California Water Today

Chapter photo. Harvesting in the Central Valley

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Chapter 4. California Water Today

About this Chapter

Chapter 4 California Water Today describes California's diverse communities and environment; the challenges of meeting our water demands; and initiatives to meet these challenges undertaken by federal, State, and local government, and regional and Tribal entities. We are already witnessing the effects of climate change—on hydrology (snowpack, river flows), storm intensity, temperature, winds, and sea levels. California is facing multiple dry years and operating under court restrictions and new regulations brought about by declining ecosystems. Meanwhile, California's policymakers and water communities are finding ways to integrate planning and water management, promote stewardship and sustainable practices, build partnerships, enact legislation, and secure funding.

See Chapter 5 Managing an Uncertain Future for discussion of how California can prepare for future water management by navigating uncertainty and risk, evaluating plausible futures, and choosing management strategies that provide for more sustainable water supply and flood management systems and ecosystems. With the use of three alternative scenarios, we project plausible, yet very different, statewide and regional water needs through year 2050.

In addition to a discussion of California's water conditions, this chapter presents statewide water balance data and summary for water years 1998 through 2005. Regional water balance summaries can be found in Volume 3 Regional Reports. More detailed data about statewide and regional water uses and supply distribution are in Volume 5 Technical Guide.

- Variable and Extreme Resources
- Land Use and Development Patterns
- Water Conditions
- Critical Challenges
- Responses and Opportunities

Variable and Extreme Resources

With its wide variety of climates and landforms, California is often described as a land of extremes; its water resources can best be described as variable. Precipitation, the primary source of the state's water supplies, varies from place to place, season to season, and year to year. Most of the snow and rain fall in the mountains in the north and eastern parts of the state, and most water is used in the central and southern valleys and along the coast. In addition, the state's ecosystem, agricultural, and urban water users have variable demands for the quantity, timing, and place of use. In any year, the state's water systems may face the threat of too little water to meet needs during droughts or the threat of too much water during floods.

Given this variability, California's local, State, and federal projects and programs form the backbone of a statewide water system that was developed during the first part of the 20th century, and these projects have worked together to make water available at the right places and times and to move floodwaters. In the past, this system has allowed California to meet most of its agricultural and urban water management objectives and

Figure 4-1 Map of California with major rivers and facilities

flood management objectives (Figure 4-1 Map of California with major rivers and facilities).

Generally, during a single dry year or two, surface water and groundwater storage can supply most water deliveries, but dry years can result in critically low water reserves. Ecosystems and agriculture often face more significant reductions in available water than do urban areas. Longer droughts can create extreme fire danger, economic harm to urban and rural communities, loss of crops, and the potential for species collapse and degraded water quality. Greater reliance on groundwater during dry years results in high costs for many users and more groundwater overdraft. At the same time, water users who have already increased efficiency may find it more challenging to achieve additional water use reductions during droughts.

In 2009, California experienced a third consecutive year of drought. Below-average precipitation and runoff began in fall 2006. The water shortage has affected the state's economy, slowing development projects and forcing growers to fallow land. For example, farmers in northern San Diego County stumped avocado trees and pulled out citrus trees due to water shortages. The Westlands Water District reported that one-third of the farmland was being fallowed in 2009, at a loss of at least 500 jobs.

In fall 2009, the US Department of Agriculture granted agricultural disaster designations due to drought, either primary, contiguous, or both, for 50 of California's 58 counties. By October, 25 California counties had requested primary designations and provided the California Emergency Management Agency (Cal EMA) with estimates of the dollar value of their drought-related losses for one or more crops for various reporting periods. The total loss for all the reporting counties was about $876 million. (See Box 4-1 Acronyms and Abbreviations Used in This Chapter.)

Californians also face the risk of extensive property damage and loss of life when too much water overwhelms the system's capacity and floods cities and farmlands as witnessed yet again in 2006.

As we develop and improve water delivery systems, we must also preserve and protect our watersheds and maintain healthy ecosystems. We rely on our watersheds and groundwater basins to provide clean and adequate surface water and groundwater. Their health is essential to California's resources and economic future. California's public agencies must manage these public trust resources for generations to come.

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Hydrologic Regions and Areas of Interest

The Department of Water Resources (DWR) divides California into 10 hydrologic regions corresponding to the state's major water drainage basins (Figure 4-2). Using these hydrologic regions and their nested subareas as planning boundaries allows consistent tracking of their natural water runoff and the accounting of surface water and groundwater supplies. See Box 4-2 (About Update 2009 Regional Reports) for a detailed description of each of these hydrologic regions and the river basins that they include.

Figure 4-2 **Hydrologic regions of California, the Sacramento-San Joaquin River Delta, and Mountain Counties Area**

Box 4-1 Acronyms and Abbreviations Used in This Chapter

BDCP	Bay Delta Conservation Plan	EO	executive order
BLM	US Bureau of Land Management	FEMA	Federal Emergency Management Agency
Cal EMA	California Emergency Management Agency	GHG	greenhouse gas
CEC	California Energy Commission	IRWM	Integrated Regional Water Management
CVP	Central Valley Project	NFMS	National Marine Fisheries Service
DAU	detailed analysis unit	PA	planning area
Delta	Sacramento-San Joaquin River Delta	RAP	region acceptance process
DFG	California Department of Fish and Game	SB	Senate bill
DRMS	Delta Risk Management Strategy	SGP	(Governor's) Strategic Growth Plan
DWR	California Department of Water Resources	SWP	State Water Project
		UWMPs	Urban Water Management Plans

Some areas of the state share common water issues or interests that stretch across boundaries from one hydrologic region to another. Two such regional overlays, the Mountain Counties area and the Sacramento-San Joaquin River Delta (the Delta) region, are part of this Water Plan. Many other regional overlays could be developed based on boundaries such as county lines, water districts, or integrated regional water management (IRWM) groups.

A component of the IRWM Program Guide is the region acceptance process (RAP), a process for identifying regions for the purpose of developing or modifying IRWM plans. At a minimum, a region is defined as a contiguous geographic area encompassing the service areas of multiple local agencies and is defined to maximize the opportunities to integrate water management activities and effectively integrate water management programs and projects within a hydrologic region defined in the California Water Plan, the Regional Water Quality Control Board (Regional Water Board region), or subdivision or other region specifically identified by DWR.

In November 2009, DWR completed the first RAP cycle by documenting recommendations on 46 submitted RAP applications. DWR approved 36 and conditionally approved 10 regions. Approved regions will be eligible for the next round of IRWM grant funding, and conditionally approved regions may have restricted eligibility for future funding (Figure 4-3).

For detailed planning and data collection purposes, DWR further subdivides the 10 hydrologic regions into 56 smaller planning areas (PAs), plus a more detailed breakdown into 278 detailed analysis units or DAUs. DWR starts most of its water supply and water use data collection activities at the DAU level. This regional information is collected, analyzed, and compiled by each of DWR's four regional offices, which are located in Red Bluff, Sacramento, Fresno, and Glendale (Figure 4-2 also shows the boundaries for these four regional offices). Regional water plan data are then consolidated into the larger hydrologic regions for presentation in the California Water Plan (Volume 3 Regional Reports). See also Volume 5 Technical Guide for list of California's PAs.

Climate

The amount and variability of precipitation can change dramatically between the northern regions of California and its southeast portions such that statewide average information does not truly depict regional conditions. Generally wet, average, and dry conditions presented for the entire state are not universally the same for individual regions of the state. It is common for the winter precipitation to be wet or above average

Box 4-2 About Update 2009 Regional Reports

In California Water Plan Update 2009, we expanded the regional reports. Each report now includes a summary of surface water quality issues and needs, regional flood and flood management issues, a table of strategies proposed by recent integrated regional water management efforts, climate change challenges, and projected water demands to the year 2050 for three alternative scenarios. These regional reports have also added information about Tribal populations in each region and Tribal lands.

The organization of these regional reports presents the water conditions today and challenges and opportunities for their future. Each separately bound regional report contains a main section as a concise summary of the most significant water information and issues related to that region. The inclusion of new information categories has greatly expanded the amount of materials collected; therefore, regional report includes a set of appendices, including information about flood management and water quality as well as data sets and other detailed information. In this manner, all of the information for each region is assembled in a single place to facilitate easier access to the materials.

Following are short descriptions of the 10 hydrologic region areas.

- **North Coast.** Klamath River and Lost River Basins, and all basins draining into the Pacific Ocean from Oregon south through the Russian River Basin.
- **San Francisco Bay.** Basins draining into San Francisco, San Pablo, and Suisun Bays, and into the Sacramento River downstream from Collinsville; western Contra Costa County; and basins directly tributary to the Pacific Ocean below the Russian River watershed to the southern boundary of the Pescadero Creek Basin.
- **Central Coast.** Basins draining into the Pacific Ocean below the Pescadero Creek watershed to the southeastern boundary of Rincon Creek Basin in western Ventura County.
- **South Coast.** Basins draining into the Pacific Ocean from the southeastern boundary of Rincon Creek Basin to the international border with Mexico.
- **Sacramento River.** Basins draining into the Sacramento River system in the Central Valley (including the Pit River drainage), from the Oregon border south through the American River drainage basin.
- **San Joaquin River.** Basins draining into the San Joaquin River system, from the Cosumnes River basin on the north through the southern boundary of the San Joaquin River watershed.
- **Tulare Lake.** The closed drainage basin at the south end of the San Joaquin Valley, south of the San Joaquin River watershed, encompassing basins draining to Kern Lakebed, Tulare Lakebed, and Buena Vista Lakebed.
- **North Lahontan.** Basins east of the Sierra Nevada crest and west of the Nevada state line, from the Oregon border south to the southern boundary of the Walker River watershed.
- **South Lahontan.** The interior drainage basins east of the Sierra Nevada crest, south of the Walker River watershed, northeast of the Transverse Ranges, and north of the Colorado River Region. The main basins are the Owens and the Mojave River Basins.
- **Colorado River.** Basins south and east of the South Coast and South Lahontan regions; areas that drain into the Colorado River, Salton Sea, and other closed basins north of the border with Mexico.

The Delta Region and Mountain Counties Area

- **Sacramento-San Joaquin Delta and Suisun Marsh.** An overlay area because of its common characteristics, environmental significance, and important role in the state's water systems. The region was the focus of the Governor's Blue Ribbon Delta Vision Task Force in 2006 through 2008. In December 2008, the Delta Vision Committee issued a final implementation report to the Governor and Legislature that includes near-term actions necessary to achieve Delta sustainability and to avoid catastrophe (see Chapter 3 Companion State Plans).
- **The Mountain Counties area.** Includes the foothills and mountains of the western slope of the Sierra Nevada and a portion of the Cascade Range. The area includes the eastern portions of the Sacramento River and San Joaquin River hydrologic regions and watersheds, and stretches from Plumas County in the north, into Fresno County in the south. This area shares common water supply and other resource issues that are compounded by urban growth. It also is the area of origin for much of the state's developed surface water supply.

Figure 4-3 **Integrated Regional Water Management planning regions accepted or conditionally accepted by DWR in November 2009**

Source: Integrated Regional Water Management Program, DWR. November 2009.

Table 4-1 California population change from 2000 to 2005 by hydrologic region

Hydrologic region	2000 Population	2005 Population	Growth
North Coast	644,000	670,287	4.1%
SF Bay	6,105,650	6,282,480	2.9%
Central Coast	1,459,205	1,524,720	4.5%
South Coast	18,223,425	19,638,116	7.8%
Sac River	2,593,135	2,882,452	11.2%
San Joaquin River	1,751,010	1,991,731	13.7%
Tulare Lake	1,884,675	2,098,631	11.4%
North Lahontan	99,010	103,885	4.9%
South Lahontan	721,490	822,168	14.0%
Colorado River	606,535	713,726	17.7%
California	34,088,135	36,728,196	7.8%

in the northern portions of the state, and below average to dry in the south and southeast portions for the same winter.

Land Use and Development Patterns

Population growth is a major factor influencing current and future water uses. From 1990 to 2005, California's population increased from about 30 million to about 36.5 million. The California Department of Finance projects that this trend means a state population of roughly 60 million by 2050. For historical population growth data by region, 1960-2005, go to Volume 5 Technical Guide. Table 4-1 shows California population change from 2000 to 2005 statewide and by hydrologic region.

California is one of the most productive agricultural regions in the world. Agriculture is an important element of California's economy, with 88,000 farms and ranches generating $32 billion in gross income in 2006, according to the California Department of Food and Agriculture and generating $100 billion in related economic activity. In 2000, California irrigated an estimated 9.6 million acres of cropland (includes multicropping) using roughly 34 million acre-feet of applied water. (See Box 4-3 The Rising Economic Efficiency of California Agricultural Water Use and the agricultural land stewardship strategy in Volume 2 Resource Management Strategies.)

California has more than 37 million acres of forest located primarily in the major mountain ranges of the state. Forests in California are owned and managed by a wide array of federal, State, Tribal, and local agencies, private companies, families and individuals, and nongovernmental organizations, each having a different forest management strategy with different goals and constraints. (See forest management strategy in Volume 2 Resource Management Strategies.)

Box 4-3 The Rising Economic Efficiency of California Agricultural Water Use

Comparing Changes in Applied Water Use and the Real Gross Value of Output for California Agriculture: 1967 to 2007

By Jim Rich, Economist, DWR
July 31, 2009

DWR economists recently analyzed how over the past 40 years the real value of California agricultural output has changed with respect to the water applied to California's farmland. The value of livestock and livestock products were included in this analysis because the vast majority of California's animal-based agriculture depends, in part, on our irrigated crops.

DWR estimates that the real, inflation-adjusted gross revenue for California agriculture increased about 84 percent between 1967 and 2007, from $19.9 billion (in 2007 dollars) to $36.6 billion. During that period, total California crop applied water use fell by 14.6 percent, from about 31.2 million acre-feet (maf) in 1967, to a preliminary estimate of 26.7 maf in 2007.

The rising real value of our agricultural output, coupled with falling crop water use, has more than doubled the "economic efficiency" of agricultural water use in California during the past 40 years. In 1967 about $638 (in 2007 dollars) of gross agricultural revenue was produced in California for each acre-foot of applied agricultural water. By 2007 this measure had risen to $1,373 per acre-foot. That represents a 115 percent increase in 40 years. Much of this increase has occurred since 2000 (see note below).

The main reason for the rise in the economic efficiency of California agricultural water use is the long-term shift out of lower-valued field crops, and into riskier, higher-valued truck, tree, and vine crops. Although such crops may bring in more average gross revenue per acre, they are subject to overproduction and sharp market swings, sometimes resulting in large net losses for the farmers who grow them.

NOTE: The source of the estimates in the second and third paragraphs is a draft DWR paper, Comparing Changes in Applied Water Use and the Real Gross Value of Output for California Agriculture: 1967 to 2007; March 2009. Find in Volume 4 Reference Guide.

Box 4-4 Land Use Jurisdiction

Cities and counties have the primary jurisdiction over land use and planning and regulation. Their authority derives from the State and its constitutional powers to regulate land use to protect the public health, safety, and welfare. Also, several statutes specifically authorize the preparation of local general plans and specific plans. The Governor's Office of Planning and Research provides advisory guidance in the preparation of the State's General Plan Guidelines that assist local governments in land use planning and management.

State and regional agencies play a limited role in local land use planning and regulation, for example:

- The California Coastal Commission regulates land use planning and development in the coastal zone, together with local agencies (cities and counties).
- The California Energy Commission has exclusive permitting authority for thermal powerplants 50 megawatts or greater and serves as a lead agency under the California Environmental Quality Act for projects within its jurisdiction.
- Three regional land use agencies have regulatory responsibilities: San Francisco Bay Conservation and Development Commission, the Coastal Commission and the Tahoe Regional Planning Agency. The regional Delta Protection Agency does not have permitting or regulatory authority.
- Regional Councils of Government (COGs) serve as metropolitan planning organizations for federal transportation planning and funding purposes although they differ from region to region in organization and regional effectiveness; COGs prepare regional growth plans to meet regional housing and transportation demand.

Land Use Patterns

California State government has typically played a limited or indirect role in land use planning (see Box 4-4 Land Use Jurisdiction). To the extent they exist for land use, state policies are expressed and "enforced" through local general plans and land use regulations.

Tribal Lands

California's 160 or so Native American Tribes may or may not be federally recognized. The federal government may set aside public lands for these Tribes as reservations or rancherias. Lists of these lands and more Tribal information appear in the regional reports. See also Tribal articles in Volume 4 Reference Guide.

Senate Bill 18 (Chapter 905, Statutes of 2004) requires cities and counties to consult with Native American Indian Tribes during the adoption or amendment of local general plans or specific plans. A contact list of California Tribes and representatives within a region is maintained by the Native American Heritage Commission. Each regional report in Volume 3 lists some Tribal information known for that region.

Water Conditions

A survey of California's water scene yields an assortment of existing crises. For example, the Delta, the hub of the state's water supply and delivery system and a crossroad of other critical infrastructure, faces serious ecosystem problems and substantial seismic risk that threaten water supply reliability and quality. Many groundwater basins suffer from overdraft and pollution. The Colorado River, an important source of water for Southern California, is weathering a historic drought that has again brought into question the hydrology used for the allocation of water among the seven states that share it. Throughout California, flood risk grows as levees age and more people live and work in floodplains.

Environmental Water

Although a considerable amount of water is dedicated to maintenance and restoration of aquatic and riparian ecosystems, environmental needs are not always met. Recent studies of the streamflow requirements of aquatic life, mainly represented by salmon, reveal that flows in many California rivers and streams sometimes fall below minimum desirable levels.

These minimum flow levels are called objectives in the scenarios of Chapter 5 Managing an Uncertain Future. Objectives for the major rivers, estuaries, and wetlands of northern and central California are tabulated in Chapter 5, along with the amount of water needed to meet each of them.

Box 4-5 DFG Streamflow Recommendations Developed in 2008

Pursuant to Public Resources Code (PRC) Section 10001, in the early 1980s the Department of Fish and Game identified 21 streams and watercourses for which minimum flow levels needed to be established in order to assure the continued viability of stream-related fish and wildlife resources. The following list of streams with high priority for the development of flow recommendations was developed in coordination with all DFG regional offices:

- Carmel River, Monterey County
- Redwood Creek, Marin County
- Brush Creek, Mendocino County
- Lower American River, Sacramento County
- Lagunitas Creek, Marin County
- Lake Tahoe Basin, multiple counties
- North Fork Feather River, multiple counties
- Upper West Fork of the San Gabriel River, Los Angeles County
- Yuba River, Yuba County
- Rush Creek, Mono County
- Lower Mokelumne River, San Joaquin County
- Parker Creek, Mono County
- South Parker Creek, Mono County
- Walker Creek, Mono County
- Upper Owens River, Mono County
- Lee Vining Creek, Mono County
- Merced River, Merced County
- Scott Creek, Santa Cruz County
- Mill Creek, Mono County
- Truckee River Basin, multiple counties
- Battle Creek, Shasta and Tehama counties

Restoration of adequate instream flows, as well as the floodplain functions that depend on flow, is the statewide priority for the California Department of Fish and Game. Thus, DFG looked beyond the list of major water bodies to identify 21 additional streams (Box 4-5 DFG Streamflow Recommendations Developed in 2008) for which flow objectives needed to be established to assure the continued viability of their fish and wildlife resources. DFG developed objectives for those streams and submitted them as flow recommendations to the State Water Resources Control Board (State Water Board) in May 2008. Flows in all 21 streams are believed to fall short of the objectives in at least some seasons and years.

