VOLUME 1 - THE STRATEGIC PLAN

CHAPTER 3

California Water Today

Owens River near Big Pine. California's ecosystems and economy depend on snowpack, which is highly variable and unpredictable. Emblematic of California, this annual variability creates a feast-or-famine water supply situation. (Dec. 12, 2013)

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Chapter 3. California Water Today

About This Chapter

Chapter 3, "California Water Today," provides a snapshot of California's water conditions and management in 2013. The chapter describes the diverse institutions, communities, and environment including the challenges of providing reliable water supplies and reducing flood risks for providing public safety, economic growth, and enhanced ecosystems. It also describes recent investments and initiatives undertaken by local, regional, State, and federal governments as well as tribal entities. A description of achievements and emerging opportunities is also included.

Since water conditions vary among wet and dry years, this chapter presents data on actual statewide and regional water use, and corresponding supply sources (water portfolios) from 2001 through 2010. Regional water balance summaries are in Volume 2, Regional Reports. More detailed data about statewide and regional water uses and supply distributions are in Volume 5, *Technical Guide.*

Over the last several years, the State's debt level is increasing and the public's willingness and ability to pay for infrastructure and government services has been wavering. Nonetheless, regional entities and water communities have continued to advance integrated regional water management (IRWM) through the development of 48 regional planning entities, receiving allocations of more than $10 billion of General Obligation (GO) bonds since 2009.

While progress has been made implementing many water management actions since 2009, the risks to California's ecosystems, water supply reliability, and public safety continue to be a concern. California's water-related assets and services are often operated independently by location or resource. For example, surface and groundwater resources are largely managed as separate resources, when they are, in fact, a highly interdependent system of watersheds and groundwater basins. Water quality, land use, and flood management are also integral to the effective management of these systems and cannot be managed separately for infrastructure or policy effectively.

This chapter, "California Water Today," addresses these topics:

- Planning for Stability amid Extreme Diversity and Variability.
- Land Use and Development Patterns.
- Water Conditions.
- IWM Funding and Expenditures.
- Critical Challenges.
- Responses and Opportunities.

Planning for Stability amid Extreme Diversity and Variability

With its wide variety of climates, landforms, people, and institutions (i.e., anthrodiversity), California is often described as a land of extreme diversity and variability. This is particularly true when it comes to California's water resource systems as well as its social, institutional, and planning factors. Effective integrated water management (IWM) planning and implementation will reduce variability and uncertainty pertaining to water supply, ecosystems, and public safety. This section provides a description of the geophysical, social variability, and diversity that affect water resource management and IWM planning. The following material provides the context necessary to understand the planning approaches and proposed solutions in *California Water Plan Update 2013* (Update 2013).

Social Diversity

California has extraordinarily rich social diversity. This subsection describes the impact of social diversity in terms of the range of stakeholders' values and priorities associated with all of the resources, benefits, and issues within the scope of IWM. These values drive planning, investment prioritization, and policy-making. This subsection also describes the importance of defining and fostering a common understanding of the geophysical systems and the value of potential solutions. Social diversity also has an influence on the alignment of government agency data management, plans, policies, and regulations.

Resource-Dependent Values

California's various cultures, organizations, and individuals naturally assign different values and priorities to IWM-related assets, services, and benefits. These groups also have differing reliance on the way natural resources are managed and the results of those actions that affect future levels of flood risk to people's lives and assets, types and levels of economic activity, and the sustainability of natural resources. Although there is not always a clear distinction, for the purposes of IWM planning, various cultures and communities can be generally defined by place and/or how they benefit from various natural resources. Disparate IWM priorities, practices, and resource consumption rates define and support California's rich social diversity.

The California Department of Water Resources (DWR) discussed resource-dependent values with a broad cross-section of stakeholders. The list below represents a sample of the range of values that emerged from these discussions. This list begins to frame the preferences and priorities that must be understood and ultimately balanced in order to implement effectively multi-objective solutions.

- Facilitate access to safe drinking water for disadvantaged communities.
- Achieve environmental water quality objectives.
- Control invasive species.
- Control water-borne disease vectors.
- Maintain a reasonably high standard of living and quality of life.
- Create diverse portfolio of climate change adaptation and mitigation strategies.
- Create and sustain diverse portfolio of economic activity for each region.

- Enhance economic stability.
- Enhance efficiency of use of energy used to move and treat water.
- Minimize greenhouse gas emissions in water management activities.
- Facilitate human/nature connections.
- Improve or maintain ambient water quality — do no harm.
- Improve water supply reliability.
- Restore declining groundwater basins, reverse land subsidence, and maintain and improve ecosystem services provided by groundwater.
- Increase beneficial effects of flood for critical habitats.
- Improve water infrastructure (green and grey) levels of service.
- Ensure instream flows for restoration, a healthy ecosystem, fish population, and water temperature.
- Modify operations to meet existing or new objectives.
- Recover sensitive species.
- Reduce direct property damages resulting from floodwater.
- Reduce disaster recovery costs.
- Reduce high-severity wildfires.
- Provide the conditions to foster economic development and reliable utility services.
- Reduce potential for loss of life.
- Create conditions for relaxation and refreshment of mind and body.
- Sustain groundwater supplies and aquifers.
- Sustain the activities, culture/expertise, and overall capabilities to produce food and fiber in California.

Public's Understanding of Geophysical Systems

People often have a partial understanding of the geophysical systems described above, which are strongly influenced by what they consider important. For example, fishermen, farmers, and flood managers are likely to have different views on river flows from changes in operation of a reservoir.

An accurate, shared, and system-based understanding of California's water resources is a necessary first step toward funding and implementing effective IWM solutions. This is true at various scales, such as groundwater basin, watershed, regional, statewide, and tribal lands. Planning processes must overcome three challenges to foster such an understanding:

1. California's water systems are unimaginably complex and linked to every facet of natural resources, the State's economic activity, and public safety.

2. Scientific understanding is far from complete.

3. Water plays very different roles in people's lives, depending on their interest, location, value placed on natural resources, and many other variables.

Geophysical Variability

Precipitation is the primary source of the state's water supplies, and it varies from place to place, season to season, and year to year. Most of the snowfall and rainfall occurs in the mountains in the northern and eastern areas, 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, there is often either one of two threats: the state's water systems may not have enough water to meet all water demands during droughts or an excess of water causes floods. Figure 3-1 provides an example of the magnitude and frequency of variability in California's hydrology.

Climate and Water Availability

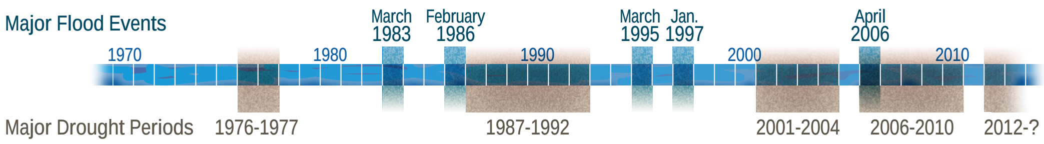
The amount and variability of precipitation, as well as temperature, differ dramatically between California's northern regions and its southeast portions. As such, statewide average information does not truly depict regional conditions and often over-generalizes California's water conditions. Wet, average, and dry conditions presented for the entire state are not often universally the same for individual regions. It is common during the same winter that the amount of winter precipitation varies from wet to above-average in one part of the state, and that it varies from below-average to dry in another part. In addition, the amount, types, and intensity of precipitation can also vary within each region within a given year and from year to year. This climatic variability compounds the difficulties of reducing flood risk, sustaining ecosystems, and enhancing water supply reliability. This also complicates government policy and regulation significantly by necessitating place-specific information, trade-offs analysis, and decision-making.

