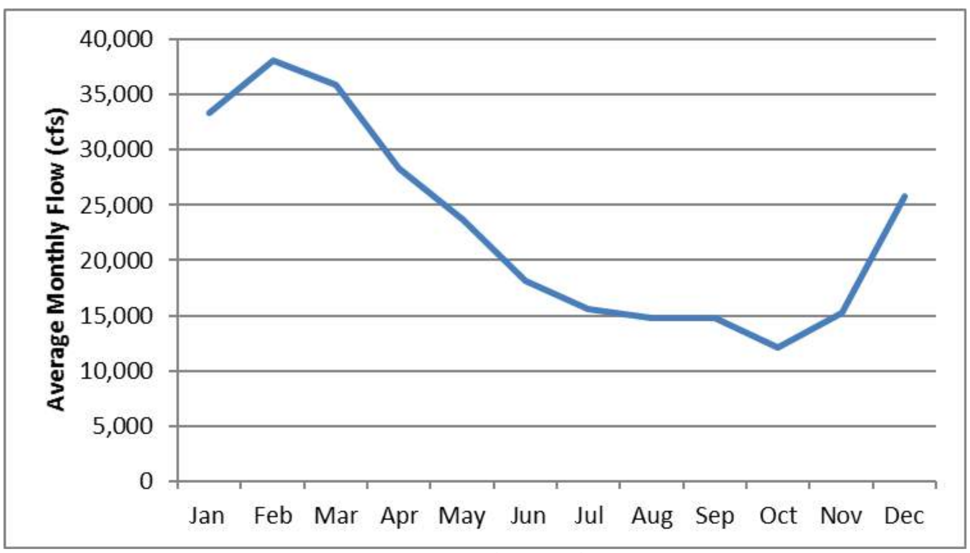
2.6.2.1. Sacramento River

The Sacramento River (see **Figure 2-18**) is an important river statewide, collecting approximately one-third of the total runoff of the state and discharging it into the Delta. This large area is defined in **Figure 2-2** as the Sacramento Hydrologic Region. The lower Sacramento River defines the western boundary of the Region and is described in this subsection as a river, instead of a watershed, to characterize this boundary. Albeit having a similar name, the Lower Sacramento Watershed is a smaller watershed delineation within the larger Sacramento Hydrologic Region. This watershed includes area on both sides of the lower Sacramento River, and only the smaller Morrison Creek Stream Group lies within the Region. This stream group of the Lower Sacramento Watershed is described in **Section 2.6.2.5**.

Sacramento River: Hydrology

The lower Sacramento River is defined as the portion of the river from Princeton to the Delta, at approximately Chipps Island. Flows in the lower Sacramento River are largely controlled by Shasta Dam and Keswick Dam on the upper Sacramento River. Shasta Dam provides flood protection for the Sacramento area, and is part of the Central Valley Project (CVP) constructed by U.S. Army Corps of Engineers (USACE) and operated by Reclamation. The portion of the lower Sacramento River that forms the western border of the Region is predominantly channelized, leveed, and bordered by agricultural lands and by Sacramento and Sacramento County.

Sacramento River flow varies following the seasonal variation in precipitation. **Figure 2-19** displays the average monthly flows at the Freeport U.S. Geological Survey (USGS) gage. Average flows during the winter months can be three times that of the summer months. Average annual flows can also vary from around 8,000 cubic feet per second (cfs) to more than 46,000 cfs.



Data Source: USGS 11447650 gage at Freeport 10/1949-09/2015
Key: cfs = cubic feet per second

Figure 2-19. Average Monthly Flows at Freeport

To assist in water planning in the Delta given the high variability in Sacramento River water flows, the State Water Resources Control Board (State Water Board) developed the Sacramento Valley Water Year Index in 1995. The Water Year Index is used to determine water year types for the Sacramento Valley as implemented in State Water Board Decision 1641, and is dependent on runoff into the Sacramento River at major tributary points. The record of the distribution of Sacramento Valley water year types portrays the historic probability of occurrence of various hydrologic years. This is shown in **Table 2-11**.

Table 2-11. Sacramento Valley Water Year Types and Occurrence (1906 – 2016)

Water Year Type	Occurrence Frequency	Most Recent Occurrence (Water Year)
Wet	36 out of 111 years (32%)	2011
Above Normal	15 out of 111 years (14%)	2005
Below Normal	21 out of 111 years (19%)	2016
Dry	23 out of 111 years (21%)	2013
Critical	16 out of 111 years (14%)	2015

Data Source: DWR/CDEC, 2017

A water year designation can be important for water supply, as Reclamation's CVP yearly water availability to various water agencies is partially determined by hydrology. This is further explained in **Section 2.9.2.1**.

The lower Sacramento River flows are managed, in part, for environmental and ecosystem purposes. Sufficient flow must be available during the spring and fall months when a variety of anadromous fish are en route to the Delta or upstream spawning and rearing grounds. There are additional smaller-scale minimum flow discharge requirements to help meet environmental needs. Discharge permits for WWTPs located along the lower Sacramento River and its tributaries specify discharge flow and quality during low-flow periods. For example, SRCSD is required to regulate discharge from the Sacramento Regional WWTP (SRWWTP) to ensure a minimum 1,300 cfs in the Sacramento River and a minimum flow ratio of 14:1 (river flow: effluent) to allow for adequate mixing of effluent for environmental needs (SRWWTP National Pollutant Discharge Elimination System [NPDES] Permit 2016).

Sacramento River: Water Quality

The lower Sacramento River water quality is influenced by the entire upstream drainage area, and is affected by agricultural runoff, acid mine drainage, stormwater discharges, municipal and industrial wastewater discharges, water releases from dams, diversions, and urban runoff. However, the river's flow volumes generally provide sufficient dilution to prevent concentrations of contaminants in the river from reaching elevated levels that affect human health. Total Maximum Daily Loads (TMDL) and Water Quality Control Plan amendments for diazinon and chlorpyrifos are in place for the entire lower Sacramento River. Other water quality parameters of concern, according to the State Water Board's

303(d) listing[3] of impaired water bodies, consist of chlordane, dichlorodiphenyltrichloroethane (DDT), dieldrin, mercury, polychlorinated biphenyl (PCB), and unknown sources of toxicity. Historically, sediment transport from hydraulic gold mining has been an issue, but sediment supply to the Sacramento River has declined over recent years because dams on tributaries and other water management actions have resulted in less sediment transport (DWR 2012b).

Nonetheless, Sacramento River water quality is sufficient for water contact recreation and municipal supply after treatment. Sacramento and FRWP use raw Sacramento River water. The water for potable uses is diverted at the Sacramento River Water Treatment Plant (WTP), located near the confluence of the Sacramento and American rivers, and the intake facility for the FRWP is located further downstream on the Sacramento River.

Sacramento River: Habitat and Species

The lower Sacramento River is used by more than 30 species of native and nonnative fish. Anadromous fish such as adult Chinook salmon and steelhead use the river as a migratory pathway to and from upstream spawning habitats and a migration route to the Delta. Many fish species that spawn in the Sacramento River and its tributaries depend on river flows to carry their larval and juvenile life stages to downstream nursery habitats. Other fish species such as the Sacramento splittail and striped bass use the lower Sacramento River, but make little to no use of the upper river.

An important component of the aquatic habitat throughout the Sacramento River is referred to as Shaded Riverine Aquatic (SRA) Cover. SRA consists of the portion of the riparian community that directly overhangs or is submerged in the river. SRA provides high-value feeding and resting areas and escape cover for juvenile anadromous and resident fishes. SRA also can provide some degree of local temperature moderation during summer months due to the shading it provides to nearshore habitats. The importance of SRA to Chinook salmon was demonstrated in studies conducted by the U.S. Fish and Wildlife Service (USFWS). In early summer, juvenile Chinook salmon were found exclusively in areas of SRA, and none were found in nearby riprapped areas (Water Forum 2005).

Sacramento River: Watershed Management and Stewardship

Numerous organizations exist for managing the entire Sacramento River watershed and its effects on the Delta. Federal and state agencies are often directly involved (e.g., TMDLs), as are research and

[3] Through the Clean Water Act, the U.S. Environmental Protection Agency (EPA) requires each state to develop a list of impaired waters, called the 303(d) list. Current pollution controls are insufficient to meet water quality standards in these waters, and the state must establish priorities to develop TMDLs to manage this pollution. The State Water Board maintains the state's 303(d) list. The 2010 list is available at: http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml

educational institutions. Independent organizations, such as the Sacramento River Watershed Program, involve thousands of people in their mission “to ensure that current and potential uses of the watershed's resources are sustained, restored, and where possible, enhanced, while promoting the long-term social and economic vitality of the region.” While the Region coordinates with and is an integral part of the Sacramento River system, management and stewardship concerns of the larger Sacramento River are not fully within the Region’s jurisdiction, nor are they the focus of this IRWMP.

2.6.2.2. Upper Bear Watershed

The Upper Bear Watershed is located in portions of Yuba, Nevada, Placer, and Sutter counties and encompasses 474 square miles. Only a small portion of the Upper Bear Watershed (32 square miles) is within the Region. **Figure 2-20** shows the Upper Bear Watershed and its subwatersheds and their relationship to the Region. While the description below is focused at the watershed level, local stakeholders often work at the subwatershed level and refer to these subwatershed names. As applicable, details of subwatershed information are provided below.

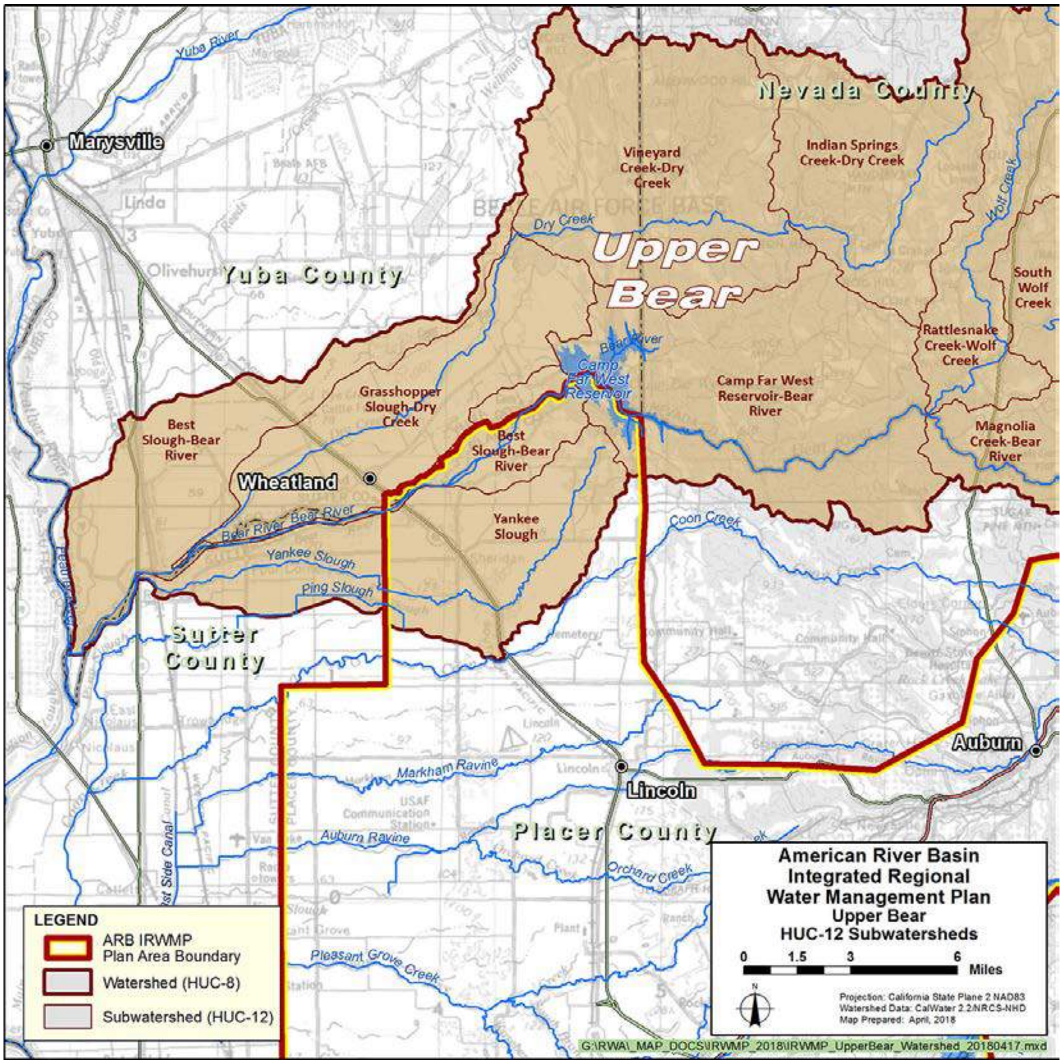


Figure 2-20. Upper Bear Watershed

Upper Bear Watershed: Hydrology

The primary hydrologic feature of the Upper Bear Watershed relative to the Region is the lower Bear River, a segment of river running 15 miles from CFW Reservoir to the confluence with the Feather River to the west. About half of this river segment serves as the northernmost boundary of the Region. CFW is a 104,000-acre-foot reservoir operated by South Sutter Water District for agricultural supply. The operation of CFW has modified the downstream flow regime for both water supply and flood management purposes.

Upper Bear Watershed: Water Quality

Water quality has been sampled in the Bear River and Yankee Slough in the portion of the Upper Bear Watershed that is within the Region. While water quality is considered good for most purposes, there are constituents that exceed protective water quality standards, causing the lower Bear River and Yankee

Slough to be placed on the State Water Board's 303(d) listing of impaired water bodies. These pollutants include: chlorpyrifos associated with agriculture; copper and other "unknown toxicity" from unknown sources; and mercury associated with past mining practices in the upper portions of the watershed.

Upper Bear Watershed: Habitat and Species

The Upper Bear Watershed within the Region is dominated by grassland and cropland. A 2009 report by the National Marine Fisheries Service (NMFS) evaluated the lower Bear River for its habitat potential to support salmon and steelhead (NMFS 2009). The report concluded that while the lower Bear River does support winter steelhead rearing habitat near its confluence with the Feather River, this segment is unlikely to support viable self-sustained populations of salmon and steelhead. Issues include reduced flows in this reach of the river from damming and diversions, relatively high water temperatures, lack of spawning gravels, and water quality concerns.

Upper Bear Watershed: Watershed Management and Stewardship

The Bear River Work Group has been actively engaged in the watershed, primarily above CFW Reservoir (see www.bearriver.us for more information). Placer County/Placer Legacy Program (Placer Legacy) actively pursues purchasing properties and conservation easements to protect and conserve open space and agricultural lands. One significant conservation easement in the Region of the Upper Bear Watershed is the 281-acre Kirk Ranch.

2.6.2.3. Upper Coon-Upper Auburn Watershed

The Upper Coon-Upper Auburn Watershed covers 434 square miles (221 square miles within the Region), and is located in western Placer County and the northern Region. **Figure 2-21** shows the Upper Coon-Upper Auburn Watershed and its subwatersheds. This watershed is undeveloped at the higher elevations and is predominantly agricultural in its lower areas. The City of Lincoln (Lincoln) and portions of cities of Rocklin, Roseville, and Auburn are located in this watershed. These cities have seen one of the highest urban development rates in the Region, converting significant portions of agricultural land into urban land. Downstream from these cities, the watershed flows primarily through flatter agricultural land. Environmental, agricultural, and new development interests present both opportunities and conflicts for watershed management on this landscape, now and into the future.

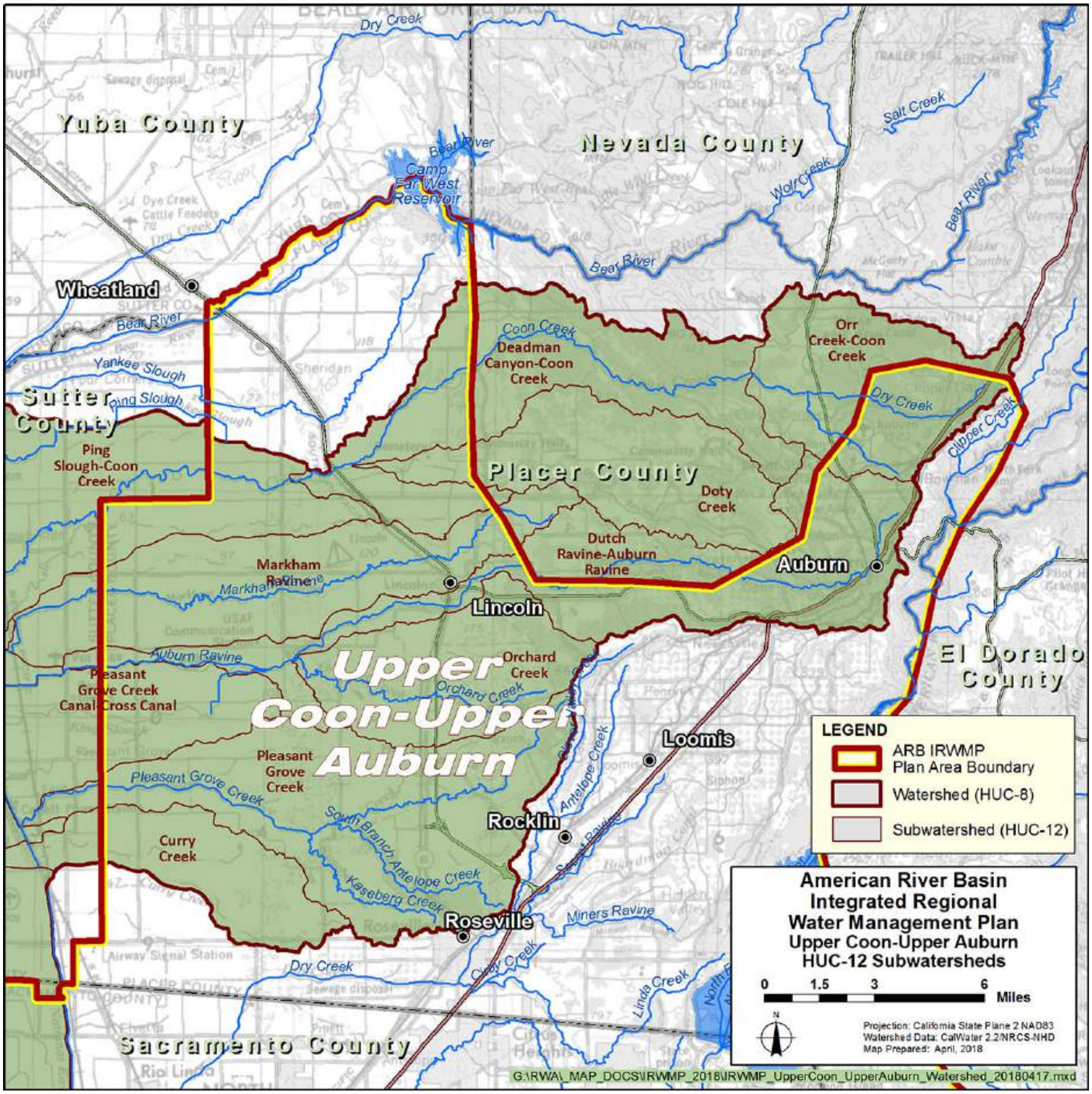


Figure 2-21. Upper Coon-Upper Auburn Watershed

Upper Coon-Upper Auburn Watershed: Hydrology

The Upper Coon-Upper Auburn Watershed does not have one unifying river but has a collection of creeks and ravines that begin in the western Sierra Nevada foothills near Auburn and Loomis and drain into the Cross Canal and the Sacramento River (see **Figure 2-18**). The four largest of these creeks and ravines are Coon Creek, Markham Ravine, Auburn Ravine, and Pleasant Grove Creek. All of these streams and their subwatersheds are relatively small and have very little natural runoff, outside of times with heavy precipitation and local flooding. Most of the stream flow is water imported from the Yuba, Bear, and American river watersheds to meet domestic and agricultural needs in western Placer County and southeastern Sutter County. While winter stream flows are heavily influenced by runoff from rainfall events, summer flows are influenced by upstream releases for irrigation water deliveries to farms, golf courses, and ranches, and from discharges from wastewater treatment facilities.

While human activity has generally stabilized ephemeral stream flow, floods and critical low flows still occur. Peak winter flows in these subwatersheds can be significantly high: 22,000 cfs in Coon Creek, 5,000 cfs in Markham Ravine, and 17,000 cfs in Auburn Ravine for 100-year events. Flooding in these watersheds is often due to backflow from the Sacramento River and can be severe. Placer County and Lincoln have developed flood management or flood control plans specifically for these creeks. Low flows occur around October, in between the end of the irrigation season and before the start of winter rains. Coon Creek has a constant flow of approximately 9.5 cfs from discharges and water transfers, while Auburn Ravine flows can be low as 1 to 2 cfs below Lincoln (Placer County 2002).

Human activity and importing water have created a unique hydrology and habitat in the Upper Coon-Upper Auburn Watershed (Placer County 2002, 2006). Present water management practices consider energy, irrigation, and wastewater needs but are not integrated with ecological concerns. Flows and water temperatures in Auburn Ravine and Coon Creek are influenced by discharges from WWTPs (NMFS 2009).

Upper Coon-Upper Auburn Watershed: Water Quality

The Upper Coon-Upper Auburn Watershed generally has good water quality. High-quality water is imported from adjoining higher elevation watersheds, improving both quantity and quality of water. The Central Valley Regional Water Quality Control Board (Central Valley Water Board) has identified beneficial uses to include irrigation, municipal and domestic uses, body-contact water recreation, navigation, and numerous habitat uses. The U.S. Environmental Protection Agency (EPA) 303(d) list, however, identifies several impairments in this watershed. Coon Creek is on the 303(d) list for chlorpyrifos, a pesticide from agricultural sources, *Escherichia coli* (*E. coli*) (a bacterium found in the stomachs of warm-blooded species that can cause food poisoning), and “unknown toxicity,” both from unidentified sources. Pleasant Grove Creek has low dissolved oxygen and sediment toxicity from unknown sources as well as pyrethroids, a pesticide, from urban runoff.

Upper Coon-Upper Auburn Watershed: Habitat and Species

Land uses in the Upper Coon-Upper Auburn Watershed include grassland, residential, and agriculture, although some forested areas exist in the foothills in the eastern portion. The watershed supports sporadic riparian and woodland habitats of mixed native and nonnative species along stream corridors, depending upon whether past land use practices allowed remnant woodlands to remain. Seasonal wetlands and vernal pools are scattered throughout the lower elevations of the watershed where soils and topography support them (Placer County 2006). These habitat communities are affected significantly by the invasion of exotic plants, including a variety of nonnative grasses and weedy species in the lower foothills, such as mustard, broom, and Himalayan blackberry.

Conveyance of irrigation water to western Placer and southeastern Sutter counties has created unique summertime habitats not found in other foothill locations. Auburn Ravine has been included in the critical habitat designation for spring-run Chinook salmon and Central Valley steelhead. The California Department of Fish and Wildlife (CDFW, formerly DFG) has historically stocked Auburn Ravine, Doty Ravine (a Coon Creek tributary), and Coon Creek with fall-run and spring-run Chinook salmon near Lincoln. Although steelhead have not been planted in Auburn Ravine, rainbow trout have been planted in water bodies connected to Auburn Ravine (DWR 2009). Coon Creek in particular has more stable flows year round and pool/riffle complexes, which allow maintenance of water stage and continued support of aquatic habitat. Coon Creek may provide the best opportunity for wildlife habitat restoration (NMFS 2009).

Upper Coon-Upper Auburn Watershed: Watershed Management and Stewardship

There are two active ecosystem restoration plans (ERP) in the Upper Coon-Upper Auburn Watershed: the 2002 Auburn Ravine/Coon Creek (AR/CC) ERP and the 2006 Pleasant Grove and Curry Creek ERP. The Auburn Ravine/Coon Creek Coordinated Resource Management Plan Group developed the AR/CC ERP with assistance from a CALFED Bay-Delta Program (CALFED) grant. Signatories of the Memorandum of Understanding (MOU) included Placer County, Nevada Irrigation District (NID), cities of Lincoln and Auburn, PCWA, South Sutter WD, Placer County Resource Conservation District, Ophir Area Property Owners Association, Placer Nature Center, private property owners, and environmental groups. Placer Legacy was responsible for preparing the Pleasant Grove and Curry Creek ERP.

Since its adoption in 2000, the Placer Legacy has been integral in implementing projects related to the ERPs through agricultural easements and land acquisition. Their 2012 newsletter lists projects, such as protecting a 320-acre property off of Auburn Ravine at Aitken Ranch, and opening the Hidden Falls Regional Park to conserve 220 acres (Phase I) and 961 acres (Phase II) for recreation along Coon Creek. Placer Legacy has been successful in securing grant funding from sources, such as CALFED and the Sierra Nevada Conservancy.

Several nongovernmental organizations with environmental or watershed interests exist as well. In 2005, the Auburn Ravine/Coon Creek Watershed Group, the Pleasant Grove/Curry Creek Watershed Group, and the Dry Creek Watershed Council (within the Lower American Watershed), formed the American

Basin Council of Watersheds (ABCW). ABCW is a group of diverse stakeholders that has continued to meet monthly since 1996. The Dry Creek Conservancy is a nonprofit organization that facilitates watershed conservation, restoration, and education in the watersheds of Dry Creek, Pleasant Grove Creek, Auburn Ravine Creek, Coon Creek, and surrounding areas in Placer, Sutter, and Sacramento counties.

Save Auburn Ravine Steelhead and Salmon (SARSAS) is another nonprofit organization, based in Auburn and is entirely run by volunteers. Their mission is to "return salmon and steelhead to the entire length of the Auburn Ravine," and they have been active working with Placer County on restoration projects to improve fish passage. One recent successful project is a fish passage installed around a gage station in collaboration with Placer County and NID. SARSAS also provides outreach and educational opportunities to local schools, incorporates traditions of Native tribes related to salmon into their community activities, and monitors and studies Auburn Ravine conditions.

2.6.2.4. Lower American Watershed

The Lower American Watershed covers 293 square miles and is almost completely encompassed within the Region, as shown in **Figure 2-22**. This watershed covers the more developed northern half of the Region. The Town of Loomis and cities of Folsom, Citrus Heights, Rocklin, Roseville, and Rancho Cordova fall entirely or partially within the watershed. The Lower American Watershed has older, built-out urban development closer to the lower American River, while the northern areas around Dry Creek and Arcade Creek and areas closer to Folsom Lake have seen high development in the past several years. This trend of development has increased environmental- and flood-related concerns.

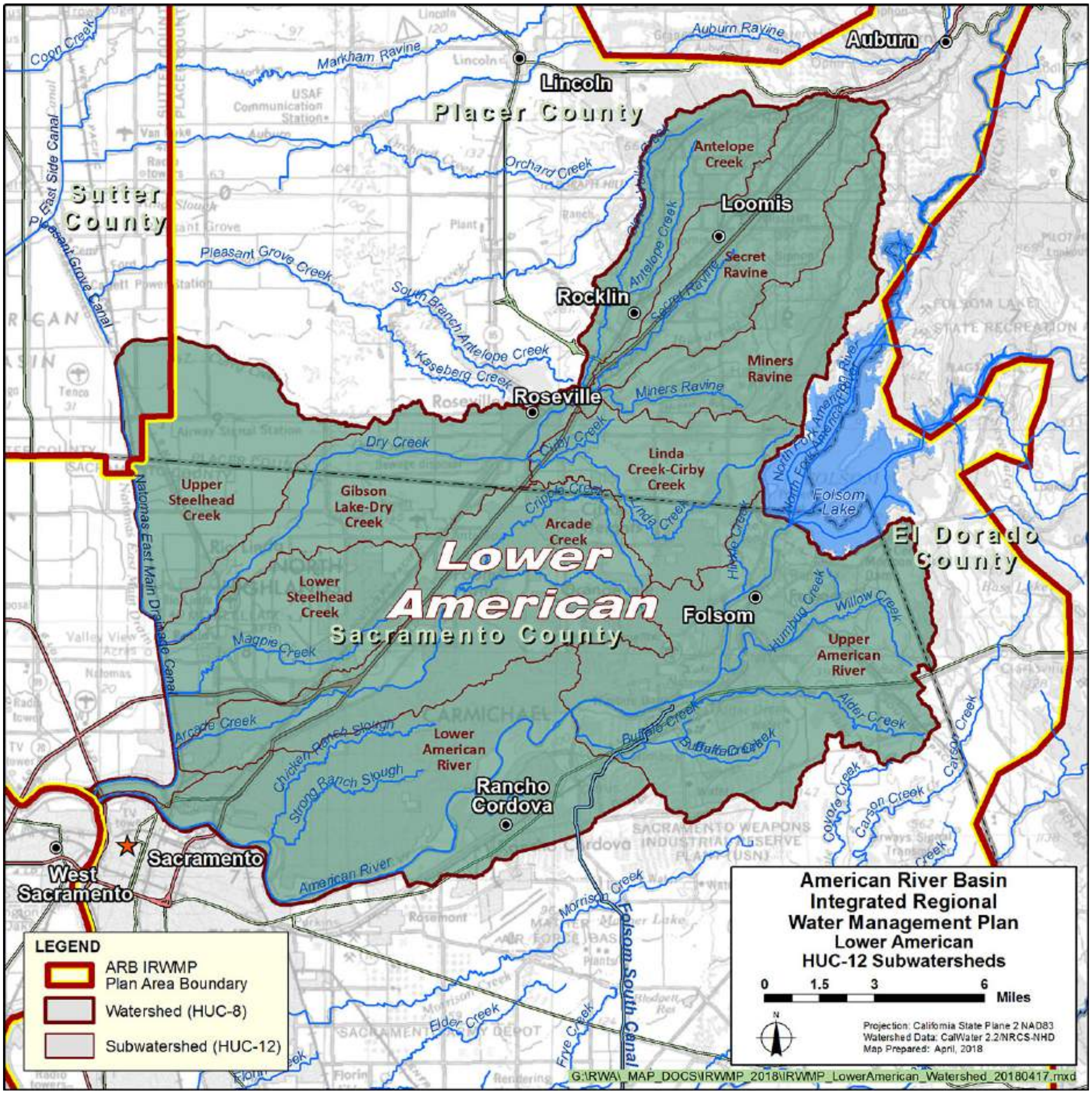


Figure 2-22. Lower American Watershed

The lower American River is the main river that flows through this watershed. It has numerous small tributaries, which are not described in this narrative. Two of the larger creeks are Dry Creek and Arcade Creek, both of which flow into the Natomas East Main Drainage Canal, also known as Steelhead Creek (**Figure 2-18**). Steelhead Creek has been channelized and altered to discharge directly into the Sacramento River. Thus, these smaller creeks in this watershed never meet the main lower American River. Throughout the rest of this Lower American Watershed description, the lower American River system will be discussed first, followed by a description of the Dry Creek, Arcade Creek, and Steelhead Creek system.

Lower American Watershed: Hydrology

Hydrology in the Lower American Watershed follows a wet-winters, dry-summers seasonal pattern and shows high annual variability, due to occasional very dry or wet years. Forty percent of the American River flow is from snowmelt, as this river originates in the Sierra Nevada, farther east of Sacramento. In contrast, Dry and Arcade creeks flows are seasonal and driven by local drainage and rainfall. The lower American River is a large tributary to the Sacramento River, accounting for 15 percent of the total flow in the lower Sacramento River (NMFS 2009).

Folsom Dam releases water from Folsom Lake, controlling the hydrology of the lower American River. Folsom Dam is an important component of the CVP, and serves multiple purposes, including water supply, hydropower, recreation, and flood control. Folsom Dam is operated, in part, according to inflows into Folsom Lake from the two upstream watersheds, which include the North, Middle, and South forks of the American River. Inflows into Folsom Lake shows seasonal variability, as the inflows of December to May can be larger than 4 times the inflow during the drier months of June to November. The historical average for unimpaired inflows is 2.8 million acre feet (MAF), but this average varies annually from 0.3 to 6.4 MAF (NMFS 2009).

Unimpaired flow into Folsom Lake determines and triggers water diversion limitations as stipulated in the WFA. The record of distribution of these WFA water year types portrays the historic probability of occurrence of various hydrologic years. This is shown in **Table 2-12**.

Table 2-12. WFA Water Year Types and Occurrence (1901–2017)

Water Year Type	Unimpaired Inflow into Folsom Lake, March–November (TAF)	Occurrence Frequency, 1901–2010
Wet	Greater than 1,600	70 out of 117 years (60%)
Average	Greater than 950 and less than 1,600	29 out of 117 years (25%)
Drier	Greater than 400 and less than 950	15 out of 117 years (13%)
Driest (i.e., conference years)	Less than 400	3 out of 117 years (2%)

Data Source: Sacramento Groundwater Authority [SGA] State of the Basin Report, 2004; SGA Basin Management Report 2006–2007, 2008a; SGA Basin Management Report, 2011; SGA Staff, pers. comm. March 16, 2018

Key:
TAF = thousand acre-feet
WFA = Water Forum Agreement

Using Nimbus Dam immediately downstream from Folsom Dam, Reclamation controls power-generating releases from Folsom Dam into suitable river flow releases. Seasonally, flows during the months of

January to May or June can be larger than 3 times the flows during the months of July to December. **Figure 2-23** shows the average monthly flows at the Fair Oaks USGS gage. Average annual flows can also vary from less than 1,000 cfs to more than 8,000 cfs.

Data Source: USGS 11446500 gage at Fair Oaks 10/1955-10/2017
Key: cfs = cubic feet per second

Figure 2-23. Average Monthly Flows at Fair Oaks USGS Gage

Folsom Dam and Nimbus Dam have modified seasonal flow and water temperature in the lower American River. To improve the environmental conditions for aquatic resources in the lower American River, the WFA developed the Lower American River Flow Management Standard (FMS). The FMS is designed to allocate flow releases from Folsom and Nimbus dams in consideration of variable hydrology and coldwater pool availability in Folsom Reservoir. The FMS includes minimum flow requirements and temperature objectives to meet fishery needs throughout the entire water year. These requirements include minimum flow requirements measured downstream from Nimbus Dam, and downstream flow requirements measured between Nimbus Dam and the mouth of the lower American River. The minimum flow requirements vary from 800 to 2,000 cfs throughout the year in response to the hydrology of the Sacramento and American river basins. Adjustments are made in response to specific conditions related to the need for spawning flow progressions, fish protection, and reservoir water conservation (Northern California Water Association 2011). Implementation of the FMS has been an ongoing collaboration effort with Reclamation, who ultimately controls dam releases.

In contrast to the lower American River, the Dry Creek, Arcade Creek, and Steelhead Creek system consists of smaller, local subwatersheds. Flows in these creeks originate as precipitation, and flows are heavily influenced by local water uses, drainage, and wastewater discharges.

Dry Creek, a 17.6-mile-long stream, (4.1 in **Figure 2-18**) receives urban runoff, open space drainage, and high-quality water from the PCWA canals, and wastewater effluent from WWTPs. City of Roseville (Roseville) also provides raw surface water to Linda Creek to sustain the natural flow for environmental purposes. There is a strong seasonal flow pattern with high flows exceeding 1,000 cfs during the wet season and low flows generally in the range of 10 to 20 cfs during the dry season. During the dry season, effluent flows can exceed the flow in the creek upstream from the WWTPs. Dry Creek has numerous local tributaries and is the largest tributary to Steelhead Creek.

Arcade Creek (4.2 in **Figure 2-18**) is a smaller tributary to Steelhead Creek. This subwatershed is highly urbanized with high flows in the wet season exceeding 100 cfs and low flows in the dry season often dropping below 1 cfs.

Steelhead Creek, or the Natomas East Main Drainage Canal (4.3 in **Figure 2-18**), drains both the Dry and Arcade creek flows into the Sacramento River. RD 1000 and Sacramento also pump drainage water into Steelhead Creek during storm events. These pumps contribute as low as 1 percent of flow in Steelhead Creek during the dry season but as high as 52 percent during storm events. These floodwaters are at times the largest contributors of flow influencing the highly variable hydrology of Steelhead Creek (American Basin Council of Watersheds 2008).

Lower American Watershed: Water Quality

The lower American River and Folsom Lake water is generally characterized as high-quality surface water that is low in alkalinity, low in disinfection byproduct precursor materials, low in mineral content, and low in organic contamination. Limited data also indicate that the source of water is low in microbial contamination from giardia and cryptosporidium. Turbidity levels tend to be higher in the winter than summer because of higher flows associated with winter storms. However, mercury resulting from historical mining activities is of concern in Folsom Lake and the American River downstream. PCBs and “unknown toxicity” from unknown sources also limit water quality and appear in EPA’s 303(d) listing.

American River and Folsom Lake water quality satisfies all the current federal regulations for raw and treated water. It is considered sufficient for water contact recreation, municipal and domestic uses, and coldwater and warmwater fish habitat (State Water Board 2010, Central Valley Water Board 2009). Intakes on Folsom Lake include Folsom WTP, Roseville WTP, and San Juan Water District’s (SJWD) Peterson WTP. Intakes along the lower American River include Golden State Water Company’s (GSWC) Coloma and Pyrites WTP, Carmichael Water District’s (CWD) Bajamont WTP, and Sacramento’s Fairbairn WTP.