DFG also developed a list of 22 other streams regarded by State and federal fish and wildlife agencies as high priority for future instream flow studies (Box 4-6). That list was submitted to the State Water Board in August 2008. Again, flows in those streams are thought to be insufficient. The combined list of 43 streams represents a broad cross-section of smaller perennial watercourses in the various regions of California.

Water Supplies and Uses

During the 20th century, Californians were able to meet water demands primarily through an extensive network of water storage and conveyance facilities, groundwater development, and more recently, by improving water efficiency.

Significant water supply and water quality challenges persist on the local and regional scale. Although some regions have made great strides in water conservation and

Box 4-6 High-priority List of Streams for Future Instream Flow Studies

The Department of Fish and Game developed this list of 22 priority streams or watercourses for future instream flow. The list was compiled and ranked based on input from DFG staff, staff from the State Water Board, US Fish and Wildlife Service, and the National Marine Fisheries Service. In developing the ranking, staff considered criteria such as (1) presence of anadromous species; (2) likelihood, that DFG flow recommendations would provide a high level of improvement; (3) availability of recent flow studies or other relevant data; and 4) the possibility of partners/willing partners and landowners.

Rank	Stream or Watercourse	DFG Region	County
1	Butte Creek	2	Butte
2	Tuolumne River (below La Grange Dam)	4	Stanislaus
3	San Gregorio Creek (lower)	3	San Mateo
4	North Fork of Navarro River	1	Mendocino
5	Big Sur River	4	Monterey
6	Santa Maria River	5	Santa Barbara
7	Redwood Creek (tributary to Maacama)	3	Sonoma
8	Bear River (below Camp Far West)	2	Placer and Nevada
9	Shasta River	1	Siskiyou
10	Carmel River	4	Monterey
11	Santa Margarita River	6	Riverside
12	Merced River (below Crocker-Huffman Dam)	4	Merced
13	Redwood Creek (tributary to Napa)	3	Napa
14	Scott River	1	Siskiyou
15	Mattole River (near Whitethorn)	1	Humboldt
16	Dry Creek (tributary to Napa River)	3	Napa
17	Deer Creek (tributary to Yuba River)	2	Nevada
18	Mojave River	6	Riverside
19	Carpinteria Creek	5	Santa Barbara
20	Santa Ana River	6	Riverside, San Bernardino
21	Middle Fork Feather River	2	Plumas
22	Dos Pueblos Creek	5	Santa Barbara

Prepared by the Department of Fish and Game Pursuant to Public Resources Code (PRC) Section 10004. August 8, 2008

efficiency, the state's water consumption has grown along with its population. Many communities in the state are reaching the limits of their supply with current water systems management practices and regulations.

The state's water resources are variable, and agricultural, urban, and environmental water uses all vary according to the wetness or dryness of a given year. In very wet water years with excessive precipitation, agricultural and urban landscape (outdoor) water demands are lower due to the high amount of rainfall that directly meets the

needs. Water demands are usually highest during average to below-average water years in which agricultural and outdoor water uses are at full deployment. During the very dry water years, demands for water are reduced as a result of urban and agriculture water conservation practices and because the available surface water supplies are at less-than-average levels for use.

An indicator of California's hydrology and the annual surface water supplies is the amount of water that flows into major rivers of the state. For the central portions of California, the Sacramento River Basin and San Joaquin River Basin indices have been used for many years to evaluate the amount of surface water available. As shown in Figure 4-4 and Figure 4-5 these two river indices describe unimpaired natural runoff from year 1906 to the present, with five-year classifications identified from wet to critical. Many decisions about annual water requirements for the Delta are based on these indices, as are the amounts of surface water supplies available to many agricultural and urban regions of the state.

***Water years** are measured from October 1 through September 30 of the following year. A water year refers to the September year, for example, water year 2006 covers the months October 2005 through September 2006.*

Surface and Groundwater—a Single Resource

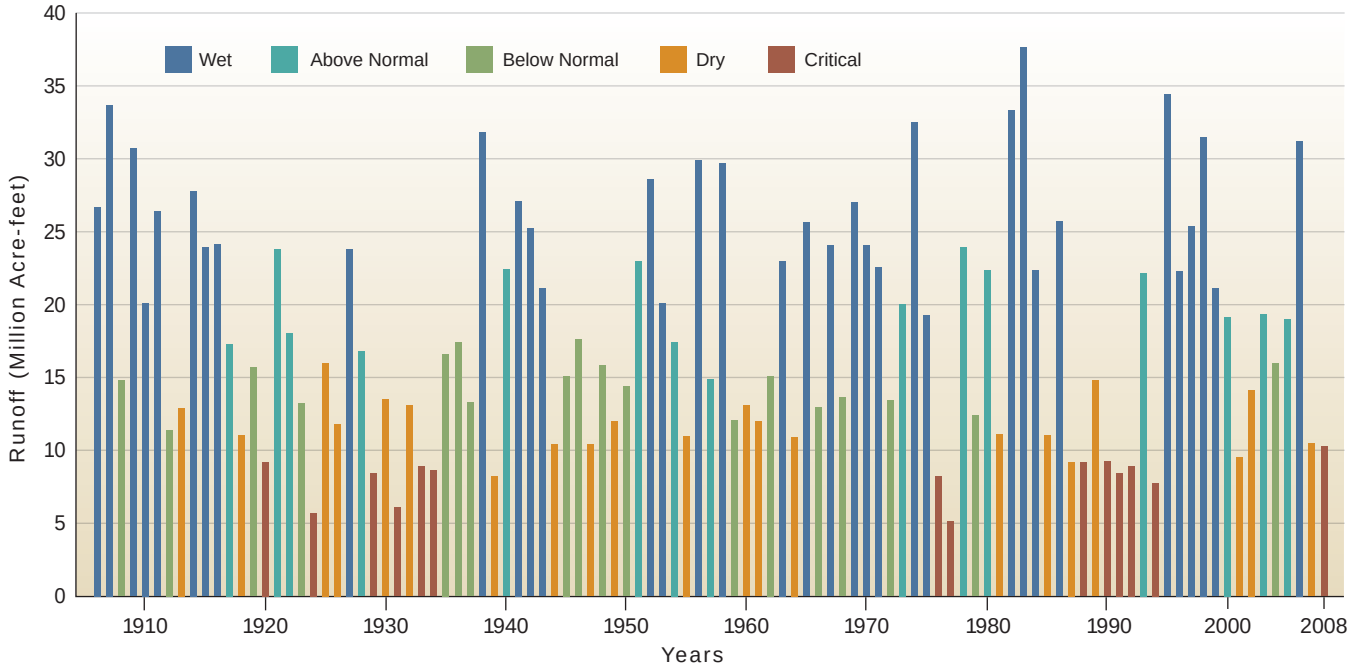
In California, winter precipitation and spring snowmelt are captured in surface water reservoirs to provide both flood protection and water supply to the state. Reservoir storage also factors into drought assessment. The state's largest surface "reservoir" is the Sierra Nevada snowpack, about 15 million acre-feet on average. A projected reduction in this snowpack due to climate change will have a critical impact on California water management. (See climate change discussion under Critical Challenges.)

Water year 2009 was another dry year for California. Figure 4-6 shows statewide runoff in percentage for 2006 through 2009 and end-of-year storage for the state's larger reservoirs: Trinity, Shasta, Oroville, Folsom, Don Pedro, New Melones, and San Luis reservoirs.

Other factors also affect the availability of surface water. In December 2007, US District Court Judge Oliver Wanger imposed restrictions on water deliveries from the Delta to protect the threatened delta smelt. This can significantly decrease deliveries to homes, farms, cities, and industry by both the State Water Project (SWP) and the federal Central Valley Project (CVP) depending on the water year type. In 2009, National Marine Fisheries Service issued a biological opinion intended to protect salmon, steelhead, and green sturgeon. NFMS calculates that its biological opinion will reduce by 5 to 7 percent combined the amount of water federal and State projects will be able to deliver from the Delta.

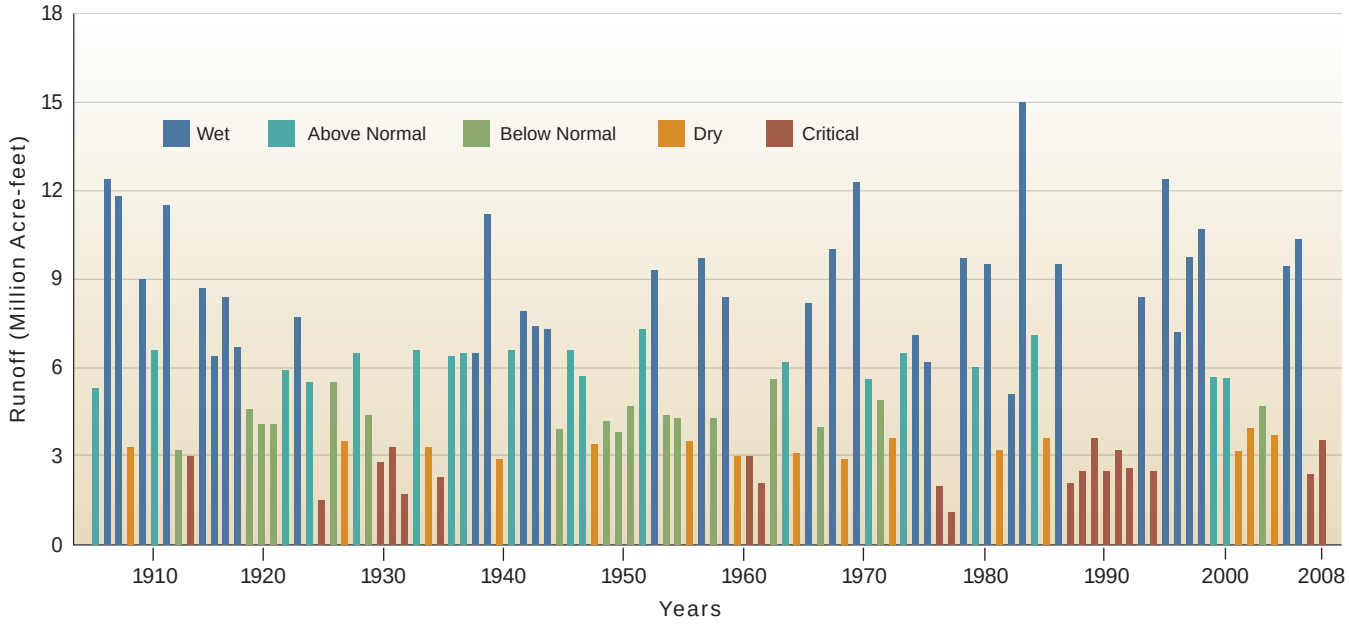
Initial SWP deliveries in 2009 were only 15 percent, although the final allocation was raised to 40 percent after early May snow and rain improved water conditions. Since the SWP began allocating deliveries in 1968, the lowest final allocations have been 35 percent in 2008; 39 percent, 2001; and 30 percent, 1991. DWR announced in December 2009 an initial allocation of 5 percent of total contracted water deliveries to the SWP contractors for 2010.

Figure 4-4 Sacramento Four Rivers unimpaired runoff, 1906–2008



The Sacramento Four Rivers are: Sacramento River above Bend Bridge, near Red Bluff; Feather River inflow to Lake Oroville; Yuba River at Smartville; American River inflow to Folsom Lake

Figure 4-5 San Joaquin Four Rivers unimpaired runoff, 1906–2008



The San Joaquin Four Rivers are: Stanislaus River inflow to New Melones Reservoir, Tuolumne River inflow to New Don Pedro Reservoir, Merced River inflow to New Exchequer Reservoir, San Joaquin River inflow to Millerton Reservoir.

Box 4-7 Groundwater Overdraft

Overdraft is the condition of a groundwater basin in which the amount of water withdrawn by pumping over the long term exceeds the amount of water that recharges the basin. Overdraft is characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years. Overdraft can lead to increased extraction costs, land subsidence, water quality degradation, and environmental impacts. A comprehensive assessment of overdraft in California's groundwater basins has not been conducted since 1980 (DWR 1980). It is estimated that overdraft is between 1 million and 2 million acre-feet annually (DWR 2003 Bulletin 118), but the estimate is only tentative with no current corroborating data.

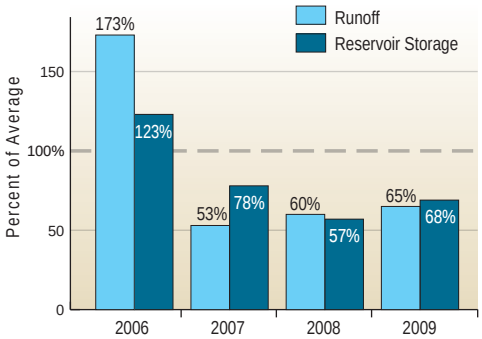
In some cases the term overdraft has been incorrectly used to describe a short-term decline in groundwater in storage during a drought, or to describe a one-year decline of groundwater in storage. A one-year decrease of the amount of groundwater in storage is an annual change in storage and does not constitute overdraft. During a drought the aquifer is being used as a reservoir, and water is being withdrawn with the expectation that the aquifer will be recharged during a wet season to follow.

The total water year 2008 deliveries for the CVP are estimated at 5.7 million acre-feet. Historically, the CVP supplies annually about 7 million acre-feet of water for agriculture, cities, and the environment.

Future deliveries of SWP water are subject to several areas of uncertainty:

- the recent and significant decline in pelagic organisms (open-water fish such as delta smelt and striped bass) in the Delta;
- climate change and sea level rise; and
- the vulnerability of Delta levees to failure due to floods and earthquakes.

Figure 4-6 Total statewide runoff and key reservoir storage end of water years 2006-2009



Statewide runoff totals and end-of-water-year storage, 2006 to 2009, for key reservoirs (Trinity, Shasta, Oroville, Folsom, Don Pedro, New Melones, and San Luis) as a percentage of average.

Source: DWR 2009

In some areas, use of groundwater resources is threatened by high rates of extraction and inadequate recharge, or by contamination of aquifers as a result of land use practices (Box 4-7 Groundwater Overdraft) or naturally occurring contaminants. Management of groundwater resources is more complex than management of surface water resources because groundwater is not visible. The quality of water in private wells is unregulated and, thus, private well owners are often unaware of the potential water quality threats in their drinking water.

Small water systems and private well owners have historically experienced most of the water shortage emergencies during droughts. The majority of these problems result from dependence on unreliable water sources, commonly groundwater in fractured rock or small coastal terrace groundwater basins. Historically, at-risk geographic areas include the foothills of the Sierra Nevada and Coast Range, inland Southern California, and the

Box 4-8 Water Portfolio Concept and Key Definitions

This box explains how to read the water balance figures and tables—statewide and regional and about related information contained in this chapter, the regional reports, and in Volume 5 The Technical Guide

The primary reason for using water portfolio tables and flow diagrams is to provide an accounting of all water that enters and leaves the state and how it is used and exchanged between the regions. This is important to all water planning activities. Water portfolio data provide information for comparison about how water uses and sources of supply can vary between the wet, average, and dry hydrologic conditions for each of the hydrologic regions of the state. The statewide information has been compiled from the 10 hydrologic regions.

The water summary table provides more detailed information about total statewide water supply sources and provides estimates for the primary uses of the state's supplies for these years. As indicated, a large component of the statewide water supply is used by natural processes, such as evaporation, evapotranspiration from native vegetation and forests, and percolation to groundwater. This water is generally not counted as part of the dedicated water supplies. Each of the regional reports presents this information at the regional level. For some of the items presented in this table, the numerical values were estimated because measured data are not available on a statewide basis.

A more detailed statewide summary of dedicated water supplies and uses for water years 1998-2005 is presented in Volume 5 The Technical Guide, which provides a breakdown of the components of developed supplies and uses for agricultural, urban, and environmental purposes. For each of the water years, information is presented as applied water and net water usage, as well as the calculated total water depletion. Much of the environmental water in this table is dedicated to meeting instream flow requirements and in Wild and Scenic rivers, which in some cases can later be reused for other downstream purposes.

Key Water Supply and Use Definitions

For consistency with the 1998 and 2005 updates of the California Water Plan, Update 2009 computes dedicated water supplies and uses on the basis of applied water data.

- **Applied water** refers to the total amount of water that is diverted from any source to meet the demands of water users, without adjusting for water that is used up, returned to the developed supply, or considered irrecoverable.
- **Water Supplies and Uses** present total statewide information only on an applied water basis. However, for the subsequent more detailed statewide data tables and each of the individual regional reports the information has been expanded to also present net water uses and water depletion.
- **Net water** supply and net water use data are smaller than applied water use. Net water use consists of water that is consumed in the system plus irrecoverable water and return flows.
- **Water depletion** is net water use minus water that can be later recovered, such as deep percolation and return flows to developed supply. Water supply information that is presented using applied water methodology is easier for local water agencies to evaluate because applied water use information is closer in concept to agency water system delivery data.

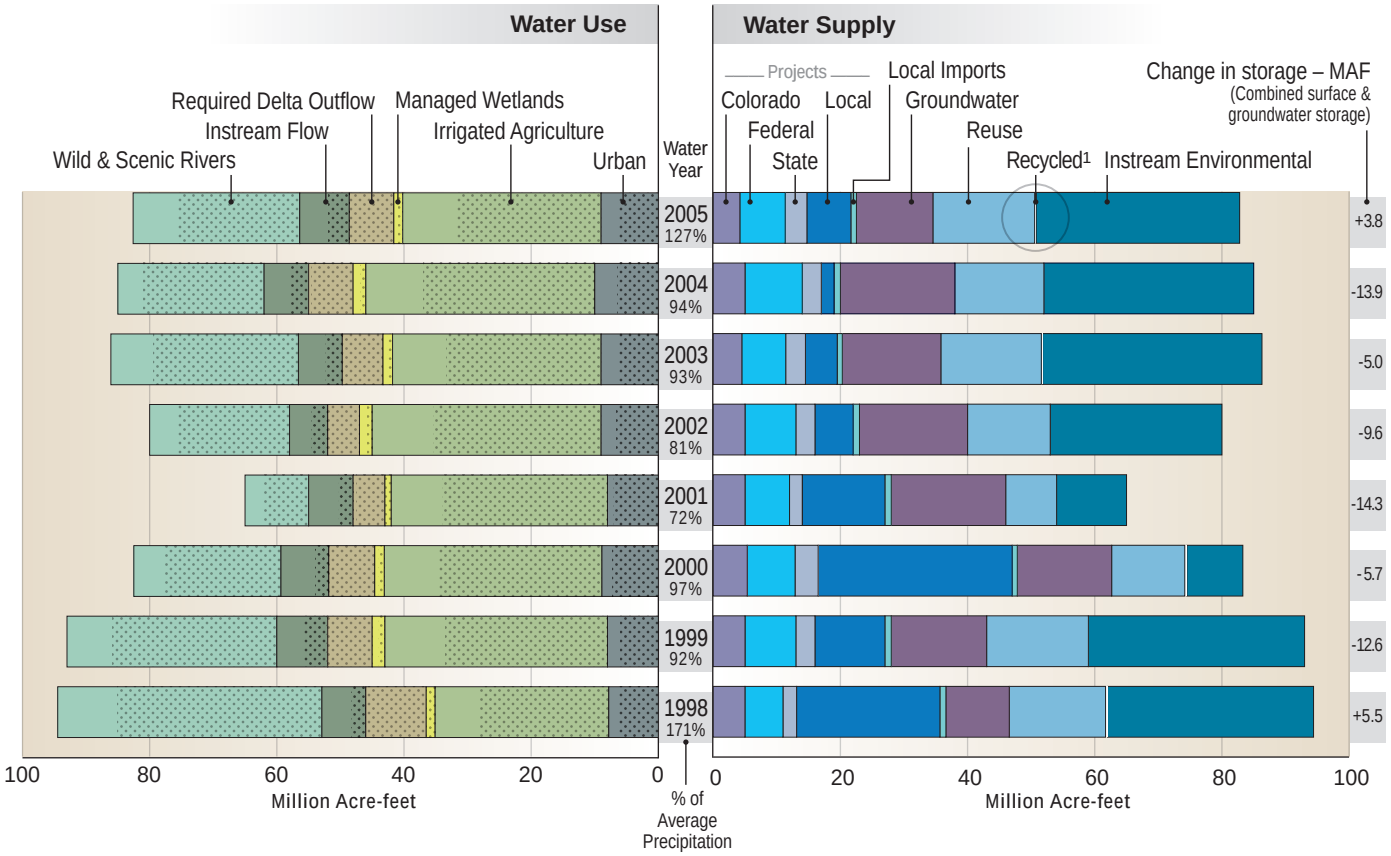
North Coast and Central Coast regions. Most small systems and private wells are located in lightly populated rural areas where opportunities for interconnections with another system, water transfers, or emergency relief are difficult.