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. 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 flood management objectives. Figure 3-2 presents a map of California with major rivers, water conveyance, and storage facilities.

Generally, during a single dry year or two, surface water and groundwater storage supply most water deliveries, but dry years result in critically low water reserves. In addition to loss of habitat, the loss of wetlands compared with historic levels has reduced statewide capacity for groundwater recharge and floodwater retention. Ecosystems and agriculture often experience more significant water reductions than urban areas. Longer droughts cause extreme fire danger, economic harm to urban and rural communities, loss of crops, potential for species collapse, and degraded water quality. Greater reliance on groundwater during dry years can result in increased pumping costs, stream depletion, groundwater overdraft, and land subsidence for many groundwater basins. At the same time, water users who have already improved their water use efficiency may find it challenging to implement additional water use reductions during droughts.

California's most recent statewide drought in water years 2007-2009 was followed by near-average hydrologic conditions in water year 2010, and a wet year in 2011. Water year 2012 was the first generally dry year statewide since the last drought. Water year 2013 was one of the driest on record. Impacts of the 2007-2009 drought are described in the DWR summary report on that event, *California's Drought of 2007-2009: An Overview* (California Department of Water

Figure 3-1 Feast or Famine



Resources 2010). California received its full basic interstate apportionment of Colorado River water throughout this period.

In response to the widespread Midwestern drought in the summer of 2012, the U.S. Department of Agriculture (USDA) streamlined its methodology for the USDA Secretary to make county-level drought disaster designations, and to make low-interest loans more rapidly available to producers. The new methodology is based on counties' short-term status as depicted in the U.S. Drought Monitor, which primarily relies on precipitation and soil moisture conditions at a weekly time scale, and is essentially independent of any characterization of drought impacts. Application of the new methodology nationwide resulted in almost all of California's counties automatically receiving drought disaster designations in 2012.

Scientific capability for intraseasonal to interannual climate forecasting (ISI forecasting) remains unreliable. Since 2008, DWR has annually funded an experimental research forecast for the coming winter season. This forecast, like the National Oceanic and Atmospheric Administration (NOAA) Climate Prediction Center's seasonal outlook, can be used to explore research approaches associated with ISI forecasting, but it is not suitable for decision-making. A single dry year, such as 2012, is a reminder of the need to prepare for the possibility that the following year may also be dry, in which case the impacts of dry conditions will likely be more pronounced.

Californians also risk extensive property damage and loss of life when too much water overwhelms the system's capacity and floods cities and farmlands. As California develops and improves its water delivery and flood control systems, it must also preserve and protect its watersheds and maintain healthy ecosystems. The state relies on its watersheds and groundwater basins to provide clean and sufficient surface water and groundwater. Healthy surface water and groundwater are essential to California's resources and economic future. California's public agencies must manage these public-trust resources for future generations. Figure 3-3 illustrates the variability in types of flooding. Figure 3-4 shows the broad range of water uses.

Hydrologic Regions and Areas

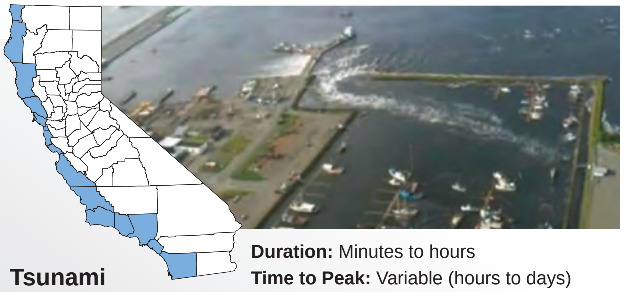
The California Water Plan (CWP) divides California into 10 hydrologic regions approximately corresponding to the state's major water drainage basins (Figure 3-5). Using these hydrologic regions and their nested subareas as planning boundaries allows consistent tracking of their natural water runoff and the accounting of surface water and groundwater supplies. In addition to sharing similar hydrology, the areas within a hydrologic region generally share similar water issues. See Box 3-1, "About Update 2013 Regional Reports," for a description of each hydrologic region and its river basins.

Figure 3-2 Map of California with Major Rivers and Facilities

Figure 3-3 Variable Flood Risk

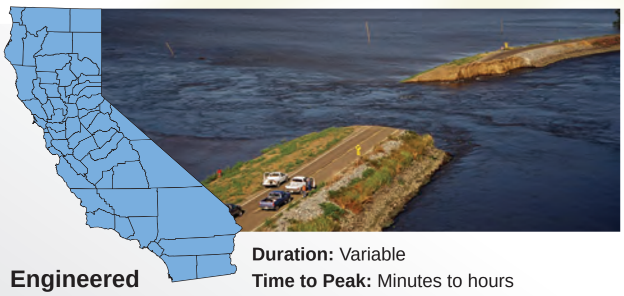
Potential Occurrence by County

Absent | Present | Likely



Tsunami Flooding

Duration: Minutes to hours
Time to Peak: Variable (hours to days)
Area Flooded: Coastal areas
Causes: Earthquake



Engineered Structure Failure Flooding

Duration: Variable
Time to Peak: Minutes to hours
Area Flooded: Areas downstream of engineered structure (i.e., levees, dams)
Causes: Failure of structures

Coastal Flooding

Duration: Seasonal
Time to Peak: Hours to days
Area Flooded: Coastal areas, bays, back bays, sounds, and inland tidal waterways
Causes: Winter and Spring coastal storms, high winds, storm surges and high tides

Debris Flow Flooding

Duration: Hours
Time to Peak: Hours
Area Flooded: Areas downstream of denuded hillsides
Causes: Heavy localized rainstorms on hillsides with charred or denuded ground

Slow Rise Flooding

Duration: Weeks
Time to Peak: Days
Area Flooded: Deep floodplains and low-lying urban areas
Causes: Heavy precipitation especially with snowmelt

Flash Flooding

Duration: Hours
Time to Peak: Hours
Area Flooded: Steep slopes and impermeable surfaces, as well as adjacent to local streams and creeks
Causes: High-volume rainstorms, thunderstorms, or slow-moving storms

Alluvial Fan Flooding

Duration: Hours
Time to Peak: Hours
Area Flooded: Surface and toe of alluvial fans
Causes: High-volume rainstorms and thunderstorms; displaces high volume of sediment

Stormwater Flooding

Duration: Hours
Time to Peak: Hours
Area Flooded: Localized urban areas
Causes: Rainstorms along with blocked or overwhelmed storm drainage systems