Water quality in the smaller Dry, Arcade, and Steelhead creeks varies seasonally and with flow. Dry Creek is comparatively larger and is not listed as a 303(d) impaired water body. Arcade Creek is impaired with the pesticides chlorpyrifos, diazinon, malathion, and pyrethroids from a combination of sources that include agricultural runoff, urban runoff, and aerial deposition. Copper and sediment toxicity from unknown sources also limit water quality in Arcade Creek. Steelhead Creek upstream from the confluence with Arcade Creek is impaired by PCBs from agricultural runoff, urban runoff, and industrial sources. Impairment downstream from Arcade Creek is caused by diazinon, mercury, and PCBs, also from a multitude of sources.

Lower American Watershed: Habitat and Species

The majority of the lower American River is paralleled by the American River Parkway, preserving the surrounding riparian zone. The river channel does not migrate to a large degree because of levees, upstream dams, and incision of the river deep into sediments. The banks of the lower American River channel provide riparian habitat—both scrub and forest consisting of cottonwood, valley oak, and willow, with occasional white alder, box elder, and Oregon ash. Understory species include wild grape, wild rose, blackberry, and elderberry. Emergent marsh habitat is found in still or slow-moving shallow water located on the edges of the river and on the banks of open water areas. These marshes are dominated by aquatic vegetation such as cattail, tule, soft rush, and blue vervain. Wildlife frequently spotted along the river include great blue heron, egret, mallards and other waterfowl, western rattlesnake, gray squirrel, river otter, beaver, turkey, mule deer, coyote, and mountain lion (Sacramento River Watershed Program 2010).

Invasive species, however, are rapidly expanding into the riparian vegetation along the lower American River. In particular, red sesbania is expanding along shorelines of streams and ponds. Pepperweed occupies extensive areas of abandoned agricultural fields with relatively moist soils and subject to periodic flooding in the first 3 miles of the American River upstream from the Sacramento River confluence. Chinese tallow tree, another recent invader, is also expanding in riparian habitats, as are longer established invaders such as arundo, Pampas grass, Spanish broom, French broom, Himalayan blackberry, and tamarisk, which can rapidly colonize exposed bar surfaces and stream banks.

Flows and water temperatures in the lower American River have been altered by the construction of Folsom and Nimbus dams. The dams also pose barriers to migratory fish and have eliminated gravel inputs to the lower river. Nonetheless, the lower American River is generally cold and clear, providing habitat for anadromous and resident fish species. The river is typically low gradient, contains gravel bars, and is composed of riffle, run, glide, and pool habitats (Reclamation 2011a).

The lower American River supports rich fish diversity, but the abundance of some individual species appears to be low. Of the 43 river species, 19 are considered numerous or common in certain portions of the lower American River, 9 are considered present or occasional, 14 are considered as few, uncommon, or rare, and 1 is now extinct. Twenty-two are believed to be non-anadromous species native to the lower American River. In addition to Chinook salmon and steelhead, a few native species have been abundant in surveys conducted in recent years, including Sacramento sucker, Sacramento pikeminnow, sculpins (prickly and riffle), tule perch, hardhead, and Pacific lamprey. Some nonnative species, such as striped bass, American shad, and smallmouth and largemouth bass occur in abundance and are an important recreational resource for anglers (Sacramento County 2008).

Several species of fish in the lower American River are of primary concern because of their declining numbers, and/or their importance to recreational/commercial fisheries. These include Chinook salmon, steelhead, Sacramento splittail, nonnative striped bass, and nonnative American shad. Management of the river to improve in-stream habitat and enhance these fisheries is a goal of many stakeholders, agencies, and organizations in the Sacramento region. These five species are described in further detail in **Table 2-13**.

Table 2-13. Species of Concern on Lower American River

Fish	Abundance in Lower American River Watershed
Chinook Salmon	The lower American River historically supported spring- and fall-run Chinook salmon. By 1955, it is believed that American River spring-run Chinook salmon were extinct due to dam construction. Since that time, fall-run Chinook salmon has been the dominant run.
Steelhead	The lower American River originally supported summer-, fall-, and winter-run steelhead. Historically, nearly all steelhead spawning occurred upstream from what is now the Nimbus Dam. By 1955, with the completion of Nimbus and Folsom dams, it was believed that summer-run steelhead were extinct from the American River. However, unsubstantiated reports from anglers indicate that remnant populations of summer-run steelhead may still exist in the river. Remnant populations of the fall-run and winter-run steelhead do still exist in the river.
Sacramento Splittail	Historically, splittail inhabited Central Valley lowland rivers and lakes. Presently, adult splittail primarily inhabit the Delta, Suisun Bay, Suisun Marsh, and other parts of the Sacramento-San Joaquin Estuary. Splittail are also known to inhabit the Sacramento River below the Red Bluff Diversion Dam and the lower sections of its tributaries, including the Feather and American rivers. Little information regarding Sacramento splittail occurrence, abundance, or habitat use is available specifically for the lower American River.
American Shad	American shad, a nonnative species, was first introduced into California in 1871. American shad is another anadromous species, migrating from the ocean to freshwater to spawn. The introduced American shad rapidly became abundant, and by 1879 a commercial fishery had developed in California. Legislative action in 1957 terminated the commercial fishery in favor of a rapidly developing sport fishery. No specific estimates are available regarding the annual run size of American shad in the lower American River.

Table 2-13. Species of Concern on Lower American River (contd.)

Fish	Abundance in Lower American River Watershed
Striped Bass	Striped bass were introduced into California in 1879 and 1882, when shipments were released in the Sacramento-San Joaquin Estuary. The species rapidly became abundant and provided the basis for a commercial fishery by 1888. Striped bass remains an important sport fish with high recreational value and it also plays an important role as a top predator in the Bay-Delta ecosystem and its watershed. Limited information is available on striped bass presence and distribution in the lower American River, based on previous surveys conducted by the USFWS.

Source: Sacramento County 2008
Key:
USFWS = U.S. Fish and Wildlife Service

Portions of the Dry, Arcade, and Steelhead creek system have been channelized and lack ecosystem values. However, the Dry Creek system has fairly well-connected riparian corridors, relatively low erosion, and fair salmonid (i.e., Chinook salmon, Central Valley steelhead, and resident rainbow trout) habitat. Chinook salmon and steelhead trout no longer spawn in upper tributaries of Dry Creek, although some spawning still occurs in the Dry Creek mainstem. Some Dry Creek tributaries may be used for spawning and shelter for salmonids as well, although spawning salmonids have not been observed in Clover Valley Creek, Antelope Creek, or Sucker Ravine (Placer County 2004).

Lower American Watershed: Watershed Management and Stewardship

Watershed management of the lower American River was one of the central concerns of the WFA that was signed in 2000. The need to balance both environmental and water supply needs off the American River initiated the 7-year-long regional Water Forum effort. The resulting integration and coordination have continued and expanded, and this 2018 ARB IRWMP Update is closely related to implementation actions of the WFA.

The lower American River has also been designated a “Recreational River” under both the California Wild and Scenic Rivers Act and the National Wild and Scenic Rivers Act. These designations provide state and national recognition, and additional protection of the river’s outstanding scenic, wildlife, historic, cultural, and recreational values. Organizations, such as the Sacramento Area Creeks Council and the American River Parkway Foundation support protection of the lower American River and its recreational values. Sacramento County has designated 4,600 acres along the river as a regional park, and its 23-mile trail system of the American River Parkway has been designated a “National Recreational Trail.” Folsom Lake is similarly surrounded by the Folsom Lake State Recreation Area, providing both recreation and habitat protection. These parks and recreational areas draw millions of local visitors each year.

Some local tributaries to the lower American River have notable, active water management plans. One is the Alder Creek Watershed Management Action Plan, developed by City of Folsom (Folsom). The 15-mile-long Alder Creek flows from the Sierra Nevada foothills west to Lake Natoma on the lower American River. Located in a place of anticipated urban development, the plan included a watershed assessment to characterize natural resource conditions as well as education and outreach to encourage watershed stewardship. With assistance from CALFED funding, Folsom developed Alder Creek management recommendations and implementation strategies in a collaborative manner (Folsom 2010).

Placer and Sacramento counties both manage the Dry, Arcade, and Steelhead creek system. The two counties jointly developed a 2003 Dry Creek Watershed Resource Management Plan, and Dry Creek is included in many of Placer County's conservation programs, such as Placer Legacy. The Dry Creek Conservancy, a nonprofit organization, also aims to facilitate watershed conservation, restoration, and education in Dry Creek, as well as in other Placer County creeks. The ABCW has been active in these creeks as well, conducting a 2008 Steelhead Creek Drinking Water Quality Study and Watershed Assessment (American Basin Council of Watersheds 2008). Recreation also plays a role in watershed stewardship, as Sacramento County manages a 6-mile corridor known as the Dry Creek Parkway. Regional plans aim to eventually create a 70-mile greenway loop in this Region.

2.6.2.5. Lower Sacramento Watershed

The Lower Sacramento Watershed lies mostly to the west and outside of the Region, but its 200 square miles within the Region includes most of the urban and developed areas adjacent to the river. Cities in this watershed include Sacramento, Rancho Cordova, and Elk Grove. The Lower Sacramento Watershed is primarily urban. The suburbs, such as Elk Grove, have been rapidly developing and expanding in the past few decades, creating water supply-, environmental-, and flood-related interests in this watershed.

The Morrison Creek Stream Group (**Figure 2-18**) carries flows from the Lower Sacramento Watershed within the Region and is the focus of the description of this subsection. Of the Morrison Creek tributaries, information for Laguna Creek[4] is more available, as it has been studied and is managed by Laguna Creek Watershed Council and the Upper Laguna Creek Collaborative. Characteristics of Laguna Creek are included in a general sense as a representative of the other creeks of the Morrison Creek Stream Group. The Lower Sacramento Watershed and its subwatersheds are shown in **Figure 2-24**.

[4] A tributary of the Cosumnes River is also named Laguna Creek, not to be confused with this one of the Morrison Creek Stream Group.

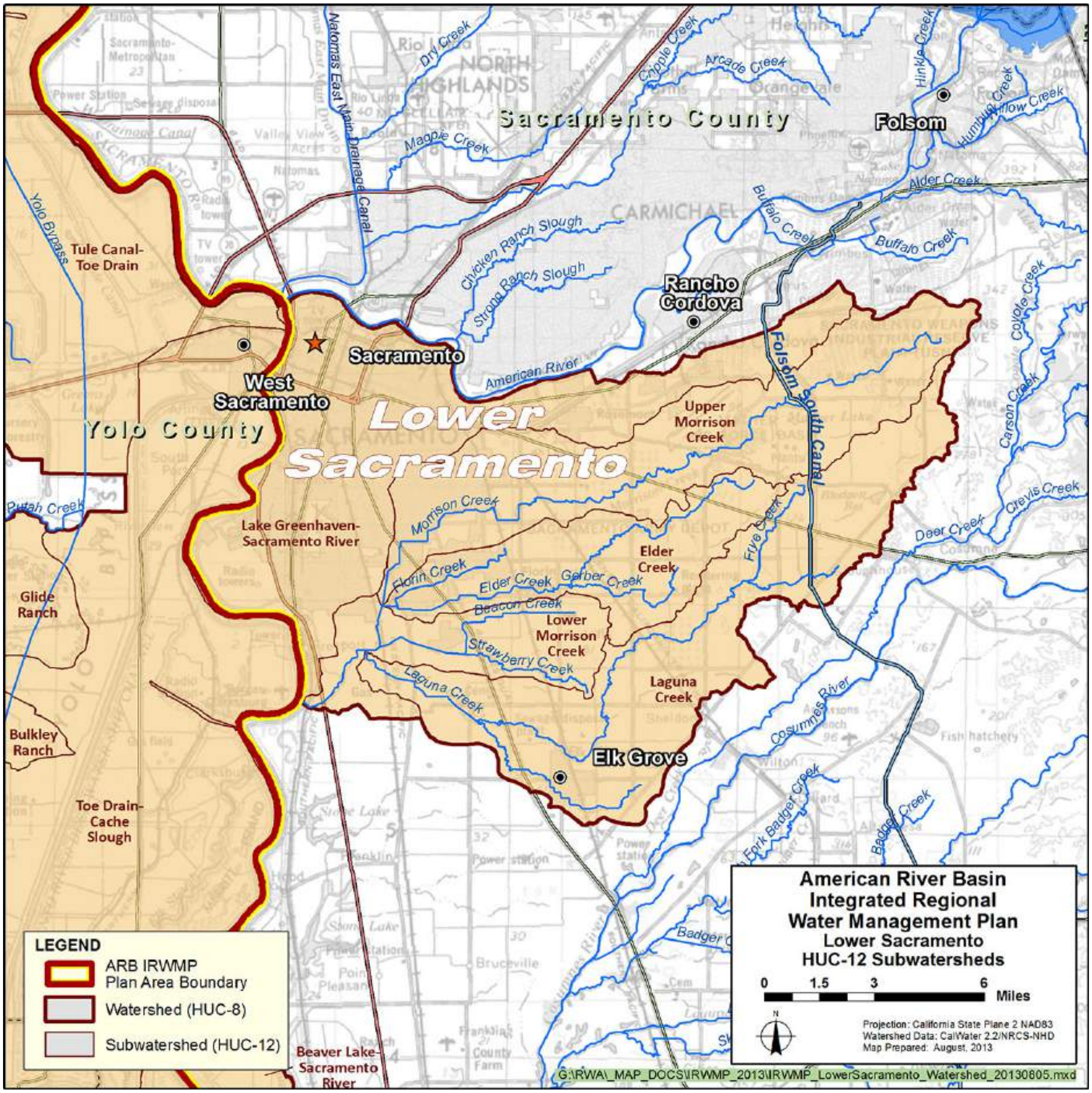


Figure 2-24. Lower Sacramento Watershed

Lower Sacramento Watershed: Hydrology

The Morrison Creek Stream Group is a tributary to the Sacramento River, and includes Morrison, Florin, Elder, Union House (Beacon), Strawberry, Laguna, and Elk Grove creeks (see **Figure 2-24**). Laguna Creek and its many tributaries, such as Elk Grove Creek, join Morrison Creek north of the SRWWTP. These streams are small, local streams that have been extensively relocated and channelized as a result of urban development. Laguna Creek, for example, is a meandering single channel that conveys runoff from an average of 16 to 17 inches of rain that falls over this small watershed. Urbanization has increased peak flows and associated erosion, habitat degradation, and flood concerns.

The Morrison Stream Group flows into Stone Lakes National Wildlife Refuge west of Elk Grove, south of the FRWP intake facility. During winter months, high flows may also be directed to the Stone Lakes National Wildlife Refuge, located in the Upper Mokelumne Watershed, described in **Section 2.6.2.7** (Elk Grove 2008).

Lower Sacramento Watershed: Water Quality

Many creeks of the Morrison Stream Group have TMDLs for the pesticide diazinon. EPA's 303(d) list also identifies sediment toxicity, polychlorinated biphenyl, and pyrethroids from unknown sources. Assuming Laguna Creek is representative of the Morrison Creek Stream Group, additional water quality concerns potentially include fecal coliform (*E. coli*) concentrations, dissolved oxygen, trace metals, and excess nutrients (Geosyntec Consultants 2007).

Lower Sacramento Watershed: Habitat and Species

As discussed, the streams of the Morrison Creek Stream Group have been extensively relocated and channelized as a result of urban development. These streams were first impacted by farming, starting in the late 19th century when native grasslands and sparse riparian vegetation were displaced by crops, pasture, and invasive nonnative grasses and weeds. Vernal pool grassland habitat can be found in some upstream reaches.

Laguna Creek, and potentially other nearby tributaries, support sensitive species, such as valley elderberry longhorn beetle, giant garter snake, and western pond turtle; aquatic foraging birds; American peregrine falcon; and nesting raptors, such as Swainson's hawk and white-tailed kite. There are no special-status fish species that are known to occur in Laguna Creek. Altered habitats and the presence of nonnative aquatic species are primary limiting factors impacting the native fish community (Laguna Creek Watershed Council 2009).

Lower Sacramento Watershed: Watershed Management and Stewardship

The Laguna Creek Watershed Council is a nonprofit organization established in 2008 that represents a diverse group of watershed residents, community group leaders, and local government agency representatives. The council has been active in watershed management and stewardship for Laguna Creek, within the Morrison Stream Group. However, similar agencies and efforts for other streams within the Morrison Creek Stream Group, as a whole, have not been identified.

2.6.2.6. Upper Cosumnes Watershed

The Upper Cosumnes Watershed covers 335 square miles of the southeastern portion of the Region. The watershed within the Region is primarily agricultural, including croplands, vineyards, pastures, and orchards. This area supports smaller communities, such as the Galt and Rancho Murieta Community Services District (Rancho Murieta), and residential areas have developed in recent years. Deer Creek and Laguna Creek (see **Figures 2-18** and **2-25**) are the main tributaries to the lower portion of the Cosumnes River that flows within the Region. The Upper Cosumnes Watershed is considered to have a high potential for effective restoration, and it is the largest, undammed (i.e., no large, permanent dams) river remaining in the Sierras. Its downstream end is also a part of the Delta and is influenced by tidal effects. Thus, there are also strong environmental interests in this watershed. Unlike the other watersheds, the Upper Cosumnes Watershed has been studied as a whole by the Cosumnes River Preserve (CRP) and is generally presented as such in this subsection description.

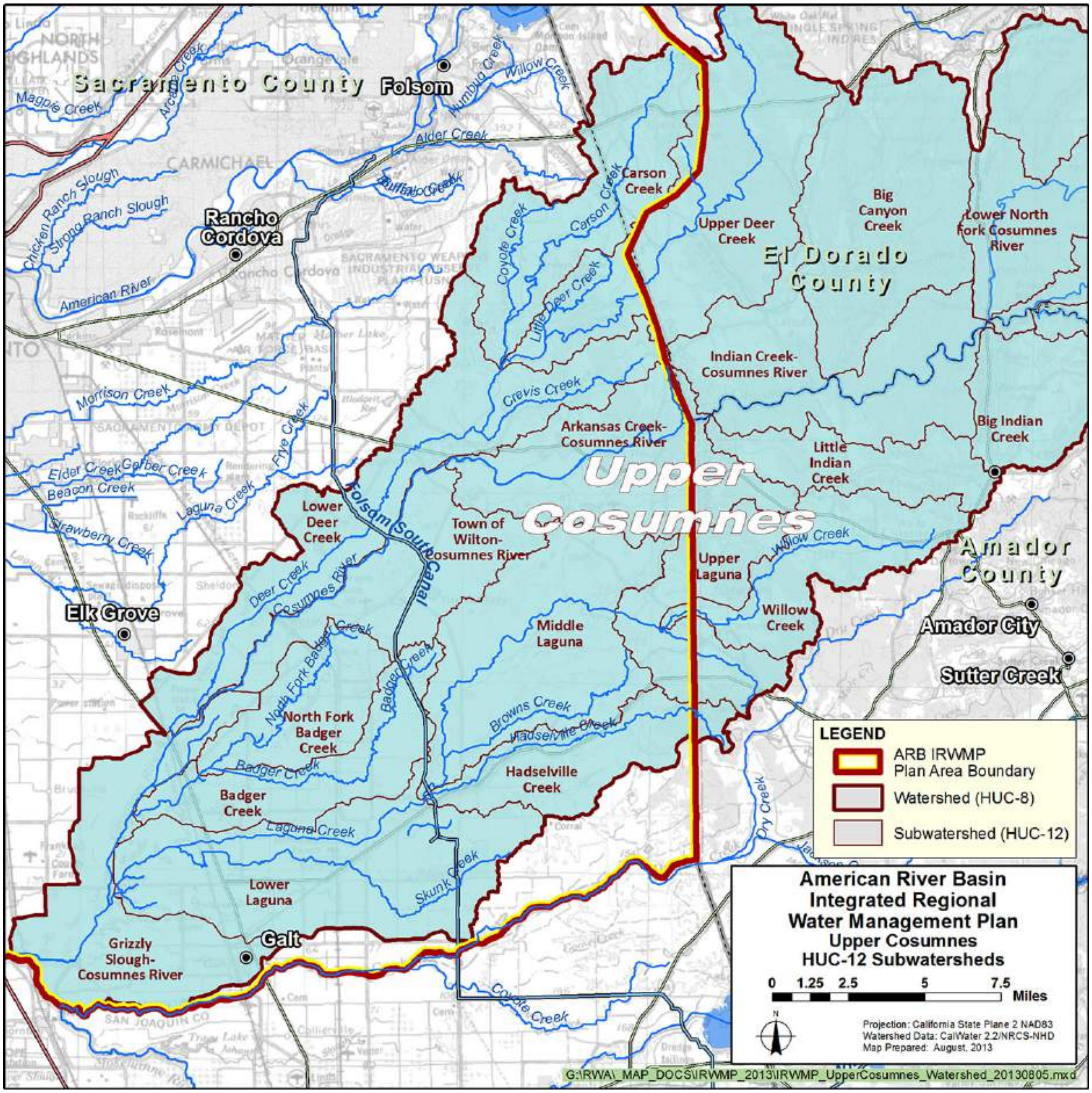
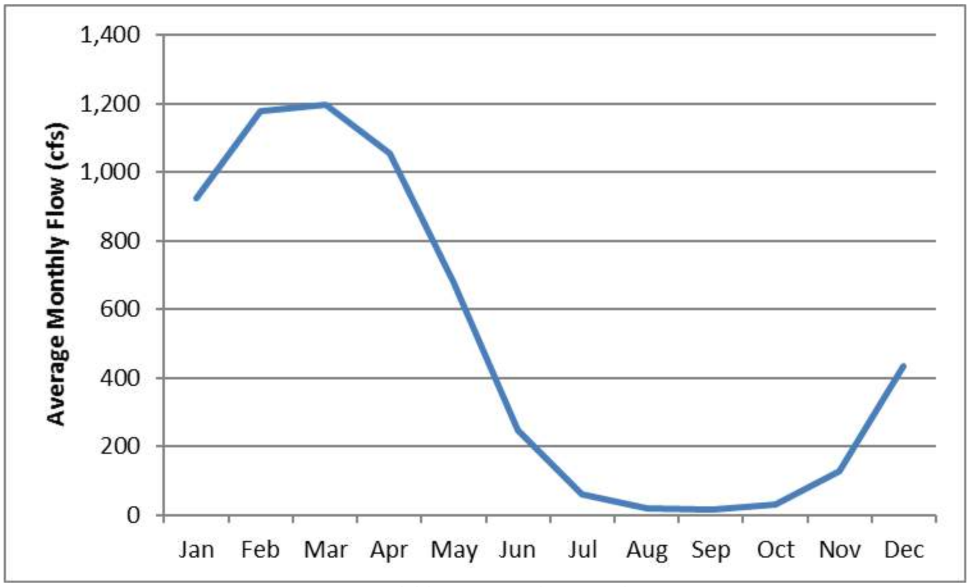


Figure 2-25. Upper Cosumnes Watershed

Upper Cosumnes Watershed: Hydrology

Flowing through the southern portion of the Region, the Cosumnes River is a tributary to the Mokelumne River and is a part of the larger San Joaquin River Hydrologic Region. The 80-mile-long Cosumnes River is a small river whose headwaters begin at about at 7,200 feet above sea level in the Sierra Nevada. The river flows southwest to the Delta. The segment of the watershed within the Region is characterized as tidal floodplain or open floodplain. The tide influences multiple shifting channels in the tidal floodplain areas, while the open (non-tidal) floodplain portion is not influenced by tides (CRP 2008).

Most of the flow in the Cosumnes River and its tributaries results from winter rain, and the annual hydrograph closely follows the pattern of precipitation. The river is considered to be undammed because it has no major hydroelectric dams. Extreme low flows (including dry bed) occur in the lower Cosumnes River in the late summer, after long periods without precipitation. Average annual flows can also vary from around 36 cfs to more than 1,500 cfs. **Figure 2-26** shows the average monthly flows for the Cosumnes River.



Data Source: USGS 11335000 gage at Michigan Bar 10/1907-03/2017

Key: cfs = cubic feet per second

Figure 2-26. Average Monthly Flows at Michigan Bar

There are no required in-stream flows for aquatic resources maintenance for the Cosumnes River. The USFWS is working to determine and evaluate these requirements that will ensure adequate flows for all life stages for all salmonids (USFWS 2013).

Upper Cosumnes Watershed: Water Quality

Water quality of the Cosumnes River is impacted by levels of nitrogen, phosphorous, and suspended sediments, from both point and nonpoint sources. Water temperature, conductivity, and pH generally increase downstream (CRP 2006). EPA's 303(d) list identifies *E. coli*, sediment toxicity, and invasive species as impairments to the Cosumnes River system. Since 2011, the Central Valley Water Board has implemented a Delta-wide mercury TMDL, and this plan identifies the entire Cosumnes River Watershed as a high mercury contributor (Central Valley Water Board 2010).

Despite contamination concerns, water quality is sufficient for water contact recreation and municipal use after treatment. Rancho Murieta Community Services District takes water from the Cosumnes River at

Granlees Dam for municipal use. Other uses are primarily agricultural for private irrigators along the river.

Upper Cosumnes Watershed: Habitat and Species

The Upper Cosumnes Watershed's lower reaches within the Region support one of the biologically richest regions in California's Central Valley. Stretches of the river are relatively unaffected by development, with sloughs, ponds, oak woods, and fertile bottomlands. Marshes and grasslands provide wintering grounds for tens of thousands of migrating birds, songbirds and raptors, including sandhill crane, tundra swan, and great blue heron. The river is home to a number of resident, fall-run native fishes, and Chinook salmon are showing signs of rebounding after years of decline. Located between Sacramento and Stockton, there is increasing pressure for urban development in the watershed. Farmland conservation is considered to be important in the coming years, as it provides habitat for wildlife and helps buffer important streamside areas from the effects of urbanization.

Upper Cosumnes Watershed: Watershed Management and Stewardship

The CRP plays an integral part in watershed management and stewardship in the Upper Cosumnes Watershed. CRP is currently a multiagency partnership, including the federal, state, and local governments, nonprofit organizations, and local school districts. Cooperative management agreement partners include:

- U.S. Bureau of Land Management
- The Nature Conservancy (TNC)
- Sacramento County Department of Regional Parks
- CDFW
- Ducks Unlimited, Inc.
- DWR
- California State Lands Commission
- NRCS
- Galt Joint Union Elementary School District

The partnership has studied and developed watershed assessment plans and CRP Management Plans. The CRP has also encouraged recreation and over 60,000 people visit each year. More information about the CRP is available on their Web site at http://www.cosumnes.org/

TNC and local farmers started a 1,040-acre organic farm on the CRP in 1995. By the year 2000, TNC had protected more than 20,000 acres of private farmland and rangeland in the watershed through conservation easements, and 10,000 acres more through direct purchase. The preserve has continued to grow and it now encompasses more than 46,000 acres. The CRP is reestablishing riparian forest and perennial grasslands through active and passive restoration efforts. Valley oak, Oregon ash, Fremont's cottonwood, box elder, willow, wild rose, and elderberry are planted to create the diverse understory of trees and shrubs found in mature riparian forest (NMFS 2009).

2.6.2.7. Upper Mokelumne Watershed

The Upper Mokelumne Watershed is located in portions of Sacramento, San Joaquin, Amador, and Calaveras counties and encompasses some 1,266 square miles. Only a small portion of the Upper Mokelumne (104 square miles) is within the Region. Most of the significant hydrologic, habitat, and watershed management of the Upper Mokelumne occurs south of the Region, so it is not described further here. The portion of the Upper Mokelumne Watershed within the Region consists of minor drainages from primarily human-made inland Delta waterways. The Upper Mokelumne Watershed and its subwatersheds are shown in **Figure 2-27**.

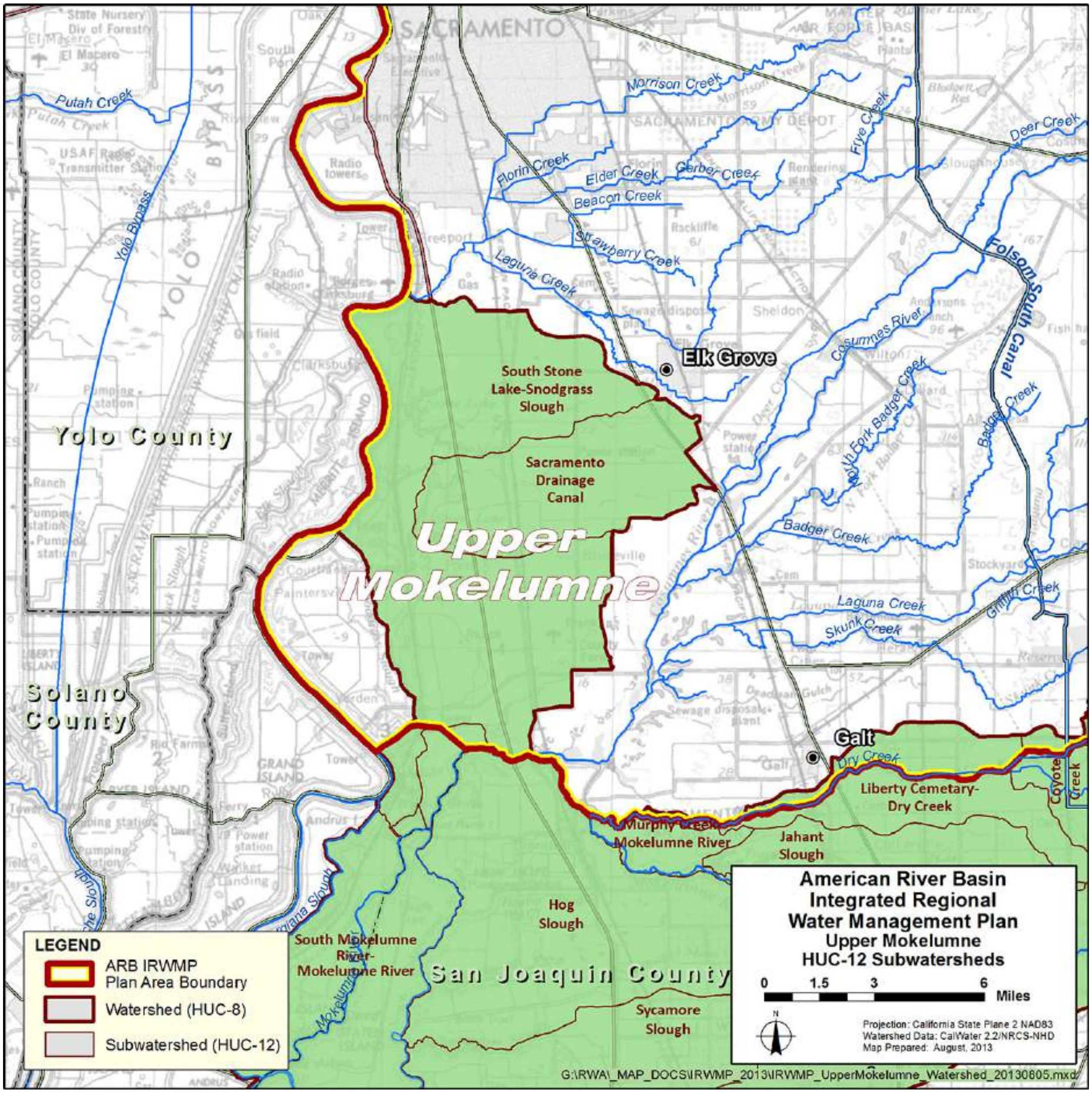


Figure 2-27. Upper Mokelumne Watershed

Upper Mokelumne Watershed: Hydrology

The primary hydrologic feature of the Upper Mokelumne is the lower Mokelumne River, which constitutes a few miles of the Region southwestern boundary. The lower Mokelumne is dammed about 34 miles upstream by the Camanche Dam and Reservoir operated by EBMUD. The operation of Camanche Dam and Pardee Dam further upriver have significantly modified the downstream flow regime.

Upper Mokelumne Watershed: Water Quality

Water quality has been characterized in the Mokelumne River for the portion of the Upper Mokelumne Watershed that is within the Region. While water quality is considered good for most purposes, there are constituents that exceed protective water quality standards, causing the lower Mokelumne River to be placed on the State Water Board's 303(d) listing of impaired water bodies. These pollutants include: chlorpyrifos associated with agricultural runoff; dissolved oxygen from unknown sources; and copper, mercury, unknown toxicity from unknown sources, and zinc associated with mining in the upper portions of the watershed.

Upper Mokelumne Watershed: Habitat and Species

The Upper Mokelumne Watershed within the Region is dominated by cropland, grassland, and wetland. In a 2009 report by the NMFS evaluated the Mokelumne River for its habitat potential to support salmon and steelhead (NMFS 2009). The report concluded that the lower river segment does have a low potential to support viable self-sustained populations of steelhead. Issues include reduced flows in this reach of the river from damming and diversions, impediments to passage, relatively high water temperatures, lack of spawning gravels, and water quality concerns.

Another noteworthy habitat within the Region of the Upper Mokelumne Watershed is the Stone Lakes National Wildlife Refuge. The refuge is part of the National Wildlife Refuge System and is a major stop along the Pacific Flyway for migrating birds. The refuge is authorized for up to 18,000 acres and is part of a partnership between the USFWS and more than two dozen other partners (see http://www.fws.gov/refuge/Stone_Lakes/). The refuge is home to more than 200 species of birds and many other fish and wildlife species.

Upper Mokelumne Watershed: Watershed Management and Stewardship

As described, the USFWS and more than two dozen partners are actively engaged in the Stone Lakes National Wildlife Refuge. USFWS adopted a Comprehensive Conservation Plan for the refuge in 2007 that provides a 15-year management direction (see http://www.fws.gov/refuge/Stone_Lakes/what_we_do/planning.html).

2.6.3. Groundwater: Groundwater Basin Characteristics

Groundwater is an important source of water supply within the Region and is an integral part of the regional water resources setting. Groundwater supports a significant portion of the Region’s water needs, and often helps reduce impacts to water users in times of shortage. Efforts to increase conjunctive use[5] in the Region have increased the use of surface water when available during wet and normal conditions, while preserving and protecting groundwater resources for dry and critically dry periods.

2.6.3.1. Hydrogeology of the Region

There are three groundwater subbasins defined by DWR that underlie the Region, as shown in **Figure 2-3**: the North American, South American, and Cosumnes groundwater subbasins. These subbasins are bounded by the Sacramento or Feather River to the west and the geologic formations of the Sierra Nevada to the east. The North American Subbasin boundaries are defined by the Bear and American rivers, the South American Subbasin by the American and Cosumnes Rivers, and the Cosumnes Subbasin by the Cosumnes and Mokelumne rivers. These subbasins are discussed separately in the following subsections after an initial characterization of the hydrogeology, water quality, and contamination issues that span across the entire Region. Each subbasin has one or more entities that manage groundwater. Groundwater extraction in the Region is discussed in **Section 2.9**.

Groundwater resources in Sacramento County and most of the Region have been extensively investigated and reported in DWR's Bulletin 118, California's Groundwater. The Bulletin's 2003 update describes various geologic formations that constitute the water-bearing deposits underlying Sacramento County and significant portions of western Placer County. Located in the Sierra Nevada foothills and mountain areas, El Dorado County does not generally have significant groundwater resources from a municipal supply standpoint. Groundwater-bearing formations in the Region include an upper aquifer system consisting of the Riverbank, Turlock Lake, and Laguna formations, and a lower aquifer system consisting primarily of the Mehrten Formation. The formations are shown in **Figure 2-28** and are typically composed of lenses of interbedded sand, silt, and clay, interlaced with coarse-grained stream channel deposits. **Figure 2-28** illustrates that these deposits form a wedge that generally thickens from east to west to a maximum thickness of about 2,500 feet under the Sacramento River.

Groundwater occurs in an unconfined to semi-confined state throughout the Region. Semi-confinement may occur in local areas, and the degree of confinement typically increases with depth. Groundwater in the Riverbank, Turlock Lake, and Laguna formations is typically unconfined. The deeper Mehrten Formation, a major source of groundwater, exhibits semi-confined conditions. The Valley Springs and

[5] As defined by the 2009 California Water Plan Update, conjunctive use (management) is 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…" (DWR). Conjunctive use involves using and storing surface water to intentionally recharge groundwater during wet years. Stored groundwater can then be used during drier years. Conjunctive use is an integral part of the WFA and requires actions such as regional cooperation, groundwater management, construction of new wells, and operational changes in water use depending on hydrologic year type.

Ione Formations underlie some of the productive aquifers in the Region and are transitional aquifer systems that contain a mixture of saline and fresh groundwater (SGA 2008b).

Groundwater in the Region moves from sources of recharge to areas of discharge. Most recharge to the local aquifer system occurs along active stream channels where extensive sand and gravel deposits exist. As a result, the highest groundwater elevations occur near the American and Sacramento rivers.