Colorado River Supplies

Prior to 2003, California's annual use of Colorado River water ranged from 4.5 million to 5.2 million acre-feet. In recent years, Arizona has begun full use of its basic apportionment, and Nevada has approached full use of its entitlement and surplus allocation. Therefore, California has had to reduce its dependence on Colorado River water to 4.4. million acre-feet in average years.

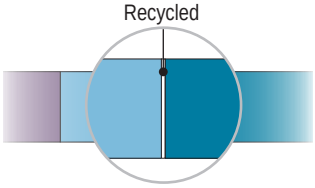
A record eight-year drought in the Colorado River Basin has reduced current reservoir storage throughout the river system to just over 50 percent of total storage capacity.

Figure 4-7 California water balance by year, 1998-2005



Stippling in bars indicates depleted (irrecoverable) water use *(water consumed through evapotranspiration, flowing to salt sinks like saline aquifers, or otherwise not available as a source of supply)*

[1] Detail of bar graph: *For water years 1998-2005, recycled municipal water varied from 0.2 to 0.5 MAF of the water supply .*



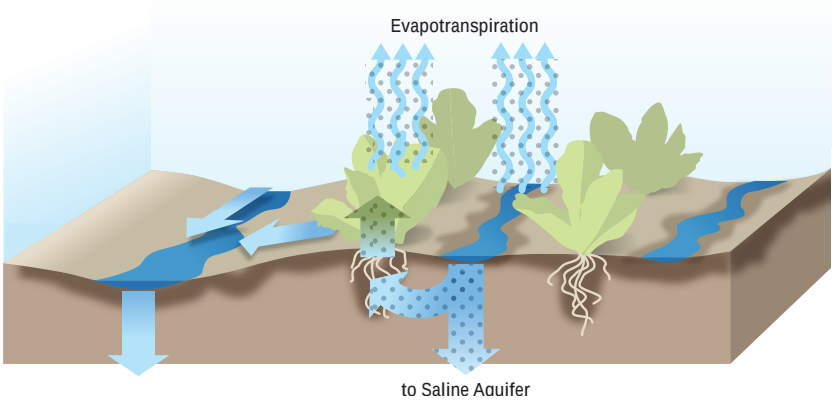


Table 4-2 California water balance summary, 1998-2005. (Numbers in million acre-feet)

Statewide	Water Year (Percent of average precipitation)							
	1998 (171%)	1999 (92%)	2000 (97%)	2001 (72%)	2002 (81%)	2003 (93%)	2004 (94%)	2005 (127%)
Water Entering the Region								
Precipitation*	329.6	181.3	187.7	139.2	160.1	184.4	186.5	251.9
Inflow from Oregon/Mexico	2.3	2.4	1.7	1.1	1.1	1.1	1.1	1.0
Inflow from Colorado River	5.0	5.1	5.3	5.2	5.4	4.5	4.8	4.2
Imports from Other Regions	NA	NA	NA	NA	NA	NA	NA	NA
Total	**336.9**	**188.8**	**194.7**	**145.5**	**166.7**	**190.0**	**192.4**	**257.2**
Water Leaving the Region								
Consumptive Use of Applied Water ** (Ag, M&I, Wetlands)	22.5	27.6	27.9	27.8	29.3	26.7	29.2	24.4
Outflow to Oregon/Nevada/Mexico	1.6	1.7	0.9	0.7	0.8	1.1	0.8	1.4
Exports to Other Regions	NA	NA	NA	NA	NA	NA	NA	NA
Statutory Required Outflow to Salt Sink	43.8	51.8	28.0	13.9	29.6	39.8	36.7	37.3
Additional Outflow to Salt Sink	73.0	34.0	37.1	17.7	24.0	29.9	24.7	22.7
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows	190.5	86.3	106.5	99.7	92.7	97.7	114.9	167.6
Total	**331.4**	**201.4**	**200.4**	**159.8**	**176.4**	**195.2**	**206.3**	**253.4**
Storage Changes in the Region								
[+] Water added to storage [-] Water removed from storage								
Change in Surface Reservoir Storage	7.2	-4.1	-1.3	-4.6	0.1	3.7	-4.1	7.9
Change in Groundwater Storage ***	-1.7	-8.5	-4.4	-9.7	-9.7	-8.7	-9.8	-4.1
Total	**5.5**	**-12.6**	**-5.7**	**-14.3**	**-9.6**	**-5.0**	**-13.9**	**3.8**
Applied Water ** (compare with Consumptive Use)	33.9	41.3	41.8	41.2	43.9	40.6	44.1	38.2

* The percent precipitation is based upon a running 30-year average of precipitation for the region; discrepancies can occur between information calculated for Update 2009 and earlier published data.

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

*** Change in Groundwater Storage is based upon best available information. Basins in the north part of the state (North Coast, San Francisco, Sacramento River and North Lahontan regions and parts of Central Coast and San Joaquin River Regions) were modeled - spring 1997 to spring 1998 for the 1998 water year and spring 1999 to spring 2000 for the 2000 water year. All other regions and years were calculated using the following equation:

GW change in storage = intentional recharge + deep percolation of applied water + conveyance deep percolation and seepage - withdrawals

This equation does not include the unknown factors such as natural recharge and subsurface inflow and outflow.

NA=Not Applicable

Water Portfolio and Water Balances

Statewide information has been compiled to present the current levels of California's developed water uses and the water supplies available for water years 1998 through 2005. Data for years 1998, 2000, and 2001 were presented Update 2005. For Update 2009, the same data structure and water portfolio concepts have been used to assemble and present statewide information for the additional years (see Box 4-8 Water Portfolio Concept and Key Definitions). Statewide summaries of the detailed water supplies and applied water uses, 1998 through 2005, are presented in Volume 5 Technical Guide. For consistency, the same portfolio format and data tables are used for regional reports.

Statewide balances are available for eight years, 1998-2005 (Figure 4-7 California water balance by year, 1998-2005 and Table 4-2 California Water summary, 1998-2005). Regional balances are available in the regional reports (Volume 3). The eight-year sequence did not include any major floods and does not encompass the possible range of far wetter and far drier years in the record.

The statewide water balance figure demonstrates the state's variability for water use and water supply. "Water use" shows how applied water was used by urban and agricultural sectors and dedicated to the environment; and "water supply" shows where the water came from each year to meet those uses.

California in an average water year like 2000 receives close to 200 million acre-feet of water from precipitation and imports from Colorado, Oregon, and Mexico. Of this total supply, about 50 to 60 percent is either used by native vegetation; evaporates to the atmosphere; provides some of the water for agricultural crops and managed wetlands (referred to as effective precipitation); or flows to Oregon, Nevada, the Pacific Ocean, and salt sinks like saline groundwater aquifers and Salton Sea. The remaining 40 to 50 percent, identified as dedicated or developed water supplies as shown in the figure and the table, is distributed among urban and agricultural uses, for protecting and restoring the environment, or as storage in surface water and groundwater reservoirs for later use. In any year, some of the dedicated supply includes water that is used multiple times (reuse) and water held in storage from previous years. Ultimately, about a third of the dedicated supply flows to the Pacific Ocean or to other salt sinks, in part to meet environmental water requirements for designated Wild and Scenic rivers and other environmental requirements and objectives.

In each of the regional reports, bar charts similar to the statewide water balance summary provide regional data; they can be compared to the statewide figure to understand how individual regions compare to the statewide distribution. Figure 4-8 depicts water balances for the hydrologic regions for year 2005, considered a wet year statewide. Water balances can be used to compare how water supplies and uses can vary between wet, average, and dry hydrologic conditions by region and how each region's water balance can vary from year to year.

Water balances can be used to compare how water supplies and uses can vary between wet, average, and dry hydrologic conditions by region and how each region's water balance can vary from year to year.

Figure 4-8 Water balance by region for water year 2005

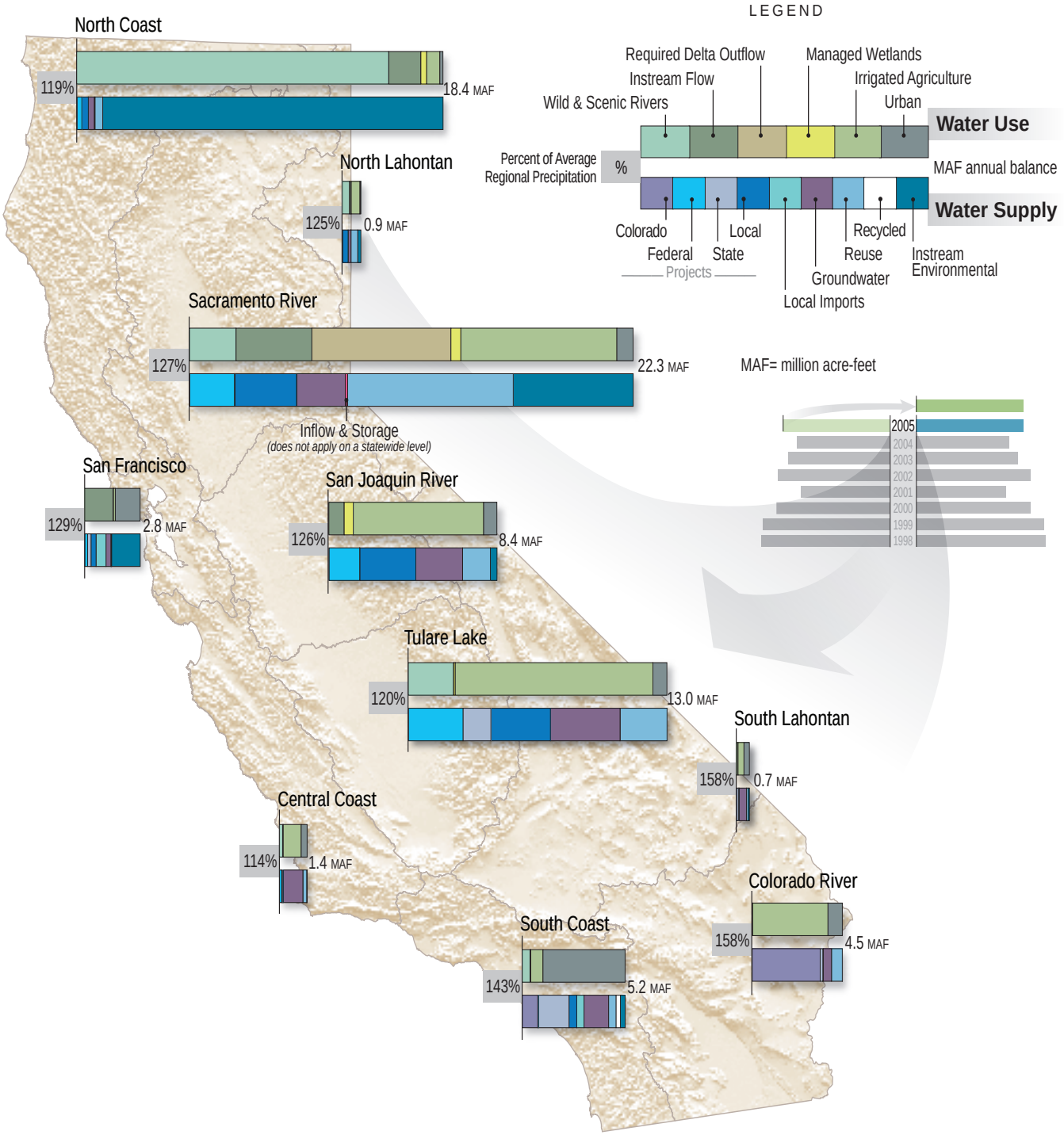


Figure 4-9 Regional inflows and outflows, water year 2005

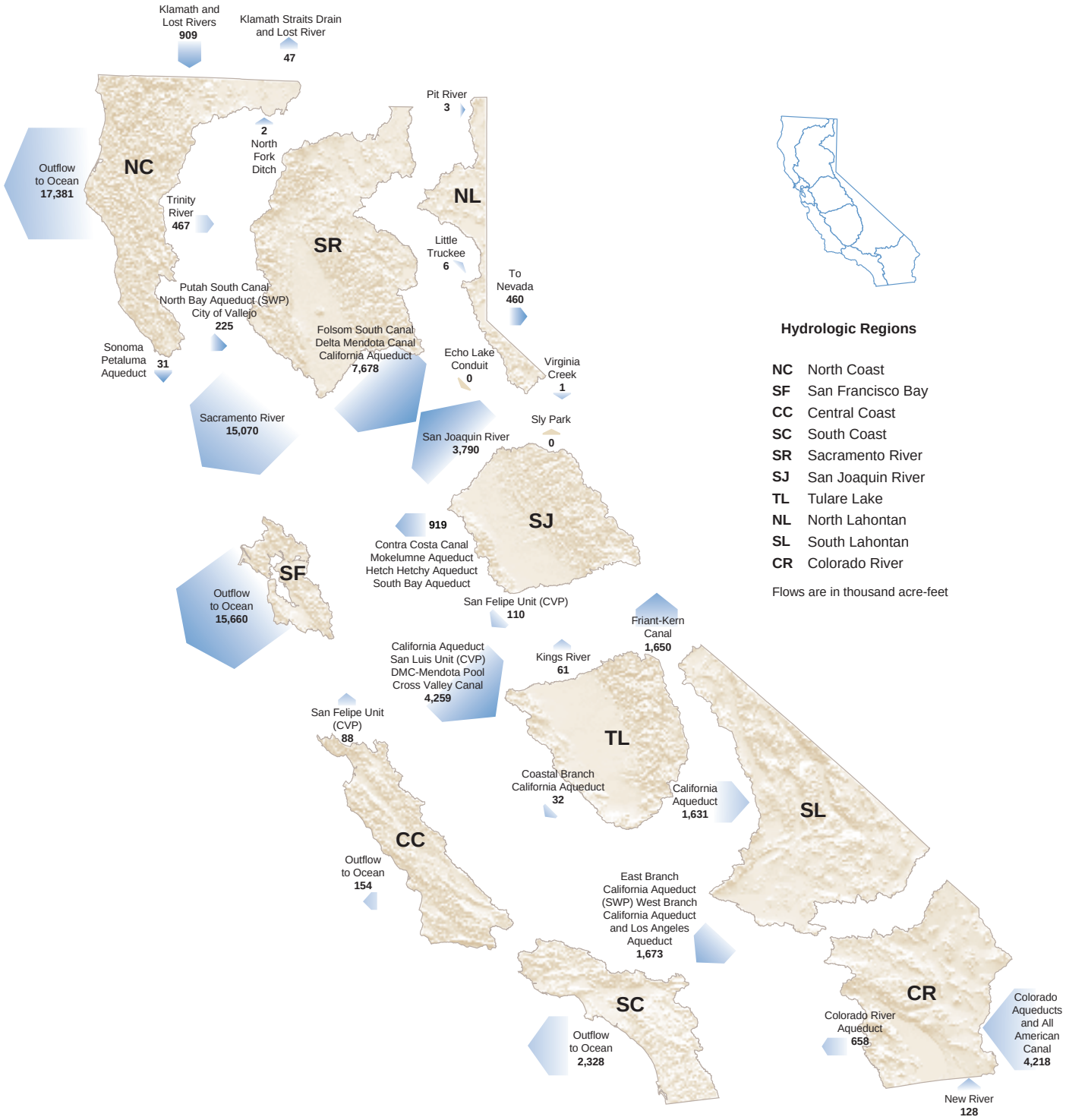


Table 4-3 Basin plan adoption dates

Regional Board Region	Latest Basin Plan
1. North Coast	2007
2. San Francisco Bay	1995
3. Central Coast	1994
4. Los Angeles	1994
5. Sacramento-San Joaquin	4th edition 1998
5. Tulare Lake	2nd edition 2004
6. Lahontan	2007
7. Colorado	2006
8. Santa Ana	2008
9. San Diego	1994

When water supply and water use information from the regional reports is accumulated for the statewide totals, some categories are not applicable, such as interregional water transfers between one hydrologic region and an adjoining region. This type of information is not shown in the statewide tables. Figure 4-9 shows inflows and outflows between California's hydrologic regions using data from current base year 2005, a wet water year.

Water Quality

With a growing population of more than 30 million and a limited supply of fresh water, the protection of water for beneficial uses is of paramount concern for all Californians. The State Water Board and the nine Regional Water Boards, under the umbrella of the California Environmental Protection Agency, are responsible for protecting California's water resources. The Department of Public Health is responsible for protecting drinking water quality. Significant discussion of the major water quality issues and initiatives are included in the 12 regional reports of Volume 3. See further discussion under Contamination of Surface Water and Groundwater under Critical Challenges.

Since the passage of the federal Clean Water Act in 1972, California has made great strides in cleaning up its rivers, lakes, groundwater aquifers, and coastal waters. The primary focus of that effort, both in California and nationally, has been on wastewater discharged from "point sources," for example, sewer outfalls and other easily identifiable sources such as pipes. An even greater challenge is pollution resulting from "nonpoint sources," for example, runoff and drainage from urban areas, agriculture, timber operations, mine drainage, and other sources for which there is no single point of discharge. Nonpoint source pollution is the most significant California water quality challenge today and requires flexible and creative responses. Although water quality issues can be essentially divided into the two categories—point and nonpoint sources—specific constituents and circumstances vary from region to region as can be seen in reading each regional report.

Drought periods underscore the inseparability of water supply and water quality. Over-pumping groundwater basins to augment water supplies reduces long-term available water supply, increases pumping costs, and in some areas, like along the coast, degrades groundwater quality. In many areas surface water and groundwater are impaired by natural and human-made contaminants that can threaten human health, degrade the natural environment, increase water treatment costs, and effectively reduce the available water supply.