Figure 3-4 Types of Water Use

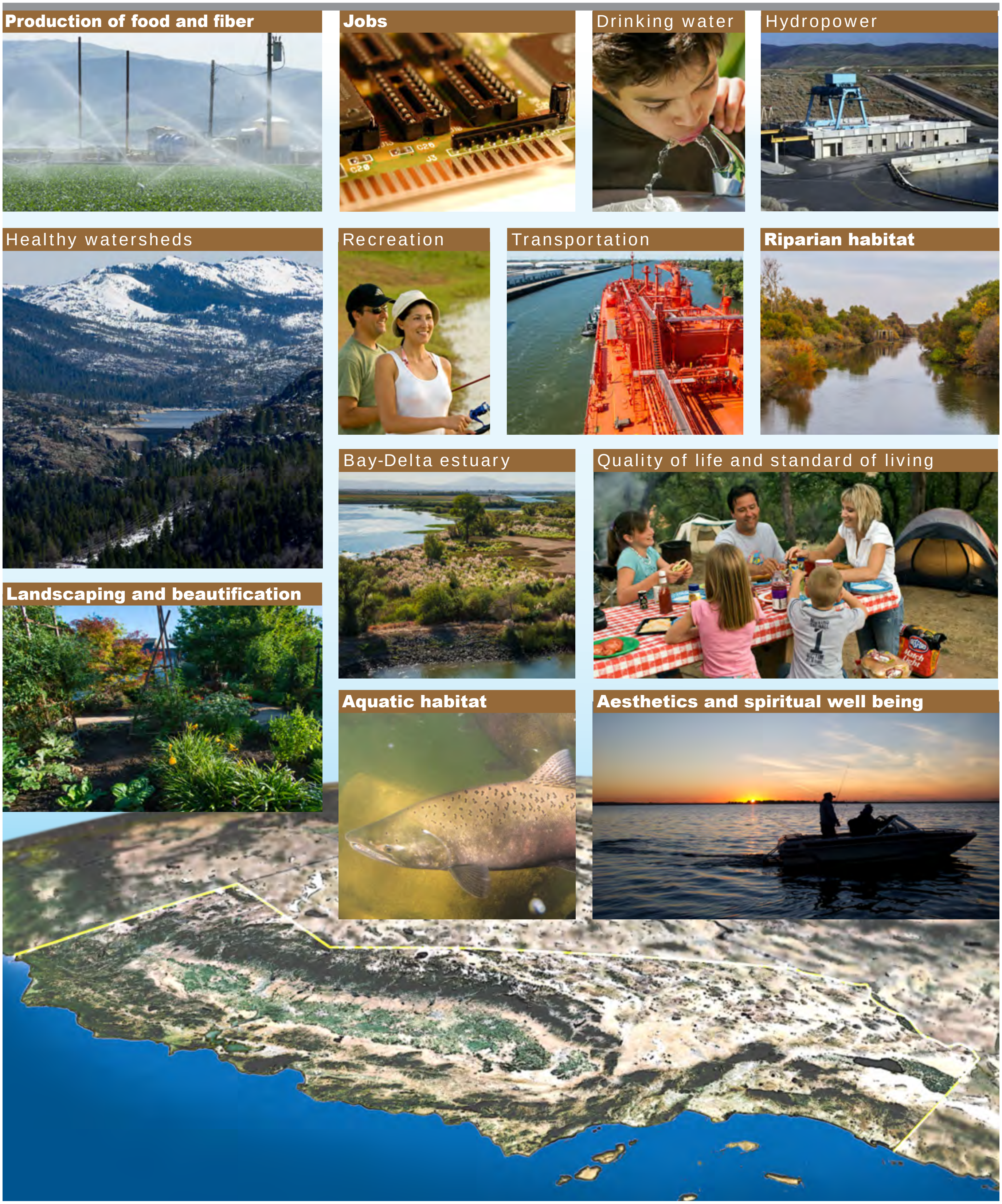


Figure 3-5 Hydrologic Regions of California, the Sacramento-San Joaquin Delta, and Mountain Counties Area

Box 3-1 About Update 2013 Regional Reports

California Water Plan Update 2009 expanded the regional reports. Each regional report in *California Water Plan Update 2013* 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 2050 for three alternative scenarios. These regional reports have also added information about tribal populations and tribal lands in each region.

These regional reports present today's water conditions in each region, and the challenges and opportunities for the future. Each separately bound regional report contains a main section, which is a concise summary of the most significant water information and issues in that region. Each regional report includes information about flood management and water quality, as well as data sets and other detailed information. The following are short descriptions of the 10 hydrologic regions and the two hydrologic areas.

Hydrologic Regions

- **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 in 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 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 the 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 Mexico border.

Delta Region and Mountain Counties Areas

- **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, 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 4, "Strengthening Government Alignment," in this volume).
- **Mountain Counties.** 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 and into Fresno County in the south. This area shares a 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.

Some regions share common water issues or interests that stretch across boundaries, from one hydrologic region to another. The common water interests and issues of two such regional overlays, the Mountain Counties area and the Sacramento-San Joaquin Delta (Delta) region, are included with the regional descriptions in Volume 2, *Regional Reports*. There are other regional overlays that could be developed based on boundaries, such as county lines, water districts, or IRWM groups.

Regions are also appropriate for flood management planning. Flood management planning at a watershed scale allows a systemwide approach to reduce flood risk. The planning scale of regions can vary from any of the 10 hydrologic regions to smaller watersheds. With financial assistance and support from DWR, regional entities in the Central Valley have begun development of regional flood management plans that address local needs, articulate local and regional flood management priorities, and establish the common vision of regional partners. These regional plans are an important step in refining and implementing the 2012 Central Valley Flood Protection Plan and are slated for completion in 2015.

IRWM Planning Regions

The geophysical variability and social diversity described above influence selection of IRWM planning regions. A component of the IRWM Program Guidelines is the Regional Acceptance Process (RAP), which is a process for identifying planning regions for the purpose of developing, modifying, and implementing IRWM plans. Generally, these IRWM regions are subdivisions of the hydrologic regions discussed above. At a minimum, an IRWM region is defined as a contiguous geographic area encompassing the service areas of multiple local agencies to maximize the opportunities to integrate water management activities and effectively align and integrate water management programs and projects within a hydrologic region. To date, 48 IRWM regions have been established (Figure 3-6).

Land Use and Development Patterns

The distribution, type, and extent of land uses all have a significant effect on virtually every aspect of IWM. Land use affects water use, water quality, natural groundwater recharge, flood risk, and ecosystem assets and services. Land use decisions are also a key driver of future investment needs for water and flood infrastructure. Population growth is a major factor influencing land use decisions. From 1990 to 2010, California's population increased from 30 million to approximately 37.3 million. By 2012, the state's population topped 38 million. The California Department of Finance projects that this trend means a state population of roughly 51 million by 2050. For historical population-growth data by region between 1960 and 2010, see Volume 5, *Technical Guide*. Table 3-1 shows the California population change from 2005 to 2010 statewide and by hydrologic region. The vast majority resides in urban areas.

Urban, agricultural, and ecosystem land uses require significantly different water use patterns. Depending on location, the major land uses generally serve multiple uses. For example, agricultural areas provide important habitat. However, given the finite supply of land suitable for agricultural activities, population growth often causes changes from agricultural to urban land use. Where and how current and future Californians live will affect the extent to which water and land will be available for agriculture and ecosystem habitats. For instance, accommodating population growth in a traditional suburban, low-density pattern without low-impact development

Figure 3-6 **Map of Integrated Regional Water Management Planning Regions**

Table 3-1 California Population Change 2005 to 2010 Statewide and by Hydrologic Region

Hydrologic Region	2005 Population	2010 Population	Growth
North Coast	656,064	671,344	2.3%
San Francisco Bay	6,132,111	6,345,194	3.5%
Central Coast	1,486,250	1,528,708	2.9%
South Coast	19,176,154	19,579,208	2.1%
Sacramento River	2,846,723	2,983,156	4.8%
San Joaquin River	1,999,295	2,104,206	5.2%
Tulare Lake	2,093,865	2,267,335	8.3%
North Lahontan	97,644	96,910	-0.8%
South Lahontan	806,672	930,786	15.4%
Colorado River	690,804	747,109	8.2%
Total	35,985,582	37,253,956	3.5%

(LID) strategies may require more water, depending on future residential and recreational landscaping practices, than in a more compact, mixed-use arrangement.

Land use decisions for California’s floodplains have major impacts on flood management. For example, many of the levees in California’s Central Valley were originally constructed to aid navigation and protect low-value agriculture. Since the late 1800s, more people have settled on the floodplains, a movement that has increased flood risk and costs of recovery. Accompanying the influx of people, a shift toward higher-value agriculture has occurred on the floodplains, which also continues to increase the risks and costs of flooding. These land use changes now demand more flood protection than can be provided by the existing flood management system. Also, land use is an important concern along California’s coast on the part of residents of low-lying areas, such as the Humboldt Bay, who are at risk from coastal as well as tsunami flooding. Because few suitable areas exist for development, seawalls, jetties, and other barriers have been put in place to reduce flood risk, even if they are not able to eliminate it. Flooding is a concern in other areas, such as Southern California, where population expands and there is pressure to develop in alluvial fan and desert areas. These increases put more people and structures at risk from flooding. Linking land use decisions and flood management can help make people and property safer when floods occur.