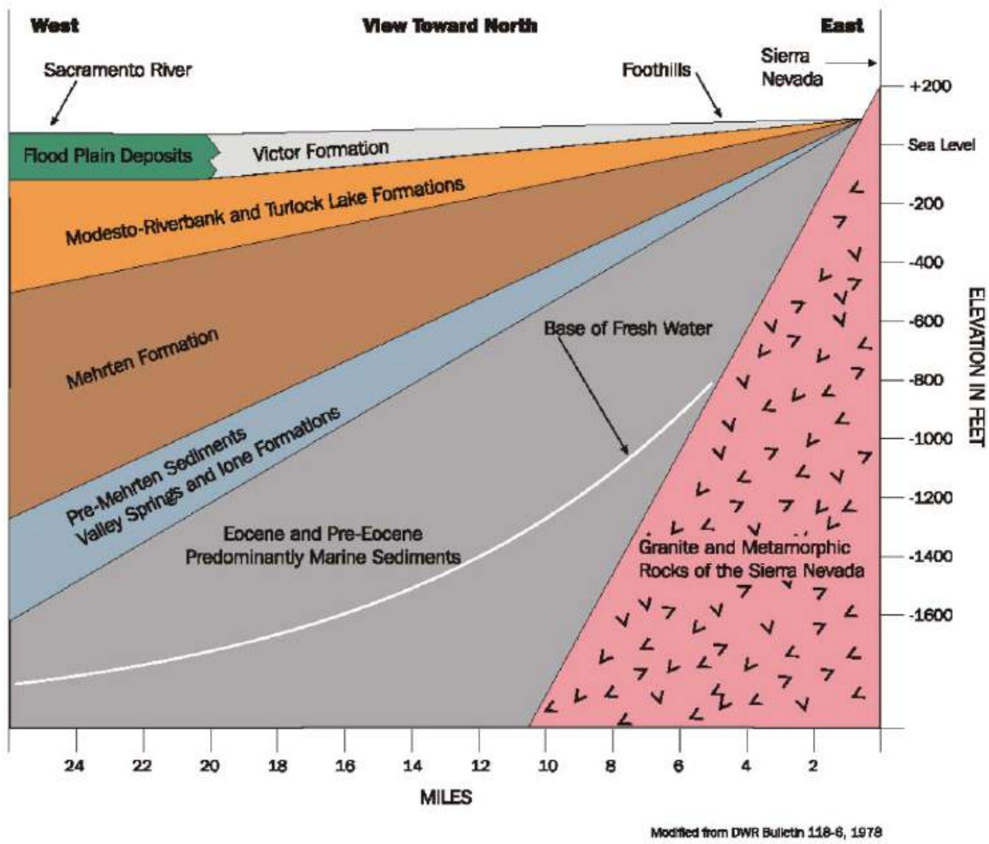


Figure 2-28. Regional Geologic Cross Section

2.6.3.2. Groundwater Quality in the Region

Water quality analyses of the aquifers underlying the Region have shown that groundwater found in the upper aquifer system is generally of higher quality than that found in the lower aquifer system. Water from the upper aquifer (specifically the Laguna Formation) generally does not require treatment (unless high arsenic levels are encountered), other than disinfection for public drinking water systems. In contrast, the lower aquifer system (specifically the Mehrten Formation) generally contains higher concentrations of iron and manganese. The lower aquifer system also has higher concentrations of total dissolved solids (TDS), although this aquifer also typically meets water quality standards as a potable water source. At depths of approximately 1,400 feet or greater (actual depth varies throughout the basin, but could be as shallow as 800 feet), TDS concentrations exceed 2,000 milligrams per liter (mg/L); thus, the groundwater is considered nonpotable (SCGA 2006). The area underlying the upper and lower aquifers (below the Mehrten Formation) is saline connate water (trapped in rock pores and often pressurized), at depths ranging from 800 feet in the east to 2,000 feet below ground surface in the west.

While the Region enjoys robust groundwater resources, contamination has and continues to be a significant management concern. There are numerous groundwater contamination plumes in the Region stemming from previous industrial activities that have directly impacted or continue to threaten groundwater quality. Throughout the Region, groundwater contamination plumes have forced some wells to be taken out of service in the past two decades, and continue to threaten other local groundwater supplies. For example, wells owned by California American Water (Cal-Am), GSWC, and SCWA have been impacted and shut down due to the migration of contaminants from Aerojet General Corporation (Aerojet), while wells in Sacramento Suburban Water District (SSWD) have been abandoned due to the McClellan plume from the former air force base (AFB). Contaminant plumes from Aerojet have migrated north, beneath the American River, impacting wells in CWD and Fair Oaks Water District (FOWD). The Aerojet and McClellan AFB locations are the largest, most extensive groundwater contamination plumes in the Region. The approximate location and extent of these plumes and others, such as the plumes from Mather AFB and the Union Pacific Railroad sites as of 2008, are shown in **Figure 2-29**. Some of the main contaminants of concern include trichloroethene, tetrachlorethene (PCE), perchlorate, and n-nitrosodimethylamine (NDMA).

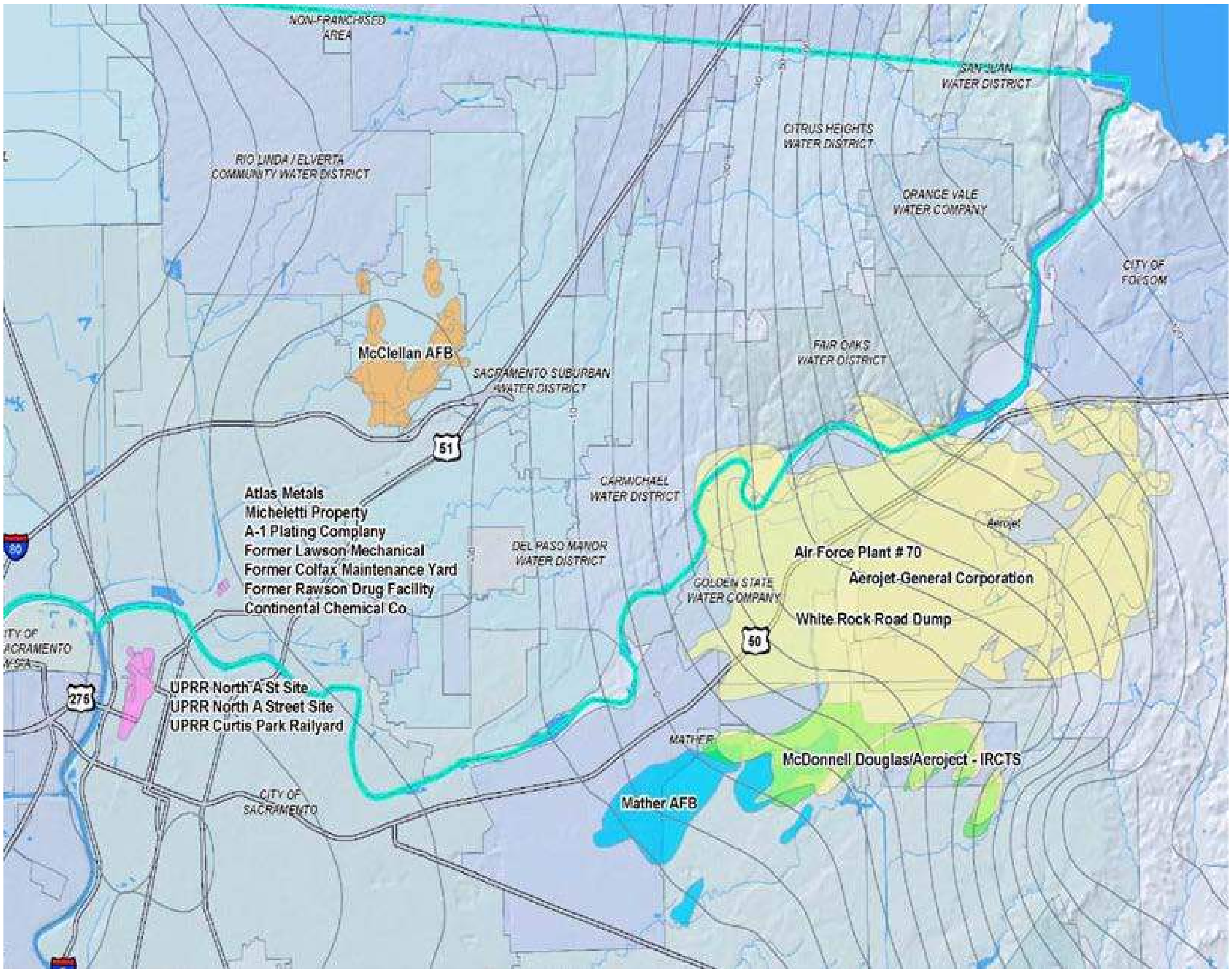


Figure 2-29. Extents of Contamination Plumes as Reported in 2011 Sacramento Groundwater Authority Basin Management Report

Monitoring wells and pump-and-treat facilities have been installed in numerous locations to control further contaminant plume migration and to remediate soil and groundwater resources. The Sacramento Environmental Management Department maintains a policy of special review by appropriate regulatory agencies for well permits within 2,000 feet of a known contaminant plume (referred to as Consultation Zones) and prohibits drilling of new public water supply wells at the former McClellan AFB to ensure public safety. In response to concerns over these contaminant plumes, the Region began a Regional Contamination Issues Committee that has met on a quarterly basis since 2004. The committee coordinates the region’s water suppliers with regulators and responsible parties to most effectively ensure cleanup of these contaminants in a timely fashion.

Other than the aforementioned contaminant plumes, groundwater from both the upper and lower aquifers is used extensively for various beneficial uses, and the groundwater quality generally meets all state and federal maximum contaminant level (MCL) standards for drinking water. From north to south in the

Region, groundwater quality has been most recently assessed by the Western Placer County Groundwater Management Plan Group (WPC) in 2017, by Sacramento Groundwater Authority (SGA) in 2016, and by Sacramento Central Groundwater Authority (SCGA) in 2016. Little formal assessment of groundwater quality conditions has been performed in the sparsely populated portion of the Region south of the Cosumnes River. However, there are no known contaminant plumes (SAWC 2010) and the City of Galt reports no MCL exceedances for any groundwater quality parameters in eight City wells in its 2016 Drinking Water Consumer Confidence Report (Galt 2017). For the remainder of the Region, extensive water quality sampling has occurred at over 200 public supply wells and dozens of monitoring wells. Typical parameters analyzed include: TDS, nitrate, arsenic, hexavalent chromium (CrVI), iron, manganese, and perchlorate. MCL exceedences for TDS, arsenic, and nitrate are rare. These parameters are discussed further below.

Total Dissolved Solids

TDS is a measure of all dissolved constituents in water, resulting primarily from the rocks and sediments with which the water comes into contact. TDS has a secondary MCL drinking water standard (associated with the aesthetics of the water) of 500 mg/L. With respect to TDS, water quality is generally very good in the Region. However, WPC did note areas of elevated TDS in portions of Placer County that are likely associated with shallow occurrences of the Ione Formation, which was deposited in a marine environment. Of 58 wells sampled by WPC, 11 wells exceeded the secondary MCL, but these tend to be concentrated in a relatively small area along the eastern margin of the basin. This area of high TDS is not considered a concern to the overall health of the Region’s groundwater basins. In the SGA area, the average TDS was 268 mg/L, with only six out of 255 distinct wells exceeding the secondary MCL. In the SCGA area, only one well out of 56 had a secondary MCL exceedance. Agencies will continue to monitor for long-term trends in TDS concentrations to determine if concentrations are increasing through time.

Nitrate

Nitrate is a commonly naturally occurring element, but elevated concentrations are often associated with human activities such as wastewater discharge, urban runoff of applied fertilizers, and agricultural activities. The MCL for nitrate is 45 mg/L. While nitrates are somewhat elevated compared to what might be considered naturally-occurring background, nitrate concentrations are not a significant concern in the Region. The data analyzed by the WPC, SGA, and SCGA included distinct samples from 493 wells. Of those, there were only two past observed concentrations exceeding the MCL. No public supply wells currently exceed the MCL. SGA calculated an average concentration of 11.5 mg/L in 252 wells. The occurrence of nitrate in the Region does not have a distinct geographic pattern, although concentrations tend to be higher in the upper aquifer as it is closer to the human activities associated with its increased concentration. Agencies will continue to monitor for long-term trends in nitrate concentrations to determine if concentrations are increasing through time.

Arsenic

Arsenic is a naturally occurring element with an MCL of 10 mg/L. Arsenic is not seen as a major groundwater quality concern in the region. However, the western half of the Region tends to have higher concentrations of arsenic. In Placer County, WPC noted that only one well out of 58 total had an MCL exceedance for arsenic. In the SGA area, only one well of 236 distinct wells sampled had an MCL exceedance. In the SCGA area, nine out of 72 wells were noted to have an MCL exceedance. In general, water purveyors have been successful in simply avoiding these areas of relatively high arsenic. Where necessary, wellhead treatment systems are demonstrated as very effective in removing arsenic to protective levels.

Hexavalent Chromium

CrVI is a dissolved metal that is commonly found in low concentrations in groundwater. It can occur naturally, but it has also been sourced historically from industrial operations. A State of California MCL was established at 10 micrograms per liter (µg/L) In July 2014, but that standard was rescinded in 2017 and is currently under review. For discussion purposes, information here is presented in comparison to the suspended MCL. In Placer County, the WPC noted the presence of CrVI, but it was not widespread. Of 58 wells sampled, only one well exceeded 10 µg/L and six wells had concentrations between 5 and 10 µg/L. In the SGA, the presence of CrVI is more extensive and is concentrated in the central part of the SGA area. Of 215 distinct wells sampled, 65 wells had concentrations between 5 and 10 µg/L and 19 wells had concentrations greater than 10 µg/L. SGA noted that higher concentrations tended to be in shallower wells. In the SCGA area, none of the 134 wells sampled exceeded 10 µg/L. Many of the affected water suppliers in the SGA are planning for potential wellhead treatment systems while awaiting the review of the CrVI MCL. SGA continues to look for options to determine the potential sources of elevated CrVI in its management area.

Iron

Iron is a naturally-occurring element and is found in groundwater as a dissolved metallic ion. Iron has a secondary MCL of 300 µg/L, because it tends to have a bad taste and can precipitate as a red-brown solid on plumbing fixtures. In general, iron concentrations tend to be higher in the Region in the lower aquifer system, which is associated with the volcanic Mehrten Formation. Elevated iron was most prevalent in SGA area where 56 wells out of 196 distinct wells exceeded the MCL. Where encountered, water suppliers generally successfully use wellhead treatment to manage the iron.

Manganese

Manganese is a naturally-occurring element and is found in groundwater as a dissolved metallic ion. Manganese has a secondary MCL of 50 µg/L, because it tends to have a bad taste and can precipitate as a black solid on plumbing fixtures. In general, manganese concentrations tend to be higher in the Region in the lower aquifer system, which is associated with the volcanic Mehrten Formation. Elevated manganese is most prevalent in SGA area (35 wells out of 183 wells exceeded the MCL) and in the SCGA area (25 wells out of 67 wells exceeded the MCL). Where encountered, water suppliers generally successfully use wellhead treatment to manage the iron.

Perchlorate

Perchlorates are a group of salts derived from perchloric acid and are used as a propellant for rockets and fireworks. The current state MCL for perchlorate of 6 µg/L is currently under review. Known perchlorate contamination in the Region is associated with the Aerojet Corporation plume shown in **Figure 2-29**. Regional water suppliers have been actively engaged and informed of remediation operations associated with the perchlorate at the facility. In some instances, wellhead treatment systems have been employed on water supplier production wells and an important management strategy for cleanup.

2.7. Flood and Stormwater Management Systems

Throughout California, and especially the Central Valley, a complex system of dams and reservoirs, levees, weirs, bypasses, and other features have been constructed over the last 150 years to protect urban and rural areas against periodic flooding. Federal, state, and local jurisdictions often overlap, complement, and at times, conflict with each other to manage this flood risk. The state designates that urban areas should maintain protection from a 200-year-level storm event, but as seen in **Figure 2-4**, areas along the American and Sacramento rivers, especially the downstream western portions of the Region, are susceptible to 100-year floods. FloodSAFE California's (FloodSAFE) California's Flood Future (2013b) studied the flood hazards in IRWM regions statewide for 100-year and 500-year floods.[6] This information is summarized in **Table 2-14**.

[6] A "100-year flood" is a flood that has a 1 in 100 chance of being exceeded in any given year. This may also be expressed as the 1% annual chance of exceedence flood, or "1% annual chance flood." Similarly, a 500-year flood has a 1 in 500 (or 0.2%) chance of being exceeded in any given year (DWR 2012a).

Table 2-14. Region's Exposure to Flood Hazards

	100-Year Flood	500-Year Flood
Land Area Exposed (acres)	118,434	241,642
Land Area Exposed (percent of total land area)	15%	31%
Population Exposed (number of people)	51,586	594,234
Population Exposed (percent of total population)	4%	41%
Total Depreciated Replacement Value of Exposed Structures and Contents ($1,000s)	$4,344,109	$13,797,914
Crop Area Exposed (acres)	47,282	81,832
Crop Area Exposed (percent of total crop area)	29%	51%
Value of Exposed Crops ($1,000s)	$66,858	$119,076
Total Sensitive Plants and Animal Species[1]	57	63
Total Essential Facilities[2]	15	250
Transportation Facilities	145	456
High Potential Loss Facilities[3]	20	55
Lifeline Utilities[4]	0	20

Source: DWR, 2013b, California's Flood Future

Notes:
[1] Sensitive species include state and federal listings of endangered and threatened species.
[2] Essential facilities include care facilities, emergency centers, fire stations, police stations, and schools.
[3] High potential loss facilities include dams and hazardous material sites.
[4] Lifeline utilities include potable water, oil, natural gas, electric power, and communication facilities.

Key:
ARB = American River Basin

Several agencies are responsible for operations and maintenance of the Region's flood and stormwater management systems, including nonpoint source water pollution control. Flood management considers systemwide flooding potential, while stormwater management concerns localized storm drainage on a smaller scale, with attendant water quality protections. Responsibilities for flood management generally fall under federal, state, and regional purviews. Federal and state governments also assist local efforts. For example, DWR's FloodSAFE is a long-term strategic initiative developed to reduce flood risk in California, and DWR's flood risk management programs are consolidated under FloodSAFE. This includes provision of voter-authorized funding through Propositions 1E and 84 to assist local flood projects. In contrast to flood management, stormwater management generally falls under county, city, or local drainage districts or their respective departments. Under Proposition 1, $200 million in grant funds were made available to implement multi-benefit stormwater projects that would support local stormwater management efforts. Green infrastructure, stormwater treatment facilities, and rainwater and stormwater capture projects are examples of multi-benefit stormwater projects funded by Proposition 1 grant funding. More information on the SWRPs found in the Region may be found under **Section 3.2.2**.

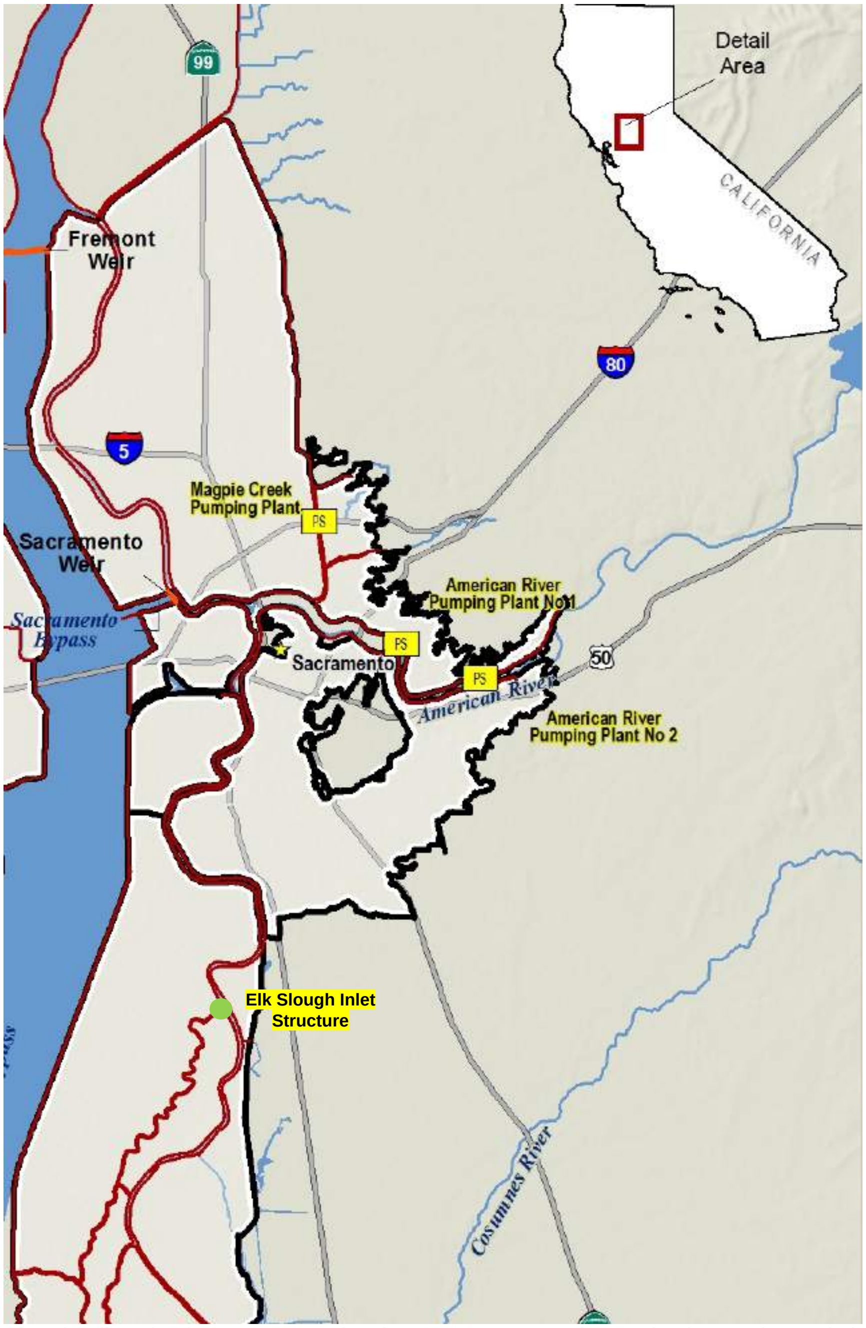
While strategies are highly dependent on regional watershed characteristics, the jurisdictions charged with flood and stormwater management responsibilities typically do not follow or align with watershed boundaries. Accordingly, this subsection begins with a region-wide perspective describing the role of the federal and state governments and the State Plan of Flood Control (SPFC) facilities in higher level flood management. SAFCA, a regional multicounty, multiagency flood management entity is then characterized. Thereafter, responsible local agencies or partnerships and relevant plans within Sacramento, Placer, and El Dorado counties are described.

2.7.1. Region State Plan of Flood Control Facilities

SPFC facilities, as legally defined in the California Water Code (CWC), are a portion of the flood management system that includes state- and federally authorized projects under the jurisdiction of DWR, Central Valley Flood Protection Board, and the USACE (DWR 2010).

The locations of SPFC facilities are shown in red in **Figure 2-30**. **Tables 2-15** and **2-16** characterize the SPFC facilities in the Region. Folsom Dam is a multipurpose reservoir that serves flood control, water supply, recreational, and ecosystem purposes on the American River. Shasta Dam is another multipurpose SPFC facility that serves flood control, water supply, recreational, and ecosystem purposes on the Sacramento River. Operations of both dams and reservoirs provide flood protection upstream from the Region.

The vast levee system in the Region is a combination of SPFC and local levees. Levees along larger streams and rivers tend to be under state and federal jurisdiction while levees along smaller local creeks and streams tend to be under local agency jurisdiction—however, there are exceptions.



Source: Central Valley Flood Management Planning Program, State Plan of Flood Control Descriptive Document (DWR 2016c)
Note: DWR may alter and update flood management-related maps as the CVFMPP evolves.
Key:
PS =Pump Plant

Figure 2-30. SPFC Facilities in the Region

DWR has studied the current status of SPFC levees and assigned levee hazard classifications according to performance on levee failure assessments. Senate Bill (SB) 5 requires urban areas to provide at least 200-year flood protection as a condition for further development. Nonurban levee design criteria vary depending on local circumstances.

Table 2-15. SPFC Facilities in the Region

Reservoir	Dam	Total Reservoir Capacity (AF)	Flood Storage Capacity (AF)	Owner/Operator
Folsom Lake	Folsom Dam	973,000	400,000 to 670,000	Reclamation

Sources: DWR, Central Valley Flood Management Planning Program, State Plan of Flood Control Descriptive Document (2010)
Key:
AF = acre-foot
ARB = American River Basin
SFPC = State Plan of Flood Control

Table 2-16. SPFC Levees in the Region

Levee Location Within the Region	Design Capacity (cfs) from O&M Manuals[1]	Classification	Channel Capacity Status[2]
Lower Sacramento River-below Fremont Weir	35,900 to 579,000	Mostly urban	Potential encroachment, Backwater Zone, Sufficient capacity
Bear River	30,000 to 40,000	Nonurban	Potential encroachment, Backwater Zone,
Yankee Slough-Tributary of Bear River	N/A	Nonurban	Potential encroachment
American River	115,000 to 180,000	Urban	Potential encroachment, Sufficient capacity
Natomas East Main Drainage Canal	1,100 to 16,300	Urban	Potential encroachment
Dry Creek-Tributary of Bear River	7,000	Urban	Potential encroachment
Arcade Creek	3,300	Urban	Potential encroachment

Sources: DWR, Central Valley Flood Management Planning Program, State Plan of Flood Control Descriptive Document (2010) and DWR, Flood System Status Report (2017a)
Notes:
[1] Range of design capacity provided for each levee located in the Region.
[2] *Different channel capacity status found along each levee located in the Region.*
Key:
ARB = American River Basin
cfs = cubic-feet per second
N/A = Not Applicable
O&M = operations and maintenance
SFPC = State Plan of Flood Control

The Central Valley Flood Protection Act of 2008 directed DWR to prepare the Central Valley Flood Protection Plan (CVFPP) for adoption by the Central Valley Flood Protection Board. The 2012 CVFPP proposed a systemwide investment approach for sustainable, integrated flood management in areas currently protected by SPFC facilities. In 2013, DWR initiated Basin-Wide Feasibility Studies, along with associated Regional Flood Management Planning (RFMP) efforts and the Central Valley Flood System Conservation Strategy, to advance both ongoing and long-term implementation of the CVFPP. RFMP is an important part of flood management improvement planning in the Central Valley. The locally-led

RFMP efforts are developing long-term, regional flood management plans that address local needs (such as urban level of flood protection requirements), articulate local/regional priorities, and establish the common vision of regional partners. DWR provided funding and resource support to help develop regional plans consistent with the 2012 CVFPP. In 2014 all regional plans were completed, and in 2017 drafts of both CVFPP Basin-Wide Feasibility Studies (Sacramento River and San Joaquin River) were released and updates to the CVFPP Conservation Strategy were adopted.

The Region, along with the Westside Sacramento IRWM Region, is part of the Lower Sacramento-Delta North Region (separate from Region boundaries), and the West Sacramento Area Flood Control Agency lead the RFMP effort. Although these RFMP and IRWM efforts have differing planning boundaries, the two initiatives will coordinate with one another. The Lower Sacramento River/Delta North Regional Flood Management Plan was released in 2014 and the two plans share similar sets of stakeholders. The RFMP was developed to address flood management regionally and identifies pre-feasibility level solutions to flood management issues. See **Section 3.4** for details of coordination between the Region and the Westside Sacramento IRWM Region.

2.7.2. Sacramento Area Flood Control Agency

Sacramento, Sacramento County, Sutter County, the ARFCD, and RD 1000 jointly created SAFCA in 1989 through a Joint Exercise of Powers Agreement to provide the Sacramento region with increased flood protection along the American and Sacramento rivers. SAFCA formed in response to the record flood of 1986 when Folsom Dam exceeded its normal flood control storage capacity and several area levees nearly collapsed under the strain of the storm. SAFCA's jurisdiction spans across two counties and multiple watersheds tributary to the lower Sacramento River, as shown in **Figure 2-4**

SAFCA's mission is "to reduce flood risk, thereby minimizing the impacts of floods on human safety, health, and welfare; and, consistent with these flood risk reduction goals, to preserve and enhance the environmental and aesthetic values that floodways and floodplains contribute to the quality of life in the Sacramento region." SAFCA is governed by a board of directors that is appointed by its member agencies. The board has 13 members, and holds monthly public meetings. Under the Sacramento Area Flood Control Agency Act of 1990 (SAFCA Act), the California Legislature conferred on SAFCA broad authority to finance flood management projects and has directed SAFCA to carry out its flood management responsibilities in ways that provide optimum protection to the natural environment. Since then, the SAFCA Act has been amended by Assembly Bill 930 of 2007 allowing SAFCA to acquire land easements as necessary and to use revenues from fees on projects that protect SAFCA's area.

Flood management projects have historically been initiated and funded by either or both federal and state laws, usually in response to major flooding events. Since the passage of Propositions 84 and 1E in 2006, the state (DWR) and state-local partnerships have become increasingly stronger in planning and implementing flood management projects. DWR works with SAFCA in the development and implementation of regional flood management projects and revisions to floodplain mapping. Natomas Basin levees have been recently upgraded in a project jointly funded by the state and SAFCA.

SAFCA receives funding from development fees and annual assessments imposed on properties that benefit in three separate districts in Sacramento and Sutter counties. **Table 2-17** identifies and describes the assessment districts and how the district funding is implemented.

Table 2-17. SAFCA Districts and Funding Expenditures

District	Area Coverage	Funding Expenditures
Operations and Maintenance (O&M) District	Areas within SAFCA's jurisdiction that are influenced by American River flows, contributing tributary creeks, and drainage channels; and are benefitted by SAFCA O&M projects	Annual operation and maintenance
Consolidated Capital Assessment District (CCAD)	Natomas Basin within Sacramento and Sutter counties, plus the portions of the City and County of Sacramento outside Natomas that lie within the 200-year floodplain of the American and Sacramento Rivers and their tributaries in North and South Sacramento.	Capital improvements include Folsom Dam, levees along the American and Sacramento River, and other levees and related flood management facilities
Natomas Basin Local Assessment District (NBLAD)	Entire Natomas Basin (all properties within Sutter County and Sacramento County within the American Basin)	Capital improvements on Natomas levees

Key:
SAFCA = Sacramento Area Flood Control Agency

2.7.3. Sacramento County Area

This subsection describes the stormwater and flood management conditions of various agencies or organizations within Sacramento County. This includes Sacramento County, six incorporated cities therein, a partnership between the county and those cities to jointly manage stormwater quality, a flood control district, and an RD. Sources of information include agency-specific management plans such as: storm drainage system master plans, the county-wide 2016 Local Hazard Mitigation Plan, and the 2009(b) Watershed Management Plan.

2.7.3.1. Sacramento Stormwater Quality Partnership

Stormwater management used herein includes water quantity (storm drainage) and water quality management of urban stormwater runoff, combined sewer system discharges, and larger, system-wide flood flows. Sacramento County and the cities of Sacramento, Citrus Heights, Elk Grove, Folsom, Galt, and Rancho Cordova, collectively known as the Sacramento Stormwater Quality Partnership (SSQP), developed and adopted a Stormwater Quality Improvement Plan in 2009, describing their compliance with their NPDES Municipal Stormwater Permit (NPDES No. CAS082597; Order NO. R5-2008-0142). This permit is issued by the Central Valley Water Board and covers the fourth term from 2008 to 2013 (SSQP, 2009). SSQP submitted, and now contains the 2013 Report of Waste Discharge and a Long-term Effectiveness Assessment for renewing the municipal NPDES permit. The county and each city collaborate on matters of mutual concern but maintain separate jurisdiction over their respective stormwater systems. Each city is briefly discussed in the following subsections.

2.7.3.2. Sacramento County

Sacramento County is responsible for various aspects of stormwater and flood management. The need for flood protection within Sacramento County has been recognized since the mid-to-late 1800s. Sacramento County, bordered by both the Sacramento and American rivers, has previously identified flooding as the county’s largest concern in the 2011 Sacramento County Local Hazard Mitigation Plan (Sacramento County, 2011b). Sacramento County is vulnerable to five flood types: localized/stormwater flooding, riverine flooding, flash flooding, levee overtopping/failure, and dam failure (Sacramento County, 2016).

The Sacramento County Department of Water Resources is responsible for drainage and flood management within the current and future urbanized portions of unincorporated Sacramento County and the cities of Citrus Heights, Elk Grove, and Rancho Cordova. The drainage and flood management system operated and maintained by Sacramento County consists of 1,443 miles of storm drain pipe, 400 miles of creeks and open channels, 33 pump stations, and 18 detention basins (Sacramento County, 2018). The Drainage Section of the Sacramento County Department of Water Resources actively works with SAFCA on the development and implementation of regional flood management projects and revisions to floodplain mapping. This department is also responsible for the Sacramento County Stormwater Quality Program, which aims to improve quality of urban stormwater runoff in partnership with the SSQP.

2.7.3.3. City of Citrus Heights

The Citrus Heights Stormwater Program oversees the operations and maintenance of a storm-drain system consisting of 26 miles of creeks, 54 miles of open ditches, 5.5 miles of concrete-lined channels, 62 bridges, hundreds of miles of pipe, and thousands of catch basins and manholes. The program also provides sandbags before official storm events and information on flood-prone areas. The Citrus Heights Satellite Work Program of the Sacramento Regional Conservation Corps staff performs numerous functions to assist city staff in cleaning and maintaining the creeks and drainage systems throughout

Citrus Heights. The goal of the program is to effectively manage stormwater runoff as a resource while improving water quality.

2.7.3.4. City of Elk Grove

Storm drainage within Elk Grove is conveyed through a storm drainage and flood control collection (SD&FCC) system consisting of approximately 400 miles of underground pipes and 60 miles of natural and constructed channels. The terrain throughout Elk Grove is relatively flat, with natural creeks and channels that traverse the city. The eastern portion (primarily east of Waterman Road) is predominantly rural with residences built on large lots and where agricultural uses are common. In 2011, Elk Grove adopted the Stormwater Drainage Master Plan, which identifies, analyzes, and selects stormwater-related projects to upgrade the SD&FCC system. The plan encompasses programs and project locations throughout both urbanized and rural areas within Elk Grove. Elk Grove also collects stormwater utility fees to maintain publicly owned water drainage facilities, manage flood, and execute the Stormwater Quality Program, as a part of the SSQP.

2.7.3.5. City of Folsom

Folsom's Public Works Department, Streets Division, operates and maintains an extensive storm drainage system, including about 190 miles of pipe, 23 miles of natural drainage channels/creeks, 30 flood management and/or water quality detention basins, and over 200 outfalls to creeks/rivers. Since late 2006, Folsom has also been involved in the Alder Creek Watershed Project, a project to manage the 11-square-mile watershed and to protect its natural resources. The 2010 Alder Creek Watershed Management Action Plan identified policies and projects to implement management actions, and some recommended site-specific projects involved floodplain restoration, Natoma Company Dam reservoir management, and stormwater detention basin.

2.7.3.6. City of Galt

Galt's storm drainage infrastructure includes over 70 miles of storm drainage lines spanning 8 inches to 84 inches in diameter, one detention pond, and two pump stations. With a few areas of planned construction, the majority of the existing storm drainage system contains sufficient capacity to convey peak runoff. Localized flooding, however, is a potential concern. Galt lacks curbs and gutters in some portions of the city and the size and capacity of some small agricultural drainage structures do not accommodate larger storm flows. The city collects storm drainage fees to pay for storm drainage operations.

2.7.3.7. City of Rancho Cordova

The Sacramento County Department of Water Resources provides drainage and flood preparedness services to the City of Rancho Cordova (Rancho Cordova), including floodplain management, review of drainage studies and improvement plans, and maintenance of the storm drainage systems. The storm drain infrastructure described under the subsection for Sacramento County includes the Rancho Cordova area. Rancho Cordova is also located within Zones 11A and 11B of the SCWA, which charges a development fee to new projects to fund the planning, design, and construction of new trunk drainage systems. City residents pay a Rancho Cordova Stormwater Utility Fee to pay for the bulk of drainage program services.

Rancho Cordova has experienced localized flooding associated with undersized drainage facilities in existing developed and developing areas. Drainage issues have been observed along Sunrise Boulevard south of White Rock Road where surface water flows exceed the capacity of drainage facilities (siphons and overchutes) of the Folsom South Canal. Existing 100-year peak flows have been observed to exceed in several of these facilities and result in localized flooding along Sunrise Boulevard as well as discharge of drainage into the Folsom South Canal.