By law, water quality basin plans prepared by the State and Regional Water Boards when approved become part of the California Water Plan. In the future, those basin plans along with other water quality reports will be integrated regionally into the water portfolios. (See Table 4-3 Basin Plan adoption dates.)

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Project Operation and Reoperation

California depends on vast statewide water management systems to provide clean and reliable water supplies, protect lives and property from floods, withstand drought, and sustain environmental values. These water management systems include physical facilities and their operational policies and regulations. Facilities include more than 1,200 State, federal, and local reservoirs, as well as canals, treatment plants, and levees. Systems are often interconnected. The operation of one system can depend on the smooth operation of another. The successful operation of the complete system can be vulnerable if any parts fail. (Read more about this management objective and related strategies in Volume 2 Resource Management Strategies.)

Conditions today are much different than when most of California's water systems were constructed; and upgrades have not kept pace with changing conditions, especially considering growing population; changing society values, regulations, and operational criteria; and the future challenges accompanying climate change. California's flood protection system, composed of aging infrastructure with major design and construction deficiencies, has been further weakened by lack of maintenance. State and regional budget shortfalls and tightened credit market may delay new projects and programs.

Conditions today are much different than when most of California's water systems were constructed; and upgrades have not kept pace with changing conditions, especially considering growing population; changing society values, regulations, and operational criteria; and the future challenges accompanying climate change.

Surface and groundwater resources must be managed conjunctively to meet the challenges of climate change. Additional water storage and conveyance improvements are necessary to provide flexibility to facilitate water transfers between regions and to provide better flood management, water quality, and system reliability in response to daily and seasonal variations and uncertainties in water supply and use.

Water Governance

In California, water use and supplies are controlled and managed under an intricate system of common law principles, constitutional provisions, State and federal statutes, court decisions, and contracts or agreements. All of these components constitute the institutional framework for the protection of public interests and their balance with private claims in California's water allocation and management.

Many State agencies are involved in California water management. For example, DWR focuses on water delivery, water supply and flood planning, and infrastructure development. The State Water Boards manage water rights and water quality through regulation. Federal agencies also play a role in California water supply, quality, and flood control. DWR formally recognized the multiple levels of water-related interests and mandates by establishing the Water Plan's Steering Committee—composed of 21 State agencies and departments—and collaborating with federal and other non-State agencies. See more discussion of this cooperation in this volume: Chapter 1 Introduction and Chapter 3 Companion State Plans. See also Water Allocation, Use, and Regulation in California and other articles on water governance in Volume 4 Reference Guide.

California Constitution

The California Constitution was amended in 1928 to require that all water uses be reasonable and beneficial and to prohibit the waste and unreasonable use or unreasonable method of use of all water resources (Art. X, sec 2).

Federal Land Management

Federal agencies are trustees of about 50 percent of California land. The federal government owns more than 62 percent of California's 37 million-plus acres of forest land with the US Department of Agriculture Forest Service as the largest public forest landowner in the state. The national forests in California were established under the Organic Act of 1897, which states that a primary purpose of the national forests is to "secure favorable flows of water."

- US Forest Service, 20,166,000 acres (53.7 percent)
- US Bureau of Land Management, 1,650,000 acres (4.4 percent)
- National Park Service, 1,287,000 acres (3.4 percent)
- Other federal entities, 231,000 acres (0.6 percent)

Environmental issues related to resource management on national forests are addressed under the National Environmental Policy Act. (See forest management strategy in Volume 2 Resource Management Strategies)

The US Bureau of Land Management administers more than 15 million acres of California's public lands, about 15 percent of the state's total acreage. Among these lands are 10.66 million acres of National Conservation Area and 3.7 million acres of Wilderness. Through BLM, the federal government also holds most (in volume) of the water rights in the state with more than 112 million acre-feet of water rights held, mainly through the delivery of the CVP.

Tribal Water Management

Water needs, rights, and uses of the many Tribes in California are as varied as the state's diverse water community. Some lack clean affordable water. Some need water for fisheries, wildlife, agriculture, and other cultural practices associated with Tribal lands.

See information on Tribes and Tribal water issues in Volume 4 Reference Guide. Regional reports list Tribal concerns expressed at Water Plan regional workshops and plenary meetings to support the California Tribal Water Summit held in November 2009. Proceedings of this summit are in Volume 4.

Flood Management

Traditionally, flood management practices focused on reducing flooding and susceptibility to flood damage largely through the physical measures intended to store floodwaters, increase the conveyance capacity of channels, and separate rivers from adjacent populations. In recent years, flood managers have recognized the potential for natural watershed functions and worked to integrate these two methods. Integrated flood management is a comprehensive approach to flood management that considers land and water resources at a watershed scale within the context of integrated water management, which aims to maximize the benefits of floodplains, minimize the loss of life and damage to property from flooding, and recognize the benefits to ecosystems from periodic flooding. Integrated flood management does not rely on a single approach to flood management, but instead uses various techniques—including traditional (or structural) flood protection projects, nonstructural measures (such as land use practices), and reliance on natural watershed functions—to create an integrated flood management system.

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For the purposes of federal flood insurance, the Federal Emergency Management Agency (FEMA) has traditionally used the "100 year" flood event, which refers to the level of floodflows expected at least once in a 100-year period. As California's hydrology changes, what is currently considered a "100-year" flood may strike more often, leaving many communities at greater risk. Moreover, as climate change alters predicted peak flows and precipitation levels, the assumption of "stationarity," which is used in flood-related statistical analyses like the "100-year" flood, becomes less assured. Planners need to factor a new level of safety into the design, operation, and regulation of flood control facilities—such as dams, floodways, bypasses, and levees—as well as the design of local sanitary sewers and storm drains.

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Critical Challenges

California is facing one of the most significant water crises in its history—one that is hitting hard because it has so many aspects. Growing population and reduced water supplies are exacerbating the effects of a multi-year drought. Climate change is reducing our snowpack storage and increasing floods. Court decisions and new regulations have resulted in the reduction of Delta water deliveries by 20 to 30 percent. Key fish species continue to decline. In some areas of the state our ecosystems and quality of underground and surface waters are unhealthy. The current global financial crisis will make it even more difficult to invest in solutions.

Figure 4-10 Potential impacts of continuing drought

Source: DWR 2009

The challenge to make sure that water is in the right place at the right time is at its greatest during dry years—when water for the environment is curtailed sharply, less water is available from rainfall for agriculture, and greater reliance on groundwater results in higher costs for many users. In the meantime, those who have already increased water use efficiency may find it more challenging to achieve additional water use reductions.

The quality of California water is of particular and growing concern. Various water management actions potentially have water quality impacts. These include transfers, water use efficiency, water recycling, conjunctive use of aquifers, storage and conveyance, Delta operations, crop idling, and hydroelectric power. Degraded water quality can limit, or make very expensive, some water supply uses or options because the water must be pretreated. Furthermore, water managers increasingly recognize that the water quality of various water supplies needs to be matched with its eventual use and potential treatment.

Challenges persist for California water management at statewide, regional, and local levels. Significant statewide challenges that require improved water management are summarized here. Challenges and opportunities on a regional level are addressed in the regional reports of Volume 3.

Dry-year Period (Drought)

A third consecutive dry year, drought conditions in the Colorado River Basin, and a Sierra snowpack that is now dangerously unreliable due to climate change are leaving many communities throughout California facing mandatory restrictions on water use and/or rising water bills. In 2008 and again in 2009, the Governor issued an executive order and proclamation in response to statewide drought conditions. If the conditions continue, the results could be catastrophic for our economy.

Impacts of drought are typically felt first by those most reliant on annual rainfall—ranchers engaged in dryland grazing, rural residents relying on wells in low yield rock formations, or small water systems lacking a reliable source. Drought impacts increase with the length of a drought, as carry-over supplies in reservoirs are depleted and water levels in groundwater basins decline (Figure 4-10 Potential impacts of continuing drought).

California's drought periods could be extended and worsened by climate change. Warming temperatures and changes in rainfall and runoff patterns may exacerbate the frequency and intensity of droughts. Regions that rely heavily upon surface water (rivers, streams, and lakes) could be particularly affected as runoff becomes more variable and more demand is placed on groundwater. Combined with urbanization expanding into wildlands, climate change could further stress the state's forests, making them more vulnerable to pests and disease and changes in species composition (see more discussion of effects and impacts of climate change in subsection on later pages). Along with drier soils, forests may experience more frequent and intense fires, resulting in changes in vegetation, and eventually a reduction in the water supply and storage capacity of a healthy forest.

During droughts, California has historically depended upon its groundwater. However, many aquifers are contaminated, requiring remediation if they are to be used as water banks. Moreover, groundwater resources will not be immune to climate change; in fact, historical patterns of groundwater recharge may change considerably. Because droughts may be exacerbated by climate change, more efficient groundwater basin management will be necessary to avoid additional overdraft and to take advantage of opportunities to store water underground and eliminate existing overdraft.

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Floods and Flooding

The need for flood management improvements is more critical now than ever before. Over the years, major storms and flooding have taken many lives, caused significant property losses, and resulted in extensive damage to public infrastructure. However,

a combination of recent factors has put public safety and the financial stability of State government at risk. California's flood protection system, composed of aging infrastructure with major design deficiencies, has been further weakened by deferred maintenance caused by funding shortfalls and regulatory obstacles. Escalating development in floodplains has increased the potential for loss of life and flood damage to homes, businesses, and communities.

Every region of the state faces flood risks. The Central Valley is a floodplain that historically was inundated at regular intervals. Coastal streams can overflow their banks during winter storms. Southern California is vulnerable to infrequent but devastating flooding. Development on alluvial fans faces unpredictable and changing paths of floodflows. Our water supplies and economy are threatened when Delta islands flood, and every part of California is exposed to the potential financial liability when levees of the Central Valley flood management system fail.

California's population growth and current development patterns present a major challenge to the state's flood management system.

California's population growth and current development patterns present a major challenge to the state's flood management system. In the Central Valley alone, much of the new development is occurring in areas that are susceptible to flooding. In some cases, land use decisions are based on poor or outdated information regarding the severity of the flood threat. Many flood maps being used by public agencies are decades old and do not reflect the most accurate information regarding potential flooding.

Catastrophic flooding within the Central Valley could equal or exceed the economic, social, and environmental damage caused by Hurricane Katrina in 2005. More than a half-million people live behind levees in California now, with populations continuing to grow. Further, State government potential liability in the aftermath of *Paterno v. State of California*, which held the state liable for flood-related damages caused by a levee failure, worsens the financial consequences of flooding.

Due to lack of funding and environmental concerns, both the State and local agencies in all regions of California have found it increasingly difficult to carry out adequate maintenance programs using established methods. Environmental regulations require that local and State agencies develop new approaches to deal with the backlog of maintenance activities. The time needed to complete environmental permitting processes can delay prompt maintenance of critical public safety infrastructure.

Climate change may worsen the state's flood risk by producing higher peak flows and a shift toward more intense winter precipitation. Rising snowlines caused by climate change will allow more of the Sierra Nevada watersheds to contribute to peak storm runoff. High-frequency flood events (e.g., 10-year floods) in particular may increase with changing climate. Along with changes in the amount of the snowpack and accelerated snowmelt, scientists project greater storm intensity, resulting in more direct runoff and flooding, which is exacerbated in urban areas by impervious land surfaces such as asphalt and traditional impervious concrete. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As streamflows and velocities change, erosion patterns will also change, altering channel

shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildland fires due to climate change, there is in turn a potential for more floods following fire, which will increase sediment loads and degrade water quality.

Adaptive Capacity. *The ability of systems, organizations, and individuals to (1) adjust to actual or potential adverse changes and events, (2) take advantage of existing and emerging opportunities that support essential functions or relationships, and/or (3) cope with adverse consequences, mitigate damages, and recover from system failures. It is an indicator of how well a system could or would adjust and/or recover to external changes or large perturbations (e.g., severe floods or droughts).*

Resilience. *Improve the capacity of resources and natural systems to return to prior conditions after disturbance.*

Environment/Ecosystem

California has lost more than 90 percent of the wetlands and riparian forests that existed before the Gold Rush. Successful restoration of aquatic, riparian, and floodplain species and communities ordinarily depends upon at least partial restoration of physical processes that are driven by water. These processes include the flooding of floodplains, the natural patterns of erosion and deposition of sediment, the balance between infiltrated water and runoff, and substantial seasonal variation in streamflow. The diminution of these physical processes lead to displacement of native species by exotics, presenting another huge barrier to ecosystem restoration.

As an example, nearly all California waterways are controlled to reduce the natural seasonal variation in flow. Larger rivers are impounded to capture water from winter runoff and spring snowmelt and release it in the dry season. Many naturally intermittent streams have become perennial, often from receipt of urban wastewater discharges or from use as supply and drainage conveyances for irrigation water. The Delta has become more like a year-round freshwater body than a seasonally brackish estuary. In each case, native species have declined or disappeared. Exotics have become prevalent, often because they are better able to use the greater or more stable summer moisture and flow levels than the drought-adapted natives. (See ecosystem restoration in Volume 2 Resource Management Strategies.)

Reliable water supplies and resilient flood protection require ecosystem stewardship and sustainability to be a primary goal and fundamental activity for water resources management. Building adaptive capacity and system sustainability requires water and flood management projects to incorporate restoration and maintenance of biological diversity and natural ecosystem processes. Water supply and flood management systems are significantly more sustainable and economical when they preserve, enhance, and restore ecosystem functions. Planning and designing for ecosystem functions will help maintain resilient systems that can recover from severe natural disruptions and, in fact, allow quicker recovery with lower economic costs. Moreover, by reducing existing, non-climate stressors on the environment, ecosystems will have more capacity to adapt to new stressors and uncertainties brought by climate change.

Reliable water supplies and resilient flood protection require ecosystem stewardship and sustainability to be a primary goal and fundamental activity for water resources management.

Climate Change

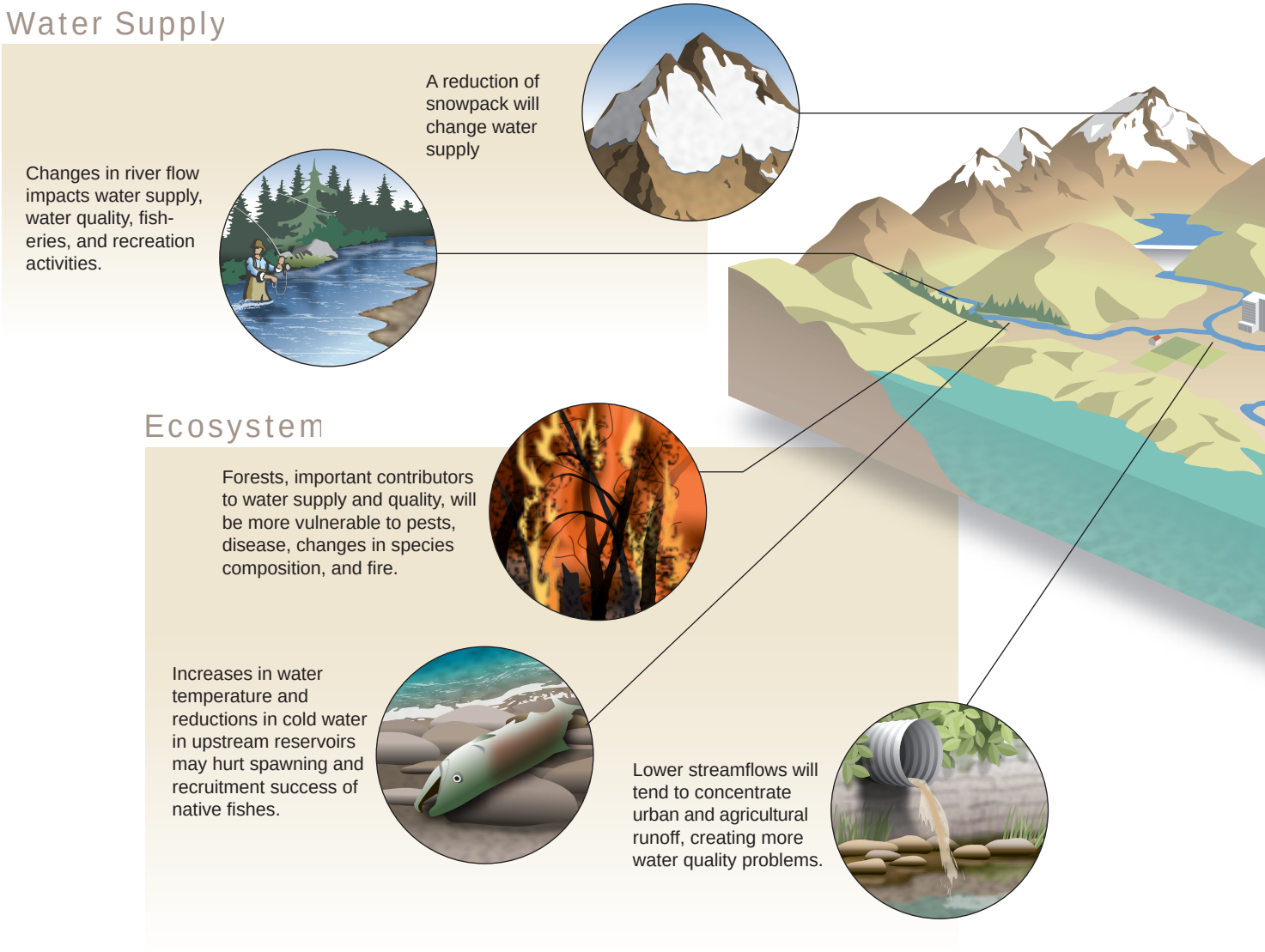
The exact conditions of future climate change remain uncertain, but there is no doubt that we are already seeing climate change effects (see Chapter 5 Managing an Uncertain Future and Volume 4 Reference Guide articles for further discussion on climate change science). Analysis of paleoclimatic data, such as tree-ring reconstructions of streamflow and precipitation, indicates a history of naturally and widely varying hydrologic

Figure 4-11 Climate change effects in California

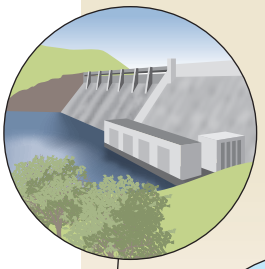
What are the Expected Impacts from These Changes?

Climate change is already having a profound effect on California's water resources as evidenced by changes in snowpack, river flows, and sea levels. Scientific studies show these changes will increase stress on the water system in the future. Because some level of climate change is inevitable, the water system must be adaptable to change.

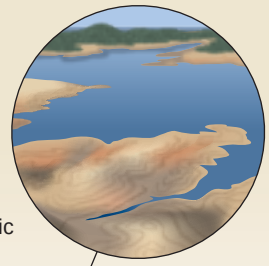
The impacts of these changes will gradually increase during this century and beyond. California needs to plan for water system modifications that adapt to the following impacts of climate change:



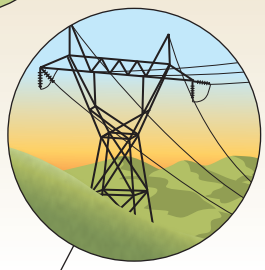
Water & Power Operations



Operation of the water system for urban, agricultural, and environmental water supply and for flood management will become increasingly difficult because of the decisions and trade offs that must be made.