Integrating urban development design with LID and Leadership in Energy & Environmental Design (LEED) (see Volume 3, Chapter 24, “Land Use Planning and Management”) means that less water is needed for landscaping, polluted runoff water is minimized, and more opportunities are created for local and floodplain management strategies.

The Legislature has adopted policies and supports programs that further the integration of land use and water management. Despite the lack of State standards for achieving more compact development or a State agency with oversight authority, changing land use patterns are accelerating as demographics are changing where people live. Another incentive for more compact development is the requirements of Senate Bill (SB) 375 (Statues of 2008), which link land use and transportation. The required community sustainability plans may benefit water management because of the general preference for compact land use.

State Land Use Policy

Given the geophysical variability and social diversity described above, the extent to which and how future land uses drive or affect IWM and land management priorities also vary throughout California. For example, mixed use, infill development, and walkable communities are often priorities within highly urbanized areas, whereas preservation of agricultural land is often a significant consideration in the Central Valley, and water supply is often of paramount concern for growing foothill communities. Also, because 50 percent of California's land area is under public ownership, forest and upper watershed land management are a significant concern and investment in the northern and eastern rural portions of the state. This generally means that land use polices must be specific and appropriate on a region-by-region basis to be effective and to support both biodiversity and anthrodiversity.

Various State government entities, such as the Tahoe Regional Planning Agency and the California Coastal Commission, have sought to provide broad policy since the 1960s for regional planning that is increasingly sustainable. More typically, however, State government has played a limited or indirect role in land use planning (see Box 3-2, "Land Use Jurisdiction"). State policies are largely expressed and enforced through local general plans and land use regulations. Incentives are provided via transportation and water grants and limited State resources for technical assistance. The intent of passing legislation for land use planning to local governments, general plans, and more recently Assembly Bill (AB) 857 (Statutes of 2002) and SB 375 (Statues of 2008), is to integrate sustainable development, resources, and land use.

Managing Urban and Agricultural/Rural Land Use

Agricultural land provides many benefits for urban development: water supply through use of agricultural lands for percolation and water storage, flooding attenuated in a cost-effective manner, and water treatment for storm runoff. While these services are possible, it is not yet standard practice for existing cities and towns to incorporate these agricultural land services into their water and flood management practices or policies.

California remains one of the most productive agricultural regions in the world and continues to be the number one state in cash farm receipts. The state's 81,700 farms and ranches received a record $37.5 billion for their output in 2010. This revenue represents 11.9 percent of the U.S. total. The state accounted for 16 percent of national receipts for crops and 7 percent of the U.S. revenue for livestock and livestock products (California Department of Food and Agriculture 2010). California agriculture generates at least $100 billion annually in related economic activity.

In 2010, California irrigated an estimated 9 million acres of cropland using roughly 25 million acre-feet (maf) of applied water. The acreage estimate includes irrigated pasture, but excludes nonirrigated pasture and rangeland. The 9-million-acre estimate includes non-bearing orchard and vineyard acres, as well as acres of failed crops. It accounts for double-cropped acres, so the actual irrigated land area growing crops in California in 2010 was somewhat less than 9 million acres. An estimate of California's 2010 multi-cropped acreage is not yet available, but it was estimated

Box 3-2 Land Use Jurisdiction

Cities and counties have the primary jurisdiction over land use, planning, and regulation. Their authority derives from the State and its constitutional powers to regulate land use for the protection of 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, which 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 power plants of 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 California 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. COGs prepare regional growth plans to meet regional housing and transportation demands.

to be about 540,000 acres in 2005 in California Water Plan Update 2009 (Update 2009) (see Box 3-3, "The Rising Economic Efficiency of California Agricultural Water Use").

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 (NGOs). Each entity has a different forest management strategy with different goals and constraints. These forest and rural lands are watersheds for many of the urban water supply sources, and are key components of flood management strategies (see Chapter 23, "Forest Management," in Volume 3, *Resource Management Strategies*).

Tribal Lands

California is home to more people of Native American heritage than any other state. There are more than 100 federally recognized Native American tribes in California and nearly the same amount of entities petitioning for recognition (non-federally recognized tribes). Federal recognition confers specific legal status on these tribes and imposes certain responsibilities on the federal government. Changes in federal Native American policy throughout U.S. history have influenced which tribes are recognized today by the federal government and which are not. California, in particular, because of its unique history, has a significant number of non-federally recognized tribes. For these same reasons, the total number of non-federally recognized tribes in California is uncertain. Nevertheless, all California tribes and tribal communities, whether federally recognized or not, have distinct cultural, spiritual, environmental, economic, and public health interests related to water. One of the primary responsibilities of the United States with

Box 3-3 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 2010

By Jim Rich, Economist, DWR, February 7, 2014

Executive Summary

The real, inflation-adjusted gross revenue for California agriculture increased more than 80 percent between 1967 and 2010, from $20.8 billion (in 2010 dollars) to $37.5 billion. During that period, the total California crop applied-water use fell by 19.6 percent, from 31.2 million acre-feet (maf) in 1967 to a preliminary, unofficial estimate of about 25.1 maf in 2010.

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 43 years. In 1967, there was $666 (in 2010 dollars) of gross agricultural revenue produced in California for each acre-foot of applied water. By 2010, this measure had risen to $1,494 per acre-foot. That represents a 124.2 percent real increase in 43 years. Much of this increase has occurred since 2000.

Summary of Research on the Economic Efficiency of California Agricultural Water Use

In recent years, representatives of California agriculture, as well as State government officials, have described the increased economic efficiency of California agricultural water use. For instance, A.G. Kawamura, the Secretary of the Department of Food and Agriculture in 2008, wrote:

> California farmers have always practiced innovative water resource management, while producing food that feeds the state and the world. Over the past four decades, the amount of water used on California farms is relatively consistent, while crop production has increased more than 85 percent.
>
> *San Francisco Chronicle Nov. 30, 2008*

California Department of Water Resources (DWR) economists have analyzed how, during the past 43 years, the real value of California agricultural output has changed with respect to the water applied to California farmland. This analysis included livestock and livestock products because the vast majority of California’s animal-based agriculture depends, in part, on irrigated crops. DWR economists estimate that, over the past 43 years, the economic efficiency of water use by California agriculture has more than doubled.

The real, inflation-adjusted gross revenue for all of California agriculture increased 80.4 percent between 1967 and 2010, from $20.8 billion (in 2010 dollars) to $37.5 billion. However, during that same period, the estimated total crop applied-water use in California fell by 19.6 percent, from 31.2 maf in 1967 to a preliminary rough estimate of about 25.1 maf in 2010.

The 25.1 maf of water was applied to slightly less than 8.9 million harvested or grazed crop acres, the large majority of which were irrigated in 2010. The acreage estimate includes irrigated pasture, but excludes unirrigated pasture and rangeland. The 8.9-million-acre estimate includes non-bearing orchard and vineyard acres, as well as acres of failed crops. It accounts for double-cropped acres, so the actual land area growing crops in California in 2010 was somewhat less than 8.9 million acres. Total crop applied-water use varies significantly from year to year, depending not only on how many acres of which crops are grown, but also on the weather in California’s major growing regions. Total gross crop revenue varies as crop acres, yields, and prices change over time. Gross revenues from animal agriculture also vary.