2.7.3.8. City of Sacramento

The Sacramento Department of Utilities provides drainage services within city limits. To manage runoff from city streets, the Department of Utilities maintains 41,000 storm drain inlets 65 miles of canals and ditches, 104 pump stations, and numerous detention basins (Public Financial Management 2011). Through this series of canals, pipes, and pump stations, water is directed away from homes and into creeks, lakes, and rivers. To assist with flood management, the Department of Utilities works year-round, ensuring that pumps, pipelines, canals, and over 18 miles of levee are maintained to provide flood protection during heavy rainfall. The Downtown, Midtown, Land Park, and East Sacramento potions of Sacramento are served by a combined sewer system. Runoff from these areas, with the exception of some wet-weather runoff, is treated at the SRCSD Regional Wastewater Treatment Plant before it is discharged into the Sacramento River. In emergency situations, the Department of Utilities is in communication with other agencies such as DWR, the California Department of Public Health, SAFCA, Sacramento County, and various RDs (Sacramento 2013).

2.7.3.9. American River Flood Control District and Reclamation District 1000

Two regional districts operate and maintain flood facilities in the Sacramento County region: ARFCD and RD 1000. The ARFCD was formed in 1927 to maintain the 40 miles of levees along the American River and portions of Steelhead, Arcade, Dry, and Magpie creeks. Year-round activities include mowing levee slopes, trimming vegetation, weed management, rodent abatement, erosion repairs, access roads maintenance, fixing gates, and equipment maintenance.

RD 1000 maintains over 40 miles of levees surrounding the perimeter of the Natomas Basin to retard floodwaters from the Sacramento River, American River, Steelhead Creek (Natomas East Main Drainage Canal), Pleasant Grove Creek Canal, and Natomas Cross Canal (which is outside the Region). RD 1000 also operates and maintains hundreds of miles of canals and seven pump stations in the Natomas Basin to collect and safely discharge the rain that falls within the Natomas Basin back into the river.

2.7.4. Placer County Area

This subsection describes the stormwater and flood management activities of Placer County, Placer County Flood Control and Water Conservation District (FCWCD), and five incorporated cities or towns within Placer County. Sources of information include each agency’s stormwater management plan (SWMP) and each agency’s Web site describing their stormwater and flood-management related programs.

2.7.4.1. Placer County

The Placer County Public Works Department has Floodplain Management and Stormwater Quality Management Programs. The Floodplain Management Program administers FEMA policies through a community effort of corrective and preventive measures for reducing flood damage to properties. This program is responsible for supervising flood zone building requirements and flood insurance programs in unincorporated areas in Placer County. Placer County’s Stormwater Quality Program aims to reduce pollutants in stormwater runoff, eliminate non-stormwater discharges and lessen the long-term impacts of stormwater discharges from development, business, and municipal activities. The plan also complies with NPDES requirements. The West Placer SWMP applies to the unincorporated areas of Placer County within the Region. Placer County also works closely with Placer County FCWCD, which is responsible for regional flood management planning, management, and mitigation.

Placer County has also implemented flood and stormwater-related projects through the Placer Legacy Open Space and Agricultural Conservation Program. A few projects, such as the Sundance-Lakeview Farms in 2008 included riparian property acquisitions or conservation easements, and a part of their reported benefits consisted of integrated flood-ecosystem management, floodwater conveyance, and floodwater storage (Placer County 2012).

2.7.4.2. Placer County Flood Control and Water Conservation District

The Placer County FCWCD was established in 1984 by the State Legislature as a Special District, separate from county government, to address flood management issues arising with urban growth. Placer County FCWCD boundaries are the same as the Placer County boundaries. The primary purpose of the Placer County FCWCD is to protect lives and property from the effects of flooding by comprehensive, coordinated flood prevention planning (Placer County 2009). Placer County FCWCD is responsible for identifying solutions for regional flood management for the entire county and for providing or assisting in coordination for regional projects. The Placer County FCWCD is also responsible for managing flood issues for multiple communities in Placer County, including Roseville, Rocklin, Lincoln, Loomis, and Auburn.

Placer County FCWCD has three separate plans with flood management objectives. The 1992 Auburn Bowman Flood Control Plan covers 41.5 square miles and identifies flooding problems, makes specific recommendations to address them, and develops a funding mechanism to implement the recommendations. The 1993 Cross Canal Watershed Flood Control Plan studies the area drained by Auburn and Markham Ravine, Coon, Curry and Pleasant Grove creeks. The Natomas Cross Canal carries the combined flow of these creeks to the Sacramento River. This study was prepared to respond to concerns over potential increases in flooding in the lower portion of the watershed due to urban development potential upstream. Finally, the Dry Creek Watershed Flood Control Plan was updated in 2011, which evaluates existing flooding problems and identifies flood management options as well as a funding mechanism to achieve plan recommendations. This updated plan recommends building regional detention basin projects for peak flow attenuation, implementing a flood warning system, repairing bridges and culverts, supporting building elevation and floodplain buy-outs, and incorporating LID measures.

2.7.4.3. City of Auburn

Auburn’s Public Works Department is responsible for the operation, maintenance and management of stormwater infrastructure. Auburn has a 2003 SWMP to reduce pollutants in stormwater runoff, to comply with NPDES stormwater regulations, and to meet the state’s general permit. Auburn contains seven main drainage basins: Auburn Ravine Creek, Lincoln Basin, North Fork American River Basin, Brewery Lane Basin, Baltimore Ravine Basin, Dutch Ravine Basin, and Mormon Ravine Basin. These waterways are used for recreation, habitat, fishing, and water supply. Adverse effects to the waterways are reduced by six federally designated minimum control measures, and Auburn annually reports on the implementation of these measures.

2.7.4.4. City of Lincoln

The Lincoln Department of Public Works/Operations Division is responsible for operating and maintaining the drainage systems within the city limits. Storm runoff drains to Markham Ravine and Auburn Ravine in the northern portion of Lincoln. The other surface water drainage systems include Ingram Slough, the Orchard Creek watershed, and a minor portion of the Pleasant Grove Creek watershed, which is located at the southern end of Lincoln. Presently, community residential and commercial development exists within the Auburn Ravine and Ingram Slough watersheds. The annexed lands south of Lincoln are within the remaining watersheds. Surface water in Lincoln is dominated by the seasonal rainfall runoff flows from the Markham Ravine and Auburn Ravine watersheds.

2.7.4.5. Town of Loomis

Loomis's Department of Public Works and Engineering has responsibility for stormwater management. The SWMP updated in 2008 complies with NPDES requirements and was approved by the Central Valley Water Board. The SWMP aims to improve the quality of water in Loomis's two natural streams: Secret Ravine and Miners Ravine, both a part of the Dry Creek Watershed. The SWMP developed and implements an interdisciplinary approach to stormwater. Of the six federally mandated minimum control measures, Loomis considers Post Construction Stormwater Management to be the best use of their resources in achieving better water quality. Because Loomis is a part of the Dry Creek Watershed, the Dry Creek Conservancy is also active in preserving local streams. Their actions also complement stormwater and flood management.

2.7.4.6. City of Rocklin

The Rocklin Department of Public Works maintains all storm drain infrastructure in Rocklin. Rocklin has had a municipal NPDES stormwater discharge permit since 2003, and implements its 2003 Stormwater Management Program. This program originally proposed six minimum control measures, which ranged from development of public education and outreach to enforcement of illicit discharge detection and elimination program. Recently, the program has expanded to include volunteer stormwater management projects, incorporation of nonstructural Best Management Practices (BMP), and focus on urban water runoff quality. Rocklin provides stormwater management guides and pollution prevention tips to various water users and potential polluters.

2.7.4.7. City of Roseville

The Roseville Department of Environmental Utilities is responsible for drainage and stormwater management within Roseville's city limits. Roseville's 2004 SWMP meets the NPDES discharge requirements and Waste Discharge Requirements. As required for SWMPs, Roseville has six minimum control measures that are implemented through BMPs. The SWMP originally planned for a 5-year implementation period, but the planned measures and BMPs are still relevant and continue to be executed, as seen in Roseville's Annual Progress Reports. Roseville also has progressive public involvement and outreach activities related to stormwater management.

2.7.5. El Dorado County Area

The El Dorado County Department of Environmental Management is responsible for drainage and stormwater management within the unincorporated areas of western El Dorado County. Along with the Departments of Transportation, General Services, Agriculture, Planning and Building, the Department of Environmental Management operates a stormwater management program to manage and improve stormwater quality. In general, the county's Stormwater Coordinator is responsible for:

- Preparing and updating SWMPs
- Approving stormwater treatment practices
- Providing Stormwater Construction Permits
- Maintaining close communication with the Central Valley Water Board
- Overseeing and coordinating implementation of the SWMP
- Monitoring the program
- Evaluating the program and reporting to the Central Valley Water Board annually

In addition, there are several community service districts in El Dorado County that provide operations and maintenance services for drainage facilities. El Dorado County also provides flood rate mapping information through its Planning Services.

2.8. Water Delivery and Wastewater Systems

This subsection describes currently existing pumping facilities, transmission facilities, collection systems, treatment facilities, storage facilities, fire protection systems, and physical plants of regional scale for the Region. Thereafter, there are per agency descriptions on the agency's water system (where applicable), groundwater system (where applicable), and wastewater treatment and recycled water system (where applicable). Agencies are described in order, generally from northeast to southwest; starting north of the American River, and then south. Dedicated wastewater agencies (i.e., agencies that do not supply surface or groundwater) are discussed in latter portions of this subsection (starting with Placer County in **Section 2.8.26**), unless the agency is a combined water and wastewater utility.

Information for this subsection is primarily from a synthesis of each agency's description with information available from UWMPs, SWRPs, Water Supply Master Plans, Water Supply Infrastructure Plans, and/or Sewer System Management Plans (SSMP). A few of the smaller agricultural water agencies, Clay Water District, Galt Irrigation District, and Omochumne-Hartnell Water District (OHWD), are not described below. These districts formed initially to purchase water supplies in areas that derive water supply from private irrigation wells. These agencies have historically purchased very limited surface water supply and have limited water supply infrastructure (SAWC 2011).

2.8.1. Major Water Supply and Wastewater-Related Infrastructure

Folsom Dam on the American River and Shasta Dam on the Sacramento River, both parts of the CVP, operated by Reclamation are major sources of raw surface water to the Region. In addition to these reservoirs, there are 15 surface WTPs and 14 groundwater treatment plants in the Region. Many agencies also have groundwater wells, many with some form of onsite wellhead treatment. The locations of these water treatment plants are shown in **Figure 2-6**. Existing WTPs and their respective capacities are listed in **Table 2-18**.

There are more water agencies than WTPs in the Region. Many agencies share joint intakes, treatment plants, and pipelines to deliver municipal water. For example:

- PCWA owns and operates a pipeline from the upper American River to provide water to Lincoln and Roseville, in addition to serving its own needs in Auburn, Loomis, and Rocklin within PCWA's service area.

- SJWD's Sidney N. Peterson WTP is located near Folsom Lake, treating and delivering water to Citrus Heights Water District (CHWD), FOWD, Orange Vale Water Company (OVWC) and the Ashland portion of Folsom, periodically providing water to SSWD and Roseville when supplies are available.

- Sacramento's Fairbairn WTP treats water that is then delivered to other agencies, including SSWD, Fruitridge Vista Water Company (FVWC), and SCWA south of the American River in Sacramento County.

- The Freeport Project serves both SCWA and EBMUD's interests; Vineyard WTP treats Sacramento River water and delivers it within SCWA and to a portion of Elk Grove.

Table 2-18. Treatment Capacity at Existing/Planned WTPs Within the Region

Source Water/Facility	Year Constructed or Last Expanded	Design Hydraulic Capacity (MGD)	Permitted Capacity (MGD)	Ultimate Capacity (MGD)
Upper American River				
PCWA				
Bowman WTP	n/a	7	7	7
Auburn WTP	n/a	8	8	8
Foothill WTP	n/a	58	58	58
Sunset WTP	n/a	8	8	8
Folsom Lake				
EID				
El Dorado Hills WTP	2010	26	26	26
Folsom				
Folsom WTP	n/a	50	50	50
Roseville				
Roseville WTP	2008	100	100	100
SJWD				
Sidney N. Peterson WTP[1]	2010	150	150	150
Lower American River				
GSWC				
Coloma WTP	2002	9	9	9
Pyrites WTP	n/a	5.4	5.4	5.4
CWD				
Bajamont WTP	2001	22	22	22
Lower American River				
City of Sacramento				
E.A. Fairbairn WTP	**2005**	**200**	**200**	**200**
Sacramento River				
City of Sacramento				
Sacramento River WTP	**2003**	**160**	**160**	**160**
SCWA				
Vineyard Surface WTP[2]	**2012**	**50**	**50**	**100**
Cosumnes River				
Rancho Murieta CSD				
Rancho Murieta WTPs[3]	**1995**	**n/a**	**3.5**	**6**

Table 2-18. Treatment Capacity at Existing/Planned WTPs Within the Region (contd.)

Source Water/Facility	Year Constructed or Last Expanded	Design Hydraulic Capacity (MGD)	Permitted Capacity (MGD)	Ultimate Capacity (MGD)
Groundwater (Offsite or Centralized Groundwater Treatment Plants)				
Elk Grove WD				
Railroad Street Treatment and Storage Facility	2005	10.4	10.4	10.4
City of Galt				
Golden Heights WTP	n/a	n/a	n/a	n/a
Industrial Park WTP[7]	n/a	n/a	n/a	n/a
SCWA				
Mather Housing WTP	1976	6	6	6
Waterman WTP	1991	8.6	8.6	8.6
Calvine Meadows WTP [4], [7]	2000	5	5	5
East Park WTP	2001	2.9	2.9	2.9
Dwight WTP	n/a	n/a	n/a	n/a
East Elk Grove WTP	2002	13	13	13
Anatolia WTP[5], [7]	2005	13	13	13
Wildhawk WTP	2006	10	10	10
Lakeside WTP	n/a	6.5	6.5	6.5
Poppy Ridge WTP[6], [7]	2025	6.5	6.5	6.5
Big Horn WTP	n/a	13	13	13

Data Sources: EID Integrated Water Resources Master Plan (2013), EID UWMP (2016a), PCWA UWMP (2016), GSWC UWMP (2016a), City of Folsom UWMP (2016), SCWA Zone 40 Water System infrastructure Plan (2016b), and direct agency comments (May 2013).

Notes:

[1] In 2012, SJWD evaluated the Sidney N. Peterson WTP's capacity. DPH approved the new permit for 150 MGD.
[2] The SCWA Vineyard WTP's design capacity has been increased from 85 MGD to 100 MGD to accommodate the replacement water supply to customers in east Sacramento County whose groundwater supply has been contaminated by Aerojet operation.
[3] Rancho Murieta has plans to expand their WTPs to a capacity of 6 MGD
[4] Zone 40 Water System infrastructure Plan Update
[5] The Anatolia WTP expansion from 6.5 MGD to 13 MGD in the future.
[6] Zone 40 Water System Infrastructure Plan Update
[7] 2013 ARB IRWMP reported values were used as no 2016 sources were available to update capacity values for each respective facility.

Key:
CWD = Carmichael Water District
EID = El Dorado Irrigation District
GSWC = Golden State Water Company
MGD = million gallons per day
N/A = not applicable
PCWA = Placer County Water Agency
SCWA = Sacramento County Water Agency
SJWD = San Juan Water District
WD = Water District
WTP = water treatment plant

There are also 11 WWTPs in the Region, as shown in **Figure 2-6** and listed in **Table 2-19**. Sewer system management is operated by individual agencies or sanitation districts, and they update their management plans periodically. Some agencies serve both water supply and wastewater roles. Others, such as Placer County and SRCSD, collect and treat wastewater across a large area from numerous water supply agencies. Permits are issued by the State Water Board, under the Statewide General Waste Discharge Requirements for Order No. 2006-0003-DWQ adopted May 2, 2006.

Common infrastructure linking adjacent water and wastewater systems include hundreds of miles of transmission mains and multiple interconnections, although not all interconnections are currently used.

Table 2-19. WWTPs in the Region

Owner	WWTP Name	Type of Treatment	Capacity (MGD)	Discharge Location	Recycled Water Production
EID	El Dorado Hills WWTP	Tertiary	4.0	Carson Creek	Yes
Lincoln	Lincoln WWTRF	Tertiary	5.9	Auburn Ravine	Yes
City of Auburn	Auburn WWTP	Tertiary	1.65	Auburn Ravine	No
Placer County	Placer County No. 3	Tertiary	0.301	Miners Ravine	No
Placer County	Sheridan WWTP	Secondary and chlorination	0.061	Land Application	No
Roseville	Dry Creek WWTP	Tertiary	18	Dry Creek	Yes
Roseville	Pleasant Grove WWTP	Tertiary	12	Pleasant Grove Creek	Yes
SRCSD	Sacramento Regional WTP	Secondary3	181	Laguna Creek	No
SRCSD	Sacramento Regional WRF	Tertiary	3	Laguna Creek	Yes
Rancho Murieta	Rancho Murieta WWTF	Secondary and Tertiary	1.55; 3.04	Cosumnes River	Yes
City of Galt	City of Galt WWTP	Tertiary	3.0	Laguna Creek	Yes

Data Source: State Water Board Wastewater Treatment Facilities Database (February 22, 2001), UWMPs, SSMPs, SRCSD 2020 Master Plan 2008, and direct agency comments (May 2013)

Notes:

[1] Average dry weather flow capacity

[3] Treatment upgrades are currently in planning and design to meet recent NPDES requirements necessitating facility upgrade

[4] 1.55 MGD secondary treatment capacity and 3.0 MGD tertiary treatment capacity

Key:

ARB = American River Basin
EID = El Dorado Irrigation District
MGD = million gallons per day
n/a = not available
R. = River
SRCSD = Sacramento Regional County Sanitation District
WRF = Water Reclamation Facility
WWTF = Wastewater Treatment Facility
WWTP = Wastewater Treatment Plan
WWTRF = Wastewater Treatment and Reclamation Facility

2.8.2. Placer County Water Agency

PCWA maintains stored water in the Sierra Nevada, upstream from the Region, and delivers this water throughout Placer County. Its canals and pipelines connect to other water agencies in Placer and Sacramento counties, making PCWA a regionally important source and transporter of water. In its service area, PCWA provides surface water and some groundwater to retail and wholesale municipal and industrial (M&I) customers. In addition, PCWA provides surface water and groundwater for agricultural customers in its service area. PCWA's service area in the Region is developing from rural water uses to urban uses.

2.8.2.1. Placer County Water Agency Water System

PCWA provides water to retail customers in one service zone, Zone 6. Zone 6 is comprised of four administrative service zones; Zones 1, 2, 3 and 5 (B. Rickards, personal communication, 2018). Zone 1 is the largest zone, which includes areas under the land-use authorities of the cities of Auburn, Rocklin, and Lincoln, a portion of Roseville, the Town of Loomis, and Placer County. The zone boundary extends from the City of Auburn to the City of Lincoln, and the area south that extends to the Sacramento County line. PCWA provides the sale of wholesale water to the City of Lincoln, the town of Rocklin, town of Loomis, other small water purveyors, and the California American Water Company. There are 16 storage tanks providing approximately 57 million gallons (MG) of storage capacity (B. Rickards, personal communication, 2018). PCWA is planning to construct a 10 MG storage tank in Rocklin within the next five years. There are approximately 610 miles of treated water pipeline in Zone 1 (B. Rickards, personal communication, 2018).

Zone 5 was created in 2000 to reduce reliance on groundwater supplies by providing surface water for commercial agricultural in the westernmost portion of Placer County, generally west of Lincoln. PCWA provides only raw surface water supplies to this region.

Currently, about a third of the total water supplied by PCWA (including areas outside the Region) is used for treated drinking water distributed through eight individual treated water systems. The PCWA treated water systems supply over 40,000 service connections. About two-thirds of the total water supplied by PCWA is raw water, used for irrigation of farms, ranches, landscapes, parks, and golf courses throughout Placer County. PCWA operates about 165 miles of canals, reservoirs, and diversions to supply approximately 4,500 raw water users. Approximately 3,000 irrigation water customers purchase irrigation water on a year-round basis while another 1,500 customers purchase irrigation water seasonally. Recycled water use for irrigation in areas adjacent to Lincoln and Roseville is anticipated to reach near 5 thousand acre-feet (TAF) by 2030.

2.8.3. City of Lincoln

Lincoln supplies a combination of surface water (treated water purchased from PCWA), groundwater, and recycled water to its service area. The subsection below describes Lincoln’s surface water, groundwater, wastewater, and recycled water systems.

2.8.3.1. City of Lincoln Water System

Lincoln’s service area is in northern western Placer County, an area that had seen heavy development in the past decade. Lincoln receives surface water from PCWA and NID that is treated at PCWA’s Sunset and Foothill WTPs. Lincoln supplies potable water through a pressurized distribution system consisting of six pressure zones. The distribution system has three gravity storage tanks with 1.5 MG, 3 MG, and 5 MG capacities, respectively, and one 1.5 MG pumped storage tank (Lincoln 2017b).

2.8.3.2. City of Lincoln Groundwater System

Lincoln currently operates 5 groundwater wells to supplement its surface water supply. These wells can supply 10 percent of the annual demand during a normal year. During emergency outages and daily shortages related to seasonal peaks, the wells can supply more than 30 percent of the demand (Lincoln 2016). Lincoln plans to install additional wells to meet 75 percent of average day demand at build-out

2.8.3.3. City of Lincoln Wastewater and Recycled Water System

The Lincoln Department of Public Services owns, operates and maintains a sanitary sewer system. The system collects and treats wastewater at the Lincoln Wastewater Treatment and Reclamation Facility (WWTRF) located on the Auburn Ravine. The WWTRF was recently expanded and upgraded, which increased the design average dry weather flow from 4.2 MGD to 5.9 MGD. The WWTRF has a future expansion potential of up to 30 MGD. Lincoln's WWTRF has received recognition for its records of safety and compliance.

Lincoln's WWTRF also produces recycled water, which is currently used for industrial and common area landscape irrigation at four sites with a net irrigation area of 382 acres. All new developments include "purple pipes" for distribution and delivery of recycled water to augment other water supplies. Lincoln is planning to expand its recycled water deliveries from its water reclamation facility and is considering expansion options that could accommodate wastewater flows from nearby agencies through a potential partnership arrangement called the Midwestern Placer Regional Sewer Project. Lincoln, Placer County, and Auburn proposed and initiated their Midwestern Placer Regional Sewer Project in March 2012. This project will include three parts: 1) sewage pumps stations will be added at the Auburn and North Auburn Wastewater Treatment Plants, 2) a pressurize pipe will be added to the new sewage pump stations at Auburn and North Auburn Wastewater Treatment Plants to move sewage to Lincoln, and 3) the Lincoln WWTRF will be expanded to take in the sewage from Auburn and North Auburn Wastewater Treatment Plants (Lincoln 2018).

2.8.4. City of Roseville

Roseville's service area is in the incorporated city limits in Placer County, near the northern boundary of Placer and Sacramento counties. Roseville serves a combination of surface water, groundwater and recycled water throughout its service area. Roseville also operates its own wastewater collection and treatment systems. The subsection below describes existing components of its surface water, groundwater, wastewater, and recycled water systems.

2.8.4.1. City of Roseville Water System

Roseville is served by five pressure zones with a small portion served by PCWA due to topography. There are 15 total interconnections between Roseville and neighboring agencies for emergency, backup, and special service needs. There are six total interconnections with PCWA, three 12-inch interconnections with SJWD, three interconnections with Cal-Am, two interconnections with CHWD, and one connection with Sacramento Suburban Water District. Roseville uses three booster pumping stations to increase and maintain pressure to its Zone 5, Zone 2, and Zone 1 pressure zones in east Roseville (Roseville 2016b).

Water distribution is accomplished through over 583 miles of water transmission and distribution mains ranging in size from 4 inches to 66 inches in diameter. The water system currently has 32. MG of storage to manage flow fluctuations on a daily basis and for emergency needs, and is projected to need a total of 49 MG of storage at system build-out. The storage infrastructure includes five pre-stressed concrete storage tanks each with a capacity of 2.9 MG, 4 MG, 6 MG, 7.25 MG, and 10 MG, and one steel storage tank with a capacity of 2 MG.

Roseville operates a 100 MGD WTP on Barton Road near Folsom Lake in the Granite Bay community. Raw water from Folsom Lake is conveyed to the WTP through parallel 60-inch and 48-inch pipelines.

2.8.4.2. City of Roseville Groundwater System

By practice and city policy, Roseville uses its groundwater supplies for backup and dry year water supply. Roseville has six but there are plans to add 10 additional wells. All six existing wells are equipped for both groundwater extraction and injection as part of Roseville's Aquifer Storage and Recovery (ASR) Program. Other wells will be equipped similarly following regulatory approval. The ASR program has received all approvals from regulatory agencies and intends to store surplus drinking water in underground aquifers for later recovery during drought/shortage conditions.

2.8.4.3. City of Roseville Wastewater and Recycled Water System

Roseville's Environmental Utilities Department studies, operates, and manages Roseville's wastewater collection and treatment system. Roseville currently operates two regional wastewater treatment facilities serving approximately 45,000 residential, 1,932 commercial, and 600 industrial sewer connections (Roseville 2016a). Approximately 751 miles of sewer collection pipe connects to the Dry Creek WWTP, located in Central Roseville, and the Pleasant Grove WWTP, located in northwest Roseville. The Dry Creek WWTP has an average dry weather flow (ADWF) capacity of 18 MGD and the Pleasant Grove WWTP has an ADWF capacity of 12 MGD. Effluent from both WWTPs is tertiary-treated, meeting Title 22 recycled water standards.

Roseville's recycled water system predominantly serves landscape irrigation demands. The program has continued to expand since its beginning in 1998. The Dry Creek WWTP and Pleasant Grove WWTP recycled water systems are independent but are interconnected. The Pleasant Grove WWTP system includes a network of 20-inch transmission pipelines; the Dry Creek WWTP system includes a network of 8- to 20-inch pipelines to serve landscape irrigation purposes for golf courses, streetscapes, parks, and irrigation and processing water at both WWTPs. The recycled water system includes two booster pump stations – one at Woodcreek Oaks and one adjacent to Pleasant Grove WWTP. In addition to storage available at the WWTPs, there are three tanks: a 1.5 MG storage tank next to the pump station at Woodcreek Oaks (Roseville 2006) and two 1 MG tanks adjacent to Pleasant Grove WWTP. Both WWTPs have the capacity to produce additional recycled water supplies for industrial and landscape irrigation uses, if needed. Roseville currently supplies recycled water to a major golf course (Morgan Creek Golf Course) within Cal-Am's service area.

2.8.5. California American Water

Cal-Am is a privately owned public utility with services areas throughout California. Cal-Am provides surface water and groundwater to ten service areas in its northern division, eight of which are in the Region covered by the ARB IRWMP (Cal-Am 2016a). Nine service areas are in Sacramento County and one is in Placer County.

2.8.5.1. California American Water Water System

Cal-Am operates eight distinct water systems in the Region. Four of the service areas are located north of the American River: Antelope, Lincoln Oaks, Arden, and West Placer. Four of the service areas are located south of the American River: Security Park, Suburban Rosemont, Walnut Grove, and Parkway. Cal-Am purchases a mix of surface and groundwater on a wholesale basis from Sacramento, PCWA, and SSWD. Cal-Am plans to construct an intertie with Zone 40 of SCWA in the near future to serve Security Park. Cal-Am has an agreement for surface water deliveries from Sacramento into its Parkway Service Area and has made arrangements for surface water deliveries for conjunctive use operations in Antelope and Lincoln Oaks. All other Cal-Am service areas are served by groundwater.

2.8.5.2. California American Water Groundwater System

Cal-Am's existing water supply facilities includes a network of more than 100 wells. Cal-Am customers are generally served by direct-feed groundwater wells, with iron and manganese treatment facilities in its Parkway system. Several wells in Cal-Am's Suburban Rosemont and Security Park System are either threatened or have been impacted by groundwater contamination emanating from the Aerojet and former Mather AFB. One well (Moonbeam) has granular activated carbon treatment that removes contaminants before use as a potable supply. In addition, several wells in the Parkway, Lincoln Oaks, Suburban Rosemont, and Security Park systems have been impacted by PCE. Three wells in Lincoln Oaks and one Parkway currently have granular activated carbon systems that are used to remove PCE.

2.8.6. San Juan Water District

Located adjacent to Folsom Lake, SJWD is a wholesale and retail agency. The entire wholesale area consists of 45 square miles and includes CHWD, FOWD, OVWC, and Folsom (Ashland area). SJWD diverts, treats, and delivers surface water to its wholesale and retail customers within its service area and has an agreement with the other agencies such as CHWD, FOWD, OVWC, and Folsom (Ashland area) to provide for their full water demands.

2.8.6.1. San Juan Water District Water System

SJWD receives water diverted from Folsom Lake, via Folsom Dam, to the Sidney N. Peterson WTP through an 84-inch and 72-inch pipeline. This WTP obtained a new permit following a capacity evaluation in 2012 that expanded its permitted capacity to 150 MGD. From the WTP, finished water is conveyed through Hinkle Reservoir (62 MG capacity) at the WTP site for delivery. SJWD owns, operates, and maintains approximately 220 miles of pipeline and six pump stations (SJWD 2017) to deliver water to retail and wholesale customers (SJWD 2018). Along with Hinkle Reservoir, SJWD has three smaller storage facilities for treated water: Kokila Reservoir (4.5 MG), Los Lagos Tank (1.6 MG) and Mooney Ridge Hydropneumatic Tank (0.05 MG) which are used for storage in SJWD retail service area.

The Cooperative Transmission Pipeline (CTP) serves most of the SJWD wholesale area, which includes FOWD, CHWD, OVWC, and SSWD. Between the WTP and C-Bar-C Park, the CTP consists of about 9,000 feet of 78-inch-diameter pipe and almost 20,000 feet of 72-inch-diameter pipe with several 30- to 48-inch-diameter stubs. The CTP provides redundancy to the older water transmission system, allowing for maintenance and rehabilitation without service interruption. Some of these older transmission mains, which were constructed in the early 20th century, are still used in conjunction with the CTP to deliver water to FOWD (the 40-inch-diameter pipeline known as the “Fair Oaks 40”) and CHWD (42- diameter pipeline). San Juan also has a 33-inch-diameter pipeline along Barton Road with an interconnection with Roseville.

SJWD has 15 connections with neighboring agencies. One of these connections is at the C-Bar-C Park where the Antelope Transmission Pipeline (ATP) begins, extending westward from the CTP, supplying water to SSWD. SJWD also has a 42-inch and 54-inch connection to the CTP at Bacon Pump Station and multiple 12-inch connections off the CHWD 42-inch pipeline. The District has seven intertie connections that are for emergency response and are normally closed. These include two interconnections with Roseville, two with PCWA, one with OVWC, and one with CHWD.

The eight remaining connections are used regularly to supply the wholesale service area. SJWD's connections for the wholesale area include three with OVWC and two with FOWD and three to CHWD.

Located immediately south of SJWD, OVWC is a mutual water company. One of SJWD's wholesale customers, OVWC currently provides surface water to its service area but no longer supplies groundwater. The subsection below describes the OVWC water system.

2.8.7. Orange Vale Water Company

Located immediately south of SJWD, OVWC is a mutual water company. One of SJWD's wholesale customers, OVWC currently provides surface water to its service area but no longer supplies groundwater. The subsection below describes the OVWC water system.

2.8.7.1. Orange Vale Water Company Water System

OVWC purchases treated surface water from SJWD per a wholesale agreement. Surface water provided by SJWD is treated at Sidney N. Peterson WTP. Treated water is transported to Hinkle Reservoir and delivered to OVWC through the CTP at five metered locations. Water is then distributed by gravity through the OVWC system. The OVWC water system consists of over 75 miles of pipeline, ranging from a 1.5-inch to a 30-inch diameter. The system also includes approximately 1,100 distribution system valves and 5,500 active connections (OVWC 2018). OVWC does not currently have any storage or treatment facilities (OVWC 2005, 2011).

2.8.8. Citrus Heights Water District

CHWD is located southwest of SJWD and adjacent to OVWC. Also a SJWD wholesale customer, CHWD currently provides surface water and groundwater to its service area. This subsection includes a description of CHWD's surface water and groundwater distribution systems.

2.8.8.1. Citrus Heights Water District Water System

CHWD has about 271 miles of transmission and distribution mains and maintains 20 interconnections with adjacent agencies which include SJWD, OVWC, FOWD, CWD, SSWD, Cal-Am, and Roseville. Three of the connections are to the CTP and one of the connections is at the CHWD transmission main. Most of the interconnections are for emergency use only and are usually closed. CHWD has three pressure zones and has no storage tanks or water treatment facilities, as it purchases treated surface water, delivered by gravity, from SJWD per a wholesale agreement (CHWD 2011).

2.8.8.2. Citrus Heights Water District Groundwater System

To supplement its surface water supply, CHWD currently operates five groundwater wells, with a projected total yield of 5,000 acre-feet per year (AFY) (CHWD 2016). In the past, groundwater production has averaged approximately 850 AFY. The district plans on adding three additional wells within the next 7 years to maintain groundwater supply reliability (CHWD 2016).

2.8.9. Fair Oaks Water District

FOWD is located south of OVWC and CHWD and is adjacent to the lower American River. One of SJWD's wholesale customers, FOWD currently provides a combination of surface water and groundwater to its service area. The subsection below describes the existing surface water and groundwater systems.

2.8.9.1. Fair Oaks Water District Water System

FOWD currently purchases surface water from SJWD per a wholesale agreement. FOWD has two types of connections: surface water supply and emergency. The two surface water supply connections with SJWD.FOWD operates three pressure zones and has five emergency interconnections with adjacent agencies, all of which are normally closed. The three interconnections with CHWD range in size from 6 to 12 inches in diameter. The interconnection with CWD is 8 inches in diameter and is equipped with a 12-inch, one-way meter to CWD. FOWD also has an 8-inch interconnection with OVWC. The district has one storage tank and booster pump (3 MG capacity).

FOWD has two primary transmission mains (Northern and Southern Transmission Mains). From the connection with SJWD, the Northern Transmission Main connects to both the 39-inch Filbert Avenue Main (which conveys water from the CTP/NTP and is the primary source of water) and the Fair Oaks 40-inch Main. The Northern Transmission Main consists of about 22,000 feet of 27- to 24-inch-diameter concrete pipe. The Southern Transmission Main runs southeast from the Fair Oaks 40-inch Main to near the Upper Pressure Zone Storage and Pumping Station before turning west. The Southern Transmission Main consists of about 20,000 feet of 30- to 28-inch-diameter steel pipe. The primary source of water to the Southern Transmission Main is the Fair Oaks 40-inch Main.

2.8.9.2. Fair Oaks Water District Groundwater System

To supplement its surface water supply, FOWD currently operates six wells, most of which are located in the east/central portions of FOWD's water system. Their capacities range from 500 gallons per minute (gpm) to 2,700 gpm. Groundwater typically accounts for about 10 percent of the FOWD's total water supply.

2.8.10. Carmichael Water District

Located adjacent to the lower American River, CWD is generally a self-sufficient water agency, with its own water rights and water infrastructure. CWD supplies a combination of surface water and groundwater to its service area. The subsection below describes the components of the surface water and groundwater systems.

2.8.10.1. Carmichael Water District Water System

The CWD water system consists of three pressure zones. To serve all three zones, CWD pumps water from the American River at Bajamont WTP (22 MGD capacity with a 28 MGD pumping capacity) on the lower American River downstream from Folsom Dam. The WTP was constructed in 2001, along with its associated 2 MG storage reservoir. The distribution system also includes two storage tanks (1 MG and 3 MG) and one additional storage reservoir.

CWD currently has four interconnections that are used primarily for emergency purposes. These interconnections are normally closed. There are interconnections with FOWD, CHWD, SSWD, and GSWC (CWD 2016).

2.8.10.2. Carmichael Water District Groundwater System

To supplement its surface water supply, CWD operates eight groundwater wells. Four of the wells are active, one is inactive, one is on standby, and two are to be decommissioned (CWD 2016). The four active wells and standby well have a combined pumping capacity of 6,550 gpm (CWD 2016). Between 2005 and 2010, CWD relied on groundwater for about 15-30 percent of its total annual water supply.

2.8.11. Sacramento Suburban Water District

SSWD is located in northern Sacramento County, purchases surface water from adjacent agencies, and relies on groundwater to meet its full demand. SSWD's water system is divided into two parts: (1) North Service Area (NSA) for the areas of the former Northridge Water District, the former McClellan Air Force Base (now McClellan Park), Arbors at Antelope, and the North Highlands service area of the former Arcade Water District; and (2) South Service Area (SSA) for the Town and Country service area of the former Arcade Water District. Between the NSA and the SSA there are 49 interconnections with adjacent agencies. Both the NSA and SSA are discussed separately below.

2.8.11.1. North Service Area Water System

The NSA distribution system consists of three pressure zones. To serve these zones there are six storage tanks in addition to groundwater pumping stations.

To deliver surface water to the NSA, SSWD uses SJWD's diversion and treatment facilities. The NSA system has two primary transmission mains that are part of the ATP. The primary east-west link of the ATP consists of about 40,000 feet of 48-inch-diameter pipe located mostly within Antelope Road. A 30-inch-diameter, 4,000-foot-long section of the ATP paralleling Interstate 80 conveys surface water to the southeastern portion of the NSA.