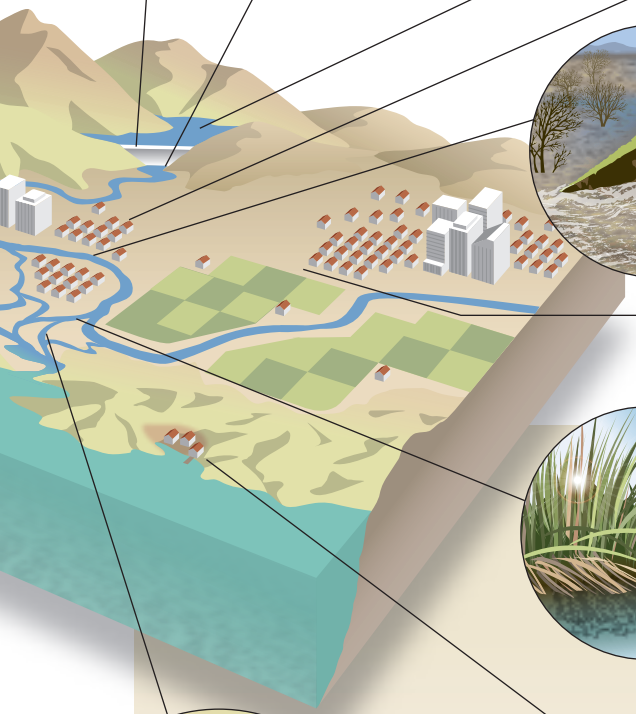


Water supply reliability will be compromised.

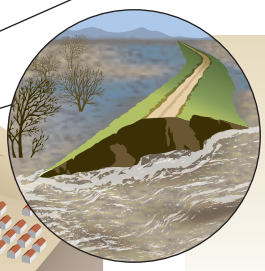


California's hydroelectric power generation may be less reliable; at the same time, higher air temperatures may increase energy consumption through increased use of air conditioning.

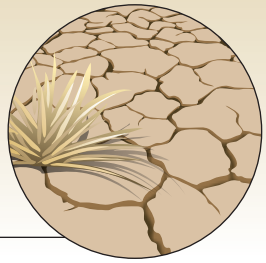
Warmer temperatures will affect water demands.



Flooding & Drought

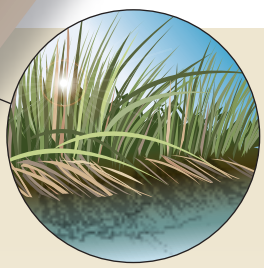


Increased flooding potentially causes more damage to the levee system.



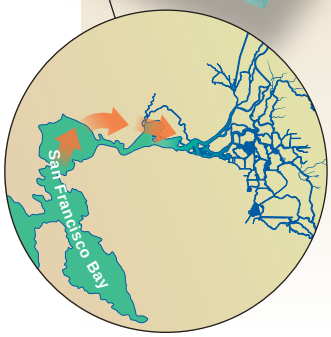
Higher temperatures and changes in precipitation will lead to droughts.

Coast & Delta



Higher water temperatures will make the Delta intolerable to some native species and also more attractive to some non-native invaders that may compete with natives.

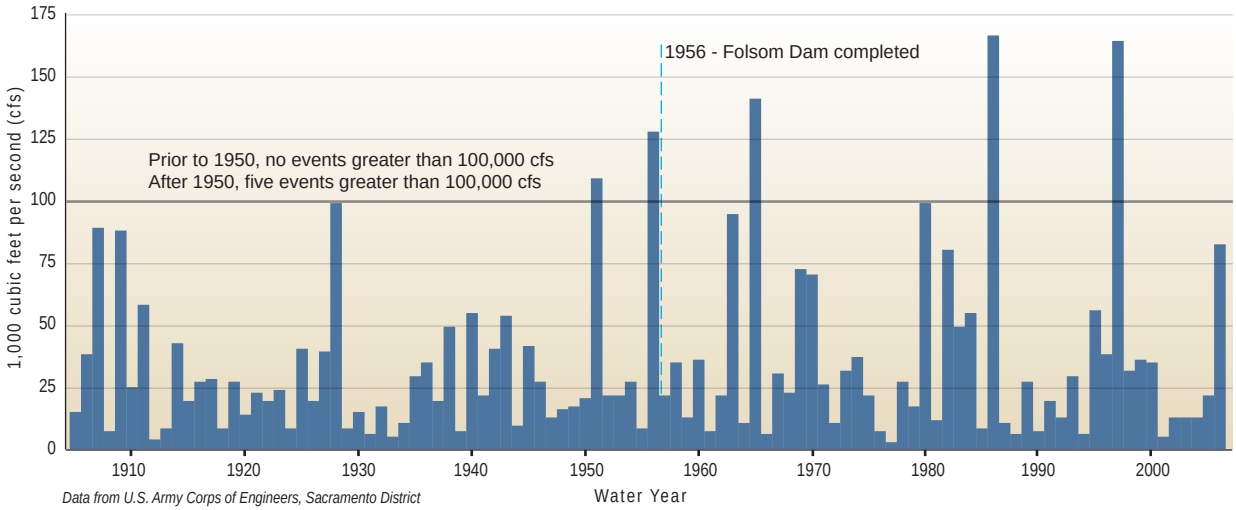
Sea level rise threatens coastal communities and infrastructure, in particular, the water system in the Sacramento-San Joaquin Delta where the existing Delta levees were not designed or constructed to withstand these higher water levels.



Increased salinity in the Delta will degrade drinking and agricultural water quality and alter ecosystem conditions.

Figure 4-12 American River runoff annual maximum three-day flow

The five highest floods of record on the American River have occurred since 1950.



conditions in California and the West, including a pattern of recurring and extended droughts. The average early spring snowpack in the Sierra Nevada decreased by about 10 percent during the last century, a loss of 1.5 million acre-feet of snowpack storage. During the same period, sea level rose 7 inches along California's coast. A disturbing pattern has also emerged in flood patterns. During the last 50 years, peak natural flows have increased on many of the state's rivers. At the other extreme, many Southern California cities have experienced their lowest recorded annual precipitation twice within the past decade. In a span of only two years, Los Angeles experienced both its driest and wettest years on record (Figure 4-11 Climate change effects in California).

Each region of the state will experience unique impacts from climate change.

California lies within multiple climate zones. Therefore, each region of the state will experience unique impacts from climate change. For some regions, improving watershed health will be an important concern. Other areas will be affected by saltwater intrusion. In particular, regions that now depend heavily on water imports from other regions will need robust strategies to increase regional self-sufficiency and cope with greater uncertainty in their future supply. Because economic and environmental effects depend on location, adaptation strategies must be regionally suited.

The water management community has invested in, and now depends upon, a system that relied on historical hydrology as a guide to the future for water supply and flood protection.

From all indications, the impact of climate change on hydrology and water resources management will be significant. The trends of the last century will likely intensify in this century. While the existing system has some capacity to cope with climate variability, extreme weather events, increased droughts and floods, and scarcity of water in some parts of the state will stretch that capacity to meet future needs. The water management community has invested in, and now depends upon, a system that relied on historical hydrology as a guide to the future for water supply and flood protection.

However, historical hydrology will have limited utility as a future planning tool (Figure 4-12 American River runoff annual maximum three-day flow).

Climate change may also impact water demand. Warmer temperatures may increase evapotranspiration rates and extend growing seasons, thereby increasing the amount of water that is needed for the irrigation of certain crops, urban landscaping, and environmental needs. Warmer temperatures will also increase evaporation from surface reservoirs. Reduced soil moisture and surface flow will disproportionately affect the environment and other water users that rely heavily on annual rainfall such as rainfed agriculture, livestock grazing on non-irrigated rangeland, and recreation.

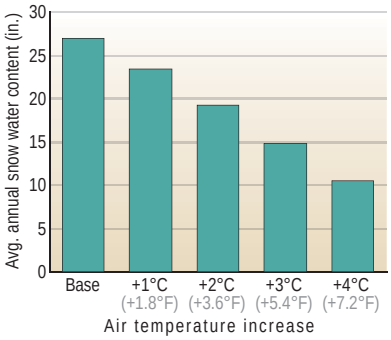
Snowmelt provides an annual average of 15 million acre-feet of water, slowly released from about April to July each year. Much of the state's water infrastructure was designed to capture the slow spring runoff and deliver it during the drier summer and fall months. Based upon historical data and modeling, DWR projects that by 2050 the Sierra snowpack will experience a 25 to 40 percent reduction from its historical average (Figure 4-13 Average annual snowmelt and Figure 4-14 Historical and projected decreasing California snowpack). Climate change is also anticipated to bring warmer storms that result in less snowfall at lower elevations, reducing the total snowpack.

Sea Level Rise

Of the many impacts of climate change, sea level rise presents the most challenging problem for which to plan because of the great uncertainty around ice sheet dynamics, as well as the potentially large impacts. Sea level rise also depends on local and regional factors such as land movement and atmospheric conditions. Much of the Delta, the current hub of California's State and federal water projects, consists of islands that are below sea level and protected by levees. Rising sea levels will increase pressure on fragile levees and will pose a significant threat to water quality. Local and regional investments in water and flood management infrastructure, as well as wetland and aquatic restoration projects, are also vulnerable to rising seas. (See Figure 4-15 Historical and projected sea level rise at Golden Gate.)

Recent peer-reviewed studies estimate a sea level rise of 4 to 16 inches by 2050 and between 7 and 55 inches by 2100 along California's coast. The implications of a 7-inch rise are dramatically different from a rise at the high end of the range. However, even a rise at the lower end of this range poses an increased risk of storm surge and flooding for California's coastal residents and infrastructure, including many of the state's wastewater treatment plants. Moreover, for Californians living in the Delta, or the millions who rely on drinking water or agriculture irrigated by Delta exports, the most critical impact of rising seas may be additional pressure on an already vulnerable levee system, which protects numerous islands that are currently below sea level and sinking. Catastrophic levee failures would likely inundate Delta communities and interrupt water supplies throughout the state.

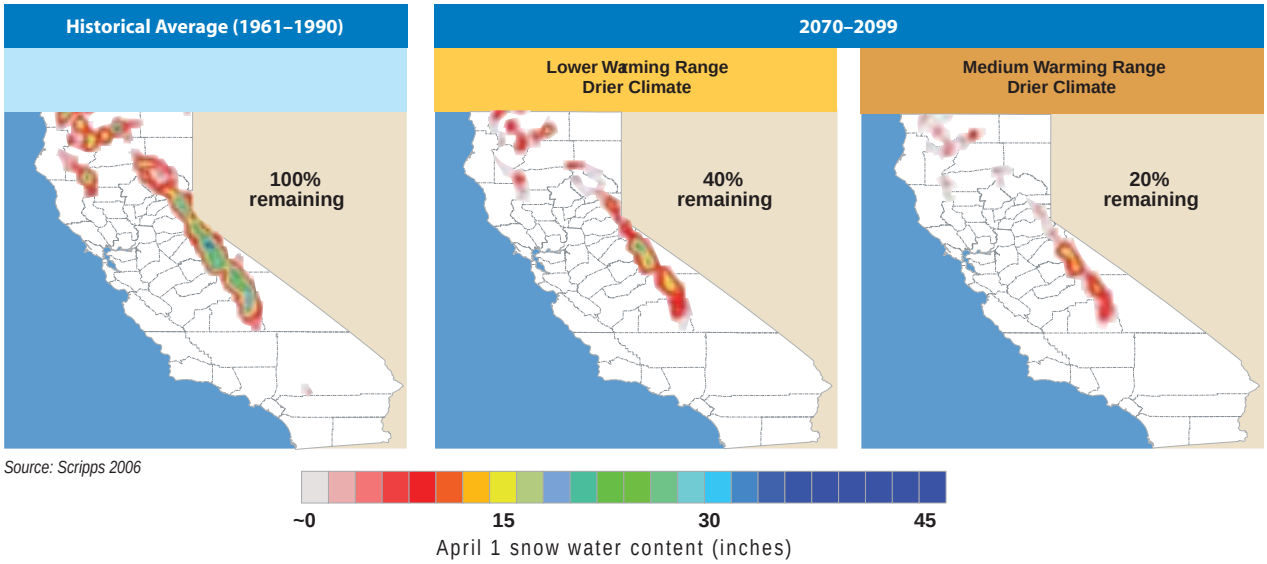
Figure 4-13 **Average annual snowmelt for Upper Feather River Basin**



Warming air temperatures may cause some of our precipitation to shift from snow to rain. This would lead to a reduction in the amount of snowpack, an important natural reservoir for storing water in the winter and later augmenting the water supply as spring snowmelt. Climate-change-induced shifts in the timing and the amount of snowmelt runoff may require revising traditional water planning practices. The Upper Feather River Basin provides water for Lake Oroville, the main water supply reservoir for the State Water Project.

Source: DWR 2009

Figure 4-14 **Historical and projected decreasing California snowpack**



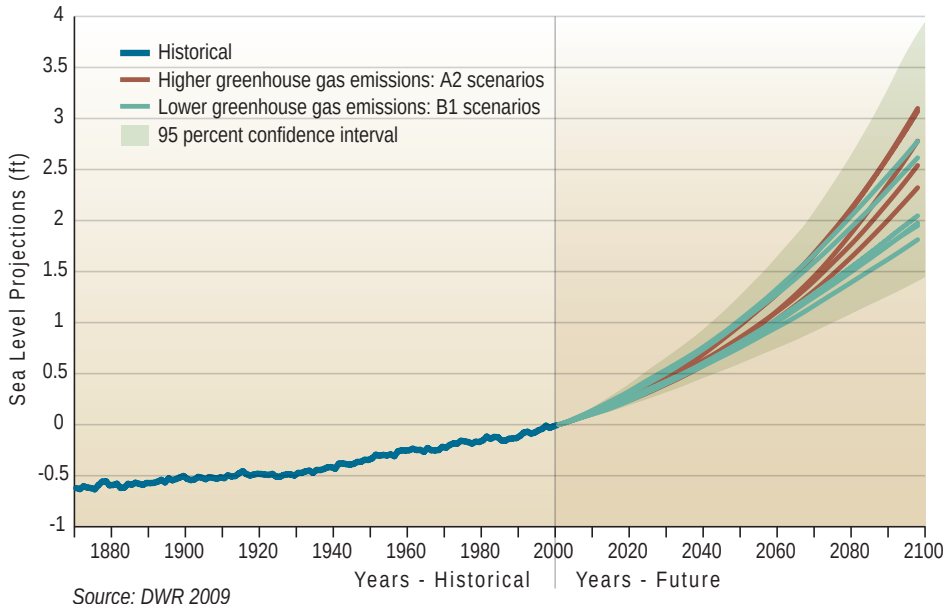
Source: Scripps 2006

Even without levee failures, Delta water supplies and aquatic habitat will be affected due to saltwater intrusion. An increase in the penetration of seawater into the Delta will further degrade drinking and agricultural water quality and alter ecosystem conditions. With the current water management system, more freshwater releases from upstream reservoirs will be required to repel the sea to maintain salinity levels for municipal, industrial, and agricultural uses. Alternatively, changes in upstream and in-Delta diversions, exports from the Delta, and conveyance through or around the Delta may be needed. Sea level rise may also affect drinking water supplies for coastal communities due to the intrusion of seawater into overdrafted coastal aquifers.

Water and Energy

Water and energy are two resources that are inherently linked, especially in California. Although water generates approximately 33 percent of the state's electricity, according

Figure 4-15 Historical and projected sea level rise at Golden Gate



Source: DWR 2009

Local and regional investments in water and flood management infrastructure, as well as wetland and aquatic restoration projects, are vulnerable to rising seas

to the California Energy Commission (CEC), water-related energy use in California consumes approximately 20 percent of the state's electricity, and 30 percent of the state's non-power plant natural gas (i.e., natural gas not used in turn to produce electricity). Water-related energy use includes pumping, treating, and distributing potable water, groundwater pumping, desalination, heating and cooling processes, pressurization, and the collection, treatment, recycling, and discharge of wastewater. Some water systems are net energy producers, for example, the federal CVP as well as San Francisco's Hetch Hetchy and the Los Angeles Aqueduct water systems. Others are net energy consumers, for example, Metropolitan Water District's Colorado River Aqueduct and the SWP. In fact, the SWP is the single largest user of electricity in the state, although the project produces about half of the energy it consumes.

Water-related energy use in California consumes approximately 20 percent of the state's electricity, and 30 percent of the state's non-power plant natural gas

Climate change may reduce the reliability of California's hydroelectric operations, which, according to the California Climate Action Registry and the California Air Resources Board, is the state's largest source of emission-free greenhouse gas energy. Changes in the timing of inflows to reservoirs may exceed generation capacity, forcing water releases over spillways and resulting in lost hydropower. Higher snow elevation, decreased snowpack, and early melting may result in less water available for power generation during hot summer months when energy demand is highest. The impact is compounded overall by the anticipated increased energy consumption due to higher temperatures and greater water demands in summer when less water is available. These conditions may in turn force greater dependency on fossil fuel generation that produces greenhouse gases.

Contamination of Surface Water and Groundwater

Water bodies may be impaired from various sources. For example, discharges from municipal and industrial facilities can impact water bodies. But compared to other sources, pollution from these point source discharges has been largely controlled. Discharges from agricultural lands, including irrigation return flow, flows from tile drains, and storm water runoff, can affect water quality by transporting pollutants, including pesticides, sediment, nutrients, salts, pathogens, and heavy metals, from cultivated fields into surface waters. Groundwater, in turn, has been affected by pesticide, nitrate, and salt contamination. Storm water flows over urban landscapes, as well as dry-weather flows from urban areas, also constitute a significant source of pollutants that contribute to water quality degradation in the state. These flows carry pollutants downstream, which often end up on the beaches and in coastal waters.

Increased frequency and intensity of rainfall will produce more pollution and sedimentation due to runoff and may overwhelm pollution control facilities.

Changes in temperature and precipitation patterns caused by climate change will affect water quality. Higher water temperatures reduce dissolved oxygen levels, which can have an adverse effect on aquatic life. Where river and lake levels fall, pollutant concentrations will increase. Increased frequency and intensity of rainfall will produce more pollution and sedimentation due to runoff. In addition, more frequent and intense rainfall may overwhelm pollution control facilities that have been designed to handle sewage and storm water runoff under assumptions anchored in historical rainfall patterns.

Changes in streamflow timing may require new approaches to manage discharge permitting and nonpoint source pollution.

Changes in the timing of river flows may affect water quality and beneficial uses in many different ways. At one extreme, flood peaks may cause more erosion, resulting in higher turbidity and concentrated pulses of pathogens, nutrients, and other pollutants. This will challenge water treatment plant operations to produce safe drinking water. Increased sediment loads associated with higher intensity flooding can also threaten the integrity of water works infrastructure, including more rapid buildup of sediments reservoir, and deposition of debris and sediments in canals and intakes. At the other extreme, lower summer and fall flows may provide less dilution of contaminants. These changes in streamflow timing may require new approaches to manage discharge permitting and nonpoint source pollution. Warmer water will distress many fish species and could require additional cold water reservoir releases. Higher water temperatures will also accelerate certain biological and chemical processes, increasing the growth of algae and microorganisms and the depletion of dissolved oxygen, and worsen the various impacts to water treatment processes. An increase in the frequency and intensity of wildfires will also have a deleterious effect on watersheds, vegetation, runoff, and, in the end, water quality.