Because of the rising value of agricultural output, coupled with falling crop water use, the economic efficiency of agricultural water use in California more than doubled during the past 43 years. Specifically, in California in 1967, there was $666 (in 2010 dollars) of gross agricultural revenue produced for each acre-foot of water applied to crops. By 2010, this measure of the economic efficiency of agricultural water use in California had risen to $1,494 per acre-foot. That represents a 124.2 percent real increase in 43 years. California agriculture is producing a lot more real gross revenue, using less applied water.

Also, note how this trend appears to have accelerated sharply between 2000 and 2010. The shift out of lower-valued field crops and into riskier, higher-valued truck, tree, and vine crops has increased during the last decade. Although such crops may bring in more average gross revenue per acre, they are more costly to produce, and subject to overproduction and sharp market swings, sometimes resulting in large net losses for the farmers who grow them. Between 2000 and 2010, real gross agricultural revenue per acre-foot of applied water increased about 36.6 percent, from $1,094 per acre-foot to $1,494 per acre-foot, expressed in 2010 dollars.

respect to Native American tribes has been to hold legal title to Native American lands in trust for the tribes. The tribes retain beneficial use of those lands. The United States also accepts legal title to lands that the tribes acquire within or adjacent to their existing reservations. In addition to trust lands, there are two other kinds of tribally owned lands — restricted fee land and fee lands purchased by tribes. Restricted fee land is land for which the tribe holds legal title, but with legal restrictions against alienation or encumbrance. Fee lands purchased by a tribe are lands where a tribe acquires legal title under specific statutory authority. Fee land owned by a tribe outside the boundaries of a reservation is not subject to legal restrictions against alienation or encumbrance, absent any special circumstances. The law is not clear regarding whether such restrictions apply to fee land within the boundaries of a reservation.

Lists of these lands and more tribal information appear in the regional reports. See also tribal articles and reference materials in Volume 4, *Reference Guide*.

SB 18 (Chapter 905, Statutes of 2004) requires cities and counties to consult with Native American tribes during the adoption or amendment of local general plans or specific plans. A contact list of California Native American Tribes and representatives within a region is maintained by the Native American Heritage Commission. Each regional report in Volume 2 lists some tribal information for that region.

Public Land Management

Federal agencies own approximately 47 percent of California's 100 million-plus acres. The U.S. Department of Agriculture Forest Service (USDA Forest Service) is the largest public forest land manager in the state. The federal agencies that manage the largest number of acres in the state are:

- USDA Forest Service — 20,741,000 acres.
- U.S. Bureau of Land Management — 15,128,485 acres.
- National Park Service — 7,559,121 acres.
- U.S. Fish and Wildlife Service — 472,338 acres.

The U.S. Bureau of Land Management (BLM) administers more than 15 million acres of California's public lands, which is about 15 percent of the state's total acreage. These lands include 15.2 million acres of public lands and 3.9 million acres of wilderness. Through the BLM, the federal government also holds most of the water rights (in volume) in the state, more than 112 maf of water rights, mainly through the Central Valley Project (CVP), which yields an annual average delivery of 7 maf.

The Organic Act of 1897 established national forests in California and states that a primary purpose of the national forests is to "secure favorable flows of water." National forests in California comprise about 20 percent of the area of the state, and because these lands are in mountainous headwaters, they provide almost 50 percent of the state's surface water.

Environmental issues related to resource management on national forests are addressed under the National Environmental Policy Act (see Chapter 23, "Forest Management," in Volume 3, *Resource Management Strategies*).

Military Activities

Military activity is part of the fabric of California. With 30 major military installations and numerous other minor installations, Department of Defense (DOD) activities in California currently employ approximately 236,000 personnel and contribute more than $56.7 billion to the state economy. Military installations can also assist in the recovery of threatened and endangered species, improve water quality, and provide buffers against urban sprawl.

Much of California's high technology economy and infrastructure is a consequence of the DOD presence and activities in the Golden State. The California military installations of yesterday protected the nation during all of the major conflicts dating back to World War I, and the state continues to host some of the nation's most critical military bases and training facilities. It is imperative that State, regional, and local governments specifically consider the national security mission and economic significance of DOD activities in California during their natural resource planning efforts. Military training and the infrastructure that supports it cannot be sustained without access to sufficient quantities of high-quality water.

Water Conditions

The risks to California's ecosystems, water supply reliability, and public safety related to flooding and water quality remain high. California's water-related assets and services are provided by many interdependent systems that historically have been managed on a project-by-project basis. This lack of systemic planning and management has contributed to an assortment of ongoing and emerging crises, as well as increased probability of large-scale social catastrophes. In addition, many resources have been managed independently. Surface and groundwater resources are largely managed as separate resources, when they are, in fact, a highly interdependent system of watersheds and groundwater basins. Water quality, land use, and flood management are also integral to the effective management of these systems. These different, but intricately connected, aspects of IWM cannot be effectively managed separately from infrastructure or policy perspectives.

Environmental Water

In addition to managing California's water resources for domestic, industrial, and agricultural use, water purveyors must also manage for the needs of the environment and its ecosystems. 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," in this volume. Objectives for the major rivers, estuaries, and wetlands of northern and

The Seawater Desalination Test Facility at Naval Facilities Engineering Command/Engineering Service Center in Port Hueneme, CA, provides a real-world test environment for long-term evaluation of desalination equipment and other water purification components, including reverse osmosis membranes, pumps, and energy recovery devices.

central California are tabulated in Chapter 5, along with the amount of water needed to meet each of them.

Ecosystems are generally healthier when water conditions are most similar to historic flow patterns. 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 Wildlife (DFW). Thus, DFW looked beyond the list of major water bodies to identify 21 additional streams. DFW developed flow objectives for those streams that needed to be established to ensure the continued viability of their fish and wildlife resources and submitted them as flow recommendations to the State Water Resources Control Board (SWRCB) in May 2008. DFW estimates that flows in all 21 streams fall short of the objectives in at least some seasons and years.

DFW 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. That list was submitted to the SWRCB in August 2008. Again, flows in those streams are estimated to be insufficient. The combined list of 43 streams represents a broad cross-section of smaller perennial watercourses in the various regions of California.

Flood Management

Flood management practices traditionally 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 development within the historic floodplains. In recent years, flood managers have recognized the potential for natural watershed functions and worked to integrate these two methods. Practicing flood management using an IWM approach considers land and water resources at a watershed scale and 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. This integrated approach to flood management does not rely on a single strategy, but instead uses various techniques that include 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.

For the purposes of mapping areas that warrant flood insurance, the Federal Emergency Management Agency (FEMA) has traditionally used the 100-year flood event, which refers to the level of flood flows expected at least once in a 100-year period (a 1-percent annual chance). As California's hydrology changes, what is currently considered a 100-year flood may occur more often, leaving many communities at greater risk for flood damage. 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.

Californians have settled near the 38 major rivers in the state — from the Klamath River in the north to the San Diego River in the south — a reality that has had its benefits and risks. Today, almost 20 percent of the California's population is exposed to flooding. Flows in California rivers vary dramatically based on meteorological conditions, hydrologic conditions, geology, and human development and encroachment patterns. Significant systems have developed over time to provide flood protection to Californians in different parts of the state, including the State Plan of Flood Control, Los Angeles River, and Pajaro River systems. Statewide, flood management agencies are responsible for operations and maintenance of:

- Approximately 20,000 miles of levees.
- More than 1,500 dams and reservoirs.
- More than 1,000 debris basins.

Many of these systems were constructed in the early to mid-1900s and are aging. This fact, coupled with increased development upstream, changes in system hydraulics, and changes in regulations, have put additional stressors on these systems.