There are nine connections or turnouts in the NSA off of the ATP. These turnouts range in size from 12 inches to 30 inches in diameter. (There are four other turnouts: three for CHWD and one for CWD.)

2.8.11.2. North Service Area Groundwater System

The NSA contains 31 active wells with a combined pumping capacity of 37,550 gpm. The groundwater production system is designed to provide 100 percent of the system demand. There are six wells in stand-by, two wells pending inactivation and one well is under construction.

2.8.11.3. South Service Area Water System

The SSA includes the town and country area of the former Arcade Water District, served as one pressure zone. The SSA distribution system includes one 5 MG capacity groundwater storage reservoir and a 14,000 gpm pump station completed in 2006. Distribution piping in the SSA ranges from 4 inches to 12 inches in diameter.

2.8.11.4. South Service Area Groundwater System

The SSA contains 40 active wells with a combined pumping capacity of 44,000 gpm. Like the NSA groundwater system, the SSA system is designed to provide 100 percent of the system demand. There is currently one well in stand-by and one well is under construction.

2.8.12. Del Paso Manor Water District

Del Paso Manor is a small public water system nearly encompassed by SSWD in its South Service Area Water System. Del Paso Manor serves water to approximately 4,500 customers using eight groundwater wells and surface water. Total groundwater production reported in 2010 was 1,409 acre-feet.

2.8.13. Golden State Water Company

GSWC is a subsidiary of American States Water Company that serves communities throughout California. In the Region, GSWC provides surface water and groundwater to over 16,000 people of the Arden Cordova Service Area. The Arden area is located south of SSWD, north of the lower American River, and is supplied entirely by groundwater. The Cordova area is located south of the lower American River, across from CWD and FOWD, and is supplied by a mixture of surface water and groundwater. This subsection describes GSWC's surface water and groundwater systems.

2.8.13.1. Golden State Water Company Surface Water System

Surface water is supplied to the Cordova System from the Coloma WTP, Pyrites WTP and CWD's Bajamont WTP. The Coloma WTP and Pyrites WTP treat water that is pumped from the Folsom South Canal, which is gravity fed from Lake Natoma at Nimbus Dam. The Folsom South Canal is part of CVP and is operated and maintained by Reclamation. There is a 24-inch transmission main that crosses under the American River conveying 4.5 mgd of treated surface water on a continuous basis from the Bajamont WTP to the Cordova System. The Arden and Cordova systems combined comprise over 20 miles of 2- to 6-inch-diameter distribution pipeline, and over 95 miles of 8- to 24-inch-diameter pipeline. The Cordova System has two 6-inch interconnections and one 12-inch interconnection with Cal-Am, two 12-inch interconnections with SCWA, two 12-inch connection with Folsom, and six reservoirs for a total storage capacity of 14.5 MG. There are currently no connections between the Arden and Cordova systems without wheeling through other agencies.

2.8.13.2. Golden State Water Company Groundwater System

The Arden system is supplied by five wells which served just over 850 AFY in 2017. The Cordova system is supplied by eight active wells with annual capacity of just over 20,000 acre-feet (AF) to supplement surface water from the three WTPs. Groundwater is estimated to account for about 30 percent of Cordova's water supply. All active wells have disinfection and there is one inactive well in the Cordova system.

2.8.14. Rio Linda/Elverta Community Water District

Rio Linda/Elverta is located west of SSWD, at the northern border of Sacramento County. It currently supplies only groundwater to its service area, although water can be purchased from SSWD through an interconnection during emergencies. Discussions for potential conjunctive use with other agencies are ongoing with neighboring districts. The subsection describes the existing water and groundwater systems.

2.8.14.1. Rio Linda/Elverta Community Water District Water System

RLECWD does not currently use surface water on a regular basis, and has an intertie with SSWD for emergency purposes. SSWD supply through the intertie is a mix of surface and groundwater, with a design capacity of 2,500 gpm.

2.8.14.2. Rio Linda/Elverta Community Water District Groundwater System

About half of the RLECWD's area is currently served by private wells; the remainder is served by RLECWD groundwater distribution facilities. RLECWD's groundwater system consists of 12 production wells. The older production wells are more than 25 years old and typically produce 350 to 950 gpm of good quality water, whereas the well-constructed in 2012 produces 2,100 gpm. RLECWD's recently reactivated well can produce 600 gpm. To increase future water supplies, RLECWD has plans replace older wells affected by hexavalent chromium by constructing two additional groundwater wells. Some of the existing wells have disinfection treatment. The only well that does not have disinfection treatment is rarely used due to high iron and manganese levels. RLECWD's water system consists of a network of 12-inch-diameter and smaller pipelines to convey water to customers. There is a 0.1 MG elevated water tank that provides system storage.

2.8.15. Natomas Central Mutual Water Company

Natomas Central Mutual Water Company (NCMWC) is a private, not-for-profit corporation formed to serve some 280 member/shareholders in northwest Sacramento County and southwest Sutter County. NCMWC serves more than 33,200 acres and has water rights for up to 120 TAF per year from Reclamation. NCMWC's distribution system includes pipelines, pumps, and more than 50 miles of canals (NCMWC 2013).

2.8.16. City of Sacramento

Sacramento currently provides surface water and groundwater to wholesale and retail customers within its city limits and the American River Place of Use (POU), a contiguous area of 63,182 acres. Sacramento is self-sufficient regarding its water supply system, with legal and infrastructural access to water from both the American and Sacramento rivers. Sacramento is also responsible for collection of wastewater and delivery to SRCSD. This subsection describes Sacramento's water, groundwater, and wastewater collection systems.

2.8.16.1. City of Sacramento Water System

Sacramento owns and operates two WTPs. The Fairbairn WTP is located on the south side of American River about 7 miles upstream from the confluence with the Sacramento River. The Fairbairn WTP intake has a diversion screen capacity of 200 MGD, but the permitted treatment capacity is 160 MGD. Additional regulatory constraints ("Hodge Decision") governing diversions on the lower American river will often limit the diversion rates between 64 MGD and 100 MGD. The Sacramento River WTP, located on the east bank of Sacramento River below the confluence with the American River, has a design capacity of 160 MGD during the summer. Permits condition limit the facility during the winter to 120 MGD.

Sacramento provides water to two pressure zones within its city limits. The larger pressure zone encompasses the majority of the city, with a smaller pressure zone in the northeastern part of the city. High lift pump stations are operated at the Sacramento River WTP and Fairbairn WTP to serve the two pressure zones. Ten smaller pump stations are operated at storage facilities throughout the city.

Sacramento currently maintains approximately 1,600 miles of transmission and distribution system mains that have a diameter range of 2 to 72 inches, where only 360 miles of the pipeline have diameter range of 12 inches or larger. In addition, Sacramento maintains 17 storage facilities, with 12 being storage reservoirs, and 5 as finished water clearwells at the 2 WTPs. Each storage reservoir in the distribution system contains a storage capacity of 3 MG with the exception of the Florin Reservoir that contains a storage capacity of 15 MG. In the southern part of Sacramento, a new distribution tank is under construction that will contain a storage capacity of 4 MG and two new groundwater wells. The total distribution storage will be 52 MG when the 4 MG "Shasta Park" storage facility is completed in 2018. The total clearwell capacity from both water treatment plants provide and additional is 45 MG.

2.8.16.2. City of Sacramento Groundwater System

In addition to surface water supply, Sacramento currently operates 32 active municipal groundwater supply wells, with 30 of these wells located within the city limits north of the American River, and the remaining two wells located south of the American River. The total capacity of the well pumping facilities is about 23 MGD (Personal Communication, B. Ewart, 2018). Sacramento is in the process of completing a well rehabilitation program which will improve the existing well capacity through a variety of projects. During this project it was discovered that the existing wells will required new pump to waste improvements for flexible operations. The City is currently identify candidate wells and developing costs estimates to plan for this potential future project (Personal Communication, B. Ewart, 2018). Recently, a new well was constructed at Shasta Park with another well under construction at the Fairbairn WTP. Due to water quality results at the Fairbairn Water Treatment Plant Well site, the equipping of the well was put on hold, and a second well at Shasta Park is currently under construction. Together the two new wells will begin to provide approximately 7 MGD of potable water, starting in 2018. The anticipated groundwater pumping capacity is expected to be approximately 25 to 30 MGD after the new wells have been constructed and the rehabilitation project has been completed.

2.8.16.3. City of Sacramento Wastewater System

Wastewater collection in the Sacramento is provided by both the city and the Sacramento Area Sewer District (SASD). SASD maintains approximately 35 percent of the public collection system within the city limits, primarily in the northwest and southeast sections of the city. The city's Department of Utilities maintains the remaining portion of the public collection system, which includes a combined sewer system in the older central city area with a total service area of approximately 7,545 acres and approximately 305 miles of 4- to 120-inch-diameter pipes. The separated sewer system is located primarily in the northeast, east, and southwest sections of the city with a total service area of about 25,435 acres. Wastewater conveyed by the city's separated sewer system, as well as unincorporated areas within Sacramento

County and the cities of West Sacramento and Folsom, is routed to SRCSD's SRWWTP for treatment and disposal via an interceptor system consisting of large-diameter pipes and pump stations (Sacramento 2015a).

2.8.17. El Dorado Irrigation District

EID supplies surface water and recycled water to customers in its service area which spans an area of 220 square miles, primarily located in the South Fork American River and North Fork Cosumnes River watersheds. EID provides water to more than 100,000 people for municipal, industrial, and irrigation uses. The portion of EID in the Region is the downstream and western portion of the larger EID service area. This subsection focuses on the El Dorado Hills area, unless otherwise noted and describes the water, wastewater, and recycled water systems and planned facilities.

2.8.17.1. El Dorado Irrigation District Water System

The EID water transmission system is comprised of three, interconnected subsystems; each subsystem is identified by its water supply source. The El Dorado Forebay and Jenkinson Lake subsystems are outside the Region, but the Folsom Lake subsystem supplies the western portion of El Dorado County, which is within the Region. Water is pumped from Folsom Lake to the El Dorado Hills WTP (26 MGD). Treated water is conveyed through distribution mains using two pump stations that supply two primary pressure zones (960 Zone and 820 Zone) and several storage tanks (EID 2013).

2.8.17.2. EID Wastewater and Recycled Water Systems

EID's three largest wastewater service areas (El Dorado Hills, Deer Creek, and Mother Lode) are served by a series of lift stations, force mains, and gravity mains that convey sewage to either the El Dorado Hills WWTP or Deer Creek WWTP. EID operates and maintains a sanitary sewer system serving a population of approximately 62,000 people with over 77 square miles of service area. The system has 388 miles of gravity collection system, 59 miles of force mains, 8,204 maintenance holes, 21,662 sewer service laterals, and 61 lift stations. The El Dorado Hills WWTP has a rated ADWF capacity of 4.0 MGD, and the Deer Creek WWTP has a rated ADWF capacity of 3.6 MGD (EID 2016b).

EID operates two interconnected recycled water systems. Approximately 65 percent of the treated effluent produced at the El Dorado Hills WWTP is reclaimed, and approximately 35 percent reclaimed at the Deer Creek WWTP. While the Deer Creek WWTP is located outside the Region, an 18-inch-diameter pipeline connects the El Dorado Hills and Deer Creek systems. EID typically discharges 1 MGD of treated effluent to Deer Creek to maintain downstream riparian habitat and provide water for beneficial uses. Disinfected, tertiary quality recycled water produced at these two facilities are distributed for irrigation of residential landscape, commercial landscape, and recreational turf. Recycled water is also used in a few areas for fire suppression and dust control. The peak capacity of the recycled water system is approximately 5.1 MGD. Since recycled water demands currently exceed recycled water supplies, the deficit is supplemented by potable water. EID plans to expand their recycled water operations as daily wastewater flows increase and to explore options for additional recycled water storage (EID 2013).

2.8.18. City of Folsom

Folsom is located south of and adjacent to Folsom Lake. Folsom currently supplies surface water almost entirely to its service area. Groundwater is only used on a limited basis for golf course irrigation and as an emergency supply for Intel Corporation. This subsection includes a description of the surface water distribution system, the groundwater system, and the wastewater system operated by Folsom.

2.8.18.1. City of Folsom Water System

Folsom supplies surface water to seven pressure zones within its city limits, and to one pressure zone that extends slightly beyond city limits to the southwest. The eight pressure zones are organized into six service areas–Folsom Service Area West, Folsom Service Area East, Folsom Plan Area, Nimbus Area, Ashland Area, and American River Canyon Area (M. Yasutake, personal communication, 2018). The Ashland Area and American River Canyon area are served by SJWD's Sidney N. Peterson WTP. While SJWD provides water supplies to both of these service areas, Folsom physically serves the SJWD water to customers in the Ashland Service Area, while SJWD serves customers in American River Canyon (Folsom 2016).

Folsom receives surface water from Folsom Lake and treats raw water at the 50 MGD Folsom WTP. Drinking water is supplied through approximately 308 miles of pipeline to approximately 20,650 service connections (M. Yasutake, personal communication, 2018). Folsom's water system also includes 12 storage tanks with a total capacity of 34.5 MG. Reservoirs 1 and 2 at the WTP have a capacity of 3 and 4 MG, respectively. Eight other storage tanks with capacities ranging from 1.5 MG to 4 MG are located throughout the distribution system, and seven booster pump stations pump water to the eight pressure zones (M. Yasutake, personal communication, 2018).

Folsom has two system interconnections: (1) an emergency connection to the Ashland District across the Rainbow Bridge, and (2) an interconnection with GSWC. Though located within Folsom, the Ashland District normally receives water service from SJWD. Both interconnections are normally closed (Montgomery Watson, 1998).

2.8.18.2. City of Folsom Groundwater System

Groundwater use within Folsom is limited to private use by the Empire Ranch Golf Course and as an emergency supply for Intel Corporation. Intel Corporation uses two emergency backup wells, with 100 and 15 gpm capacities, respectively (Folsom 2016).

2.8.18.3. City of Folsom Wastewater System

Folsom operates and maintains 275 miles of gravity sewer lines, 3 miles of force mains, 96 miles of lower sewer laterals, and 14 active pump/lift stations (M. Yasutake, personal communication, 2018). Folsom's primary wastewater customers are residential, industrial, and commercial customers with most wastewater generated from residential users. Folsom conveys this wastewater to the SRCSD system where it is treated at the SRCSD Wastewater Reclamation Facility (Folsom 2017a).

2.8.19. Sacramento County Water Agency

SCWA provides retail water supply to portions of unincorporated Sacramento County, the City of Rancho Cordova, and the City of Elk Grove. SCWA also provides wholesale water supply to a portion of the service area of EGWD. It is anticipated that SCWA will also provide wholesale water supply in the future to Cal Am's service area in Rio del Oro. EGWD operates a retail water system serving customers within a portion of the City of Elk Grove. (SCWA 2016a).

SCWA supplies a combination of surface water, groundwater, and recycled water to eight main service areas. The combined Mather Sunrise and Laguna Vineyard public water systems are known as Zone 40. The Mather Sunrise system consists of the Zone 40 NSA. The Laguna Vineyard water system consists of both the Zone 40 Central Service Area (CSA) and SSA (SCWA 2016a). The other service areas include: Arden Park Vista, East Walnut Grove, Hood, Northgate 880, Southwest Tract, and the Metro Air Park (SCWA 2016a). This subsection describes the water and groundwater systems. SCWA's recycled water system is operated (by agreement) in collaboration with SRCSD, which is described in **Section 2.8.29**.

2.8.19.1. Sacramento County Water Agency Water System

The SCWA water system has a total storage capacity of 31 MG and 10 pump stations. SCWA also maintains over 70 miles of transmission mains of 16 inches to 48 inches in diameter. SCWA's water system includes the Vineyard WTP, 12 groundwater treatment plants (GWTP), direct feed wells, storage facilities, and the Franklin Intertie. The current capacity of the Vineyard WTP is 50 mgd, with an ultimate capacity of 100 mgd (SCWA 2016b). The City of Sacramento also treats a portion of SCWA's surface water at its Sacramento River WTP, and then wheels that water through its distribution system to the Franklin intertie (SCWA 2016b). The Franklin Intertie has a capacity of 11.1 mgd.

Tertiary treated wastewater is supplied from SRCSD's Water Reclamation Facility to a part of SCWA's Laguna Vineyard system. The 5 MGD Water Reclamation Facility is located at the Sacramento Regional Wastewater Treatment Plant site. SCWA owns and maintains the recycled water distribution system. This program is called the Phase I SRCSD/SCWA Water Recycling Pilot Program (WRPP) (SCWA 2016a).

2.8.19.2. Sacramento County Water Agency Groundwater System

SCWA service areas are generally dependent on groundwater supplies. The Arden Park Vista, Northgate 880, Hood, East Walnut Grove, and Mather Sunrise water systems are completely reliant on groundwater. Groundwater is supplied by SCWA's system of groundwater wells and as remediated groundwater that is extracted by others. SCWA has a combination of direct-feed wells and groundwater treatment facilities where needed.

GWTPs maintained by SCWA include the Anatolia GWTP, Mather Housing GWTP, Calvine Meadows GWTP, East Park GWTP, East Elk Grove GWTP, Wildhawk GWTP, Waterman GWTP, Big Horn GWTP, Dwight Road GWTP, Lakeside GWTP, and Poppy Ridge GWTP (SCWA 2016a).

Typical municipal capital facilities for groundwater production include groundwater extraction wells (including raw water piping from the wells to the treatment plant), treatment, at grade storage tanks, booster pumps, and transmission pipelines to the distribution system. Treatment plants typically remove iron, manganese, and in some cases arsenic. SCWA also has a remediated groundwater supply of 8,900 AFY through an agreement with Sacramento County and Aerojet-General Corporation (SCWA 2016b). The remediated groundwater is pumped from the northern portion of the South American Subbasin and discharged into the American River from Aerojet's Groundwater Extractions and Treatment facilities, located in Rancho Cordova.

2.8.20. Elk Grove Water District

Elk Grove Water District (EGWD) serves more than 42,000 people in an area of approximately 13 square miles in southern Sacramento County. Surrounded on all sides by SCWA, EGWD provides treated water from SCWA to their Service Area No. 2 customers and groundwater to its Service Area No. 1 customers.

2.8.20.1. Elk Grove Water District Water System

EGWD supplies a mix of surface water and groundwater to Service Area No. 2, and EGWD is responsible for maintenance and operation of the distribution mains. SCWA wholesales the water to EGWD, and they own and operate one WTP, the East Elk Grove Groundwater Treatment Plant, which is located within the service area.

2.8.20.2. Elk Grove Water District Groundwater System

In Service Area No. 1, EGWD owns and operates groundwater wells and the Railroad Street Treatment and Storage Facility. This facility includes the groundwater treatment plant, two aboveground storage tanks, production wells, and multiple pipe distribution systems. The facility contains a maximum capacity of 10.4 MGD that can pump up to 16,000 gpm (EGWD 2016). After the Recently refurbished Hampton Village WTP supplies an additional 1,000 gpm of water to EGWD (EGWD 2017).

2.8.21. Fruitridge Vista Water Company

FVWC relies almost entirely on groundwater to serve an area of 4 square miles south of Sacramento along State Route 99. The service area to the east of State Route 99 is primarily residential, but contains some commercial areas and three schools. The service area to the west of State Route 99 is primarily commercial, but contains some residential and commercial areas in addition to two schools. FVWC considers their service area to be 95 percent built-out, except for the south and southeast areas.

FVWC operates 16 groundwater wells, which have been sufficient to meet past water demands. FVWC has taken four wells out of production due to methyl tertiary-butyl ether and PCE contamination, and replaced this loss in supply with three new wells and two new permanent interties with Sacramento. Additionally, FVWC has six emergency interties with both Sacramento and Cal-Am.

2.8.22. Tokay Park Water Company

Tokay Park Water Company is a small water district serving an area of under 2 square miles southeast of FVWC. Service is provided to approximately 199 primarily residential connections. Supply is from groundwater. Estimated demand is 142 AFY (Sacramento Local Agency Formation Commission 2013).

2.8.23. Florin County Water District

Florin County Water District is a small water district serving an area of approximately 2.5 square miles east of Tokay Park Water Company. Service is to approximately 12,588 customers through 2,213 connections. Supply is from 10 groundwater wells. Estimated demand is 2,668 AFY (Sacramento Local Agency Formation Commission 2013).

2.8.24. Rancho Murieta Community Services District

Rancho Murieta is located in southeastern Sacramento County along the Cosumnes River. Rancho Murieta uses surface water and recycled water in its service area, although access to groundwater is an option being considered to diversify its water supply portfolio in dry years. Surface water storage and increased recycled water capacity are also being studied.

2.8.24.1. Rancho Murieta Community District Water System

Rancho Murieta's water supply stems from Granlees Dam on the Cosumnes River. Raw water is distributed by booster pumps and pipelines to three primary reservoirs (Calero, Chesbro, and Clementia) with a combined usable storage of 4,608 AF. Rancho Murieta has two WTPs with a combined capacity of 3.5 MGD, and both plants have plans for expansion if needed for a total capacity of 6.0 MGD.

2.8.24.2. Rancho Murieta Community Services District Wastewater and Recycled Water Systems

Rancho Murieta Wastewater Reclamation Plant (WWRP) serves the entire Rancho Murieta community, producing 537 AFY of treated effluent. The collection system consists of gravity sewer lines with three lift stations. The WWRP has secondary and tertiary treatment systems, with a design flow of 1.55 MGD and design capacity of 3.0 MGD, respectively (Central Valley Water Board 2014).

Rancho Murieta treats all of its wastewater to Title 22 standards and distributes recycled water to irrigate golf courses, which have a normal year water demand of 550 AFY. Rancho Murieta's WWRP stores secondary wastewater in two large reservoirs, and then applies tertiary treatment during the irrigation season from April to November.

2.8.25. City of Galt

Located approximately 20 miles south of Sacramento, Galt serves an area of 3,815 acres. Of this total area, 58 percent is residential, 19 percent is commercial and light industry, and the remaining 23 percent are parks, open spaces, or mixed uses. Galt does not have access to surface water and relies on groundwater to meet water demands.

2.8.25.1. City of Galt Groundwater System

Galt owns and maintains over 99 miles of water lines ranging from 1 to 24 inches in diameter, eight active wells, four above ground water storage tanks, and five treatment plants. Galt plans to drill new water supply wells to increase system capacity and water availability to meet planned needs. The Golden Heights WTP has a current capacity of 1,815 gpm and is planned to be expanded to 4,500 gpm in 2013. Industrial Park WTP will potentially be upgraded from 1,360 gpm to 4,160 gpm. A new WTP and wells are also being planned at Kost Reservoir.

2.8.25.2. City of Galt Wastewater and Recycled Water System

Galt owns, maintains, and operates its own WWTP, gravity sewer pipelines and force mains, sewer lift stations, and pump stations. The city collects wastewater from residential, commercial, institutional, and industrial customers within the service area. The WWTP is permitted for 3.0 MGD and currently operates at approximately 2.2 MGD. Treated effluent is used for irrigation purposes and/or is discharged to Laguna Creek.

Galt's WWTP consists of secondary treatment, tertiary filtration, and ultraviolet (UV) disinfection, and connects to an effluent storage reservoir with a capacity of 70 MG. This WWTP has the capacity to produce recycled water, but currently, neither the necessary distribution infrastructure nor the demand exists for widespread use. However, Galt has identified potentially interested irrigation water customers. Galt applied 335 MG of recycled water in 2011 to an onsite agricultural reuse site to grow fodder crops.

2.8.26. Placer County

Placer County is responsible for providing wastewater services for the entire unincorporated area of Placer County (outside of cities of Lincoln, Roseville, and Auburn and the areas served by the South Placer Municipal Utility District). Placer County Environmental Engineering Division operates and maintains 10 separate sanitary sewer systems that are self-supporting and maintained through user fees.

Five of the 10 separate sewer systems are located in the Region. Sewer Maintenance District (SMD) 1 is located in North Auburn, and 102 miles of pipe carry wastewater to the North Auburn lift station, which is conveyed to the City of Lincoln Regional WWTP. SMD 2 in Granite Bay and County Service Area 28, SMD 3 in Horseshoe Bar/Folsom Lake, and Zone2A3 in Sunset Industrial Park consist of 118 miles, 16 miles, and 10 miles of sewer pipes, respectively. All three of these systems connect to Roseville's WWTPs for treatment. Zone 6 in Sheridan has 3 miles of pipeline, it is small but has its own WWTPs (R. Mahoney, personal communication, 2018).

Wastewater capital improvement projects are continuously identified and planned on facilities and pipes in all Placer County Districts and Central Service Areas (R. Mahoney, personal communication, 2018).

2.8.27. City of Auburn

Located in the northeastern corner of the Region, Auburn owns and operates its own wastewater treatment and collection system, which serves the city within its boundaries.

Auburn maintains over 85 miles of wastewater collection lines and 11 sewer lift stations throughout the city. This network of pipes collects sewage from residences and businesses and transports it to the Auburn WWTP located west of the city. The Auburn WWTP discharges its tertiary treated effluent into Auburn Ravine at a maximum permitted flow of 1.65 MGD. Auburn plans to upgrade its WWTP to improve performance and comply with NPDES permits. The WWTP upgrades include constructing a new oxidation ditch along with its associated facilities (Auburn 2017).

2.8.28. South Placer Municipal Utilities District

South Placer Municipal Utilities District (SPMUD) provides wastewater collection and conveyance services for the communities of Rocklin, Newcastle, Loomis, Penryn, and portions of Granite Bay (Loomis Basin Chamber 2013). SPMUD has a service area of 18,560 acres and approximately serves 29,000 dwelling units. The SPMUD system includes 247 miles of pipeline and eight pump stations, and the wastewater is conveyed to the Dry Creek Regional WWTP or the Pleasant Grove Regional WWTP, which are operated and maintained by Roseville. Newcastle Sanitation District was annexed into SPMUD.

2.8.29. Sacramento Regional County Sanitation District

SRCSD collaborates with other local agencies in the Sacramento area to collect, convey, and treat wastewater at the SRWWTP. SRCSD's Interceptor System conveys wastewater from Folsom, Sacramento, City of West Sacramento, and SASD, serving over 250 square miles. As of 2013, the system involved about 111 miles of gravity interceptors, and 61 miles of force mains. The SRWWTP, located in Elk Grove, treats about 181 MGD on an average dry day, provides secondary treatment, and discharges into the Sacramento River. Treatment upgrades are currently in planning and design to meet recent NPDES requirements necessitating facility upgrades (Water Technology 2018). Sacramento County's Department of Water Quality provides staffing for operations, maintenance, engineering, and administrative services for SRCSD and County Sanitation District 1. These special districts provide sanitary sewer and wastewater collection, conveyance, and treatment within the urbanized areas of Sacramento County and the Livoti Tract in south Placer County.

Although primarily a wastewater treatment provider, SRCSD uses recycled water produced at its Water Reclamation Facility (WRF) to meet nonpotable water demands on its own property and wholesales it to SCWA to meet nonpotable demands as part of the SRCSD/SCWA Demonstration Project.

SRCSD embarked on its Water Recycling Program with a goal to manage discharge from the SRWWTP to the Sacramento River while providing a reliable supply source for water purveyors in the region, where feasible. In conjunction with the secondary treatment provided at SRWTP, SRCSD operates its 3 MGD WRF to produce tertiary treated recycled water at the same site. For Phase I of the Water Recycling Program, SRCSD partnered with SCWA to use all of the 3 MGD capacity for onsite uses at the Sacramento Regional WWTP complex and nonpotable commercial and public landscape areas in the Laguna West, Lakeside, and Laguna Stonelake developments located within SCWA's service area immediately south of SRCSD's facility. The Phase 2 service area consisted of the East Franklin and Laguna Ridge development areas located to the south and east of the Phase 1 system. Expansion of the

SRCSD Recycled Water Program into the Phase 2 area required a separate recycled water pipeline to be constructed from the Sacramento Regional WWTP to facilities owned and operated by SCWA. Much of the internal "purple" pipe distribution system has been constructed as part of recent development.

SRCSD's Water Recycling Opportunities Study, completed in 2007, identified a goal of recycling 30 to 50 MGD with new water agency partnerships elsewhere in the region by 2030. Since 2010, a new discharge permit issued by the Central Valley Water Board requires SRCSD to treat all of its effluent to tertiary levels by June 2021, which could greatly expand opportunities for using recycled water in the future. SRCSD is currently undertaking the EchoWater Project as a way to comply with stricter and newer water quality requirements for wastewater. It is a public works projects aimed at improving the quality of treated wastewater such that there will be a 95 percent reduction in ammonia that is discharged to the Delta. The EchoWater Project is expected to be completed by 2023 (SRCSD 2013). SRCSD is also collaborating with Sacramento Municipal Utility District to move recycled water, instead of potable water, to Sacramento Power Authority Cogen Plant to use for its cooling towers. The construction work associated with constructing the pipeline is expected to be completed by 2018 (SRCSD n.d). SRCSD is also developing a program to irrigate agricultural land and create habitat for endangered wildlife through the South Sacramento County Agriculture and Habitat Lands Water Recycling Project. For this project, SRCSD submitted a Proposition 1 Water Storage Investment Program Application.

2.9. Water Demands and Supplies

This subsection describes water demands and supplies in the Region. Because the Region is significantly urbanized, this subsection focuses on M&I water use. However, the Region has significant private agricultural water users who use a combination of seasonal surface waters or self-supplies using groundwater. Some water agencies, such as PCWA Zone 5, specifically deliver water for larger scale irrigation uses. **Section 2.9.1** portrays historic and projected water demands in the Region, as well as ongoing demand reduction efforts. **Section 2.9.2** begins with a brief discussion on surface water rights and contracts within the Region, which legally dictate areas of water availability. The subsection then explains restrictions on surface water availability, groundwater use patterns, and recycled water availability. The water supply picture is summarized with a description of the water agencies' current water supply portfolios and their projected future water supplies. This subsection concludes with an explanation of how these water demands and supplies interact and play a role in shaping future development in the Region.

Water agency demand and supply portfolios for RWA member agencies were developed as part of the North American Basin Regional Drought Contingency Plan (NAB RDCP). The NAB RDCP was a collaborative planning effort to explore opportunities to collaborate and cooperate to enhance regional reliability, and to increase the resiliency of the Region's water resources in the face of future climate and drought conditions. The effort was cost-shared by Reclamation through Reclamation's WaterSMART Drought Response Program.

To develop the portfolios, information was gathered from state, local, and regional planning documents, including 2015 UWMPs, Master Plans, General Plans, and capital improvement programs. An initial water budget and vulnerability analysis for agency was developed to highlight the demand variability throughout the course of year, and variability of supplies across different hydrological conditions per the WFA water year types. This information was compiled into draft water supply portfolios, which were sent to each agency for review. Interviews were conducted confirm accuracy and completeness of information presented in the water supply portfolios, fill data gaps, and identify vulnerabilities and opportunities. Finally, the water budget for each agency was updated using the information from the interviews. The water agency demand and supply portfolios included information on: current and projected demands, estimate of conservation potential, available supply sources, surface water rights and contract entitlements, groundwater production capacity, and recycled water.

Water supply portfolios for agencies not included in the NAB RDCP were developed for use in the Regional Water Reliability Plan (RWRP) evaluation. The RWRP is an RWA-led planning effort to achieve long-term water supply reliability by investigating and identifying potential coordinated and collaborative actions among the region's water agencies. Water supply portfolios for agencies not included either the NAB RDCP or RWRP were updated using information from regional and agency-specific plans, such as UWMPs, Master Plans, and water supply assessments. **Figure 2-31** illustrates the NAB RDCP and RWRP participating agencies' boundaries.

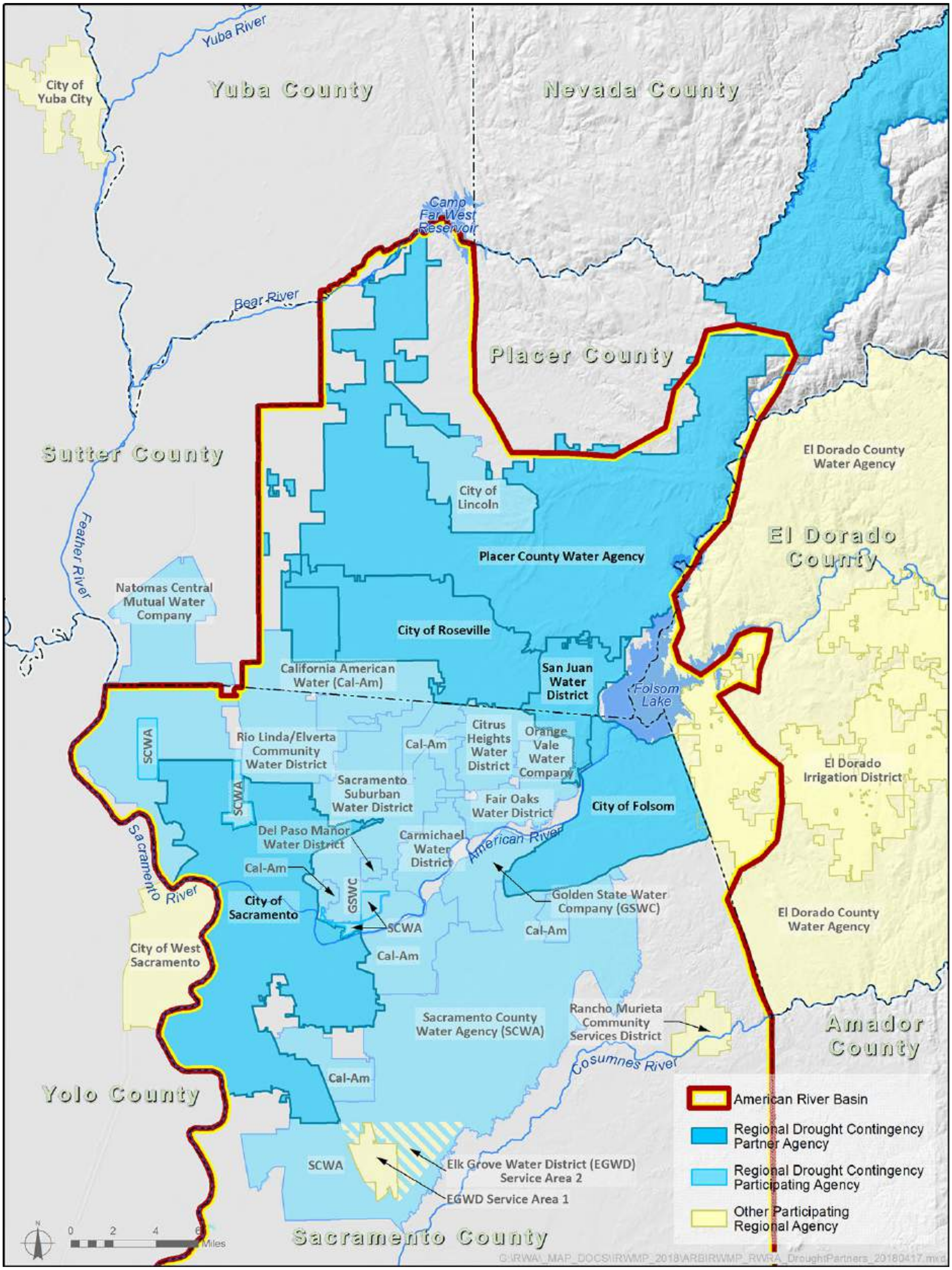


Figure 2-31. NAB RDCP and RWRP Participating Agencies

2.9.1. Water Demands

Current and projected water demands help determine anticipated future water supply needs. Water demand is dependent on numerous factors, such as population, land use, season, efficiency of the distribution system, and water user efficiency. M&I water demands vary hourly, within a single day, and seasonally, thus demands are typically normalized for general discussion purposes. Residential water demands typically peak in the morning and early evening, corresponding to when residents wake up and return home. Seasonally, summers have a higher water demand than winters due to outdoor irrigation. With the Sacramento region's hot, dry climate and long summer season, more than 65 percent of a household's yearly water consumption typically goes toward landscape irrigation (Sacramento 2016a). The following subsections discuss historic and projected water demands annually, as well as demand management efforts within the Region.

2.9.1.1. Historical Water Demands

Recent historical water demands in the Region are provided in **Table 2-20**. These demand reports include system losses, but do not include wholesale deliveries to other agencies. Historically, water demands in the Region increased with population growth. . However with the implementation of the Energy Policy Act of 1992, local and regional water efficiency programs, increased public outreach and the continued installation of water meters billed volumetrically, the region has experienced a decreasing trend in water demand, especially in the last decade.

For example, water demands within the Region decreased from about 919,642 AFY in 2005 to 821,574 AFY in 2010. More recently water demands in the Region continued to decrease from 2010 to 457,177 AFY in 2015. The significant reduction in demand can be attributed to the demand drivers listed above as well as the state issued mandatory water conservation emergency drought restrictions that were active during 2015. As the state and Region emerged from the peak of the drought in 2015, water demand in the Region has recovered during 2016 and 2017.