Delta Vulnerabilities

The California Delta is in many respects the heart of our state, at once a water supply, an ecosystem, and a place that is indispensable to modern California.

The California Delta is in many respects the heart of our state, at once a water supply, an ecosystem, and a place that is indispensable to modern California. Improving the Delta ecosystem is a legally required condition of improving the water delivery system for Californians. But the Delta ecosystem is in deep trouble and the problems are increasing. Invasive species, water pumping facilities, and urban and agricultural

pollution are degrading water quality and threatening multiple fish species with extinction. Encroaching urban development in the Delta is reducing wildlife habitat today and foreclosing opportunities to improve the ecosystem—and the Delta water conveyance system—in the future. The levee system has eliminated the dynamic land-water interfaces crucial for aquatic and riparian plants and animals.

In December 2008, the US Fish and Wildlife Service issued a new biological opinion for Delta smelt that would severely constrain water project operations, especially in the fall months.

More than half of Californians rely on water conveyed through the Delta's fragile and vulnerable levee system for at least part of their water. Residents and businesses near the Delta and San Francisco Bay area are most dependent on water from the Delta and its watershed. Urban areas south of the Tehachapi Mountains also use water exported from the Delta. Much of California's irrigated agriculture depends on water from the Delta watershed; one-sixth of all irrigated lands in the nation are in this watershed, including the southern San Joaquin Valley.

More than half of Californians rely on water conveyed through the Delta's fragile and vulnerable levee system for at least part of their water.

Overall, climate change will exacerbate many of the Delta's most difficult challenges. The seasonal mismatch between the demand for and availability of water will widen. The conditions under which the ecosystem will need to be managed will become more uncertain.

Deferred Maintenance and Aging Infrastructure

California's facilities require costly maintenance and rehabilitation as they age. In addition, they face many challenges: meeting the needs of a growing population and changing water use patterns, withstanding catastrophic natural events like earthquakes and floods, and adapting to the changes that accompany global climate change. Bottlenecks develop when physical and operational changes of existing water management systems do not keep pace with changes in capacity, regulations, and new environmental data.

Aging facilities risk public safety, water supply reliability, and water quality. The SWP is more than 35 years old; the federal CVP is more than 50 years old. Some local facilities were constructed nearly 100 years ago. Current infrastructure disrepair, outages, and failures and the degradation of local water delivery systems are in part the result of years of underinvestment in preventive maintenance, repair, and rehabilitation. The Public Policy Institute of California estimated the state's water supply and wastewater treatment systems maintenance backlog to be about $40 billion.

Aging facilities risk public safety, water supply reliability, and water quality. The SWP is more than 35 years old; the federal CVP is more than 50 years old. Some local facilities were constructed nearly 100 years ago.

Current water resources infrastructure is already strained to meet existing, competing objectives for water supply, flood management, environmental protection, water quality, hydropower, and recreation. In a changing climate, the conflicts between competing interests will be even greater as supplies become less reliable. Because prediction of climate change impacts will never be perfect, flexibility must be a fundamental tactic,

especially with respect to water system operations. The improved performance of existing water infrastructure cannot be achieved by any single agency, and will require the explicit and sustained cooperation of many.

Levees

Much of the land in the Delta region is below sea level and is protected by a fragile system of levees. Many of the region's 1,330 miles of levees were built in the late 1800s and early 1900s without using modern engineering practices. The Delta levees are critical for protecting the various assets, resources, uses and services that Californians obtain from the region.

Since 1900, levee failures during high water and during dry weather have caused Delta islands to be flooded a total of 158 times. Some islands have been flooded and recovered multiple times.

Since 1900, levee failures during high water and during dry weather have caused Delta islands to be flooded a total of 158 times. Some islands have been flooded and recovered multiple times. A few islands, such as Franks Tract, have never been recovered.

Delta Risk Management Strategy Phase I (DRMS 2009) identified other concerns including the following:

- A major earthquake of magnitude 6.7 or greater in the vicinity of the Delta region has a 62 percent probability of occurring sometime between 2003 and 2032. This could cause multiple levee failures fatalities, extensive property destruction, and adverse economic impacts of $15 billion or more.
- While earthquakes pose the greatest risk to Delta region levees, winter storms and related high water conditions are the most common cause of levee failures in the region. Under business-as-usual practices, high water conditions could cause about 140 levee failures in the Delta over the next 100 years.
- Dry-weather levee failures (also called "sunny-day" events) unrelated to earthquakes, such as from slumping or seepage, will continue to occur in the Delta about once every seven years. Costs to repair a single island flooded as the result of a dry-weather levee failure are expected to exceed $50 million.
- The failure of levees in Suisun Marsh could result in impacts on several terrestrial wildlife species of concern, including the federally endangered saltmarsh harvest mouse and the California clapper rail.

DWR's document "Flood Warnings: Responding to California's Flood Crisis," submitted to the Legislature in January 2005 identified major deficiencies and challenges to the flood management system in the California Central Valley. A majority of California's agriculture industry is dependent on water from the Delta, and a catastrophic levee failure would result in cessation of pumping capacity for as much as 18 months, causing $30 billion to $40 billion in economic damage to the state.

The urgency of California's vulnerable Delta levees became more pronounced as the world watched the Katrina disaster hit New Orleans in August 2005. The US Army Corps of Engineers, in cooperation with DWR, identified 24 critical erosion sites on project levees in the Sacramento and San Joaquin River Flood Control systems that need repair before a catastrophic levee failure occurs.

Following these revelations and other findings, Governor Schwarzenegger in 2006 declared a State of Emergency for California's levee system.

Catastrophic Events and Emergency Response

The Delta faces extraordinary risks in both the near term and the long term. Earthquakes, river floods, sunny-day levee failures, and continuing subsidence and sea level rise all pose substantial risks to people, property, and infrastructure. Yet emergency response is divided among many different entities—at least 14 fire districts and 14 sheriff and police departments. During high water, many islands direct their own flood fights, although some uniformity is provided by DWR. The US Army Corps of Engineers has oversight authority only for those levees that meet its standards.

Traveling Delta roads to repair levees can be difficult, especially during high water when response crews must cross bridges or use auto ferries. Island living presents challenges for individual family emergency plans when children attend schools on islands separate from their homes.

Effective emergency preparedness and other actions are needed to reduce risks to people, property, and State interests in the Delta.

In other areas of California, catastrophic failure of dams could expose people and property to severe and swift flooding. Dams are designed and constructed to meet stringent safety standards and are subject to periodic inspection by DWR's Division of Dam Safety. Evacuation procedures are incorporated into hazard mitigation plans of local jurisdictions. Maintenance of these structures is needed to maintain their integrity and periodic review of potential structural risks associated with catastrophic events (such as earthquakes and floods) are needed to assure that these structures can withstand future threats.

Data Gathering and Sharing

A growing population, our stressed ecosystems, and California's economic future and its reliance on agriculture, industry, and technology all compete for the state's limited water resources. At the same time, uncertainty in climate change, energy sectors, and other drivers of future change require that we develop effective management strategies based on better science and technology. Data analysis, modeling, and other scientific tools are required to create and improve strategies that can maximize water supply reliability and water quality.

Scientists and managers must employ integrated water management and a systems approach to freshwater withdrawals, use, and disposal that considers physical, chemical, biological, social, behavioral, and cultural aspects.

Government reports have concluded that a key role for science and technology is to expand options for management and use of our water resources. Scientists and managers must employ integrated water management and a systems approach to freshwater withdrawals, use, and disposal that considers physical, chemical, biological, social, behavioral, and cultural aspects. Water law, economic incentives, public awareness,

public education, and sensitivity to differences in value systems are cornerstones of effective water resource management. These require data and analytical tools that are greater than now available to water managers. (Read further discussion in Chapter 6 Integrated Data and Analysis.)

Disadvantaged Communities

All Californians do not have equal opportunity or equal access to State planning processes, programs, and funding.

Californians from disadvantaged, small, and underrepresented communities continue to face economic and environmental inequities with respect to water supply, participation in water policy and management decisions, and access to State funding for water projects. All Californians do not have equal opportunity or equal access to State planning processes, programs, and funding for water allocation, improving water quality, and determining how to mitigate potential adverse impacts to communities associated with proposed water programs and projects. (See Volume 4 Reference Guide article Environmental Justice in California Government.)

Most water, wastewater, and flood projects are not developed for disadvantaged and underrepresented communities; yet they can impact them. Even projects that convey "general" public benefit may not benefit environmental justice or disadvantaged communities proportionally. For example, water conservation programs that are heavily dependent upon toilet and washing machine rebates will have greater penetration in middle and upper class communities than they will on poorer communities that purchase less frequently and cannot afford the initial outlay for the fixture.

Funding

At a time when flood management maintenance and improvement efforts should be increased, investments in water, water quality, and infrastructure have been reduced at local government levels. Local governments in California have been severely restricted by two constitutional amendments regarding the use of property tax or benefit assessments to generate revenue (Propositions 13 and 218). The federal government also reduced the maximum that it would pay for the cost of new flood management projects, from 75 percent to 65 percent of the total project cost.

Although recent bond measures like Propositions 84 and 1E will provide a down payment for improving California's water and flood systems, climate change presents an ongoing risk that requires a long-term commitment of funding that is properly matched to anticipated expenditures, beneficiaries, and responsible parties.

Responses and Opportunities

Stewardship and Sustaining Natural Resources

California water resource management is placing more emphasis on integrated water management. Update 2005 promoted integrated water management to ensure sustainable water uses with and emphasis on environmental stewardship. Proposition 84 (see

Box 4-9 Investing in Watersheds

- **Invest Consistently.** A steady investment in watersheds results in the best yields. For over 30 years, DWR's programs have provided technical and financial assistance to local watershed managers on an ongoing basis.
- **Actively Manage Resources.** DWR works with agencies and groups to continually evaluate priorities, needs, and outcomes from State grants and assistance.
- **Promote Diversity and Balance Assets.** DWR offers diverse programs and local support activities, and has successfully invested millions of dollars to achieve sound watershed management for people and communities throughout California.
- **Build Trust.** DWR staff works closely with project proponents to guarantee a sound technical basis for their projects; conducts fair and open project selection processes for grant and loan programs; and promotes and participates in Environmental Justice efforts. DWR provides technical and financial assistance to support local community consensus building, planning and project implementation, and provides local coordinators for projects, giving a face to the program at the local, State, and federal levels.
- **Create Enduring Value.** DWR works in partnership with stewardship groups, organizations, and government agencies at all levels. DWR resource restoration programs reduce flood damage, support water supply reliability, protect and aid recovery of endangered species, protect and restore wetlands, enhance natural stream and river functions, and preserve the public trust resources of California.

discussion in Statewide and Interregional) authorized the appropriation of $1 billion to DWR to allocate to foster IRWM. Grants are awarded for projects that provide more than one benefit. Among those benefits can be water conservation and water use efficiency; creation and enhancement of wetlands and the acquisition, protection, and restoration of open space and watershed lands; watershed protection and management; agricultural lands stewardship; and ecosystem and fisheries restoration and protection.

Agricultural lands stewardship and working landscapes will increasingly be relied on to attenuate peak precipitation runoff and conserve water, as well as to provide critical habitat at key locations and sequester carbon while maintaining ongoing primary productivity of food and fiber. Moreover, this strategy helps landowners maintain their farms and ranches rather than being forced to sell their land because of pressure from urban development. New assistance programs and laws and regulations affecting agriculture have been created and enacted, and old ones eliminated, reduced, or expanded as drescribed in Chapter 20 Agricultural Lands Stewardship of Volume 2 Resource Management Strategies.

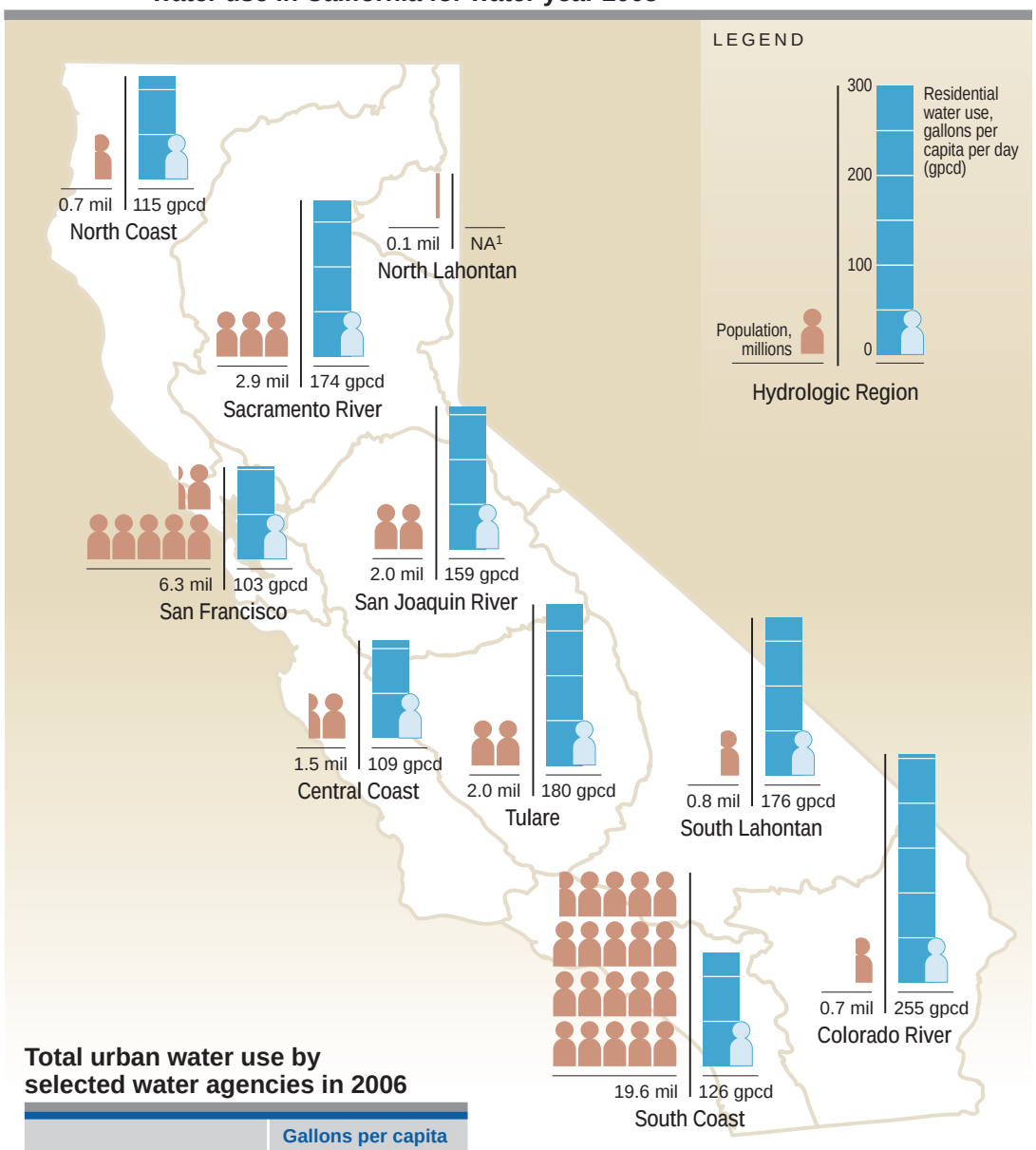
Watershed and Resource Restoration Programs

The DWR Watershed Program works with locally led stewardship efforts to integrate the needs of communities, urban and rural, with resource management that sustains watershed ecology. The program strives to inform and educate people about their watersheds and the benefits and values that those watersheds provide. It promotes managing water resources to protect, restore, and enhance the natural and human environments in California. DWR uses an investment strategy to guide its watershed programs (Box 4-9).

The California Watershed Indicators Council was formed to begin developing a framework for assessing the health of watersheds throughout the state.

The California Department of Conservation administers its Watershed Program to advance sustainable watershed-based management of California's natural resources through community-based strategies. The new statewide watershed program is an extension of the previous CALFED Bay-Delta Watershed Program and will include grants for watershed coordinators. Go to Web site: www.conservation.ca.gov/dlrp/wp/Pages/Index.aspx.

Figure 4-16 Regional population and per capita residential water use in California for water year 2005



Total urban water use by selected water agencies in 2006

Water Agency	Gallons per capita per day
San Francisco	95
Santa Barbara	127
Marin (MWD)	136
Los Angeles (LADWP)	142
Contra Costa (CCWD)	157
San Diego	157
East Bay (EBMUD)	166
Victorville (VVCWD)	246
Bakersfield	279
Sacramento	279
San Bernardino	296
Fresno	354

Developed by DWR staff using PWSS date from 2006

1. The North Lahontan Hydrologic Region does not have enough usable data in the Public Water Systems Survey (PWSS) database to compute for baseline values.

Population data source: CA Department of Finance. 2006. *Report E-4 Population Estimates for Cities, Counties and State, 2001-2006 with 2000 DRU Benchmark*.

Residential water use data source: 20x2020 Agency Team. *20x2020 Water Conservation Plan*. 2009.

The per capita residential water use numbers in this map were taken from the *20X2020 Water Conservation Plan*. Those numbers were developed using DWR's Public Water Systems Survey (PWSS) data, averaging available data from 1995 to 2005. The urban water use data in the portfolios in the Water Plan were developed using the PWSS data for specific years, not an average of years. Thus, it is possible to compute a per capita residential water use number using the Water Plan urban residential water use values and populations, with differing results from the *20X2020 Water Conservation Plan* values.

Conservation: 20 percent Reduction by 2020

On February 28, 2008, Governor Schwarzenegger wrote to the leadership of the California State Senate outlining key elements of a comprehensive solution to problems in the Delta. The first element on the Governor's list was "a plan to achieve a 20 percent reduction in per capita water use statewide by 2020." In March 2008, the 20x2020 Agency Team convened and has developed a plan to meet the goal set by the Governor. Go to http://www.swrcb.ca.gov/water_issues/hot_topics/20x2020/index.shtml for information. See Senate Bill No. 7 Statewide Water Conservation as part of the 2009 Comprehensive Water Package discussed later under Statewide and Interregional Planning and Response. Figure 4-16 shows regional population and per capita residential water use in California for water year 2005.

Some of DWR's conservation efforts include:

- Encouraging widespread implementation of cost-effective conservation programs by urban and agricultural water suppliers.
- Helping water agencies develop water shortage contingency plans so they are prepared for future dry conditions or supply interruptions.
- Implementing programs to conserve water in landscaping and helping irrigation districts, farmers, and managers of large urban landscapes stretch their available water by providing daily information on plant water needs.

According to the California Energy Commission, end use of water is the most energy intensive portion of the water use cycle in California. Measures to increase water use efficiency and reuse will reduce electricity demand from the water sector which in turn can reduce greenhouse gas emissions.

End use of water is the most energy intensive portion of the water use cycle in California.

Regional/Local Planning and Management

Water managers have learned that even though imported supplies will continue to be important, they cannot be relied on to satisfy growing water demands. In the 1980s, concerns for protecting the environment were manifested in strong new laws and regulations. These regulations affected the ability of interregional water projects to deliver water. The resulting uncertainty also contributed to hesitancy to invest in additional facilities for these interbasin systems and forced water agencies to make difficult decisions about how to provide a reliable water supply.

Local and regional agencies are looking more intensely at local water management options such as water conservation and recycling measures and groundwater storage. Water managers are learning that planning for sustainable water use must address multiple resource objectives—water use efficiency, water quality protection, and environmental stewardship—and consider broad needs—economic growth, environmental quality, and social equity.