The largest flood management system in California is the State-federal system, known as the State Plan of Flood Control. Although the system has been instrumental in transforming the Sacramento and San Joaquin valleys into well-known productive regions, as well as in preventing billions of dollars in damages and loss of life, flood damage continues to occur at unacceptable levels. The aging infrastructure does not meet modern engineering standards in many locations, and it does not provide appropriate levels of protection given population and property within the floodplains. The consequences of flooding are much higher today than when many of the facilities were built. Investigations for the Central Valley Flood Protection Plan (CVFPP) indicate that about half of Sacramento River basin levees (urban and rural) do not meet current safety criteria or have a high potential for failure. Additionally, about half of the channels have inadequate capacity to convey design flows. The existing level of urban flood protection is among the lowest in the nation.

Water Supplies and Uses

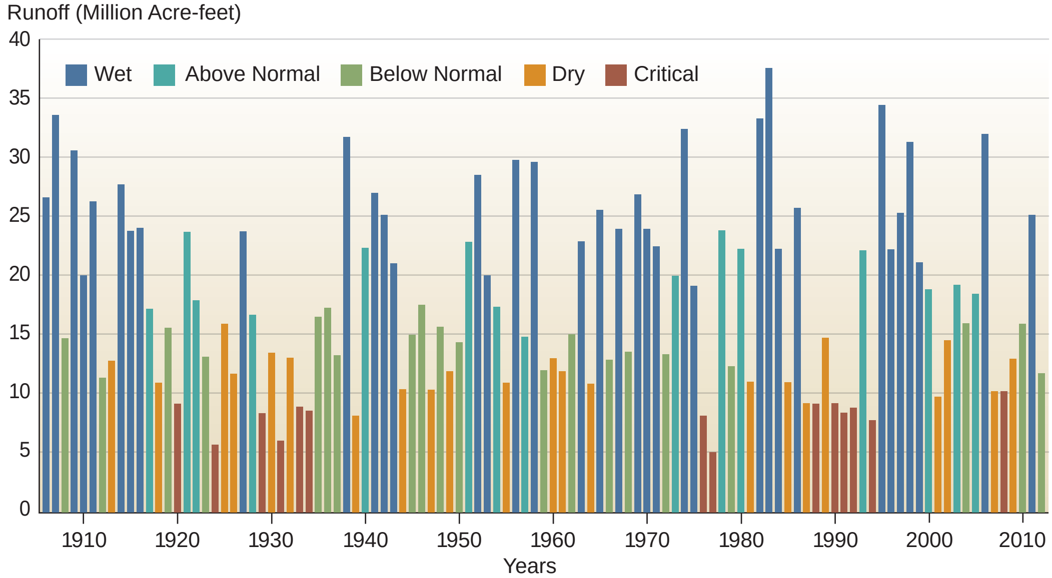
During the 20th century, Californians were able to meet water demands primarily through an extensive network of water storage and conveyance facilities, groundwater development, and more recently by improving water efficiency.

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 efficiency, the state's water consumption has grown along with its population. Many communities 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, agricultural and urban landscape (outdoor) water demands are lower because the high amount of rainfall directly meets these 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 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. However, increasing trends toward permanent cropping reduces California's ability to respond to changing supplies and increases reliance on groundwater supplies to meet demand.

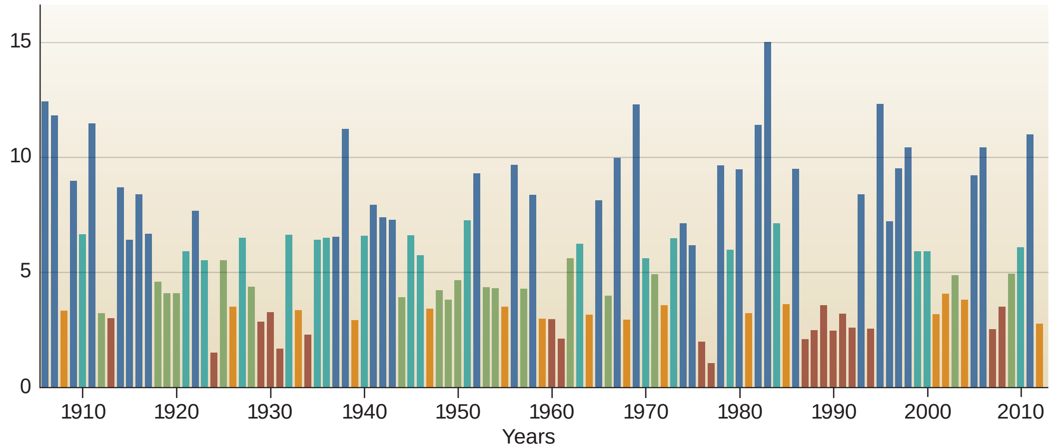
An indicator of California's hydrology and the annual surface water supplies is the amount of water that flows into the state's major rivers. For the central portions of California, the Sacramento River basin and San Joaquin River basin indices have been used for many years to evaluate the amount of available surface water. As shown in Figures 3-7 and 3-8, these two river

Figure 3-7 Sacramento Four Rivers Unimpaired Runoff, 1906-2012



Note: 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 3-8 San Joaquin Four Rivers Unimpaired Runoff, 1906-2012



Note: The four San Joaquin rivers are Stanislaus River inflow to New Melones Reservoir, Tuolumne River inflow to New Don Pedro Reservoir, Merced River inflow to New Exchequer Reservoir, and San Joaquin River inflow to Millerton Reservoir.

indices describe unimpaired natural runoff from 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.

Surface and Groundwater Connections

Winter precipitation and spring snowmelt are captured in surface water reservoirs to provide flood protection and water supply, as well as water for the environment. Reservoir storage also factors into assessing resilience under drought. The state's largest surface "reservoir" is the Sierra Nevada snowpack, about 15 maf on average, which becomes snowmelt that ultimately feeds and replenishes the surface water reservoirs. A projected reduction in this snowpack as a result of climate change will have a severe impact on California water management (see the "Climate Change" section under "Critical Challenges" in this chapter).

Water year 2012 was another dry year for California. Figure 3-9 shows percentages of statewide runoff for 2006 through 2012 and end-of-year storage for the state's larger reservoirs: Trinity, Shasta, Oroville, Folsom, Don Pedro, New Melones, and San Luis.

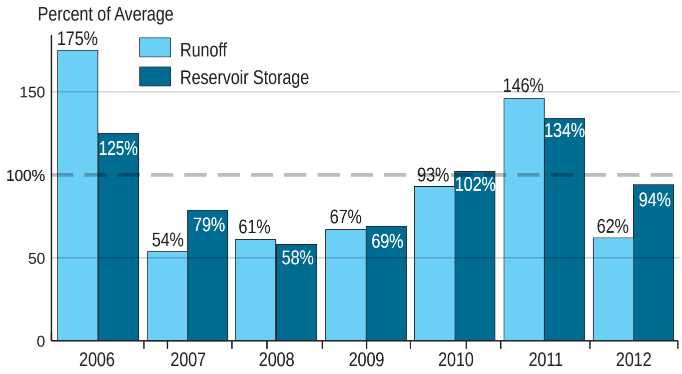
Other factors also affect the availability of surface water. In December 2007, U.S. District Court Judge Oliver Wanger imposed restrictions on water deliveries from the Delta to protect the threatened delta smelt. This can significantly decrease deliveries to homes, farms, cities, and industry by both the State Water Project (SWP) and the federal CVP, depending on the water year type. These export pumping restrictions continue to have a significant impact on water supply, most recently in February, 2013.