Table 2-20. Estimated Recent Historical Water Demands (AFY)

Water Agency	2005	2010	2015
California American Water	44,970	37,297	28,421
Carmichael Water District	12,496 [1]	9,732	7,142
Citrus Heights Water District	19,034	13,725	9,974
Del Paso Manor Water District	1,657	1,409	1,409[7]
El Dorado Irrigation District	37,223	32,525	30,167
Elk Grove Water District	7,915	6,720	5,311
Fair Oaks Water District	12,454	11,800	8,130
Florin County Water District	2,668	2,668	2,668
City of Folsom	24,974	26,243	18,587
Fruitridge Vista Water Company	4,891	4,157	3,596
City of Galt	5,300	5,174	4,163
Golden State Water Company [2]	18,098	16,478	11,593
City of Lincoln	9,376 [3]	9,203	7,629
Natomas Central Mutual Water Company	37,332	23,438	23,438[7]
Orange Vale Water Company	4,915	4,585	3,256
Placer County - Ag/Ag-Res	56,300	58,300	58,300[7]
Placer County Water Agency, Zone 1 TW [4]	36,253	35,608	29,675
Placer County Water Agency, Zone 1 (ARB) TW[4]	29,097	28,985	24,642
Placer County Water Agency, TW (Z1 & Z3) [4]	36,253	36,289	30,324
Placer County Water Agency, RW Deliveries[4]	54,505	52,990	43,912
Placer County Water Agency, Z5 Deliveries[4]	11,808	12,240	10,137
Rancho Murieta Community Services District	2,008	1,710	1,711
Rio Linda/Elverta Community Water District	3,400	2,720	2,109
City of Roseville [5]	31,075	28,633	22,881
City of Sacramento	131,564	108,276	84,832
Sacramento County - Ag/Ag-Res [6]	192,500	192,500	192,500
Sacramento County Water Agency	35,971	35,509	29,149
Sacramento Suburban Water District	41,193	36,386	27,502
San Juan Water District	14,270	12,650	9,666
Tokay Park Water District	142	142	142
Regional Total	**919,642**	**821,574**	**457,177**

Sources:
Rio Linda/Elverta Community Water District data were provided in the 2015 Public Draft UWMP. City of Galt data were provided in the 2015 UWMP. Rancho Murieta Community Services District's information is from their 2006 and 2010 Integrated Water Master Plan and 2016 Water Supply Assessment – Ranch Murieta North Project. Florin County and Tokay Park Water District data are estimates from Sacramento County Local Agency Formation Commission, as other data are not available. Placer County Ag/Ag-Res data are from 2013 Draft Western Placer County Sustainable Yield. Sacramento County Ag/Ag-Res data are estimated from the Sacramento Area Integrated Water Resources Model (SacIWRM).
All other information was taken from the 2015 UWMP of each water agency.

Notes:
[1] 2005 Carmichael Water District demand is for 2006 (CWD 2011).
[2] Golden State Water Company includes Cordova System only.
[3] 2005 City of Lincoln demand is for 1996 (Lincoln, 2003) and 2006 (Lincoln, 2010).
[4] PCWA resides over two IWRMP regions, the American River Basin (ARB) and the Cosumnes American Bear Yuba (CABY) regions. Only a portion of PCWA's Zone 1 region is within the ARB Region. Historical consumption of PCWA's various zones are provided (B. Rickards, personal communication, 2018).
[5] City of Roseville also provides raw surface water to Linda Creek for to sustain the natural flow for environmental purposes. The water usages for the years above are: 27.77 MG for 2005, and 73.1 MG for 2010.
[6] Sacramento County Ag/Ag-Res data theoretically include water use by Clay Water District, Galt Irrigation District, Omochumne-Hartnell Water District, and South Sutter WD.
[7] 2015 historical water demands were not available, assumed 2010 historical water demands.

Key:
AFY = acre-feet per year
Ag/Ag Res = agriculture/ agricultural-residential
UWMP = Urban Water Management Plan

2.9.1.2. Projected Water Demands

In UWMPs, each water agency estimated its future water demands based on a minimum of land-use and population projections through 2035 (**Table 2-21**). Anticipated effects of climate change are separately discussed in **Section 2.10**. If a water agency contracts its water to another agency, that demand is shown under the retailing agency using the water, and not under the agency that sold the water. Demand projections at least to 2040, providing a 20-year planning horizon, will be available for the next round of UWMP updates in 2020. From 2015 to 2035, the Region is expecting a greater than 23 percent increase in overall water demands due to growth.

Table 2-21. Projected Annual Water Demands (AFY)

Water Agency	2015	2020	2025	2030	2035
California American Water	28,421	40,742	43,587	46,946	50,989
Carmichael Water District	7,142	10,374	10,300	10,226	10,151
Citrus Heights Water District	9,974	16,970	17,383	17,797	18,210
Del Paso Manor Water District 1	1,409	1,600	1,600	1,600	1,6002
El Dorado Irrigation District	30,167	43,43,4777	446,8336,	50,696	553,12838
Elk Grove Water District	5,311	7,694	7,917	7,972	8,038
Fair Oaks Water District	8,130	11,768	12,080	12,398	12,726
Florin County Water District 1	2,668	2,668	2,668	2,668	2,6682
City of Folsom	18,587	25,575	27,685	28,527	29,283
Fruitridge Vista Water Company	3,596	6,609	6,609	6,609	6,609
City of Galt	4,163	5,858	6,405	7,072	7,808
Golden State Water Company	11,593	17,342	17,697	18,312	18,968
City of Lincoln	7,629	12,291	13,478	15,296	17,113
Natomas Central Mutual Water Company	32,000	29,000	23,000	23,000	23,0002
Orange Vale Water Company	3,256	4,567	4,686	4,860	4,981
Placer County – Ag/Ag-Res	60,000	60,000	60,000	60,000	60,0002
Placer County Water Agency	22,366	177,351	196,950	209,954	224,056
Rancho Murieta Community Services District	1,711	2,041	2,532	2,854	3,428
Rio Linda/Elverta Community Water District	2,109	4,846	5,681	6,650	7,462
City of Roseville	22,881	41,054	43,300	46,074	48,762
City of Sacramento	84,832	122,229	129,548	138,882	148,213

Table 2-21. Projected Annual Water Demands (AFY) (contd.)

Water Agency	2015	2020	2025	2030	2035
Sacramento County – Ag/Ag-Res	183,450	174,400	165,350	156,300	156,300[2]
Sacramento County Water Agency	29,149	48,121	55,489	63,288	71,145
Sacramento Suburban Water District	27,502	40,004	40,910	41,345	41,340
San Juan Water District	9,666	15,855	16,773	17,624	18,509
Tokay Park Water District[1]	142	142	142	142	142
Regional Total	**540,741**	**809,415**	**838,803**	**869,827**	**668,583**

Notes:
Rio Linda/Elverta Water District data were provided in the 2015 UWMP. City of Galt data were provided in the 2015 UWMP. Rancho Murieta Community Services District's information is from their 2016 Water Supply Assessment – Ranch Murieta North Project. Placer County Ag/Ag-Res data are from 2013 Draft Western Placer County Sustainable Yield. Sacramento County Ag/Ag-Res data are estimated from the Sacramento Area Integrated Water Resources Model (SacIWRM). Del Paso Manor Water District data were provided by personal communication with D. Sedwick, 2018. All other information was taken from the 2015 UWMP of each water agency or personal communication is agency staff.
[1] Growth is not expected for these water agencies.
[2] 2035 projected water demands are not available, 2030 projected water demands were assumed.
Key:
AFY = acre-feet per year
Ag/Ag Res = agriculture/ agricultural-residential
UWMP = Urban Water Management Plan

2.9.1.3. Conservation and Demand Management

Conservation and demand management help promote smart growth and smart water management in light of urban development and the associated increases in water demand. Increasing water users, interest in reducing water waste, and uncertainties posed by climate change all result in a need for demand management. The most recent drought highlighted the continued need for both long- and short-term demand management as well as the success that can be achieved from implementing demand management and the resulting water use reductions. This subsection describes the water use targets each agency has set to meet the statewide goal of decreasing per capita water use and describes how those targets will be met. Effective demand management will increase regional water supply reliability, which is discussed in **Section 2.9.3**.

20 Percent Reduction by Year 2020

In February 2008, the state released a seven-part comprehensive plan for improving the Delta. As part of this effort, the Legislature directed state agencies to develop a plan to reduce statewide per capita urban water use by 20 percent by the year 2020. This marked the initiation of the 20x2020 Water Conservation Plan process. Resulting from this plan, all urban water suppliers had to plan for a 20 percent reduction in per capita water demand by 2020 and 10 percent by 2015. Calculation methodologies and targets were required and identified in water supplier's 2015 UWMPs and are summarized in **Table 2-22**.

Table 2-22. Baseline and Target Demands (gallons per capita per day)

Water Agency	Baseline Demand	2015 Target	2020 Target
California American Water	216	195	173
Carmichael Water District	296	266	237
Citrus Heights Water District	286	257	229
El Dorado Irrigation District	301	271	241
Elk Grove Water District	239	215	191
Fair Oaks Water District	348	314	279
City of Folsom	440	396	352
Fruitridge Vista Water Company	154	117	123
City of Galt	217	196	174
Golden State Water Company	400	360	320
City of Lincoln	241	217	193
Orange Vale Water Company	301	271	241
Placer County Water Agency	306	292	261
Rio Linda/Elverta Community Water District	226	*204*	*181*
City of Roseville	309	278	247
City of Sacramento	282	253	225
Sacramento County Water Agency	295	265	236
San Juan Water District	516	464	413
Sacramento Suburban Water District	257	231	206

Long-term Water Use Efficiency Measures

After several years of historic drought, Governor Edmund G. Brown Jr. declared a drought state of emergency on January 17, 2014 and directed the State Water Resource Control Board (State Board) to adopt emergency regulations. These regulations included mandates to urban water suppliers to implement drought response plans and limit outdoor irrigation and other water practices. Starting on April 1, 2015, Governor Brown issued a series of executive actions to continue to address the state's severe drought conditions. These included Executive Order B-29-15 which mandated a 25 percent statewide reduction in potable urban water use. Urban water suppliers were assigned a conservation standard from 4 to 36 percent reduction in water use, based on their residential gallons per capita per day for the months of July to September 2014. Urban water suppliers in the Region rose to the challenge. Sacramento-area residents and businesses contributed to 12 percent of the state's total savings from June 2014-December 2016. In 2016, Sacramento-area urban water supplier and residents reduced water use by 25 percent, compared to 2013. Although the state of drought emergency was lifted in April 2017, water conservation remains a central focus in California and the Region.

Executive Order B-37-16, signed in May 2016, sought to establish long-term conservation measures in California. The Order focused on one of the ten principles originally outlined in the California Water Action Plan: "Make Conservation a California Way of Life." State legislation is currently being considered to support implementation of the Order. The legislation (Assembly Bill 1668 and SB 606), as currently amended, would require DWR and the State Board to develop standards for water loss, indoor and outdoor residential use and commercial, industrial, and institutional water use. If passed, the legislation would have large impact on water use efficiency practices throughout California.

Urban Water Demand Management Practices and Measures

Conservation and demand management have been and will continue to be actively employed throughout the Region. Potential conservation BMPs were studied initially in this region in Sacramento's Water Conservation Study/Urban Management Plan prepared in September 1991. Subsequently, the Water Forum recommended an expanded list of conservation measures, including residential water metering. Through discussions with various stakeholders and water agency representatives, the Water Forum developed a list of conservation measures, or BMPs, for adoption and implementation. The Water Forum anticipates full implementation of these BMPs by the year 2030.

The BMPs adopted by the Water Forum are a subset of those developed by the California Urban Water Conservation Council (CUWCC)[7] and DWR. CWC Section 10631 also stipulates that Demand Management Measures (DMM) required in UWMPs are synonymous with CUWCC's BMPs. Nineteen of the 26 water agencies in the Region develop UWMPs, and these agencies are required to implement and track progress on the BMPs or DMMs. Explanations of DMMs are available in DWR's *2015 Urban Water Management Plans Guidebook for Urban Water Suppliers* (DWR 2016b). One of the BMPs/DMMs that discusses wholesale agency assistance programs is only applicable to a handful of agencies within the Region.

Regional Water Use Efficiency Program

The RWA operates an award-winning Water Use Efficiency Program (WEP), a program designed to help its participants implement their BMPs by pooling resources. All members of the RWA, except the City of Yuba, have participated in this program since its creation in 2001 or since they have joined the RWA. WEP's advisory committee continues to meet every other month. WEP has a user-friendly Web site named "Be Water Smart," which can be accessed at http://www.bewatersmart.info/. WEP program activities include:

[7] The California Urban Water Conservation Council has transitioned to the California Water Efficiency Partnership.

- Toilet, clothes washer, turf removal, and irrigation efficiency rebate programs.
- Residential customer workshops on how to conserve water indoors and outdoors.
- Annual trainings for landscape professionals on river friendly landscape principles and practices.
- Water education programs including a public services announcement video contest geared towards high school and middle school students.
- Annual public outreach campaigns that include radio, television, online, and social media advertising. Campaign themes have included Rethink Your Yard and Check Your Soil and Save. RWA coordinates events and messaging with local water agencies.
- Partnering with state and local entities like Save Our Water and the Sacramento Tree Foundation on public outreach efforts
- Indoor fixture direct installations for low income households and commercial, industrial, and institutional facilities located in low income neighborhoods or that service low income households.

2.9.1.4. Metering Policies

Water metering was a contentious issue historically in the Region for a variety of social, physical and financial reasons. Notwithstanding regional sentiment, a variety of laws and policies have been enacted to addressing water metering:

- Since 1992, CWC Section 525-529.7 requires all new construction statewide to have water meters installed during construction.
- Agencies using CVP water, including water supplied under Public Law 101-514 (Fazio Water) (e.g., SJWD) have been required to meter all connections since the Central Valley Project Improvement Act was passed in 1992.
- Signatories to The Water Forum Agreement (2000) agreed to phased implementation of water meters over a period of years.
- Assembly Bill 2572, passed in 2004 requiring water meters on all residences by 2025 for urban water suppliers, which primarily addressed agencies with water metering prohibitions in their

charters. An urban water supplier is defined in CWC Section 10617 as having either 3,000 connections or supplying more than 3,000 acre-feet of water per year.

Almost all water agencies in the Region are now fully metered or have plans for full meter implementation with metered rates by 2025. 91 percent of the water accounts in the Sacramento Region are metered. Most Sacramento-area water providers are 100 percent metered and have been for years. Others are continuing to upgrade their systems, including installing state-of-the art wireless water meter reading systems at homes and businesses.

2.9.2. Water Supplies

Meeting water demands with adequate and reliable water supplies is an essential goal of water agencies. Potential sources of water supply include surface water, groundwater, and recycled water. In the Region, most water demands are met by surface water supplies, with groundwater meeting most the remaining demand. A small, but growing percentage of supplies are met by recycled water. Total regional demands met by surface water, groundwater, and recycled water supplies is currently being calculated as part of the RWRP. Recycled water is a hydrology-independent source of supply. However, recycled water is used only in certain portions of the Region, and a larger scale integration of recycled water into the regional water portfolio remains a continuing goal and a challenge. After a discussion of each of these water sources, this subsection concludes with a characterization of the current water supply portfolios and projected water supplies for each water agency, portraying some of the future challenges in the Region.

2.9.2.1. Surface Water Supplies

The Region has three sources of surface water: American, Sacramento, and Cosumnes rivers. Availability of surface water is dependent on water rights and contract agreements, which legally define who can use water where, when, and how. Surface water availability is also constrained by hydrology and related diversion limitation agreements or legal restrictions as well as infrastructure capacity to pump, treat, store, and deliver water at the time, quantity, and quality that it is needed. Discussion of surface water constraints is presented in **Section 2.9.2.1** and includes the Water Forum Agreement, Hodge Flows, and Reclamation’s CVP restrictions.

Water Rights and Contracts

This subsection provides a regional overview of available surface water from the Sacramento, American, and Cosumnes rivers pursuant to water rights, contracts, and other agreements. This information is presented by agency in **Table 2-23**. This discussion on water rights and contracts is intended to provide a general overview on water availability from a high-level discussion perspective, and is not an exacting legal description. Listed water rights and contracts include known conditions or restrictions, such as POU, diversion rate limitations, and seasonal or hydrologic restrictions. The data displayed in **Table 2-23** show the potential maximum amount of water an agency may access, including supplies possibly available during surplus conditions, if the agencies have the infrastructure capacity and water demands to accommodate the diversion. Information listed in the table was gathered through regional and local water plans and other documents, as well as interviews conducted with regional water purveyors as part of the NAB RDCP and RWRP.

The discussion of water supply availability by agency and the interplay of constraints, such as hydrology, infrastructure capacity, and availability of supplemental supplies is found in **Section 2.9.2.5**. Thus, data presented in **Table 2-23** does not necessarily correlate with current actual or future agency water demand data.

Water is commonly "wheeled" in the Region from wholesaler to retailers through subcontracts, assignments, and agreements. For example, Roseville has an agreement with SJWD to receive 4,000 AFY from SJWD's 25,000 AFY contract with PCWA for Middle Fork Project water. Due to these subcontracts, assignments, and agreements, the water rights and contracts data are not directly totaled to provide an overall regional number. As shown in **Table 2-23**, agencies that provide water to other retailers throughout the Region include PCWA (from their Middle Fork Project water rights), Sacramento (from the American River), SCWA, SJWD (CHWD, FOWD, and OVWC), and SSWD. A brief narrative follows **Table 2-23** to describe the water rights and contracts in the Region.

This subsection focuses on water rights and contracts held by municipal water agencies. Accordingly, there may be other, independent agricultural water rights holders from the American, Sacramento, and Cosumnes rivers that are not listed. Further, an agency's water right or contract outside the Region, if distinguishable, is not included for overall clarity. This is especially relevant to PCWA and EID, who have jurisdiction and active service areas across Placer and El Dorado counties, respectively, but which are beyond the formal Region.

Table 2-23. Surface Water Rights and Contracts

Water Agency	American River		Sacramento/Cosumnes Rivers	
	Description of Right or Entitlement	Maximum Use (AFY)	Description of Right or Entitlement	Maximum Use (AFY)
California American Water	Purchase from Sacramento	4,831	N/A	N/A
	Purchase from SSWD	2,000		
	Purchase from SCWA	5,000		
	Total	11,831		
Carmichael Water District	Appropriative	10,859	N/A	N/A
	Appropriative	3,669		
	Appropriative	18,099		
	Aerojet Contract	2,200		
	Total	34,827		
Citrus Heights Water District	Wholesale contract with SJWD	Unspecified quantity [1]	N/A	N/A
	Total	N/A		
Del Paso Manor Water District	Contract with Sacramento via SSWD	2,460	N/A	N/A
	Total	2,460		
Fruitridge Vista Water Company	Contract with Sacramento	3,629		
	Total	3,629		
El Dorado Irrigation District [2]	Reclamation-Folsom Reservoir	7,550		
	From EDCWA, Public Law101-514 Fazio [3]	7,500		
	FERC Project 184 (Appropriative)	15,080		
	License 2184 and Pre-1914 Water Rights	4,560		
	Licenses 11835 and 11836 Permit 21112	23,000		
	Applications 5645X12, 5644X02	17,000		
	and partial assignment of Applications 5645, 5644 with El Dorado-SMUD Cooperation Agreement[15]	30,000		
	Total	104,690		
Elk Grove Water District			Purchase from SCWA [4]	2,935
			Total	2,935
Fair Oaks Water District	Wholesale contract with SJWD	Unspecified quantity [1]		
	Total	N/A		
Folsom, City of	Pre-1914	22,000	N/A	N/A
	Pre-1914 Co-tenancy with GSWC (assigned in perpetuity)	5,000		
	Agreement with SCWA for Public Law 101-514 “Fazio Water”	7,000		
	Pre-1914 and CVP Supply through wholesale contract with SJWD for Ashland	1,540		
	GET A and GET B Supply	3,250		
	Total	38,790		

Table 2-23. Surface Water Rights and Contracts (contd.)

Water Agency	American River		Sacramento/Cosumnes Rivers	
	Description of Right or Entitlement	Maximum Use (AFY)	Description of Right or Entitlement	Maximum Use (AFY)
Golden State Water Company	Pre-1914 [5] Total	5,000 5,000		
Lincoln, City of	Contract with PCWA Contract with NID [6] Total	34,000 12,000 47,000	N/A	N/A
Natomas Central Mutual Water Company [7]			Appropriative from Sacramento River (conditioned by Settlement Agreement with Reclamation) Total	120,200 120,200
Orange Vale Water Company	Wholesale contract with SJWD Total	Unspecified quantity [1] N/A		
Placer County Water Agency	Middle Fork Project CVP Contract Agreement with PG&E PG&E (Zone 3) Purchase Agreement (1982) South Sutter WD Contract Pre-1914 Pre-1914 Appropriative Right (S000959) Pre-1914 Appropriative Right (S000967) Pre-1914 Appropriative Right (S010397) Pre-1914 Appropriative Right (S010398) Total Subcontracted to Lincoln, Roseville, SJWD, and SSWD [10]	120,000 35,000 100,400 [8] 25,000 12,000 3,400 [9] Not stated Not stated Not Stated Not Stated 295,800 (118,000)	N/A	N/A
Rancho Murieta Community Services District	N/A	N/A	Cosumnes River: Permit 16762 Total	 6,368 6,368
Roseville, City of	CVP Contract Water Transfer Agreement with SJWD (wet and average years only) Water Purchase Agreement with PCWA Total	32,000 4,000 30,000 66,000	N/A	N/A
Sacramento, City of	Appropriative (conditioned by Settlement Agreement with Reclamation) [11] Total Obligated sales to neighboring agencies	245,000 245,000 (30,017)	Sacramento River: Pre-1914 and Appropriative (conditioned by Settlement Agreement with Reclamation) Total	81,800 81,800

Table 2-23. Surface Water Rights and Contracts (contd.)

Water Agency	American River		Sacramento/Cosumnes Rivers	
	Description of Right or Entitlement	Maximum Use (AFY)	Description of Right or Entitlement	Maximum Use (AFY)
SCWA	CVP Supply (SMUD 1, SMUD 2, and Fazio Water)	45,000	Sacramento River:	
	Wholesale Water Agreement(s) with Sacramento	9,300	Appropriative Water [12]	35,000
	Total	54,300		
	Subcontracted to EGWD [13]	(4,600)		
San Juan Water District	Pre-1914	33,000	N/A	N/A
	CVP Contract	11,200		
	"Fazio" Water (Public Law 101-514)	13,000		
	Water Purchase Agreement with PCWA	25,000		
	Total	82,200		
	CHWD, FOWD, Folsom, and OVWC [14]	(42,697)		
Sacramento Suburban Water District	Agreement with City of Sacramento	9,300	N/A	N/A
	Agreement with PCWA	12,000		
	Purchased Water from USBR (Section 215)	200		
	Total	21,500		

Data Source: RWRP (RWA 2018), 2015 UWMPs, Rancho Murieta 2010 Integrated Water Master Plan Update, Rio Linda/Elverta 2015 UWMP.

Notes: [1] CHWD, FOWD, OVWC, City of Folsom north of the American River (Ashland area), and the San Juan Water District Retail service area have an unspecified quantity contract with SJWD that states that SJWD will deliver water according to each of their demands.

[2] EID also has water rights from the El Dorado Forebay and Jenkinson Lake, which are not part of the Region.

[3] Projected to be available by 2020.

[4] EGWD does not have any entitlements to surface water; however, EGWD does purchase wholesale water from SCWA who does have surface water rights to Sacramento River water. This volume of water was the highest amount of water EGWD purchased from SCWA since 2010, as reported in EGWD's 2015 UWMP. The water was most likely primarily groundwater delivered by SCWA to EGWD. However, depending on SCWA's infrastructure, there is the potential that SCWA could deliver the water as 100% surface water.

[5] GSWC has access to Pre-1914 water through the Natoma Ditch Company and associated POU. A portion of this water (5,000 AF/year) is contracted to Folsom.

[6] This number reflects that of a normal year.

[7] For use in both Sacramento and Sutter counties. Includes base supply of up to 98,200 AF and CVP supply of up to 22,000 AF.

[8] Water sources are Yuba and Bear rivers, outside the Region.

[9] Water sources are tributaries to Auburn Ravine and Coon Creek, outside the Region.

[10] PCWA supplies Lincoln from a mix of all their water sources, including but not exclusively of Middle Fork Project Water.

[11] Settlement agreement with Reclamation limits Sacramento's total diversion from the Sacramento and American rivers. This total was 227,500 AFY in 2010 and is to gradually increase to 326,800 by 2030.

[12] SCWA's appropriative water rights to divert water from the American and Sacramento Rivers (Permit 21209) provide intermittent water that typically would be available during the winter months of normal or wet years. The number shown is the expected long-term average use of the water and not the water right amount, which can range up to 71,000 AFY.

[13] SCWA water sold to EGWD is a mix of surface and groundwater.

[14] Amount wholesaled from SJWD includes contracts with CHWD, FOWD, OVWC, and Folsom (Ashland area), with unspecified quantities.

[15] Section 5.1.1 of the El-Dorado SMUD Cooperation Agreement indicates that 40,000 acre-feet of SMUD water will be available after 2025. For conservative Normal Year planning purposes, El Dorado Irrigation District uses 30,000 acre-feet of available supply.

Key:
AFY = acre-feet per year
Cal-Am = California American Water
CHWD = Citrus Heights Water District
CVP = Central Valley Project
EDCWA = El Dorado County Water Agency
EGWD = Elk Grove Water District
EID = El Dorado Irrigation District
FERC = Federal Energy Regulatory Commission
FOWD = Fair Oaks Water District
GET = Groundwater Extraction and Treatment
GSWC = Golden State Water Company
N/A = not applicable
NID = Nevada Irrigation District
OVWC = Orange Vale Water Company
PCWA = Placer County Water Agency
POU = Place of Use
Rio Linda/Elverta = Rio Linda/Elverta Community Water District
SCWA = Sacramento County Water Agency
SJWD = San Juan Water District
SMUD = Sacramento Municipal Utility District
South Sutter WD = South Sutter Water District
SSWD = Sacramento Suburban Water District
UWMP = Urban Water Management Plan

American River Water Rights

Water agencies in the ARB hold just over 500,000 acre-feet of American River water rights for consumptive use purposes (Reclamation 2017). Eight agencies participating in the ARB IRWMP have water rights on the American River: CWD, EID, Folsom, GSWC, PCWA, Sacramento, SCWA, and SJWD. Details of these water rights are summarized in **Table 2-23**. The POU of this water is usually coincident with the jurisdictional boundaries of the respective agencies. Exceptions include Sacramento who has an authorized POU for American River water outside the current city limits, generally, including: (1) portions of SSWD, (2) Del Paso Manor, (3) SCWA Arden Park Vista Service Area, and (4) CWD. The POU for SJWD's water rights is most of its wholesale service area. The POU for PCWA prioritizes use in Placer County before use in Sacramento County. Portions of the Region are supplied by water sources that lie outside of Region boundaries, including the upper American, Bear, and Yuba rivers. However, water diverted in the Region is not currently exported outside Region boundaries. Aside from local water agencies, the Reclamation has rights to much of American and Sacramento River water through their construction of the CVP.

American River Contracts

Four agencies have existing water supply contracts with Reclamation for CVP supplies: EID, PCWA, Roseville, and SJWD. SJWD provides CVP water to agencies within its wholesale service area, including CHWD, FOWD, Folsom-Ashland, and OVWC. Details of these contract entitlements are summarized in **Table 2-23**.

In addition, SJWD and SCWA have water supply contracts with Reclamation from Public Law 101-514 (commonly referred to as "Fazio Water"). SJWD's supply is used within SJWD's Sacramento County wholesale area. Folsom has a subcontract with SCWA for 7,000 AFY. EID also receives Fazio Water from El Dorado County Water Agency. SCWA's "SMUD Assignment" water is another water supply contract with Reclamation.

Four agencies with American River water rights contract their water to other local water agencies: PCWA, Sacramento, SCWA, and SJWD. PCWA has water contracts with Reclamation and Pacific Gas and Electric (PG&E) and provides water to Cal-Am, Lincoln, Roseville, SJWD, and SSWD. Sacramento provides (or can provide) American River water to Del Paso Manor, FVWC, SCWA, and SSWD within its American River POU. SSWD further subcontracts some of this water to Cal-Am, potentially Del Paso Manor, GSWC, and portions of SCWA. SCWA has appropriative water rights to divert water from the American (via the Sacramento River) and subcontracts some of that water to Cal-Am and Elk Grove.

SJWD is a wholesaler to CHWD, FOWD, OVWC, Folsom (Ashland), and also contracts with SSWD and Roseville (SJWD 2015).

Sacramento River Water Rights

NCMWC, Sacramento, and SCWA have water rights on the Sacramento River. Total rights held by NCMWC in both Sacramento and Sutter counties are for up to 120,200 AFY per a Settlement Agreement. Sacramento holds a combination of pre-1914 and appropriative water rights on the Sacramento River for diversion of up to 225 cfs, up to 81,800 AFY, for service in the city limits. SCWA also has an appropriative water right to divert water from the Sacramento River to provide intermittent water that typically would be available during the winter months of normal or wet years.

Cosumnes River Water Rights

Rancho Murieta obtains all its water supplies from the Cosumnes River through Permit 16762 issued in 1969 and renewed for 2001 to 2020.

Aerojet Replacement Water Supply

Aerojet has legal responsibility for groundwater contamination in Sacramento County. This contamination has affected water agencies' groundwater supplies, including GSWC and Cal-Am. Aerojet provides replacement water from its extraction and treatment of contaminated groundwater at several groundwater extraction and treatment (GET) facilities. Treated water is then discharged into several tributaries of the American River. Legal agreements include contracts to use this remediated Aerojet water.

Aerojet has guaranteed that replacement water supplies will be made available to offset lost groundwater production in the Cordova System (GSWC), up to a maximum 15,200 AFY. The Settlement Agreement requires that Aerojet supplies replacement water. GSWC can divert up to 5,000 AFY of GET water via the Folsom South Canal.

In 2010, SCWA entered into an agreement with Aerojet to transfer ownership of 8,900 AFY of remediated groundwater (SCWA 2011). CWD also obtains reclaimed water from Aerojet facilities.

The 2007 Aerojet Agreement between Folsom and Aerojet stipulates that Folsom has access to GET water from GET Facilities A and B. Both facilities underwent modifications, pursuant to the Partial Consent Decree with the EPA. In recent years, Folsom has relied on Aerojet to pump and treat groundwater for its service area. Per the 2007 agreement, Folsom may treat 3,250 AFY of groundwater produced by GET Facilities A and B to serve industrial demands (Folsom 2016).

Other Agreements

Folsom, SSWD, Roseville, and SJWD have temporary contracts with Reclamation for surplus water (often referred to as Section 215 water). Section 215 water is available on an intermittent basis subject to hydrologic conditions.

Surface Water Use Restrictions

The beginning of **Section 2.9.2.1** discussed the legal background and setting of water availability in the Region. The maximum water rights and contract amounts, however, are rarely used. Some of the limiting factors are the WFA, Hodge Flows (a legal decision), Reclamation's CVP restrictions, and infrastructure limitations of the water delivery systems. Annual hydrology and inflows to Folsom Lake triggers the WFA and Hodge Flows as both seek to maintain environmental flows in the lower American River during dry and critically dry periods. CVP allocations are similarly hydrology dependent. Infrastructure limitations result from water demand growth apart from existing infrastructure or sources of supply, lack of funds to maintain older systems and construct new facilities, and differing system designs among individual water agencies.

The drought showed regional vulnerabilities to climate change were not limited to water supply infrastructure, but also water rights. Water rights on the American River were historically viewed as 100 percent reliable. However, in response to the drought, the State Water Board issued curtailments on water right diversions throughout the state, including pre-1914 rights (Reclamation 2017). In 2014 and 2015, water rights in the Region became subject to curtailment notices, as illustrated in **Figure 2-32**. Further, access to CVP supplies was limited by historically low storage in Folsom Reservoir. Water agencies were close to losing their intake's physical ability to access water in Folsom Reservoir in 2015, even though they still had the legal right to divert water (Reclamation 2017). These regulatory and physical infrastructure constraints have redefined the water supply reliability vulnerabilities of many water users. These constraints will likely increase with climate change. The water agency demand and supply portfolios developed for the NAB RDCP and RWRP assessed the priority and POU restrictions for surface water rights and reliability of contract entitlements for each agency. Mitigation strategies to address vulnerabilities to water rights curtailments are described in **Section 2.10.2**.

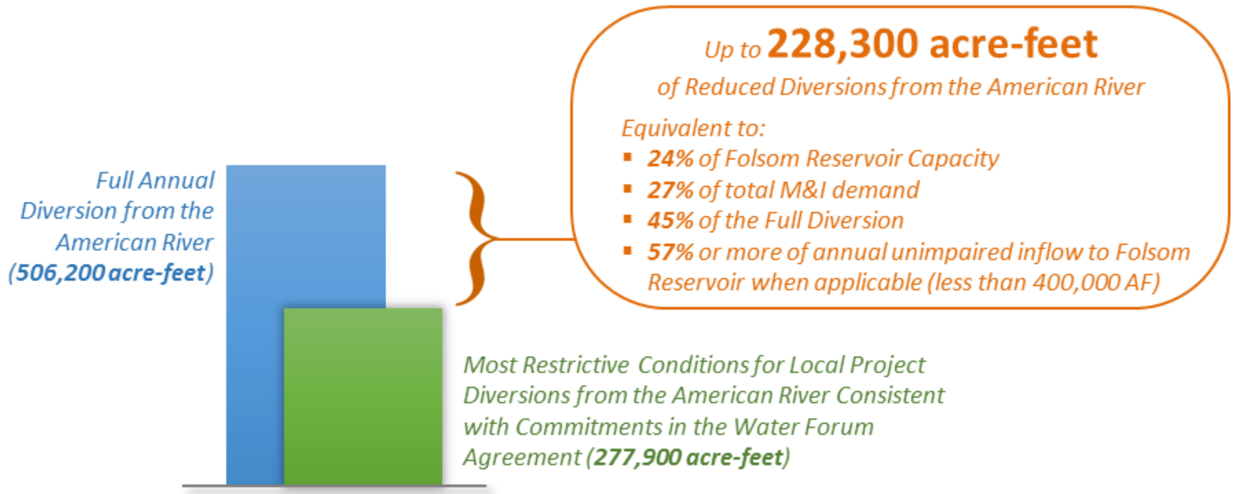


Figure 2-32. Summary of American River Water Rights Curtailments During the Drought

Water Forum Agreement

The WFA, a voluntary MOU among signatories, includes water diversion restrictions according to the American River hydrologic year types, restricting overall water diversions (AFY) for each signatory agency. These restrictions are intended to maintain flows in the lower American River in times of shortage. As shown in **Table 2-23**, water year types for the American River are determined by the amount of unimpaired inflow into Folsom Lake from March to November. Each signatory faces restrictions during drier or dry years, and some agencies, such as Roseville, have agreed to leave water in the American River during certain years of shortage. Other water agencies, such as Folsom, which has limited groundwater availability, have signed agreements with neighboring agencies willing to use more groundwater supplies, so that Folsom can maintain their use of surface water during dry years. Similarly, SJWD, CHWD, FOWD, OVWC and the Ashland portion of Folsom, adopted a surface water supply and water shortage management plan in 2008 to address conjunctive use of surface and groundwater supplies.

Hodge Flows

Hodge Flows stem from a legal decision made by Judge Richard Hodge on the *Environmental Defense Fund v. East Bay Municipal Utility District* litigation. Water diversion rates are restricted if river flows that bypass the Fairbairn WTP are below 2,000 cfs from October 15 through February 28, 3,000 cfs during March through June, and 1,750 cfs during July through October 14. American River water from Sacramento is subject to these Hodge Flow criteria.

Reclamation's CVP Water Use Conditions

Reclamation imposes a shortage policy for CVP water in times of drought, unavoidable interruptions, and other operational restrictions from legal obligations. This shortage policy applies to CVP water from both

American and Sacramento rivers. Reclamation's shortage policy, generally, is as follows: when deemed necessary, irrigation water is first reduced. Once irrigation water is at 75 percent allocation, both M&I and irrigation water allocations are incrementally reduced until M&I allocation is 75 percent of the full allocation and irrigation allocation is 50 percent of the full amount. Reclamation reserves the right to impose further restrictions as necessary. Full 100 percent allocation is defined as the amount of water used in the most recent 3 years of full water availability, not necessarily the contracted amount.

2.9.2.2. Groundwater Supplies

As discussed in **Section 2.6.3**, the Region overlies productive and generally high-quality groundwater subbasins. Groundwater is both a primary supply for some agencies and a supply that augments surface water use for some agencies, especially during shortage periods. The WFA established sustainable yields for each the three groundwater subbasin underlying Sacramento County in the Region, and prescribed a regional conjunctive use program to optimize regional water supplies. The GSAs in the Region and IRWM Coordination Zone will further refine the sustainable yields and water budgets for these subbasins as part of development of the GSPs. While groundwater is a regionally significant source of supply, some agencies, particularly those along the eastern edge of the Region, do not have access to groundwater due to underlying geologic conditions.