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Box 4-10 Complementary Management Approaches: IRWM and Watershed Management

Many overlapping characteristics and issues confront integrated regional water management and watershed management. Both approaches are being used in California to combine local, State, and federal resources to create a broader, more flexible water management system. Watershed management is a process of evaluating, planning, managing, and organizing land and other resource use within a watershed while maintaining a sustainable ecosystem. For regional planning purposes in California, a watershed includes living (including the people who live and work in the watershed) and nonliving elements within a defined geographical area that is generally characterized by the flow of water. Watershed management seeks to balance changes in community needs with evolving ecological conditions. (See Volume 2 for more discussion of watershed management as a resource management strategy.)

Coordination of Water and Land Use Planning

Several recently adopted and ongoing General Plan updates (e.g., Marin County, Solano County) have included local Climate Action Plans that establish local policies to reduce greenhouse gas emissions and adapt to the potential effects of climate change. The areas of local government influence and authority for reducing greenhouse gas emissions include community energy use, waste reduction and recycling, water and wastewater systems, transportation, and site and building design.

Large water purveyors (3,000 acre-feet/year of serving 300 customers) must prepare Urban Water Management Plans (UWMPs) that evaluate water supplies and demands over a 20-year period and are updated every 5 years (Water Code Sec. 10610 et seq.).

Integrated Regional Water Management and Planning (IRWM)

With integrated regional water management (IRWM), regions have been able to take advantage of opportunities that are not always available to individual water suppliers: reduce dependence on imported water and make better use of local supplies; enhance use of groundwater with greater ability to limit groundwater overdraft; increase supply reliability and security; and improve water quality. The extent to which regions have carried these out has been driven by considerations like economics, environment, engineering, and institutional feasibility. (See Box 4-10 Complementary Management Approaches: IRWM and Watershed Management)

Throughout California, stakeholders are working together to develop regional and watershed programs that cover multiple jurisdictions and provide multiple resource benefits. In several regions, agencies have formed partnerships to combine capabilities and share costs. IRWM has taken a foothold and is on the rise (Box 4-11 Examples of Regional Water Planning Efforts and Figure 4-3 for region acceptance process, 2009).

On September 30, 2008, Governor Schwarzenegger signed SBxx 1 (also denoted as SBx2 1 or SB2x 1) (http://www.leginfo.ca.gov/pub/07-08/bill/sen/sb_0001-0050/sbx2_1_bill_20080930_chaptered.pdf). SBx2 1 contains replacement language for

Box 4-11 Examples of regional water planning efforts

The following examples were provided to the Water Plan by the Roundtable of Regions

North Coast

- Araujo Dam Restoration Project
- Newell Water System Upper Mattole River Culvert Replacement
- Westport Water Tank

Sacramento River

- Red Clover Valley Restoration – Upper Feather River Watershed
- The Bear River Project: Reducing Legacy Mercury Contamination

San Francisco Bay

- Mocho Groundwater Demineralization Plant
- Water Saving Hero Campaign

North Lahontan

- Merrill Davies Meadow Restoration Project

San Joaquin River

- Yosemite Spring Park Utility Company Improvements

Central Coast

- Groundwater Recharge Enhancement
- City of Watsonville Recycled Water Facility and Pajaro Valley Water Management Agency Coastal Distribution System
- Salinas Valley Water Project
- Santa Maria Wastewater Treatment Plant Expansion
- Los Osos Wastewater Project

Tulare Lake

- Southern Sierra IRWM Effort
- Alta Irrigation District Harder Pond recharge and banking project

South Coast

Los Angeles

- Calleguas Regional Salinity Management Project
- Arundo Removal
- Las Virgenes Creek Restoration
- Joint Water Pollution Control Plant Marshland Enhancement (Bixby Marshland)

Santa Ana

- Arlington Desalter
- Orange County Groundwater Replenishment System
- Solar Array at RP-5 Wastewater Treatment Plant

San Diego

- Tri-County Funding Area Coordinating Committee
- El Monte Valley Groundwater Recharge and River Restoration Project
- Carlsbad Desalination Project Local Conveyance
- Rancho California Water District Water Reclamation Project
- Santa Margarita Conjunctive Use Project

South Lahontan

- Inyo-Mono Integrated Regional Water Management Project
- Upper Amargosa Creek Recharge and Nature Park Project
- Antelope Valley Regional Recycled Water Project

Colorado River

- Coachella Valley Regional Water Management Group potential projects include water conservation, recycling, conjunctive use and water quality improvements.
- Salton Sea restoration partnership
- Coachella Canal Lining
- All-American Canal Project

Regional strategies information provided by Roundtable of Regions

Box 4-12 New Law Supports Integrated Regional Water Management

The new Water Code language now known as the Integrated Regional Water Management Planning Act clarifies what an IRWM plan should address and also contains guidance to DWR as to the contents of guidelines for the IRWM grant program. The new language also broadens the definition of a regional water management group to include other persons who may be necessary for the development and implementation of a plan that meets requirements of Water Code Section 1040 and 10541.

The new IRWM Planning Act language includes seven things all IRWM plans shall do:

1. Protection and improvement of water supply reliability, including identification of feasible agricultural and urban water use efficiency strategies.
2. Identification and consideration of the drinking water quality of communities within the area of the plan.
3. Protection and improvement of water quality within the area of the plan, consistent with the relevant basin plan.
4. Identification of any significant threats to groundwater resources from overdrafting.
5. Protection, restoration, and improvement of stewardship of aquatic, riparian, and watershed resources within the region.
6. Protection of groundwater resources from contamination.
7. Identification and consideration of the water-related needs of disadvantaged communities in the area within the boundaries of the plan.

Among the contents of DWR guidelines requirements in the new planning act are:

- IRWM plans to be developed in a collaborative process;
- IRWM plans include consideration of the resource management strategies contained in the California Water Plan 2005 update and all subsequent updates;
- Evaluation of adaptability to climate change of water management systems; and
- IRWM plans include a public process that provides outreach and opportunity for participation in plan development and implementation of the plan by listed applicable stakeholders.

the Integrated Regional Water Planning Act of 2002 (California Water Code Section 10530 et seq) as well as the first appropriations for the IRWM grant program from Propositions 84 and 1E (see under Propositions and Bonds). See also Box 4-12 New Law Supports Integrated Regional Water Management.

Water agencies in many regions are successfully employing a mix of resource management strategies, many with State and federal incentives.

Water agencies in many regions are successfully employing a mix of resource management strategies, many with State and federal incentives. Experience is showing that these regional efforts can better resolve regional needs, especially when paired with statewide water management systems. Regional water management options can reduce physical and economic risks and provide regional control over water supplies. More is being done to meet water demands with water conservation, reoperation of facilities, water recycling, groundwater storage and management, transfer programs, and, in limited cases, regional or local surface storage reservoirs. (See Volume 2 Resource Management Strategies for further discussion of regional management options.) Overall, this increased focus on IRWM solves water management problems more efficiently, considers other resource issues, and enjoys broader public support.

Statewide and Interregional Planning and Response

We have learned that solutions to California's water management issues are best planned and carried out on a regional basis. However, State government has led collaborative efforts to find solutions to water issues having broad public benefits such as protecting and restoring the Delta, Salton Sea, Lake Tahoe, and Mono Lake. Statewide and interregional responses to water resource emergencies and management needs are

Box 4-13 Mokelumne River Forum and Interregional Conjunctive Use

A forum made up primarily of water agencies and local governments with an interest in the Mokelumne River has met since 2005 to discuss how to meet water management needs in the Sierra foothills, San Joaquin County, and the East Bay while resolving long-standing water rights disputes. The result of those discussions is a concept called the Mokelumne River Inter-Regional Conjunctive Use Project (IRCUP).

The IRCUP envisions conjunctive use on an inter-regional scale, with the potential to provide water supply and environmental benefits to a broad range of Mokelumne River basin stakeholders. Benefits would include:

- Storage and supplies for drought protection and to meet the future water needs of the citizens of Amador and Calaveras Counties.
- Long-term drought protection for areas of Alameda and Contra Costa Counties that are served by the East Bay Municipal Utility District (EBMUD).
- Drought protection, replenishment of water to reverse groundwater basin overdraft, and water to serve as a means to create a hydraulic barrier to prevent further salinity intrusion for the citizens of San Joaquin County.
- Replenishment of the groundwater basin by storing wet weather flows and then using that stored water to meet the supply and environmental needs of the citizens overlying the Eastern San Joaquin Groundwater Basin.

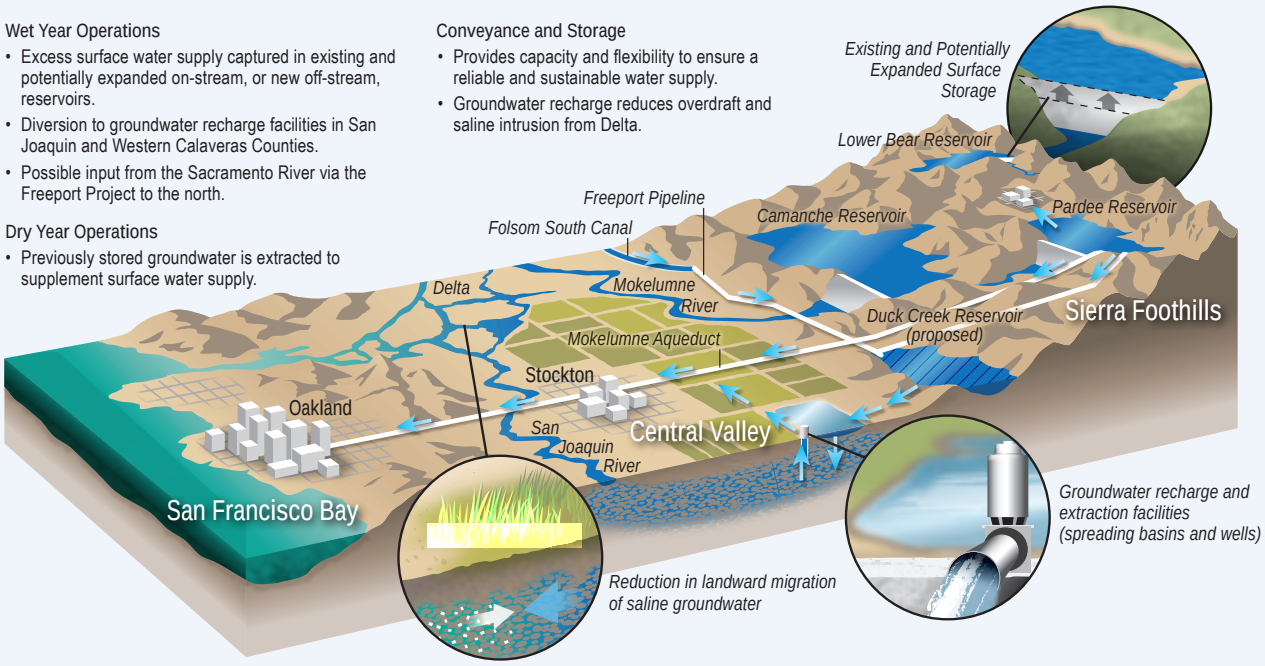
The forum has recently begun to expand its discussions to consider environmental principles and alternative water management solutions, such as demand-side management and the use of treated storm water and disinfected wastewater for groundwater recharge.

The Mokelumne River flows from the western Sierra Nevada into the Sacramento-San Joaquin River Delta and provides water for the environment, agriculture, hydropower generation, and communities in the watershed. Water is also exported for use in the EBMUD service area.

Mokelumne River Forum Members

- Alpine County
- Amador County
- Amador Water Agency
- Calaveras County Water District
- Calaveras Public Utility District
- California Department of Water Resources
- City of Lodi
- City of Stockton
- San Joaquin County Flood Control and Water Conservation District
- Mokelumne River Water and Power Authority
- East Bay Municipal Utility District
- Jackson Valley Irrigation District
- North San Joaquin Water Conservation District
- Stockton East Water District
- Woodbridge Irrigation District

Elements of the Mokelumne River Integrated Regional Conjunctive Use Project



summarized in this section, including programs, task forces, reports, water bonds, legislation, and federal programs. (See Box 4-13 Mokelumne River Forum as a specific example of interregional response.)

Recent Litigation

Pueblo right. *A water right possessed by a municipality which, as a successor of a Spanish or Mexican pueblo, is entitled to the beneficial uses of all needed, naturally occurring surface water and groundwater of the original pueblo watershed. Pueblo rights are paramount to all other claims.*

California's water rights system incorporates riparian doctrine, prior appropriation doctrine, ground water use, and pueblo rights. The state's water law is contained in the California Water Code at www.legininfo.ca.gov. For information on water litigation and legislation since Update 2005, go to Volume 4 Reference Guide.

Recent Legislation

2009 Comprehensive Water Package

Governor Schwarzenegger and State lawmakers successfully crafted a plan to meet California's growing water and ecosystem challenges. A comprehensive deal was approved and signed by the Governor as part of the 2009-10 Seventh Extraordinary Session in November 2009. The package represents major steps toward ensuring a reliable water supply for future generations, as well as restoring the Delta and other ecologically sensitive areas.

The plan is composed of four policy bills (SB-Senate bills) and an $11.14 billion bond. It establishes a Delta Stewardship Council, sets ambitious water conservation policy, ensures better groundwater monitoring, and provides funds for the State Water Boards for increased enforcement of illegal water diversions. The bond, which must be approved by voters, will fund, with local cost-sharing, drought relief, water supply reliability, Delta sustainability, statewide water system operational improvements, conservation and watershed protection, groundwater protection, and water recycling and water conservation programs. Some information about individual policy bills are listed below. For more information, see 2009 Comprehensive Water Package Summary in Volume 4 Reference Guide.

- SB 1 Delta Governance/Delta Plan establishes the framework to achieve the co-equal goals of providing a more reliable water supply to California and restoring and enhancing the Delta ecosystem. The co-equal goals will be achieved in a manner that protects the unique cultural, recreational, natural resource, and agricultural values of the Delta.
- SB 6 Groundwater Monitoring requires, for the first time in California's history, that local agencies monitor the elevation of their groundwater basins to help better manage the resource during both average water years and drought conditions.
- SB 7 Statewide Water Conservation creates a framework for future planning and actions by urban and agricultural water suppliers to reduce California's water use. For the first time in California's history, this bill requires the development of agricultural water management plans and requires urban water agencies to reduce statewide per capita water consumption 20 percent by 2020.

- SB 8 Water Diversion and Use/Funding improves accounting of the location and amounts of water being diverted by recasting and revising exemptions from the water diversion reporting requirements under current law. Additionally, this bill appropriates existing bond funds for various activities to benefit the Delta ecosystem and secure the reliability of the state's water supply, and to increase staffing at the State Water Boards to manage the duties of this statute.

The Safe, Clean, and Reliable Drinking Water Supply Act of 2010 is an $11.14 billion general obligation bond proposal that would provide funding for California's aging water infrastructure and for projects and programs to address the ecosystem and water supply issues in California. The bond is composed of seven categories, including drought relief, water supply reliability, Delta sustainability, statewide water system operational improvement, conservation and watershed protection, groundwater protection and water quality, and water recycling and water conservation. The proposed bond is expected to go before voters in November 2010.

Strengthening Flood Protection

In October 2007, the Governor signed several pieces of legislation aimed at strengthening flood protections in California. The legislative package will lead to the development of a comprehensive Central Valley Flood Protection Plan, reform the Reclamation Board to improve efficiency, require cities and counties to increase consideration of flood risks when making land use decisions, and create a new standard in flood protection for urban development in the region. Below are some examples of this legislative package. See Volume 4 the Reference Guide for article on more water-related legislation approved in California since Update 2005.

- **AB 162 Land Use: Water Supply.** AB 162 requires cities and counties to amend the land use element of their general plans to identify those areas that are subject to flooding as identified by floodplain mapping prepared by the Federal Emergency Management Agency or DWR. The act also requires, upon the next revision of the housing element, that the conservation element identify rivers, creeks, streams, flood corridors, riparian habitat, and land that may accommodate floodwater for purposes of groundwater recharge and storm water management.
- **SB 5 Central Valley Flood Protection Act.** SB 5 requires DWR and the Central Valley Flood Protection Board (formerly named the Reclamation Board) to prepare and adopt a Central Valley Flood Protection Plan by 2012, and establishes flood protection requirements for local land-use decisions consistent with the Central Valley Protection Plan.

In 2006, DWR launched a multi-faceted initiative to improve public safety through integrated flood management. Success of the FloodSAFE program depends on active participation from many key partners.

California FloodSAFE Program

In January 2005, Governor Schwarzenegger drew attention to the state's flood problem, calling for improved maintenance, system rehabilitation, effective emergency response, and sustainable funding. In a white paper titled "Flood Warnings: Responding to California's Flood Crisis," DWR outlined the flood problems that California faces and offered specific recommendations for administrative action and legislative changes.

Since that time, California has begun the long process to improve flood management systems – investing heavily to complete emergency repairs quickly near several high-risk urban areas, informing the public about flood risks, enacting significant new laws, and providing funds to lead a sustained effort to improve flood management statewide. In 2006, DWR launched a multi-faceted initiative to improve public safety through integrated flood management. The FloodSAFE program is a collaborative statewide effort designed to accomplish five broad goals:

- **Reduce the Chance of Flooding.** Reduce the frequency and size of floods that could damage California communities, homes and property, and critical public infrastructure.
- **Reduce the Consequences of Flooding.** Take actions prior to flooding that will help reduce the adverse consequences of floods when they do occur and allow for quicker recovery after flooding.
- **Sustain Economic Growth.** Provide continuing opportunities for prudent economic development that supports robust regional and statewide economies without creating additional flood risk.
- **Protect and Enhance Ecosystems.** Improve flood management systems in ways that protect, restore and where possible enhance ecosystems and other public trust resources.
- **Promote Sustainability.** Take actions that improve compatibility with the natural environment and reduce the expected costs to operate and maintain flood management systems into the future.

Success of the FloodSAFE program depends on active participation from many key partners, such as Cal EMA, Central Valley Flood Protection Board, DFG, US Army Corps of Engineers, FEMA, US Fish and Wildlife Service, the National Oceanic Atmospheric Administration, Tribal entities, and many local sponsors and other stakeholders. DWR will continue to work closely with key partners and stakeholders to accomplish the FloodSAFE Vision.

Recent Drought Response

In June 2008, the Governor declared a statewide drought, directing State agencies and departments to take immediate action to address the serious drought conditions and water delivery reductions. He also issued a Central Valley State of Emergency Proclamation for nine Central Valley counties (Sacramento, San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare, and Kern) to address urgent water needs. DWR and the US Bureau of Reclamation held workshops, “Preparing for Action,” for urban water suppliers in October 2008 to help them better prepare for a drought.

In response to dry conditions in 2007, when Southern California communities experienced their driest year on record and when the Colorado River Basin continued in a period of unprecedented dryness, DWR published “California Drought: An Update” (April 2008). The purpose of this report was to update an earlier DWR report on drought published in 2000, with special emphasis on advanced drought-related research. The report features contributed articles from climate scientists whose research covers a wide

range of drought, climate change, and variability topics. It also provides updates on hydrologic conditions and selected resource management subjects since publication of the 2000 report. A 2009 update was also published in December.