Surface water supplies are also affected by groundwater pumping. Groundwater pumping results in a depletion of aquifer storage and a lowering of the groundwater table. Aquifer storage is replaced through increases in stream infiltration or through the capture of groundwater underflow that would otherwise have discharged into the stream and contributed toward base flow. For production wells located near surface water systems, the majority of streamflow depletion resulting from pumping occurs within months. However, for those wells located farther from the surface water system, or constructed to draw from deeper in the aquifer, the lag time and long-term effects of groundwater pumping on streamflow depletion can last for years.

In some basins, aquifers remain permanently or seasonally connected to surface water systems and provide a much-needed contribution to base flow during summer and fall months. In far too many basins, groundwater levels have been permanently lowered below the elevation of nearby stream channels. In these basins, streams that once flowed year-round now go dry over extended periods and over longer reaches of the stream. Disconnection of our groundwater and surface water systems can have devastating impacts on our cold water fishery, riparian habitat communities, and ecosystem services.

Incidentally, 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 depending on unreliable water sources, such as groundwater from fractured rock aquifers or small and shallow coastal-terrace groundwater basins. Historically, at-risk geographic areas include the foothills of the Sierra Nevada and the Coast Range, inland Southern California, and the 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 can be scarce. These findings do not necessarily reflect the quality of water delivered to the public, since many communities treat their water prior to delivery. Also, these findings do not reflect private domestic well users or other small water systems that are not regulated, because no comprehensive database exists for these systems.

Figure 3-9 Total Statewide Runoff and Key Reservoir Storage, End of Water Years 2006-2012



Note: Statewide runoff totals and end-of-water-year storage, 2006 to 2012, for key reservoirs (Trinity, Shasta, Oroville, Folsom, Don Pedro, New Melones, and San Luis) as a percentage of average.

As surface water supplies continue to decrease owing to the uncertain conditions described above and new restrictions on exports through the Delta, groundwater use will continue to increase. In some areas, however, 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 (see Box 3-4, "Groundwater Overdraft") or naturally occurring contaminants. Management of groundwater resources is more complex than management of surface water resources because of highly variable aquifer conditions, limited data collection, misconceptions regarding groundwater, and the general out-of-sight, out-of-mind approach toward this valuable resource. The quality of water in private wells is unregulated, and so private well owners are often unaware of the potential water-quality threats in their drinking water.

State Water Project Deliveries

Initial SWP deliveries in 2012 were only 60 percent of contractual amount, though the final allocation was raised to 65 percent after early May snow and rain improved water conditions. The amount of SWP water delivered was 2,836,364 acre-feet (af). Since the SWP began allocating deliveries in 1968, the lowest final allocations have been 35 percent in 2008, 39 percent in 2001, and 30 percent in 1991.

Future deliveries of SWP and CVP 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.
- The vulnerability of Delta levees to failure resulting from floods and earthquakes.

DWR released the 2011 State Water Project Delivery Reliability Report on July 20, 2012. The 2011 report is the latest in a series of reports on the delivery reliability of the SWP, the largest State-built and operated water and power system in the United States. The summary states, "California faces a future of increased population growth, coupled with the potential for water

Box 3-4 Groundwater Overdraft

Overdraft is the condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions. Overdraft can be characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years. The calculation of overdraft requires an evaluation of change in groundwater storage over multiple years that, as a whole, represent average hydrology and water supply. To calculate overdraft, the average annual change in groundwater storage must be calculated over an extended period that includes a varied hydrologic regime to accurately approximate average conditions. 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 (California Department of Water Resources 1980). The California Department of Water Resources estimated that overdraft is between 1 and 2 million acre-feet annually (California Department of Water Resources 2003), but the estimate is 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 used as a reservoir, and water is withdrawn with the expectation that the aquifer will be recharged during a wet season to come.

shortages and pressures on the Delta." The newest report updates estimates of current (2011) and future (through 2031) SWP deliveries, taking into account pumping restraints to protect delta smelt, salmon, and other fish species, as well as variations in precipitation and impacts of climate change. Some key points in the report are as follows:

- Estimates of average annual SWP exports under conditions that exist for 2011 are 2,607 thousand acre-feet (taf), 350 taf or 12 percent less than the estimate under 2005 conditions.
- The estimated average annual SWP exports decrease from 2,607 thousand acre-feet per year (taf/yr.) to 2,521 taf/yr. (a reduction of 86 taf/yr. or about 3 percent) between the existing and future conditions and scenarios.

The report is online at http://baydeltaoffice.water.ca.gov/swpreliability/index.cfm.

Central Valley Project Deliveries

The CVP operates 18 dams and reservoirs, 11 power plants, and 500 miles of canals and other facilities between the Cascade Range near Redding and the Tehachapi Mountains near Bakersfield. It serves agricultural, municipal, and industrial needs in the Central Valley, urban centers in parts of the San Francisco Bay Area, and is the primary water source for many Central Valley wildlife refuges. In an average year, the CVP delivers approximately 7 maf of water for agriculture, urban, and wildlife use, irrigating about one-third (3 million acres) of California's agricultural lands and supplying water for nearly one million households (U.S. Bureau of Reclamation 2009). Future deliveries of CVP water are subject to several areas of uncertainty, as described under the "State Water Project Deliveries" section above.

Colorado River Supplies

Before 2003, California's annual use of Colorado River water ranged between 4.5 and 5.2 maf. In recent years, Arizona has begun to exercise 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 maf 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.

Local Water Supplies

Local water supplies are highly variable throughout the state. Local agencies use some of the water supplies listed in the above sections and develop their own supplies. In some cases, these locally developed supplies include water imported from other hydrologic regions.

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 2010. Data for years 1998, 2000, and 2001 were presented in *California Water Plan Update 2005*; Update 2009 presented water years 1998-2005. For Update 2013, the same data structure and water portfolio concepts have been used to assemble and present statewide information for the additional years (see Box 3-5, "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 presented here for 10 years, 2001-2010 (Table 3-2, "California Hydrologic Water Balance Summary, 2001-2010," and Figure 3-10, "California Water Balance by Water Year, 2001-2010"). Regional balances are available in Volume 2, *Regional Reports*. The 10-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 3-10, 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; *water supply* shows where the water came from each year to meet those uses.

California, in an average water year similar to 2010, receives about 200 maf of water from precipitation and imports from Colorado, Oregon, and Mexico. Approximately 50-60 percent of this total supply is 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, or salt sinks, such as saline groundwater aquifers and the Salton Sea. The remaining 40-50 percent, identified as dedicated or developed water supplies and as shown in Figure 3-10, 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 used multiple times (reused water) and water that is held in storage from previous years. Ultimately, about

Box 3-5 Water Portfolio Concept and Key Definitions

This box explains how to read the water balance figures and tables (statewide and regional) and related information contained in this chapter, the regional reports, and in Volume 5, *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. 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.