Table 2-24 shows historical groundwater pumping for public water suppliers in the Region from 2006–2015, as reported in the 2015 UWMPs. Similar to regional water demands, these data show a 24 percent decrease in groundwater use over the past 9 years, which in part, can be attributed to an increase in conjunctive use practices. The Sacramento region has been moving toward more conjunctive use of surface water and groundwater depending on hydrologic conditions. Conjunctive use is the coordinated use of surface water during wet years and groundwater during dry years. This trend is not as evident between 2000 and 2010 when, for example, significantly more surface water was used in 2008 even though it was classified as a drier year (SGA 2018). In 2010, however, additional Water Forum requirements related to surface water use came into effect. Since that time, conjunctive use has increased. For example, in 2010, 2011, and 2012, which classified as wet or average, more surface water was used than groundwater.

2013, 2014, and 2015 (all dry years) saw more groundwater used than surface water. As seen in Table 2-24, some agencies increased groundwater extraction in 2013 and 2014. This can be attributed to water rights curtailments and a reduction in surface water resources caused by the drought. For example, groundwater production in the North American Basin increased during 2013 and then decreased thereafter to a volume nearly equal to 2011 (SGA 2018). This reduction was in large part due to conservation efforts during drought conditions. The Region reduced total water demand (groundwater and surface water) by 20 percent in 2014 and 30 percent in 2015 compared to 2013.

The reported reduction in groundwater extraction over the past nine years supports observed recovering groundwater levels in SGA and SCGA Basin Management Reports. Independent groundwater pumpers and small water suppliers are not required to report extractions in California, so those data are not available for this report.

Table 2-24. Groundwater Extraction (AFY)

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
California-American Water	40,748	41,320	44,012	42,907	34,849	29,811	32,893	38,136	33,951	27,966
Carmichael Water District	3,519	2,868	1,581	1,609	1,518	1,469	1,579	2,030	3,417	2,543
Citrus Heights Water District	100	98	352	2,120	1,560	962	587	465	1,930	841
Del Paso Manor Water District [6]	1,673	1,737	1,650	1,489	1441	1,398	1,533	1,549	1,432	1,180
El Dorado Irrigation District	0	0	0	0	0	0	0	0	0	0
Elk Grove Water District	6,365	6,963	6,460	5,407	3804	4615	5582	5194	4117	3398
Fair Oaks Water District	845	899	2,225	1,109	1,194	1,516	1,562	1,319	2,329	872
City of Folsom	0	0	0	0	0	0	0	0	0	0
Fruitridge Vista Water Company [2]	3,717	n/a	n/a	n/a	4,157	n/a	n/a	n/a	n/a	11,273
City of Galt	5,668	6,203	5,953	5,741	5,174	5,120	5,699	6,132	5,382	4,163
Golden State Water Company	14,425	11,006	10,438	9,324	7,679	5,731	6,685	7,273	5,111	4,397
City of Lincoln	623	924	1,085	836	962	0	0	0	0	0
Orange Vale Water Company	0	0	0	0	0	0	0	0	0	0
Placer County Water Agency [3]	0	0	0	0	0	0	0	0	0	0
Rio Linda/Elverta Community Water District	3,378	3,305	3,340	2,914	2,719	2,542	2,857	3,051	2,449	2,109
City of Roseville [4]	0	1,468	392	0	0	0	0	0	296	6
City of Sacramento	20,917	18,618	18,414	18,867	17,768	17,811	14,363	12,568	14,393	13,479
Sacramento County Water Agency	34,152	35,803	39,248	39,450	37,121	34,626	30,629	28,828	27,781	24,652

Table 2-24. Groundwater Extraction (AFY) (contd.)

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Sacramento Suburban Water District	26,559	37,084	23,516	23,021	20,178	19,119	27,530	38,145	32,561	27,422
San Juan Water District	0	0	0	0	0	0	0	0	0	0
Total	**162,670**	**168,197**	**158,626**	**154,809**	**140,092**	**124,731**	**131,375**	**144,550**	**135,126**	**111,848**

Notes:
[1] Del Paso Manor Water District is not required to submit UWMPs but reports data to Sacramento Groundwater Authority. Del Paso Manor Water District data were provided by personal communication with D. Sedwick, 2018
[2] Fruitridge Vista Water Company did not report data for all noted years in its 2010 and 2015 UWMP.
[3] Placer County Water Agency does use groundwater supplies in Zone 40 near Truckee, but not in western Placer County
[4] Groundwater use in 2007 and 2008 was driven by the Aquifer Storage and Recovery demonstration project as opposed to water supply, Source: 2010 UWMP
[5] 2011-2015 groundwater extractions were provided from the 2015 UWMPs.
Key:
AFY = acre-feet per year
UWMP = Urban Water Management Plan

2.9.2.3. Recycled Water

Seven agencies in the Region (SRCSD, SCWA, EID, Lincoln, Rancho Murieta, Roseville, and Galt) use recycled water as part of their water supply portfolios. Recycled water is a hydrology-independent supply, making it a very reliable source of water. Availability and production of recycled water is directly dependent on the availability of treatment and distribution infrastructure with a complementary customer demand for recycled water supply. Recycled water is expected to become an increasingly valuable regional water supply resource as local, regional, and statewide water demands continue to grow and other supplies become less reliable.

Table 2-25 below summarizes the current use of recycled water in the Region. SRCSD, primarily a wastewater treatment provider, uses recycled water produced at its WRF to irrigate parks and school field in addition to wholesales recycled water to SCWA as part of the SRCSD/SCWA Demonstration Project. Galt also has capacity to produce recycled water, but currently uses it only at onsite agricultural fields. EID, Lincoln, Rancho Murieta, Roseville, and Galt currently operate recycled water programs to meet nonpotable water demands in their respective service areas and offset demands for potable water supplies.

Table 2-25. Recycled Water Use Summary–2015

Agency	Recycled Water Treatment Facility	Recycled Water Use (AFY)	Approx. Percent of Total Water Supply (%)
EID	El Dorado Hills WWTP Deer Creek WWTP [1]	2,400	3
Galt	Wastewater Treatment Plant	603	14
Lincoln	City of Lincoln WRTF	270	4
Rancho Murieta CSD	Rancho Murieta Wastewater Reclamation Plant	550	9
Roseville	Dry Creek WWTP Pleasant Grove WWTP	4,060	10
SCWA	SRCSD WRF	575	2
SRCSD	SRCSD WRF	500	N/A

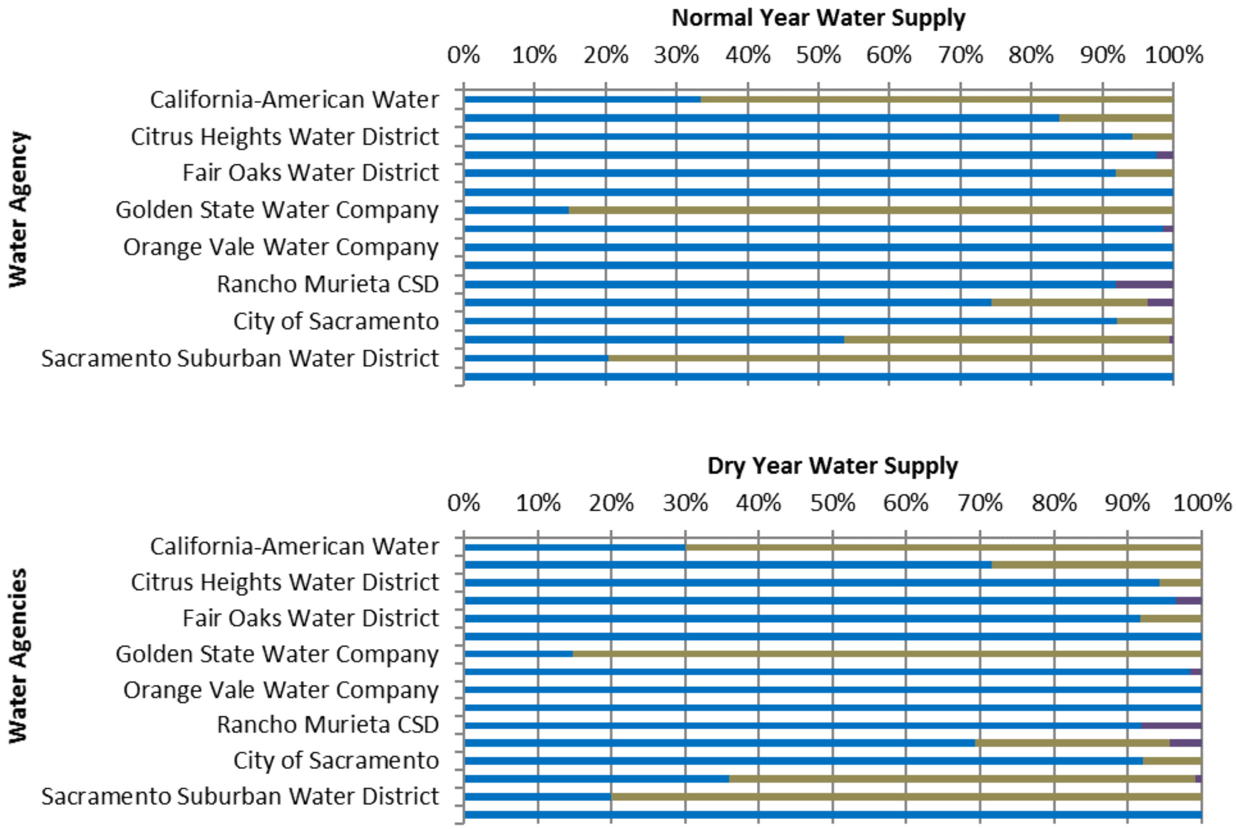
Notes:
Recycled water use in 2015, per each agency's 2015 Urban Water Management Plan (UWMP), except for Rancho Murieta which is from 2010 Integrated Water Master Plan Update.
[1] Deer Creek WWTP is not located in the Region, but its system is interconnected with the El Dorado Hills system.
Key:
AFY = acre-feet per year
CSD = Community Services District
EID = El Dorado Irrigation District
SCWA =Sacramento County Water Agency
SRCSD = Sacramento Regional County Sanitation District
WRF = Water Recycling Facility
WRTF = Water Recycling Treatment Facility
WWTP = wastewater treatment plant

2.9.2.4. Desalinated and Imported Water

Currently, there is no known use of desalinated or imported water in the Region, and use of these supplies is not anticipated in the future.

2.9.2.5. Agency Water Supply Portfolios

Agency water supply portfolios describe the relative percentage of various water supply sources used by individual water agencies. An agency's portfolio can be affected by physical, legal, and hydrologic considerations associates with their respective supplies as explained in **Section 2.9.2.1**. Most water agencies in the Region are required to submit an UWMP, which includes information on an agency's water supply portfolio in normal and dry years. Water agency supply portfolios were updated as part of the NAB RDCP and RWRP. Water supply information for participating agencies was gathered from regional and local water planning documents, including 2015 UWMPs and Master Plans. Interviews were then conducted with each agency to validate the information in the draft portfolios and fill any data gaps. The reported data for current normal year reliability and data for current dry year reliability are presented in **Figure 2-33**. This figure shows which agencies have access to surface water, groundwater, and/or recycled water, and the relative proportions of those sources used by each water agency.



Source: Normal or average year and single-dry year water reliability information in UWMPs and from the 2018 RWRP

Notes:
-Only those agencies that had complete normal and dry year water supply information were presented.
-The average and dry values were obtained from the water supply data presented in the 2018 RWRP.

Figure 2-33. Water Supply Portfolios as Reported in 2015 UWMPs

Figure 2-33 illustrates that groundwater continues to be a resource for some agencies and the Region as a whole in dry years to offset restrictions in surface water use. Thus, operational flexibility of water supply distribution becomes a regionally significant challenge, especially during dry years. If the Region were to leverage its surface water and groundwater assets through conjunctive use and banking activities, it could augment the limited storage of Folsom Lake and provide needed buffers to weather drought periods. The total estimated groundwater storage capacity north and south of the American River is more than double the capacity of Folsom Reservoir. Different from surface water storage, groundwater banking operations could extend over several years with both "puts" (recharge) and "takes" (recovery), giving additional flexibility to regional operations and potential participation in the statewide water market and other water transfer programs. However, the investment in infrastructure needed to fully realize a large-scale regional conjunctive use opportunity is significant. The Region has undertaken several planning efforts to establish a regional conjunctive use program, including the RWRP, NAB RDCP, American River Basin Study (ARBS), and American River Basin Water Marketing Strategy Project. The RWRP evaluated regional opportunities for conjunctive use in the Region. This included identifying the main inhibitors to a conjunctive use program, evaluating the storage potential of regional groundwater basins, assessing infrastructure constraints, and developing a conjunctive use operations simulation. This analysis indicated that using existing infrastructure, region-wide recharge could be increased by up to 61 TAF per year in wet years by offsetting groundwater use with surface water, and region-wide recovery could be increased by up to 66 TAF per year in dry years by offsetting surface water use with groundwater (RWA 2018). The ARBS is an ongoing effort to further assess the water supplies and demands in the Region and address regional demand-supply imbalance and infrastructure deficiencies under the existing and future climate change conditions. The ARB Water Marketing Strategy Project focuses on leveraging the potential for regional conjunctive use to further enhance existing regional market transfers through surface water reservoir reoperation and individual groundwater substitution practices. The project will evaluate the potential for water market asset development; determine the infrastructure investments needed to realize that market; and formulate an implementation plan that includes recommendations on governance, reporting and monitoring procedures.

2.9.2.6. Projected Water Supplies

Projecting water supply availability and relating these projections to estimated future water demands are integral to planning over a 20-year horizon. **Table 2-26** below summarizes water supply projections reported by each water supply agency in their respective 2015 UWMPs. These data includes surface water, groundwater, and recycled water supplies. Projections for 2040will be available for all water agencies with the next iteration of UWMPs in 2020. According to the available data, water supplies for the Region are expected to fully meet projected demands through 2035.

Table 2-26. Projected Water Supplies

Water Purveyor	Projected Water Supplies (Acre-feet/Year)				
	2015	2020	2025	2030	2035
California American Water	33,578	42,291	45,244	48,730	52,926
Carmichael Water District	41,473	41,473	41,473	41,473	41,473
Citrus Heights Water District	9,974	16,970	17,383	17,797	18,210
Del Paso Manor Water District	1,600	1,600	1,600	1,600	1,600
El Dorado Irrigation District	79,046	77,490	107,690	107,790	107,990
Elk Grove Water District	9,775	7,694	7,917	7,972	8,038
Fair Oaks Water District	21,241	23,338	23,338	23,338	23,338
Florin County Water District	2,668	2,668	2,668	2,668	2,668[2]
City of Folsom	18,587	38,790	38,790	38,790	38,790
Fruitridge Vista Water Company	14,532	14,532	14,532	14,532	14,532

Table 2-26. Projected Water Supplies (contd.)

Water Purveyor	Projected Water Supplies (Acre-feet/Year)				
	2015	2020	2025	2030	2035
City of Galt	4,163	5,858	6,405	7,008	7,675
Golden State Water Company	11,593	17,342	17,697	18,312	18,968
City of Lincoln	7,629	12,291	13,478	15,296	17,113
Natomas Central Mutual Water Company	32,000	29,000	23,000	23,000	23,0002
Orangevale Water Company	3,256	4,568	4,686	4,860	4,981
Placer County – Ag/Ag-Res	60,000	60,000	60,000	60,000	60,000[2]
Placer County Water Agency[1]	226,243	233,800	268,300	270,800	272,800
Rancho Murieta Community Services District	6,368	6,368	6,368	6,368	6,368
Rio Linda/Elverta Community Water District	2,109	4,846	5,681	6,650	7,462
City of Roseville	41,880	70,421	70,791	72,759	73,143
City of Sacramento	84,832	275,917	288,288	294,419	294,419
Sacramento County – Ag/Ag-Res	183,450	174,400	165,350	156,300	156,300[2]
Sacramento County Water Agency	29,149	82,900	82,900	87,900	97,900
Sacramento Suburban Water District	27,502	60,500	56,500	56,500	56,500
San Juan Water District	9,666	82,200	82,200	82,200	82,200
Tokay Park Water District	142	142	142	142	142
Regional Total	**962,456**	**1,387,419**	**1,452,421**	**1,467,204**	**1,488,536**

Notes:
Rio Linda Elverta Community Water District data were provided in the 2015 UWMP. Rancho Murieta Community Services District data were provided in the 2016 Water Supply Assessment – Rancho Murieta North Project. Del Paso Manor Water District data were provided by personal communication with D. Sedwick, 2018. All other information was taken from the 2015 UWMP of each water purveyor. Sacramento and Placer County - Ag/Ag-Res is independent pumping, so it was assumed that future demand estimates would be fully met.
[1] Only Zones 1 and 5 in the Placer County Water Agency system are in the American River Basin Region
[2] Water supplies projected for the year 2035 was not available so 2030 projected water supply values were assumed.
Key:
UWMP = Urban Water Management Plan

2.9.3. Future Outlook Considering Water Supplies and Demands

Comparing estimated Region water demands (**Table 2-21**) and estimated water supplies (**Table 2-26**), along with an understanding of Region water rights and contracts (**Table 2-23**) generally leads to the conclusion that overall, the Region has sufficient water to meet future needs—which is true in normal water years and especially true when comparing the Region to other IRWM regions statewide. However, future water shortages in single and multi-year scenarios continue to be of concern. For example, the State Water Board curtailed water rights in 2015, the first time since 1977 that senior water right holders had their water rights curtailed. Consequently, such curtailments have an impact on local water demands. RWA, its member agencies, and the Region expect to face future challenges and uncertainties and have created an ARB IRWMP Framework (**Section 5**) to effectively address those challenges at multiple levels of detail. The Region has a history of pro-actively planning for the future, and continues to benefit from decades of integrated planning efforts. Ongoing regional planning efforts include the RWRP, NAB RDCP, ARBS, and American River Basin Water Marketing Strategy Project. **Section 5** contains a more comprehensive discussion on water resources issues and challenges facing the Region, but at a high level, the following issues potentially impact water demands, water rights, and water supplies, and are under active investigation:

- Climate change and associated hydrologic impacts
- Aging infrastructure and lack of funding to replace aging infrastructure
- Better integration of water infrastructure systems
- Groundwater contamination
- Urban conversion
- Protection of water rights
- Water quality and increasing regulations
- Watershed and ecosystem protection
- Integration with statewide water planning efforts

2.9.4. Conjunctive Use

As established in the Water Forum Agreement (completed in 2000), the Region has been actively and continually engaged in a regional conjunctive use program. Many agencies have the ability to use surface water in-lieu of groundwater in wet years and rely more on groundwater in dry years (e.g., SSWD, City of Sacramento, City of Roseville, SCWA, FOWD, and OVWD). However, California's historic drought and increasing hydrologic variability have revealed greater potential risk to agencies' surface water supplies in the Region than previously assumed. This is especially critical to agencies that have limited in-district groundwater supplies. To address these vulnerabilities, the Region has undertaken several planning efforts to analyze the potential for an expanded regional conjunctive use program. These efforts included the NAB RDCP and RWRP, as well as the ongoing ARBS and ARB Water Marketing Strategy Project.

Analysis of conjunctive use potential in the North and South American subbasins was conducted as part of the NAB RDCP and RWRP. The analysis looked at the potential of the subbasins to store additional surface water supplies, a key factor in the success of a regional conjunctive use program. The analysis showed that the combined available storage capacity across both the North and South American subbasins is around 2 million acre-feet, based on spring 2017 groundwater conditions. This large, available capacity readily supports expansion of conjunctive use in the Region. The analysis also showed that existing infrastructure in the North and South American subbasins (surface water treatment, groundwater extraction, interties, and conveyance) could support expansion of conjunctive use practices. In wet years, existing in-lieu and direct recharge across the Region may be increased by around 60 TAF. In dry years, extraction of groundwater may be increased by nearly 60 TAF to recover banked water supplies. Key barriers to realizing this conjunctive use potential are institutional factors, namely the cost difference in producing surface water and groundwater among agencies the Region. Establishing a regional groundwater bank could help alleviate some of these challenges.

The analysis also found that establishing a groundwater bank would provide many regional benefits, including improvements to regional water reliability. Groundwater banking would provide seasonal and annual flexibility by reducing reliance on surface water and maximizing the use of available water supplies. Groundwater conditions would improve by actively storing more water in the basins either through in lieu or direct methods.

The findings from this analysis will be further refined and expanded upon as part of the ARBS and ARB Water Marketing Strategy Project. The Region will continue to identify constraints and opportunities to establish a regional conjunctive use program.

2.10. Climate Change

Clear indications of a changing climate have been observed in California and the western United States over the last several decades. Statewide average temperatures have increased by about 1.7°F between the years 1895 and 2011, with even greater increases observed in the Sierra Nevada over that timeframe (CEC 2012). The effects of climate change on hydrology in California are already apparent, including changes to snowpack, river flows, storm intensity, temperature, winds, and sea levels. Planning for and adapting to the continuation of these trends, particularly their impacts on public safety, ecosystem, and long-term water supply reliability, will be among the most significant challenges facing water and flood managers this century (CNRA 2009, DWR 2013c).

State and local agencies are already engaged in a number of efforts designed to improve California’s ability to adapt to a changing climate. IRWM planning efforts are collaborative and include many entities involved in water management. These aspects make IRWM an appropriate platform for addressing issues, such as climate change where multiple facets of water management are affected on a regional scale. To this end, climate change is one of 16 “standards” in the 2016 IRWM Guidelines, that IRWM plans must meet to receive planning and implementation grant funds through Propositions 1. To provide guidance for implementing this climate change standard and incorporating climate change analyses into the IRWM planning process, DWR developed the Climate Change Handbook for Regional Water Planning (Handbook) (EPA/DWR 2011).

In accordance with the Handbook, this subsection describes the vulnerabilities due to climate change that stakeholders in the Region are likely to face in the future. Based on the severity of the vulnerability, each is given a ranking in relation to one another. This ranking process helps the Region determine where they are potentially vulnerable to climate change, and which considerations require the greatest attention. In addition, this subsection describes efforts that member agencies have taken to adapt to climate change and to reduce greenhouse gas (GHG) emissions in the Region.

The first vulnerability assessment for the Region was conducted as part of the 2013 ARB IRWMP Update. A revised vulnerability assessment was conducted for the Region following the historic California drought which began in 2012. The impacts of the drought were most evident in 2014 and 2015 after multiple dry years and record-low snowpack led to severe water rights curtailments and overdrafted groundwater basins in many parts of the state. The drought was followed by a series of storm surges in early 2017 that caused flooding. These extreme events revealed substantially greater risks to the public water supply system in the greater Sacramento region than previously anticipated. Hence, the revised vulnerability assessment was conducted as part of the NAB RDCP and RWRP. Regional climate change vulnerabilities and mitigation strategies first identified in 2013 have been updated with information from the NAB RDCP, RWRP, and other local and regional planning efforts. These include individual agency Water Shortage Contingency Plans, the Sacramento and San Joaquin Rivers Basin Study, and the American River Basin Plan of Study.

2.10.1. Regional Climate Change Effects and Vulnerabilities

This subsection describes the approach for assessing and prioritizing climate change vulnerabilities in the Region.

2.10.1.1. Approach

This approach for assessing climate change in the Region involved the following steps:

1. Characterizing the Region.
2. Reviewing regional climate change impacts.
3. Assessing and prioritizing climate change vulnerabilities using a checklist.

4. Conducting a quantitative vulnerability assessment.
5. Compiling ongoing efforts to address climate vulnerabilities.

This approach was developed consistent with the general approach outlined in the Handbook.

2.10.1.2. Characterize Region

To adequately analyze and address the potential impacts of climate change, a description of the existing resources in the Region that may be impacted is required. **Sections 2.1** through **2.9** characterize the water resources, environmental, and socioeconomic characteristics of the Region.

2.10.1.3. Review Regional Climate Change Impacts

Literature Review on Climate Change Impacts

There have been multiple studies of climate change impacts on water resources specific to the western United States and California. A literature review was conducted to survey existing information and determines the potential regional impacts of climate change. Reviewed documents included:

- Cal-Adapt (CEC 2011)
- Reports on the Third Assessment from the California Climate Change Center (CEC 2012)
- California Climate Adaptation Strategy (CNRA 2009)
- Central Valley Flood Protection Plan (DWR 2017b)
- Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future (NRC 2012)
- SECURE Water Act Section 9503(c) – Reclamation Climate Change and Water, Report to Congress (Reclamation 2016a)
- California's 2017 Climate Change Scoping Plan (CARB 2017)
- Sacramento County Climate Action Plan (Sacramento County 2011a)
- North American Basin Regional Drought Contingency Plan (PCWA et al. 2017)
- Regional Water Reliability Plan (RWA 2018)

- Sacramento and San Joaquin Rivers Basin Study (Reclamation 2016b)
- American River Basin Plan of Study (Reclamation 2017)

Climate change is projected to alter temperature patterns, globally and in California. Effects can include changes in average temperature, the timing of seasons, and the degree of cooling that occurs in the evening. In California, temperature increases are expected to be more pronounced in the summer and in inland areas (CNRA 2009). The degree of change experienced partially depends on global GHG emissions and atmospheric GHG concentrations. Temperatures are projected to increase steadily during this century, with generally greater changes occurring farther inland. In the Sacramento region, warming increases are estimated to be about 1 degree Celsius (°C) to 3°C (1.8°F to 5.4°F) at mid-21st century (2055) and about 2°C to 5°C (3.6°F to 9°F) at end-of-century (2084). The period since 1950 has been warmer across the U.S. Southwest (including California) than in any comparable period in the last 600 years (DWR and CNRA 2016). However, it is recognized that current regional climate projections contain substantial uncertainty. At the local level, specific changes to seasonal temperature profiles are more difficult to project precisely. Global climate models have coarse spatial and temporal scales that make projections for regions the size of the Region difficult. Regionally downscaled models are being developed that provide a higher level of resolution, but still include substantial uncertainty in their results (DWR 2017b).

Available climate projections suggest that over the next century, precipitation will likely progress from initially steady or slightly increasing, to slightly decreasing over the Sacramento River Basin (Reclamation 2016). Even without any change in the quantity of precipitation, a warmer climate is likely to lead to increased watershed evapotranspiration, an increase in the fraction of precipitation falling as rain instead of snow, and a decrease in spring snowpack and snowmelt (CEC 2012). Already, a greater proportion of annual runoff has been occurring earlier in the water year (Knowles et al. 2006). The combination of earlier snowmelt and shifts from snowfall to rainfall seem likely to increase flood peak flows and flood volumes, which is likely to affect associated flood risk (Miller et al. 2003, Fissekis 2008, Dettinger et al. 2009). Higher snow lines (elevations) could increase flood risk because more watershed area contributes to direct runoff (DWR 2017).

Mean sea level is expected to rise by approximately 4.8 to 23.9 inches by the year 2050 at the Golden Gate Bridge (NRC 2012). The lower Sacramento River in the southern portion of the Region is tidally influenced, and will be affected by rising sea levels. Despite predictions for somewhat less overall precipitation over the long term, the Region is also predicted to have more extreme storms (Sacramento

County 2011a). The Sacramento region is also projected to have more frequent, longer, and more-extreme heat waves and longer periods of drought (Sacramento County 2011a).

Recent Climate Change Impacts

The extreme hydrologic conditions experienced in the Region and throughout California since 2012 have underscored the need for the Region to address regional vulnerabilities to climate change impacts. Recent drought, floods, and wildfires have shown that climatic change will continue impact regional water supplies, water demands, water quality, ecosystems, and hydropower operations. The 2016 Sacramento and San Joaquin Rivers Basin Study identifies these projected impacts from future climate change conditions.

From 2012 to 2016, California experienced a prolonged drought with record-breaking low levels of precipitation, mountain snowpack, and snowmelt runoff. 2014 was the warmest recorded year in California history (USGS 2018). In 2015, the annual snowpack survey showed that mountain snowpack was five percent of historic average, the lowest level recorded (DWR and CNRA 2016).

The impacts of the drought were evident and wide-spread. Lack of surface water resources and issuance of water rights curtailments resulted in increased groundwater pumping and historic low groundwater levels in basins throughout the state. In addition to threats to water supply, low groundwater levels threatened water quality for many individual well owners and small, rural community water systems. Water right curtailments also caused severely reduced contract allocations, mandatory conservation measures, and relaxed regulatory flows and water quality requirements for environmental protection.

In the Region, the dry lakebed of Folsom Reservoir became symbolic of the regional impacts of the drought. On December 4, 2015 storage in Folsom Reservoir stood a record low level of 135,561 acre-feet. This surpassed the prior low of 140,600 acre-feet, which occurred during the 1977 drought. During this time, there was limited stored water to meet local water right diversions and CVP contract delivery demands, threatening the water supply to over one million people in the lower portion of the Region.

The Region experienced a series of Atmospheric Rivers and storm systems in January 2017. Water from storm systems, king tides, release, and runoff into the watershed impacted several areas of the Region. Conditions caused by the extreme drought exacerbated the impacts of the storms. In January 2017, Governor Brown declared a state of emergency in counties across California, including El Dorado, Placer, and Sacramento. In Sacramento County, areas particularly affected included Rio Linda, Point Pleasant, Glanville tract, Wilton, and other southern portions of the County (Sacramento County 2018). Governor

Brown declared an end to the drought in April 2017, and that was soon followed by a series of storm surges that caused flooding and devastating wildfires .

2.10.1.4. Identify and Prioritize Key Regional Areas of Potential Vulnerability

During the 2013 ARB IRWMP Update, the participating agencies identified and prioritized areas of potential vulnerability to climate change impacts. This was done with the intent of helping the Region better plan adaptation actions to target specific, high-priority climate vulnerabilities. Defined by the Intergovernmental Panel on Climate Change (IPCC), vulnerability is a function of the character, magnitude, and rate of climate variation (collectively, the climate hazard) to which a system is exposed, as well as to non-climatic characteristics of the system, including its sensitivity, and its coping and adaptive capacity (IPCC 2001).

The Handbook provided a useful checklist for qualitatively determining areas of potential vulnerability within the Region. Indicators of potential vulnerability include currently observable climate impacts, presence of climate sensitive features, and adaptive capacity of regional resources. At this point in the analytical process, the actual magnitude of impacts or consequences resulting from a potential vulnerability was not required. This information was used in the planning process to prioritize regional planning objectives, define performance metrics, and focus a more detailed, quantitative analysis.

During the 2013 ARB IRWMP Update, stakeholders in the Region met to discuss climate change mitigation and adaptation. Based on information provided by stakeholders in these meetings, the assessed likelihood of vulnerabilities, and regional values, prioritization was accomplished qualitatively, with issues assigned a low, medium, or high priority. The complete set of checklist responses and prioritizations can be found in **Appendix C**. The vulnerabilities of high priorities in the Region are described in the following subsection.

These vulnerabilities were refined as part of the NAB RDCP and RWRP using updated water supply and demand information. Following a review of regional characteristics and water agency experiences during the recent drought period, the NAB RDCP and RWRP partners elected to limit the scope of vulnerability assessments to the water supply (municipal/industrial and agricultural) and environmental (in-stream natural resources) sectors. The NAB RDCP focused on identifying regional vulnerabilities to water supply and environmental resources resulting from a drought. As discussed in **Section 2.9**, the core of the vulnerability assessment focused on developing agency-specific Water Supply Portfolios. The assessment was conducted in four primary steps: (1) summarize available information, (2) develop initial water supply budget and vulnerability analysis, (3) meet with agency to confirm information and fill data gaps, and (4) update water supply budget and vulnerability analysis.

Through the vulnerability assessment process, a comprehensive list of vulnerabilities was compiled. The vulnerability assessment completed for the NAB RDCP provided a detailed analysis of the drought-specific vulnerabilities. The RWRP goes beyond the scope of the NAB RDCP by evaluating a broader set of vulnerabilities and mitigation strategies that go beyond drought. The vulnerability assessment identified seven vulnerability "themes," each with multiple vulnerability categories (**Table 2-27)**.

Table 2-27. Identified Vulnerability Themes and Categories

Vulnerability Theme	Vulnerability Category
1. Institutional threats to surface water availability	• Increasing constraints on CVP/Folsom Reservoir Operations • Evolving State and Federal Regulations • Agency Specific Water Rights/Contract Limitations • Allocation Shortages of CVP Supplies • Water Right Curtailments
2. Physical threats to surface water availability	• Climate Change/Hydrologic Variability • Inability to Divert during Low Storage/Flow Conditions • Source Contamination
3. Institutional threats to groundwater availability	• New Drinking Water Standards • New State Water Quality Regulations • Future Constraints Related to SGMA
4. Physical threats to groundwater availability	• Groundwater Contamination • Groundwater Production Capacity Limitations • Groundwater Injection Limitations
5. Institutional limitations on sharing supplies	• Existing POU/Service Area Limitations • Evolving State and Federal Requirements for Transfers • Disparity in Cost of Water • Diverse Agency Goals & Interests
6. Physical limitations on sharing supplies	• Differing Fluoridation Practices • Limited Intertie Capacities • Incompatible Pressure Zones • Differing water quality • Lack of metering on interties
7. Threats to infrastructure integrity	• Aging Infrastructure • Lack of redundancy for critical facilities • Geologic Hazards • Flooding Hazards
Other Challenges	• Reliance on single supply source • Unrealized recycled water potential • Limited capacity to serve growth • Lack of Real-time Data Sharing

Key:
CVP = Central Valley Project
POU = place of use
SGMA = Sustainable Groundwater Management Act

After a list of vulnerabilities were identified, participating agencies developed mitigation strategies to address those vulnerabilities. The steps for developing mitigation strategies included the following activities: 1) identification of mitigation strategies; 2) screening of identified mitigation strategies; and 3) evaluation of retained mitigation strategies. The climate change vulnerabilities and mitigation strategies identified in the updated vulnerability assessments have been included in Sections **2.10.1** and **2.10.2** below.

Currently in development, the ARBS will further assess the water supplies and demands in the Region and address regional demand-supply imbalance and infrastructure deficiencies under the existing and future climate change conditions. The results of the ARBS will be used to refine and augment the mitigation strategies described below. Other local and regional climate adaptation plans, such as the Placer County Sustainability Plan, will also be considered as they are finalized.

2.10.1.5. Prioritize Regional Vulnerabilities

The following are descriptions of the highest priority vulnerabilities in the Region.

Water Demand

Increased potential for summer water shortage. The Region is vulnerable to increased summer water shortages from increased summer water demand and potential increases in agricultural crop water demand.

Currently, demand during summer months is as much as 50 percent higher than the average month; demand during and winter months is as much as 50 percent lower than the average month (see **Section 2.9**). Much of this seasonal increase in demand is due to higher landscaping irrigation demands during the summer months (Sacramento County 2011a). Warming temperatures and increased frequency and magnitude of extreme events will exacerbate this already increased summer demand, as experienced during the recent multi-year drought.

The vulnerability analysis conducted as part of the NAB RDCP showed that, consistent with demand patterns throughout the year, the greatest deficits during a drought would occur during summer months when demands are highest (PCWA et al. 2017). For the purposes of this vulnerability assessment, a Highly Restricted Supply scenario was developed to reflect a severe supply disruption situation where one or more of an agency’s primary water supply(ies) becomes unavailable for an extended duration during a drought. This scenario is beyond the requirements of UWMPs, varies for each agency depending on their portfolio of water supplies, and represents their most dire conditions whether due to drought, climate change, change in regulatory environment, etc. Each agency identified which parts of their supply were most vulnerable and which were most reliable for purposes of determining the potential deficit. This only considers drought-related vulnerabilities. Under a highly restricted supply scenario, many agencies in the

Region could experience deficits that would require significant additional customer conservation to achieve desired service levels and reliability of service going forward.

Agricultural production in the Region is an essential contributor to the local economy. In Sacramento County alone, agricultural production was valued at $507 million dollars in 2016 (Sacramento County Agricultural Commission 2016). A variety of crop types are grown in the Region, including row crops, tree crops, and irrigated grains. Many of these crops are sensitive to climate change and will require increased irrigation during the dry season (Sacramento County 2011a). A secondary impact could be a decline in the agricultural economy. In 2015, the drought cost the agriculture industry in the Central Valley an estimated $2.7 billion (CARB 2017)

Water Supply

- **Reduced water supply reliability**. The Region is vulnerable to reduced water supply reliability from three primary drivers: reliance on snowpack, existing storage capacity limitations, and increased drought potential.

American River runoff from April through July is dominated by snowmelt (see **Section 2.9**). Water supply in the Region relies heavily on the late season storage provided by snowpack. Agencies in the Region have limited access to alternative water sources, such as the Sacramento River. Prolonged drought and reduced snowpack may cause institutional and physical threats to surface water availability, in addition to threats to groundwater availability, infrastructure integrity and the ability to share water supplies. Source contamination may also occur with a reduction in water supply reliability.