In February 2009, Governor Schwarzenegger issued a proclamation declaring a state of emergency due to drought conditions. In response, DWR issued a report to the Governor, California's Drought: Water Conditions and Strategies to Reduce Impacts (March 2009) and monthly drought updates that detail regional responses to this drought and its regional impacts. (See DWR's California's Drought Web page at http://www.water.ca.gov/drought/updates.cfm.)

The US Department of Interior responded by creating a Federal Drought Action Team of representatives from many federal agencies to work cooperatively with California's drought response team to respond to communities facing significant drought. In addition, the US Bureau of Reclamation would provide operational flexibility to convey and store water to facilitate transfers and exchanges that can move water to critical-need areas, and to expedite any related environmental review and compliance actions. See the American Recovery and Reinvestment Act for water reuse projects and other water projects.

DWR continues to work on actions to prepare for the possibility California's drought continuing into 2010 and beyond. These include increased water conservation, a 2010 drought water bank, a long-term water transfer program, improvements to the California Irrigation Management Information System, and meeting with Ca1 EMA and other state and local agencies to coordinate emergency response activities.

DWR and Water Plan staff and the State Agency Steering Committee prepared a five-year Statewide Drought Contingency Plan as part of Update 2009. The purpose of the plan is to articulate a coordinated State government strategy for preparing for, responding to, and recovering from drought. (See Volume 4 Reference Guide.)

2009 Drought Water Bank

To help facilitate the exchange of water throughout the state, DWR established the 2009 Drought Water Bank. Through the program, DWR purchased about 74,000 acre-feet of water from willing sellers primarily from water suppliers upstream of the Delta. This water was transferred using SWP or CVP facilities to water suppliers that were at risk of experiencing water shortages in 2009 due to drought conditions and required supplemental water supplies to meet anticipated demands.

Governor's Strategic Growth Plan

The Strategic Growth Plan (SGP), designed to restore and maintain California's roads, schools, ports, and water supply, was launched in January 2006. Governor Schwarzenegger proposed investing and leveraging billions of dollars in the state's

infrastructure over the next 20 years to maintain California's economic strength and high quality of life.

In September 2008, Governor Arnold Schwarzenegger signed SB 732, creating the Strategic Growth Council. The council is a cabinet level committee that is tasked with coordinating the activities of state agencies to:

- improve air and water quality,
- protect natural resource and agriculture lands,
- increase the availability of affordable housing,
- improve infrastructure systems,
- promote public health, and
- assist State and local entities in the planning of sustainable communities and meeting AB 32 goals

The Council is composed of agency secretaries—from Business Transportation and Housing, California Health and Human Services, California Environmental Protection Agency, and the California Natural Resources Agency—the director of the Governor's Office of Planning and Research, and a public member appointed by the Governor.

Substantial investments in water management activities are needed to support a vital economy, a healthy environment, and a reliable water supply (http://gov.ca.gov/index.php?/issue/sgp-backpage/sgp-flood-water). The Strategic Growth Plan proposes $5.95 billion to ensure reliable water supplies and cope with climate change effects:

- Water Storage - $4.5 billion ($2.5 billion general obligation bonds and $2.0 billion revenue bonds)
- Delta Sustainability - $1.0 billion (general obligation bonds)
- Water Resources Stewardship - $250 million (general obligation bonds)
- Water Conservation - $200 million (general obligation bonds)

AB 32 – California Global Warming Solutions Act of 2006

The AB 32 Scoping Plan was developed in coordination with the Climate Action Team. The Scoping Plan proposes a comprehensive set of actions designed to reduce overall GHG emissions in California.

California is the 12th largest emitter of carbon in the world despite leading the nation in energy efficiency and environmental protection standards. For this reason, the California Global Warming Solutions Act of 2006 mandated a reduction of greenhouse gas (GHG) emissions to 1990 levels by 2020. The California Air Resources Board is the lead agency for implementing AB 32 and developing a scoping plan to outline the State's strategy to achieve the 2020 GHG emissions limit. The board approved the Scoping Plan in December 2008.

The AB 32 Scoping Plan was developed in coordination with the Climate Action Team. CAT included a multi-agency water-energy subgroup that developed GHG mitigation strategies for energy consumption related to water use. The Scoping Plan proposes a comprehensive set of actions designed to reduce overall GHG emissions in California, improve the environment, reduce the state's dependence on oil and diversify energy sources, save energy, create new jobs, and enhance public health. The measures in the Scoping Plan will be developed over 2009 and 2010 and be in place by 2012.

The water and energy component of the Scoping Plan includes six approaches to achieving a reduction in the energy intensity of water uses and water and wastewater management systems:

1. Water use efficiency
2. Water recycling
3. Urban water reuse
4. Locating renewable generation projects with existing water system infrastructure
5. Implementing energy efficiency and cost-effectiveness at local and regional water infrastructure projects
6. Establishing a public goods charge for funding investments in water efficiency and other IRWM strategies that will lead to GHG reductions

The water and energy component of the Scoping Plan includes six approaches to achieving a reduction in the energy intensity of water uses and water and wastewater management systems ... and improving water quality and water supply reliability.

These actions may also have the co-benefit of improving water quality and water supply reliability.

Sea Level Rise

In November 2008, the Governor issued an executive order (EO S-13-08) to enhance the state's management of climate impacts from sea level rise, increased temperatures, shifting precipitation, and extreme weather events. Among other benefits, the executive order was meant to provide consistency and clarity to State agencies on how to address sea level rise in current planning efforts, thereby reducing the time and resources unnecessarily spent on developing different policies using different scientific information.

The order contained four key actions:

- Initiate California's first statewide climate change adaptation strategy that will assess the state's expected climate change impacts, identify where California is most vulnerable, and recommend climate adaptation policies by early 2009
- Request the National Academy of Sciences establish an expert panel to report on sea level rise impacts in California to guide state planning and development efforts
- Issue interim guidance to State agencies to plan for sea level rise in designated coastal and floodplain areas for new projects
- Initiate a report on critical existing and planned infrastructure projects vulnerable to sea level rise

State Water Resources Control Board (California Water Boards)

The California Water Boards adopted their Strategic Plan Update 2008-2012 on September 2, 2008. It includes environmental, planning, and organizational priorities.

Adaptive Management. *In regard to a marine fishery, this is a scientific policy that seeks to improve management of biological resources, particularly in areas of scientific uncertainty, by viewing program actions as tools for learning. Actions shall be designed so that even if they fail, they will provide useful information for future actions. Monitoring and evaluation are emphasized so that the interaction of different elements within the system can be better understood.*

The Water Boards' Strategic Plan considers climate change and other drivers that affect future change. Most of the actions in this strategic plan will be carried out in a watershed framework. (See Box 4-11 Complementary Management Approaches: IRWM and Watershed Management).

Delta and Suisun Marsh Planning and the Delta Vision

State government is involved in a number of major planning efforts to evaluate the Delta and Suisun Marsh ecosystems and water supply issues and to recommend strategies and actions for their improvement including Bay Delta Conservation Plan, Delta Risk Management Strategy (DRMS), Delta Regional Ecosystem Restoration Implementation Plan, the Suisun Marsh Plan, and Delta Vision. These overlapping concurrent efforts are forging strategies and actions that will be comprehensive and cohesive, and build upon each other to improve the Delta ecosystem and water supply reliability in response to the impacts of climate change.

- The purpose of the Bay Delta Conservation Plan (BDCP) is to help recover endangered and sensitive species and their habitats in the Delta in a way that also provides for sufficient and reliable water supplies. The BDCP will (1) identify and implement conservation strategies to improve the overall ecological health of the Delta, (2) identify and implement ecologically friendly ways to move fresh water through and/or around the Delta, (3) address toxic pollutants, invasive species, and impairments to water quality, and (4) provide a framework to implement the plan over time. More information is available at www.resources.ca.gov/bdcp/ .
- DRMS evaluates the risks from Delta levee failures and ways to reduce those risks. Preliminary evaluations show that the risks from earthquakes and floods are substantial and are expected to increase in the future. In Phase 1, DRMS is evaluating the risk and consequences to the Delta and the state associated with the failure of Delta levees and other assets considering their exposure to a number of hazards today and in the future. In Phase 2, DRMS will evaluate strategies and actions that can reduce risks and consequences. Additional information is available at www.drms.ca.gov .
- The Delta Regional Ecosystem Restoration Implementation Plan is identifying restoration opportunities within the Delta and Suisun Marsh ecological restoration zones. It applies the Ecosystem Restoration Program Conservation Strategy to the Delta, refines existing, and develops new, Delta restoration actions, and includes a conceptual model, implementation guidance, program tracking, performance evaluation, and adaptive management feedback. Additional information is available at www.delta.dfg.ca.gov/erpdeltaplan/ .
- The Governor established the Delta Vision Task Force in 2006 to develop a durable vision for sustainable management of the Delta including Suisun Marsh. The task force published its vision for the future of this crucial and gravely threatened resource in December 2007. In that vision, the task force described a future in which the California Delta will continue to thrive over the coming generations, despite the major challenges – ranging from climate change to subsidence to population growth – that it will face. At the core of the Delta Vision is a set

of 12 integrated and linked recommendations. Of these 12 recommendations, two are especially central:

- The Delta ecosystem and a reliable water supply for California are the primary, coequal goals for sustainable management of the Delta.
- The California Delta is a unique and valued area, warranting recognition and special legal status from the State of California.

The Delta Vision Task Force completed its Delta Strategic Plan in October 2008 with strategies, actions, and performance measures for realizing the vision. More information is available at www.deltavision.ca.gov.

On January 5, 2009, The Delta Vision Committee submitted its final implementation plan to the Governor on recommended actions to how the California Delta should be managed to fulfill its co-equal goals. The implementation plan sets priorities based on the Delta Vision Strategic Plan (http://www.deltavision.ca.gov/).

A government framework to address Delta issues is part of the 2009 Comprehensive Water Package. See that (earlier) subsection for discussion of SB 1 Delta Governance/ Delta Plan.

Federal, State, and local agencies, duck clubs, and other private landowners have developed a landmark comprehensive plan to protect and enhance public trust and wildlife values, water quality, and recover endangered species in the Suisun Marsh. The Suisun Marsh Plan is intended to enhance habitat for migratory birds as well as aquatic and terrestrial species, improve levees, restore tidal marshes and other ecosystems, and improve water quality. More information on the planning effort is available at: www.delta.dfg.ca.gov/ suisunmarsh/charter.

SWAN (Statewide Water Analysis Network)

For Update 2009, SWAN (the Statewide Water Analysis Network) prepared both a short-term and long-term plan to improve and peer-review data and analytical tools. SWAN's plan includes pilot studies and the development of presentation and decision-support tools to make complex technical information more accessible to decision-makers and resource managers.

For example, the uncertainty that remains in the rate and magnitude of long-term climate change must be reduced. Improved data collection and a robust monitoring network will help identify trends, provide for better real-time system management, and evaluate and, if necessary, correct mitigation and adaptation strategies. (See Chapter 6 Integrated Data and Analysis)

Propositions and Bonds

In recent years, California voters approved a series of bonds to preserve and enhance the state's natural resources. Propositions 12, 13, 40, and 50 made available a total of $10.1 billion that have been used by local governments and State agencies for a wide variety of activities such as water conservation, acquisition of land to protect wildlife habitats, and restoration of damaged ecosystems.

The infrastructure package approved by the voters in November 2006 included water and flood measures in propositions 1E and 84. These measures provided $4.9 billion

Box 4-14 SBxx 1 Appropriations for Integrated Regional Water Management (IRWM) Grants

SBxx 1 contains appropriations for the IRWM grant program from Proposition 84 and Proposition 1E. The appropriations consist of:

- $150 million from Proposition 1E for Storm Water Flood Management projects
  - Not less than $100 million will be available for projects that address immediate public health and safety needs and strengthen existing flood control facilities to address seismic safety issues.
  - $20 million will be available for local agencies to meet immediate water quality needs related to combined municipal sewer and storm water systems to prevent sewage discharge to state waters.
  - $20 million will be available for urban stream storm water flood management projects to reduce the frequency and impacts of flooding in watersheds that drain to the San Francisco Bay.
- $181.791 million from Proposition 84 subdivided to:
  - $100 million for implementation grants (from funding area allocations in Proposition 84):

    Not less than $20 million shall be allocated to support urban and agricultural water conservation projects to meet a 20 percent reduction in per capita water use by 2020,

    Not less than $10 million will be used to support projects that address critical water supply or water quality needs for disadvantaged communities.
- $39 million for planning grants and local groundwater assistance grants which consist of:
  - $30 million for planning grants (half interregional and half funding area allocation),
  - Not less than $3.9 million to facilitate and support the participation of disadvantaged communities in integrated regional water management planning,
  - $9 million for local groundwater assistance grants (interregional allocation).
- $22.091 million for interregional projects, which includes:
  - $10 million to connect municipal and industrial water supply aqueducts that cross the Delta, and
  - $2 million to Tulare County for development of an integrated water quality and wastewater treatment program plan.
- $20.7 million for program delivery

NOTE: The $150 million is half of the amount of Storm Water Flood Management funding authorized by Proposition 1E. The $100 million in IRWM implementation funds is one-ninth of the $900 million total funding allocated to specific regions in Proposition 84.

for flood management and approximately $1 billion for IRWM including wastewater recycling, groundwater storage, conservation, and other water management actions.

Following the Governor's emergency declaration for California's levee system in February 2006, key repairs to 33 critical erosion sites protecting Central Valley communities were completed in record time. The State is advancing funds and working with the federal government to repair 71 additional levee erosion sites damaged in last year's floods. The State began an effort to evaluate 350 miles of urban levees for hidden defects, and is leading a coordinated effort involving federal and local agencies to avoid a major flood disaster in California.

In September 2008, Governor Schwarzenegger signed SBx2 1 to appropriate $842 million in funding from Proposition 1E and 84 passed by voters in 2006 (See Box 4-14 for appropriations). See also separate entry for information on propositions.

Proposition 1E – Disaster Preparedness and Flood Protection Bond Act

In 2008, the State took action to improve California's flood protection system by including $211 million in Proposition 1E funding for four critical levee improvement and construction projects in three Northern California counties. This $211 million investment will help rebuild California's aging levee system and protect Californians from dangerous floods that could harm communities, agriculture, and water supplies.

The bond funds will fund four critical flood protection projects:

- Sacramento Area Flood Control Agency, Natomas Levee Improvement Program (Sacramento County), $49 million.
- Levee District No. 1 of Sutter County, Lower Feather River Setback Levee at Star Bend (Sutter County), $16.3 million.
- Reclamation District 2103 (Wheatland), Bear River North Levee Rehabilitation Project (Yuba County), $7.4 million.
- Three Rivers Levee Improvement Authority, Feather River Setback Levee (Yuba County), $138.5 million

Proposition 84

In November 2006, voters approved The Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006 (Proposition 84) authorizing $5.4 billion in general obligation bonds for natural resources purposes. These new bond funds will enable the state to continue investing in important projects targeted to improve water quality and drinking water availability, flood protection, State and local parks, coastal and ocean protection, and habitat conservation.

These funds have contributed to programs and projects in 18 State departments, boards, and conservancies, including:

- Tahoe Conservancy's Environmental Improvement Program, which will help preserve the world renowned clarity of North America's largest alpine lake;
- Department of Forestry and Fire Protection to preserve urban forestry and biomass projects to reduce the state's emissions of greenhouse gases;
- Department of Fish and Game to restore Bay-Delta and coastal fisheries;
- Wildlife Conservation Board to preserve and protect forests, wildlife habitat, rangeland, grazing land and grasslands, and oak woodlands;
- State Coastal Conservancy and the San Francisco Bay Area Conservancy Program to help protect the scenic beauty, recreational opportunities, and economic vitality of California's 1,100 miles of magnificent coastline;
- Ocean Protection Trust Fund to expand efforts to preserve and protect California's unique ocean resources and diverse marine life;
- DWR for IRWM projects that will improve and enhance California's use of its natural water resources and for a wide array of expenditures to improve flood protection around the state; and

- State Water Board to leverage federal funds for infrastructure investments to prevent pollution of drinking water supplies and for matching grants to local agencies to reduce storm water contamination of rivers, lakes, and streams.

Safe, Clean, and Reliable Drinking Water Supply Act of 2010

A $11.14 billion water bond proposal is part of 2009 Comprehensive Water Package discussed earlier in this section. Californians will have an opportunity to vote on this proposal in November 2010.

Federal Government

Water for America Initiative

In 2008, the federal government created a national Water Initiative to coordinate and support federal water research, education, and technology transfer activities to address changes in water use, supply, and demand in the United States. It includes support to increase water supply through greater efficiency and conservation. The Water for America Initiative merges three US Bureau of Reclamation water supply management programs (Water 2025, Water Conservation Field Services, and Investigations) and uses the scientific expertise of the US Geological Survey to monitor water quality, quantity, and flows in the nation's rivers and streams as well as the conditions of the its major aquifers.

Under the initiative, the Department of Interior (DOI) partnerships with state, local, and tribal governments will use the latest technologies in water planning and management to help communities respond to their changing water needs. At the watershed level, DOI agencies will work with urban, rural, and agricultural water users to stretch existing water supplies and carry out measures to protect endangered species at high-risk watersheds, thereby averting water crises.

The initiative will

- conduct a nationwide assessment of water availability and human and environmental water use by 2019, describing the change in water flows, groundwater storage, and water use,
- proceed with regional-scale studies that compare the current status of water storage and flows to prior conditions for each of the nation's 21 water resource regions,
- cooperate with states and local government in selected watersheds or aquifer systems to increase use of new technologies in water planning and management,
- cooperate with states to map the geologic framework of the nation to improve characterization of the nation's aquifers, and
- modernize the nation's 7,000 stream gages by replacing obsolete telemetry to ensure continued real-time operations and provide more timely information needed for better water management, and stabilize the long-term network by reestablishing critical streamgages discontinued in the past two decades.

American Recovery and Reinvestment Act of 2009

Under the American Recovery and Reinvestment Act of 2009, California water agencies were awarded $391 million to expand water supplies, repair aging water infrastructure, and address drought mitigation. Projects include the installation of temporary pipelines and pumps, drilling and installation of new water wells, well-enhancement projects, and a groundwater monitoring effort. These investments will help preserve permanent crops and associated jobs in an area that is experiencing a prolonged drought, economic hardship and some of the highest unemployment rates in the United States.

With the assistance of the Bureau of Indian Affairs, Native American projects were identified that will assist in meeting the water supply needs of Tribal communities impacted by the drought. Funds for the Gray Lodge, Pixley, and Volta Wildlife Refuges will assist in protecting the environment by providing more reliable water sources for the refuges and make more water available for other uses. Find a description of the projects at http://www.doi.gov/documents/BORDroughtProjectSummaries.pdf.

Federal Water Action Plan

In December 2009, President Obama's administration released a coordinated interim action plan to be taken by six federal agencies in addressing California's water crisis. The coordinated federal water action plan will:

- strengthen the federal government's coordination of actions with the state,
- help to meet water needs through actions that promote smarter water supply and use,
- help ensure healthy ecosystems and improved water quality, and
- call for agencies to help deliver drought relieve services and ensure integrated flood risk management.

View the Interim Federal Action Plan for the California Bay-Delta at www.doi.gov/documents/CAWaterWorkPlan.pdf.

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