Current regional reservoir operating conditions limit storage opportunities during winter runoff season; increased winter runoff will not necessarily translate into increased storage of water leading into the spring season. In the entire American River watershed (combined watersheds of the Lower American and the upstream watersheds of the American River), the ratio of storage to annual runoff is approximately 0.64, indicating that this is likely to be the case (Roos 2005). In addition, less spring snowmelt could make it more difficult to refill winter reservoir flood control space during late spring and early summer of many years, potentially reducing the amount of surface water available during the dry season (Roos 2005). Conversely, storage capture of snowmelt runoff has traditionally occurred during the late spring and early summer seasons. Reductions in runoff during this season likely would translate into reductions in storage capture and, likewise, reductions in water supply for warm season delivery.

The Region is projected to have more frequent, longer, and more-extreme heat waves and longer periods of drought (Sacramento County 2011a) which would reduce the reliability of regional water supplies from year to year. The 2012 to 2016 drought exposed the vulnerability of water agencies in the Region that rely solely on surface water. North of Delta CVP M&I allocations were cut to 75 percent, whereas in the past a reduction of 25 percent had only been experienced (PCWA et al. 2017). In the ten-year period from 2007 through 2016, Folsom Reservoir dropped below 200,000 acre-feet three times, with its lowest ever recorded storage of under 135,000 acre-feet in December 2015 (PCWA et al. 2017). While emergency pumps and barges could provide water at lower storage volumes, when storage volumes fall below 110,000 AF, water supply diversions would be substantially impacted. While such storage levels have never occurred, low storage in Folsom appears to be increasing in frequency during droughts.

The spills observed at Folsom Dam following the intense winter storms that contributed to the end of the drought suggested that the system did not have the needed capacity to store water when available. From December 2016 through March 2017, the cumulative volume of Folsom Dam released for flood control purpose could fill the reservoir over four times. Water managers in the Region continue to experience a growing imbalance between water demands and water supply due to a variety of factors, including population growth; increased regulatory requirements; changes in CVP operations; inadequate infrastructure; and lack of interagency planning necessary to address emerging climate change conditions, and increasingly intense and more frequent extreme events (droughts and floods). The imbalance will only increase with climate change.

Another threat to water supply is low flows in rivers, which could potentially reduce the amount and accessibility of surface water by agencies that divert directly from the American or Sacramento Rivers. If river flows are sufficiently low, surface water diversions could even be cut off. Agencies relying predominantly on these supplies would then need to rely on transfers from other agencies, all or in part, to meet demands. For example, the City of Sacramento identified this vulnerability as an ongoing concern because its ability to divert flows from the lower American River diversion are impacted when flows are below 500 cfs (PCWA et al. 2017). Similarly, on the Sacramento River, when flow drops below 6,000 cfs to 6,500 cfs, the capacity of its other diversion structure is reduced. Such low flows occurred during the recent drought. This vulnerability is likely to occur again, and would have a moderate impact on their supply.

Constraints on conjunctive use and water transfers. One inhibitor to regional reliability and resiliency to future drought and climate change impacts is limited conjunctive use in the region. There are a number of factors that may inhibit expanded regional conjunctive use or inter-agency water transfers. The lack of interties between agencies limits both wet year in-lieu/injection and dry year recovery. In some cases, only a new valve and meter would be needed to make an existing intertie capable for regular conjunctive use operations. On the other extreme, completely new interties and pipelines would need to be constructed to enable more readily sharing of supplies. Without a robust network of interties between surface water and groundwater using agencies, the ability to share water is limited. Differing fluoridation practices throughout the Region serve as another limitation to expanding regional conjunctive use. The NAB RDCP presents a map to identify each system's fluoridated practices. About half the agencies fluoridate their water while the other half do not. This is an issue for regular sharing of supplies, but typically does not limit supply sharing during emergencies and short-term applications (PCWA et al. 2017).

Limitations in groundwater production and injection capacity limit agencies' ability to participate in conjunctive use projects. Limitations in groundwater productions was identified as a vulnerability by over a quarter of the agencies participating the RWRP. Existing groundwater-using agencies stated that higher groundwater production would improve operational flexibility, and would put them in a better position to partner on conjunctive use projects. For example, current groundwater production for some agencies is only sufficient to meet existing demands within the agency and there is limited to no ability for exchange opportunities via groundwater substitution pumping in summer months with other agencies. In addition, lack of groundwater injection capacity prevents the use of available surface water in wet years for groundwater recharge as part of conjunctive use program. Groundwater injection is regulated by the Environmental Protection Agency through the Safe Drinking Water Act (described in the following section). Currently, only the City of Roseville has the potential to inject surface water through their Aquifer Storage and Recovery Program. For the RWRP, City of Lincoln, Rio Linda/Elverta Community Water District, San Juan Water District's wholesale service area, and Sacramento Suburban Water District identified mitigation strategies to employ Aquifer Storage and Recovery Programs which if implemented could potentially increase regional injection capacity around 16 thousand acre-feet in wet years.

Water Quality

- **Reduced beneficial use of water from degraded water quality**. The Region is vulnerable to degraded water quality as a result of (1) increased contaminant loads from more frequent or intense storm events, and (2) rising surface water temperatures.

While current water quality in the Region is generally characterized as good, storm events pose problems for water treatment due to increases in turbidity and disinfection byproduct precursors (Sacramento County 2010). Climate change is expected to increase the frequency and magnitude of extreme precipitation and runoff events, potentially increasing these existing issues.

Water temperature is expected to generally rise in regional streams, lakes, and reservoirs as air temperature rises. This will adversely impact aquatic habitats and species (discussed below). For the Region, increasing temperatures are likely to increase challenges for providing suitable habitat conditions for salmonid populations, particularly fall-run Chinook salmon. Folsom Reservoir is operated to release cold water during the late summer and early fall months to provide suitable habitat conditions for anadromous fish survival. With a warming climate, the quantity of suitable cold water in storage is likely to decrease. At the same time, the need for these colder water releases is likely to increase due to warmer in-stream temperatures (Reclamation 2016a).

Prolonged droughts may threaten both surface water and groundwater quality. During dry periods, demand for groundwater is anticipated to increase as surface water availability decreases. Although not experienced in this area, heavily pumped aquifers sometimes experience degradation in water quality due to concentrations of pesticides, fertilizers, salts, industrial pollutants, and other contaminants. This impacts not only available water supply, but also public health. Differing water quality may also impact the ability of agencies to share supplies during droughts, floods, or other events (PCWA et al. 2017).

Water quality differences between surface water and groundwater may also serve as a barrier to establishing a regional conjunctive use program. Some agencies have concerns about receiving lower quality groundwater from neighboring agencies as compared to their surface water. For example, the City of Folsom has contracts with Gekkeikan and Kikkoman that allow only high quality surface water to be distributed. The City of Roseville, among others, have similar limits to conjunctive use due to existing policies limiting groundwater for emergency use only and customer preferences.

Flooding

- **Increased riverine flood risk**. In the Region, major infrastructure, residences, and industries are currently located in the 200-year floodplain. Population growth and economic development behind levees in the Region has greatly increased flood risk over time. These issues are likely to be exacerbated, as climate change is expected to increase the frequency and magnitude of extreme precipitation and runoff events. Additionally, changes in storm magnitude may overwhelm potentially undersized internal drainage systems in the Region.

- **Increased tidal flood risk**. Tidally influenced levees in southwestern portion of the Region will experience increased pressure under sea level rise scenarios. A rise in sea level would increase hydrostatic pressure on levees currently protecting low-lying land in the Delta, much of which is already at or below sea-level. These effects threaten to cause potentially catastrophic levee failures that could inundate communities, damage infrastructure, and interrupt water supplies throughout the state (Hanak and Lund 2008). Sea-level rise may also cause issues with intakes or outfalls from water or wastewater treatment facilities.

Ecosystem and Habitat Vulnerability

- **Increased adverse impacts to habitats and species**. The Region includes substantial acreages of vulnerable and already fragmented wetland and aquatic habitats. The Region is also home to a number of climate-sensitive and state- and federally listed threatened and endangered species, including salmonids and migratory bird species. **Section 2.6.2** and **Appendix B** contain descriptions of existing vulnerable habitats and species within the Region. Agencies within the Region have numerous plans for restoration of these habitats in place, but these may be inhibited by a changing climate.

In addition, warmer air and water temperatures potentially could improve habitat for invasive species that outcompete natives. Climatic changes could decrease the effectiveness of measures currently used to control invasive species (Hellman et al. 2008). Invasive species, including various nonnative fish and plant species, are an ongoing issue within the Region. Some invasive species, such as quagga mussels, may additionally impact maintenance of hydraulic structures.

Existing quantified environmental flow requirements have been established to improve aquatic habitat, but these do not necessarily account for climate change. One example is the lower American River flow. Water for prescribed flows may not be available at the correct time, or if available, may not be at the proper temperature, as described earlier (under “Water Quality”). This may affect allowable diversions and water use downstream. A reduction on the amount of water available for aquatic species may lead to water quality impairments that may affect the health of aquatic species.

Low flows in rivers can cause detrimental impacts to native and local species such as Chinook salmon and the Central Valley steelhead trout. It is of critical importance that there be specified and maintained flow and temperature releases from Folsom Reservoir. Ultimately, dry water years could reduce fish habitat (PCWA et al. 2017).

2.10.1.6. Quantitative Vulnerability Assessment

As part of the 2013 ARB IRWMP Update, the Sacramento Area Integrated Water Resources Model (SacIWRM) was used to evaluate the impacts of climate change on water resources in the Region. SacIWRM is an integrated hydrologic model that simulates the groundwater and surface water resources in the Region. The model uses various input data, most significant of which from a water supply perspective are: precipitation, streamflows, land use, agricultural and urban water demand, and surface water deliveries. The model also uses groundwater production data as inputs, where known (e.g., urban areas), but can simulate groundwater production data to meet demands in areas when the data are unavailable (e.g., rural and agricultural areas).

This climate analysis used information from DWR modeling exercises to evaluate future water deliveries under future climate change conditions. Applicable data from this broader DWR modeling effort was used as local input into the SacIWRM to assess potential impacts on the Region's surface water and groundwater resources. Because the data generated for the DWR analysis were for significantly different purposes than for the Region analysis, this is not intended to be a rigorous technical analysis. Rather, it meant to begin to provide an understanding of the expected magnitude of impacts potentially associated with future climate change. A technical memorandum of the modeling assumptions and results is provided in **Appendix D**.

Data extracted from the DWR analysis indicate there could be the following impacts:

- **Precipitation** – Monthly distribution of rainfall is expected to change under climate change conditions. March and December precipitation would increase by approximately 17 percent, while precipitation would be reduced in other months. The long-term average precipitation is expected to decrease by 7 percent.

- **Streamflow** – Changes in precipitation would result in similar changes in streamflows. American River annual flows would decline by an average of 8 percent, while the long-term average monthly reservoir releases would increase in March (+17 percent), April (+6 percent) and October (+23 percent) under climate change conditions. Similarly, Cosumnes River annual flows would decline by an average of 9 percent, but in contrast, the long-term average monthly Cosumnes River flows would only increase in December (+11 percent) under climate change conditions. Sacramento River annual flows would decrease by an average of 1 percent, while the long-term average monthly flows would increase in July (+4 percent), August (+8 percent), and October (+9 percent).

- **Surface Water Deliveries** – Changes in streamflows would result in significant changes in surface water deliveries from the American River and Folsom Reservoir. Changes in deliveries to each water supplier would depend on availability of surface water and water rights of the water supplier. The average annual surface water deliveries from the American River could typically be decreased by a range of 1 to 6 percent, while summertime decreases could be up to 12 percent. In contrast, average annual deliveries on the Sacramento River could increase by approximately 2 percent because summertime flows could be increased.

Using the above information in the SacIWRM and running a 105-year future projection with an assumed 2030 level of development yielded the following potential impacts on the Region relative to a future condition with no expected climate change:

- **Total Water Demand** – Average annual demand for water could increase by about 0.5 percent (an increase of more than 4,000 AFY). This is most likely due to the total amount and timing of precipitation to meet demands mostly in the agricultural sector.

- **Surface Water Supply** – Average surface water supply would be expected to be reduced by 0.8 percent (a nearly 5,000 AFY decrease). This is mostly associated with reduced availability of diversions from the American River for urban water suppliers.

- **Groundwater Supply** – To meet the increased total demand and reduced surface water availability groundwater production is expected to increase by more than 2 percent per year (an increase of 11,000 AFY). While for the Region as a whole this is not a large volume of groundwater, localized impacts could be more significant. For example, most of the supply to be made up by groundwater will be in agricultural areas that are already served primarily by groundwater. Groundwater elevation declines in the range of 20 feet could be expected. In urban areas nearer rivers and streams, the impacts to groundwater elevations could be fairly limited.

The SacIWRM was used to run a second future scenario, in which urban water suppliers would receive a 10 percent cutback to their surface water diversions when inflows into Folsom Reservoir are less than 2,000 cfs. This cutback was added for the second scenario because DWR modeling indicated that the frequency of Folsom Reservoir inflows that are below 2,000 cfs was expected to increase under future climate conditions. Under this scenario, the following results are expected relative to future conditions with no expected climate change:

- **Total Water Demand** – Average annual demand for water could increase by about 0.5 percent (an increase of more than 4,000 AFY). This is most likely due to the total amount and timing of precipitation to meet demands mostly in the agricultural sector. These are the same results as for the first scenario, as no additional demand changes would be expected.

- **Surface Water Supply** – Average surface water supply would be expected to be reduced by 5.4 percent (a nearly 33,000 AFY decrease). Again, this is mostly associated with reduced availability of diversions from the American River for urban water suppliers.

- **Groundwater Supply** – To meet the increased total demand and reduced surface water availability, groundwater production is expected to increase by about 6.5 percent per year (an increase of more than 33,000 AFY). Groundwater elevation declines in agricultural areas would still be expected to be in the 20 feet range. In contrast to the first scenario, groundwater elevations in the urban areas could be expected to decline, as they are absorbing a majority of the reduced diversions. Groundwater elevation declines in the urban areas would likely be more in the range of 10 feet or more.

2.10.1.7. Further Data Gathering and Analysis

Based on the quantitative analysis above and experiences during the recent drought, impacts to localized areas that are heavily reliant on groundwater could be significant. Additionally, areas that are exclusively reliant on surface water could experience shortages, particularly if conditions similar to the second scenario were to materialize. Expanding conjunctive use operations in the Region will help address these concerns. RWA is working with local water suppliers on the following studies and data gathering efforts to continue to assess potential impacts and develop adaptive strategies to address concerns related to future climatic conditions:

- RWA will continue to coordinate with the groundwater management entities on tracking Region-wide changes in groundwater elevations through the California Statewide Groundwater Elevation Monitoring (CASGEM) program. RWA will continue to report to the RWMG on trends.

- RWA will continue to coordinate with the Groundwater Sustainability Agencies to comply with the Sustainable Groundwater Management Act and maintain groundwater storage levels.

- RWA will incorporate regional stormwater resource plans and include stormwater as a resource in local integrated water management efforts.

- Water use efficiency and conjunctive use operations are two key strategies to adapt to future climate change impacts on water supply. In 2014, RWA began collecting additional water use information from urban water suppliers to determine the Region's compliance with 20 percent by year 2020 gallon per capita per day reductions. RWA began to collect information on the amount of groundwater and surface water used by these agencies on a monthly basis to begin developing a greater understanding of the conjunctive use potential of the Region. Using existing infrastructure capacities and current water use and demands, it was found that there is a potential to increase region-wide recharge by 61 thousand acre-feet per year in wet-years through both in-lieu and direct recharge, and recovery by 66 thousand acre-feet per year in dry years. This information will also help inform planning efforts and for the development of projects to help expand conjunctive use in the Region in addition to groundwater banking.

- The RWRP developed mitigation actions that would help expand conjunctive use. With near-term infrastructure improvements, there is a potential to increase region-wide recharge by 36 thousand acre-feet per year in wet years beyond the existing opportunity, and recovery by an additional 40 thousand acre-feet per year in dry years above existing opportunities. With the near-term improvements, both recharge and recovery has the potential to increase by about 50 percent. The cost to implement these improvements ranges from $150 to $250 million. Revenue from creating a groundwater bank could serve to offset some of the capital costs associated with facility improvements, including improvements that may have been implemented by local agencies regardless of a bank.

- RWA completed a study with SMUD (the primary electric utility) to assess the water-energy relationship of the Region in 2014. The study will help identified areas where water and energy demands can be reduced, resulting in GHG emissions reductions. SMUD is using this information to inform investment decisions for demonstration projects that reduce energy demands associated with the Region's water systems or increase the use of renewable energy by the water sector, thus reducing GHGs. SMUD and RWA are collaborating on implementation of these projects. The study also helped to inform planning efforts and the development of projects that can address both adaptation and mitigation related to future climate conditions.

- In addition to the efforts described above, the ARBS was initiated in 2017, and it is intended to integrate the considerations of surface water and groundwater uses as well as environmental water needs in a way that may help the Region (including Reclamation) better manage all of its water resources into the future. Operational decisions will be improved with new information on climate change specific to the Region.

2.10.2. Climate Change Mitigation and Adaptation Strategies

Region stakeholders and participants recognize the importance of managing for climate change. Strategies for managing climate change include both mitigation and adaptation. Mitigation involves actions to reduce GHG emissions, while adaptation involves responding to the effects of climate change.

As part of the 2018 ARB IRWMP Update, RWA identified local climate action and sustainability plans. **Table 2-28** shows whether the counties and cities in the Region have developed or plan to develop a GHG emissions inventory and/or a plan that addresses climate change. These, and other regional climate action planning documents, are also identified in **Appendix F**. GHG emissions from water-related infrastructure and projects and adaptation actions, such as water conservation, are integral components of many of these plans. Many ARB stakeholders have contributed to their respective city or county plans.

1 **Table 2-28. GHG Emissions Inventories and Climate Change-Related Plans in the Region**

Municipality or Agency	GHG Emissions Inventory	Climate Action Plan, GHG Emission Reduction Plan, or Related Plan
El Dorado County	Plan to do	Plan to do
City of Citrus Heights	Yes, conducted as part of Sacramento County-wide GHG emissions inventory	2011 City of Citrus Heights Greenhouse Gas Reduction Plan
City of Elk Grove	Yes, conducted as part of Sacramento County-wide GHG emissions inventory	2013 City of Elk Grove Climate Action Plan 2013 City of Elk Grove General Plan Update – Sustainability Element
City of Folsom	Yes, conducted as part of Sacramento County-wide GHG emissions inventory	2017 City of Folsom Sustainability Action Plan
City of Galt	Yes, conducted as part of Sacramento County-wide GHG emissions inventory	2017 Compilation and Analysis of Local Climate Action Plan Measures
City of Rancho Cordova	Yes, conducted as part of Sacramento County-wide GHG emissions inventory	Yes, in progress
City of Sacramento	Yes, done with Sacramento County plan	2012 City of Sacramento Climate Action Plan 2035 City of Sacramento General Plan Update – Sustainability Element
Sacramento County	Greenhouse Gas Emissions Inventory for Sacramento County, 2009 and 2016	2009 Greenhouse Gas Emissions Inventory and Forecasts 2011 Climate Action Plan Strategy and Framework 2012 Sacramento County Climate Action Plan – County Government Operations Climate Action Plan – Communitywide Greenhouse Gas Reduction and Climate Change Adaptation (in-progress) 2015 Greenhouse Gas Emissions Inventory and Forecasts Update
City of Auburn	N/A	N/A
City of Lincoln	Yes, in progress	Yes, in progress
City of Rocklin	Yes, in progress	Yes, in progress
City of Roseville	City-operations Climate Action Plan, 2009; Community-wide Sustainability Action Plan, in progress	City-operations Climate Action Plan, 2009 2010 City of Roseville Community-wide Sustainability Action Plan
Town of Loomis	No plans	No plans
Placer County	Yes	Yes, in progress

Source: California Office of Planning and Research 2012, Citrus Heights 2011, Elk Grove 2013a, Elk Grove 2013b, Folsom 2017b, Galt 2017, Sacramento 2012, Sacramento 2015b, Sacramento County 2009, Sacramento County 2011a, Sacramento County 2012, Sacramento County 2015, Roseville 2009a, Roseville 2010
Key:
ARB = American River Basin
GHG = greenhouse gas

In addition to counties and cities, other agencies in the Region are involved in GHG emission reporting. The Climate Registry is a nonprofit organization that provides a nationwide database for consistent and transparent tracking/reporting of GHG emissions (http://www.theclimateregistry.org/). The following agencies in the Region are current members of this registry:

- PG&E
- PCWA
- Sacramento Metropolitan Air Quality Management District
- SMUD

Several water supply agencies have been progressive in developing GHG emission-related plans. For example, PCWA has completed an Energy and Greenhouse Gas Benchmark Study, which benchmarked PCWA's energy use, inventoried GHG emissions, and developed energy and GHG emissions options. Stakeholders and participants are already working to inventory GHG emissions and are contributing to reducing GHG emissions by reducing energy consumption, investing in renewable energy, purchasing carbon offsets, and conducting other mitigation-related actions. The City of Folsom is also currently conducting an energy efficiency analysis of the city's water and wastewater operations (M. Yasutake, personal communication, 2018).

Appendix C includes the results of an ARB water supply agency survey documenting GHG inventory and reduction efforts. The appendix contains a detailed list and descriptions of completed and planned mitigation strategies undertaken by survey respondents, as well as climate change mitigation strategies from local climate action plans.

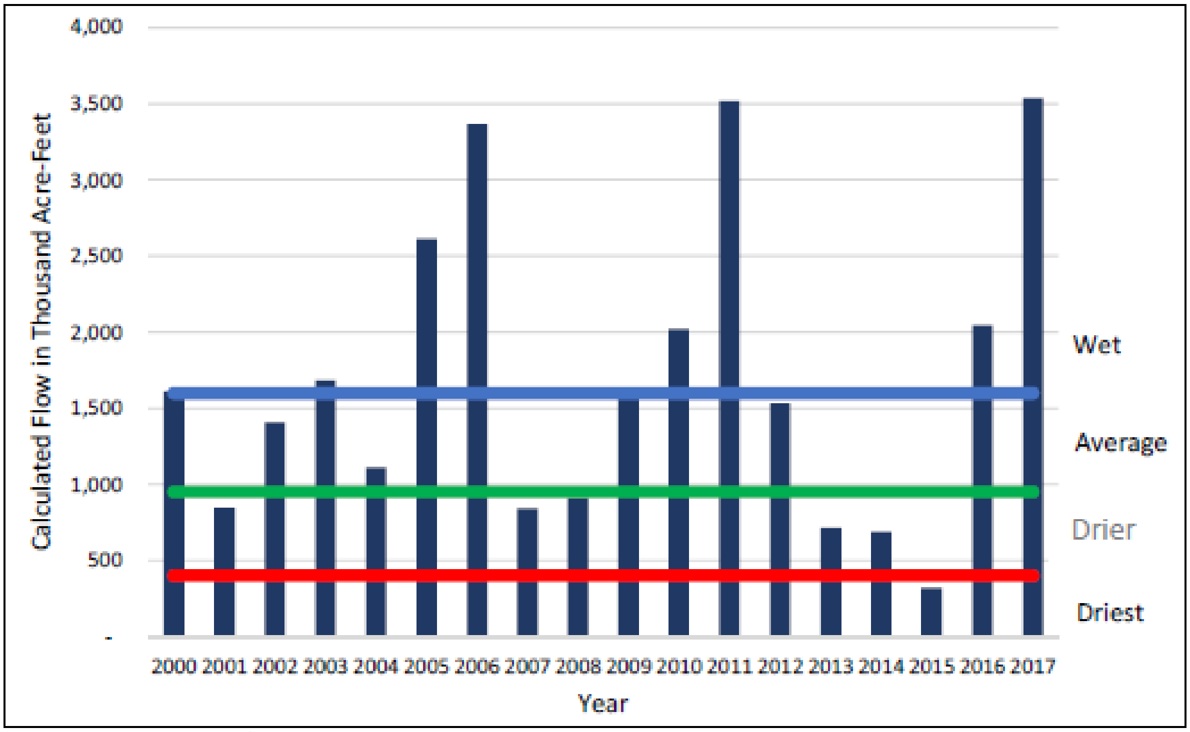
In contrast to mitigation strategies, the intent of adaptation strategies is to have a water management system that is more adaptable to increasingly uncertain climate patterns and extremes. Actions that are already underway, such as conjunctive use, water conservation measures, and integrated flood management will also help the Region be more adaptable to climate change. These actions have been described throughout **Section 2**, and are also briefly described below. Additional mitigation strategies may be added following completion of the RWRP and ARBS.

- **Water demand reduction** – Reducing human water use increases water reliability during drier years and allows the same quantity of water to be available for other needs. Current efforts, such as decreasing urban per capita water demand, installing water meters, and public education (**Section 2.9.1**), help reduce water demand.

- **Water supply system improvements** – A more adaptable water supply system increases efficiency of water use, which will become more important with increasingly frequent and extremely dry years. Current efforts, such as conjunctive use management (**Section 2.6.3**), recycled water use (**Section 2.9.2**), and constructing interconnections between adjacent water districts (**Section 2.8**), increase water supply reliability in the Region. Creating recycled water opportunities may provide an additional source of water to meet non-potable demands and reduce potable water when surface water supplies are limited. New interties may be constructed to allow agencies to share water supplies across service area boundaries if a primary water source becomes unavailable, as in the 2012 to 2016 drought. Injection wells may be constructed to recharge groundwater. Interbasin water transfer agreements may also be completed. For long-term regional water supply management, water managers will need to monitor both reservoir storage levels and snowpack. Once a water supply threat is identified, water agencies and managers must respond quickly.

- **Integrated flood management** – A comprehensive structural and nonstructural flood management system is necessary to adapt to the anticipated higher frequency and magnitude of floods. State (e.g., Central Valley Flood Management Planning Program) and local flood management efforts involve both structure improvement projects and consideration of floodplain easements and use of LID methods (**Section 2.7**).

- **Ecosystem stewardship** – Ecosystem- and environmental resources-related projects and supporting resilience of the environment will be increasingly important, as climate change also affects the environment. Numerous environmental and watershed management groups are active within the Region (**Section 2.6.2**), and nonstructural flood projects and programs currently involve environmental habitat considerations (**Section 2.7**). The Lower American River Modified Flow Management Standard is a comprehensive package of linked actions to achieve two co-equal objectives of providing a safe and reliable water supply while also preserving the aquatic life of the lower American River (PCWA et al. 2017). Unimpaired inflow into Folsom Reservoir is an index that the water managers can reference to measure the potential amount of water supplies that maybe available for a given year, per the Water Forum Agreement. Since execution of the Water Forum Agreement, one-third of years (6 out of 18) have been classified as drier or driest (**Figure 2-34**). Based on the water year type, agencies may proactively take specific actions in anticipation of potential water supply shortages.



Source: PCWA 2017 et al.

Figure 2-34. Calculated Unimpaired Inflow into Folsom Reservoir, March-November

- **Watershed stewardship** – Management of water resources from a watershed perspective is integral to promoting integrated management of resources for water supply, flood/stormwater management, and ecosystem needs. Numerous environmental and watershed management groups are active in the Region (**Section 2.6.2**).

Climate change mitigation and adaptation strategies are also an important part of the IRWMP. ARB strategies were designed to be flexible and adaptable so that climate change, among other future changes in the Region, can be addressed. New strategies can be proposed and vetted into the IRWMP every quarter. GHG emissions reduction and/or climate change adaptation components of ARB projects are also considerations in the project review process. These IRWMP Framework elements are described in greater detail in **Sections 5.6** and **5.7**.

Regional water transfers – Developing and expanding water transfer agreements, particularly intrabasin transfer of CVP contract supplies, would facilitate sharing of supplies and enable agencies to receive additional supplies under drought or emergency conditions (PCWA et al. 2017). Inter-agency transfer agreements may also increase operational flexibility and identify additional opportunities for supply transfers to expand conjunctive use. Addressing distribution system pressure differences between agencies and adding new interties would increase the ability to share supplies with neighboring agencies. Modifying contracts and/or expanding Place of Use would also help facilitate sharing of supplies. The improved flexibility to sharing supplies would help some agencies access alternative supplies should their primary water source become unavailable or for expanding regional conjunctive use.

New surface water diversions - New surface water diversions could provide redundancy of supplies should the current Folsom Reservoir intake become inoperable (e.g., lake levels below current intake). A permanent emergency intake at Folsom Reservoir could improve reliability to attaining Folsom Reservoir supplies during when reservoir storage levels are below the existing intake. Also, a new river diversion on the Sacramento River would reduce reliance on the American River supplies, and increase drought resiliency by providing access to alternative source of surface water supplies.

Groundwater banking - Increasing conjunctive use and groundwater banking would increase reliability of groundwater basin to provide dry year supplies. Groundwater banking agreements, including establishing a regional groundwater bank, would facilitate regional collaboration (PCWA et al. 2017). It would also facilitate collaboration with Reclamation to integrate Folsom operations with the groundwater basin to enhance drought resiliency and protection of environmental resources on the Lower American River. Regional GSPs may identify additional opportunities to enhance groundwater recharge and store water for use during dry years, while maintaining basin sustainability.

2.11. Technical Analysis

This subsection describes the technical information and analysis used in development of the ARB IRMWP. RWA, as the RWMG, and ARB stakeholders used this information to understand regional water resources conditions (**Section 2**); to update ARB vision, goals, objectives, and strategies (**Section 5**); and to revise means of implementing the IRWMP into the future (**Section 6**). The discussion below provides a summary of the technical data and information sources and the technical analyses used. Monitoring and collecting data from IRWMP implementation and data management into the future are discussed in **Sections 6.3** and **6.4**, respectively.

2.11.1. Technical Data and Information

The water resources systems surrounding the Region have been extensively studied and monitored for many years. Data for ARB IRWMP were collected from local, regional, state, and federal agencies. Information from local agencies often provides the level of detail that larger scale studies do not. Selecting to use plans, such as UWMPs, that are mandated or supported by the state, ensures that the information collected from numerous local agencies was compiled following similar standards, for similar purposes, and in a similar time frame. Many local agencies in the Region also collaborate to develop regional plans and efforts, such as GMPs/GSPs, SWRPs, the NAB RDCP, the RWRP, ARBS, American River Basin Water Marketing Strategy Project, or other studies. The scale of information in these documents is ideal for an IRWMP and the data can be said to have been vetted by several local agencies. A list of identified local water plans can be found in **Appendix F**.

State and federal data were used when they provided sufficient detail (e.g., demographics) or when a statewide perspective was important (e.g., flood management systems). In cases where various local agencies provided differing information (e.g., surface water quality issues in the Region), state or federal sources were used as the neutral and accepted information.

Uncertainties in data do exist, especially since this IRWMP is a synthesis of data from numerous sources that report similar information, possibly collected in different ways. In some cases, different sources do not fully agree with each other. Nonetheless, the data are accurate enough that they portray the overall picture of the Region.

An overview of the data and information used to support the ARB IRWMP is shown in **Table 2-29**.

Table 2-29. Data Used in the 2018 ARB IRWMP Update

Section	Type of Data	Sources
2.1-2.4	Political and agency boundaries	Cal-Atlas; 2010 U.S. Census
2.5	Population, finance, and demographic data	2000, 2008, 2010, and 2016 U.S. Census; 2018 and 2012 SACOG data; State of California Department of Finance, State of California Employment Development Department 2018
2.5	Land-use data	California Department of Conservation data; 2017 Cropland Data Layer, USDA National Agricultural Statistics
2.6	Hydrologic (surface and groundwater) and climatic data	GMPs/studies; USDA NRCS watershed delineations; CIMIS; Western Region Climate Change, USGS, and DWR/CDEC gage data; relevant watershed studies, including NMFS studies.
2.6	Surface and groundwater quality data	Agency data; GMPs/studies; U.S. EPA 303(d) list for impaired waters, Water Board beneficial use data; SGA
2.6	Ecosystem and habitat data	Habitat conservation plans, CDFW CNDDB, local watershed management plans and studies.
2.7	Stormwater and flood data	SWMPs; DWR, flood-related documents; and other city or county hazard management plans, SWRPs
2.8	Water and wastewater system data	2015 UWMPs; sewer system master plans, and related studies and projects
2.9	Water supply, demand, and reliability information	2015 UWMPs and other agency water supply plans; GMPs/studies; NAB RDCP; RWRP
2.10	Climate change data and relevant efforts	GHG inventories, climate action plans, NAB RDCP 2017, RWRP 2018

Note:
Much of the data have been augmented by personal communications or stakeholder/agency input.
Key:
CDEC – California Data Exchange Center
CDFW – California Department of Fish and Wildlife
CIMIS – California Irrigation Management Information System
CNDDB – California Natural Diversity Database
DWR – California Department of Water Resources
GHG – greenhouse gas emissions
GIS – geographic information system
GMP – groundwater management plan
NAB RDCP= North American Basin Regional Drought Contingency Plan
NMFS – National Marine Fisheries Service
NRCS – National Resources Conservation Service
SACOG – Sacramento Area Council of Governments
SWMP – stormwater management plan
U.S. EPA – U.S. Environmental Protection Agency
USDA – U.S. Department of Agriculture
USGS – U.S. Geologic Survey
UWMP – urban water management plan

Some of the regional and local water plans and studies cited in **Table 2-29** are described below.

- **Urban Water Management Plans and Studies** – Documents that provide information about the Region's water supply outlook and related management strategies include 2015 UWMPs. The 2015 UWMPs were prepared by each of the Region's urban water suppliers with greater than 3,000 connections or that serve at least 3,000 AF annually. UWMPs are updated every 5 years and include historical water use information and 20-year projections of water demands, water supplies, recycled water use, and a water shortage contingency plan. Additionally, the 2015 UWMPs contained each supplier's water conservation targets to meet the requirements of Senate Bill (SB) X7-7 requirements of 20 percent water conservation by 2020.

- **Groundwater Management Plans and Studies** – The Region is actively managing its groundwater resources through planning and monitoring efforts. GMPs completed or updated within the Region include: the Western Placer County GMP, the North American River Basin GMP, the Central Sacramento County GMP, and the South Basin. These plans define basin management objectives (BMO) necessary to maintain the quality, reliability, and sustainability of groundwater resources on local and regional scales. These BMOs complement the IRWMP objectives. GSAs throughout the Region are currently developing GSPs or alternative plans to GSPS (Alternatives) to sustainability manage the basins' groundwater resources. The GSPs or Alternatives will describe conditions in the basins and identify sustainable management actions and projects. Critically-overdrafted high- and medium-priority groundwater basins must be managed under a GSP by January 31, 2020. All other basins designated as high- or medium-priory must be managed under a GSP by January 31, 2021. Development of these GSPs is addressed as a 2018 ARB IRWMP Update strategy (**see Section 5.6**). Although GSP management actions were not identified during the 2018 ARB IRWMP Update, they will be incorporated throughout future integrated water management planning efforts.

- **Recycled Water Plans and Studies** – The Region is diversifying its water supply portfolio through the use of recycled water. Several agencies supply recycled water that offsets potable water use or provides other beneficial uses. These agencies completed studies and projects over the past decade that contributed technical data used in the ARB IRWMP.

- **Stormwater and Flood Management Plans and Studies** – Several stormwater and flood management planning efforts have been completed or are underway in the Region. The American River Basin SWRP and the West Slope SWRP were recently completed and aim at integrating stormwater in their ongoing integrated regional water management efforts. These efforts identify opportunities for and benefits of enhancing storm and flood management systems. Stormwater-related plans provided information on current stormwater management systems and the NPDES permits relevant to the Region. Local flood management plans identified local flooding concerns as well as augmented watershed descriptions of local creeks. Understanding of both local stormwater and flood management will assist implementation of any water quality- and LID-related objectives and strategies.

- **Watershed and Habitat Conservation Plans and Studies** – Several watershed and habitat conservation planning efforts have been completed or are underway in the Region. The ARB IRWMP objectives and strategies reflect some of the concerns and initiatives identified in these planning efforts. Habitat Conservation Plans (HCP) and related efforts established regional conservation and development guidelines to protect natural resources while improving and streamlining the permitting process for endangered species and wetland regulations. By proactively addressing the Region's long-term conservation needs, these efforts strengthen local control over land use and provide greater flexibility in meeting water management and other needs in the Region. HCPs and related plans provide species and habitat information to guide future efforts in regional habitat and species management.

2.11.2. Technical Analyses and Methods

Several components of this ARB IRWMP required more in-depth analysis or data management methods than compiling information from other studies and data sets. As part of the 2013 ARB IRWMP Update, RWA conducted a quantitative climate change vulnerability analysis. This involved combining information from DWR's CalSim model with the SacIWRM to assess the effects of climate change on the surface water and groundwater resources. The results of this analysis, described in **Appendix D**, provided information about how future climate conditions could change water supply reliability, stream flow, and groundwater levels.

To develop this IRWMP and to assist continued implementation into the future, RWA continues to update and use a Web-based Opti tool. This tool acts as a database of ARB project information, as well as a means to share water-related information, events, and projects with the regional community. Opti also allows quick analysis of current ARB projects throughout the Region. This tool is described in further detail in the following sections: its role in stakeholder outreach and collaboration in **Section 3**, its role in collecting project information in **Section 5**, and its role as a data management tool and adaptable tool into the future in **Section 6**.

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