A more detailed statewide summary of dedicated water supplies and uses for water years 1998-2010 is presented in Volume 5, *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 flows 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, 2005, and 2009 California Water Plan updates, *California Water Plan Update 2013* computes dedicated water supplies and uses based on 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 solely 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 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.

one-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 by water year provide regional data. Comparing them with the statewide figure helps to illustrate how individual regions compare with the statewide distribution. Figure 3-11 depicts water balances

Table 3-2 California Statewide Water Balance for 2001-2010 (in maf)

Statewide (maf)	Water Year (Percent of Normal Precipitation)									
	2001 (72%)	**2002** (81%)	**2003** (93%)	**2004** (94%)	**2005** (127%)	**2006** (127%)	**2007** (62%)	**2008** (77%)	**2009** (77%)	**2010** (104%)
WATER ENTERING THE REGION										
Precipitation	139.2	160.1	184.4	186.5	251.9	251.1	123.3	152.2	151.8	205.0
Inflow from Oregon/Mexico	1.1	1.1	1.1	1.1	1.0	2.3	1.2	1.2	1.0	0.9
Inflow from Colorado River	5.2	5.4	4.5	4.8	4.2	4.6	4.7	4.9	4.6	4.7
Imports from Other Regions	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total	**145.5**	**166.6**	**190.0**	**192.4**	**257.1**	**258.0**	**129.2**	**158.3**	**157.4**	**210.6**
WATER LEAVING THE REGION										
Consumptive use of applied water[a] (Ag, M&I, Wetlands)	26.5	27.7	25.7	28.2	23.7	25.6	28.6	29.0	28.1	25.0
Outflow to Oregon/Nevada/ Mexico	0.5	0.8	1.1	0.8	1.4	2.1	0.8	0.9	1.0	1.1
Exports to other regions	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Statutory required outflow to salt sink	12.6	23.1	31.0	26.0	24.6	43.7	20.3	20.6	18.3	24.4
Additional outflow to salt sink	14.8	13.6	18.7	18.1	20.0	48.4	9.2	10.6	8.6	13.8
Evaporation, evapotranspiration of native vegetation, groundwater subsurface outflows, natural and incidental runoff, ag effective precipitation & other outflows	105.4	111.2	118.7	133.2	183.7	142.9	89.8	114.3	113.4	149.2
Total	**159.8**	**176.4**	**195.2**	**206.3**	**253.4**	**262.7**	**148.7**	**175.4**	**169.4**	**213.5**
CHANGE IN SUPPLY										
[+] Water added to storage [-] Water removed from storage										
Surface reservoirs	-4.6	0.1	3.7	-4.1	7.9	1.4	-8.0	-3.9	1.1	5.1
Groundwater[b]	-9.7	-9.6	-8.7	-9.8	-4.1	-6.1	-11.5	-13.1	-13.1	-8.0
Total	**-14.3**	**-9.5**	**-5.0**	**-13.9**	**3.8**	**-4.7**	**-19.5**	**-17.0**	**-12.0**	**-2.9**
Applied water[a] (ag, urban, wetlands) (compare with consumptive use)	43.7	46.6	43.3	47.2	41.6	44.4	48.1	47.9	46.5	42.7

Notes:

maf = million acre-feet, M&I = municipal and industrial

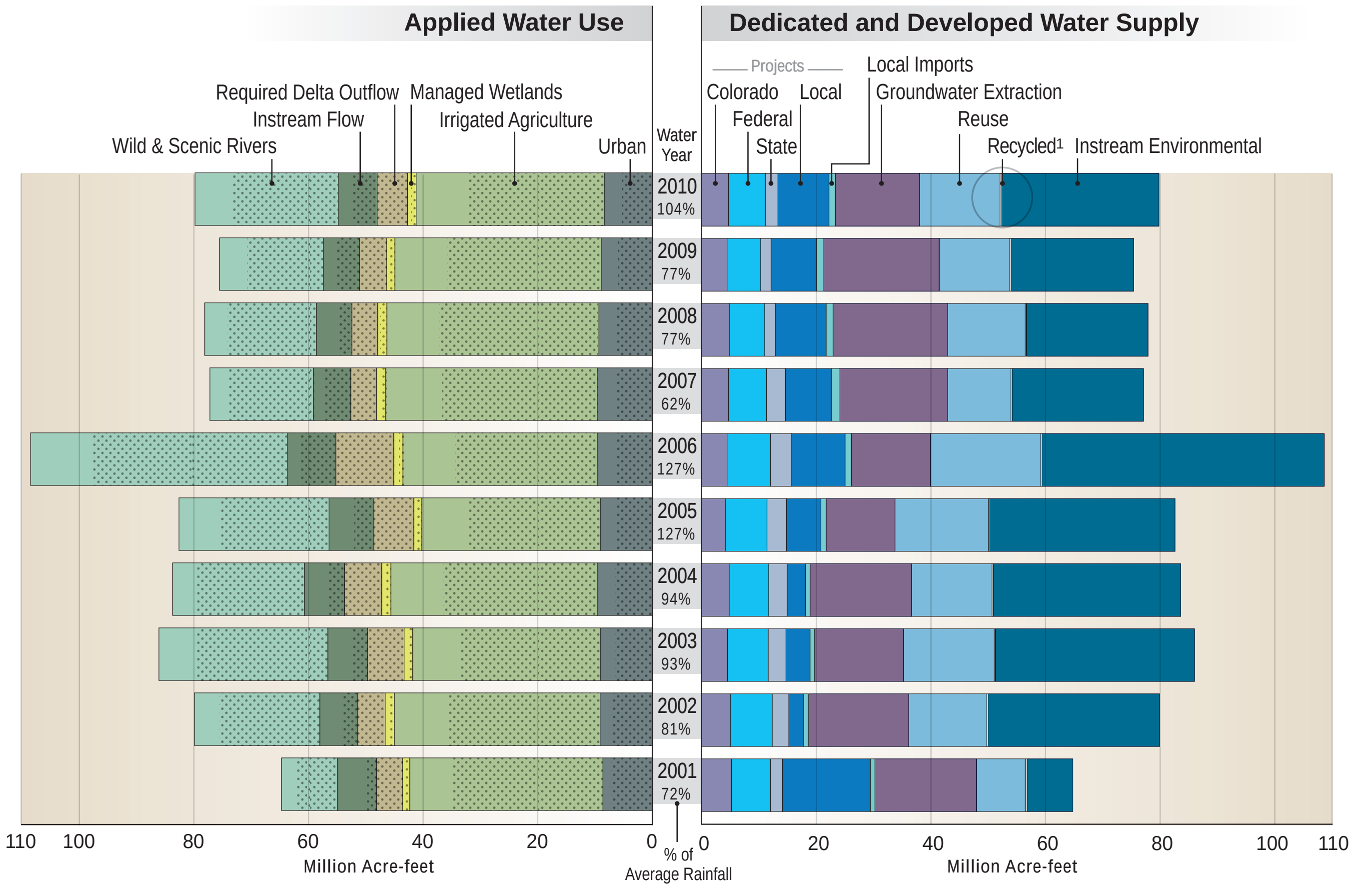
[a] Definition: Consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is greater than consumptive use because it includes consumptive use, reuse, and outflows.

[b] Definition: Change in Supply: Groundwater – The difference between water extracted from and water recharged into groundwater basins in a region. All regions and years were calculated using the following equation: change in supply: groundwater = intentional recharge + deep percolation of applied water + conveyance deep percolation and seepage - withdrawals.

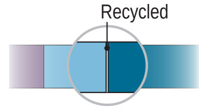
This equation does not include unknown factors such as natural recharge and subsurface inflow and outflow. For further details, refer to Volume 4, *Reference Guide*, the article “California’s Groundwater Update 2013” and Volume 5, *Technical Guide*.

Figure 3-10 California Water Balance by Water Year, 2001-2010

California's water resources vary significantly from year to year. Ten recent years show this variability for water use and water supply. Applied Water Use shows how water is applied to urban and agricultural sectors and dedicated to the environment and the Dedicated and Developed Water Supply shows where the water came from each year to meet those uses. Dedicated and Developed Water Supply does not include the approximately 125 million acre-feet (MAF) of precipitation and inflow in an average year that either evaporates, are used by native vegetation, provides rainfall for agriculture and managed wetlands, or flow out of the state or to salt sinks like saline aquifers (see Volume 1, Table 3-2). Groundwater extraction includes annually about 2 MAF more groundwater used than what naturally recharges – called groundwater overdraft. Overdraft is characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years.



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 2001-2010, recycled municipal water varied from 0.2 to 0.7 MAF of the water supply .*

For further details, refer to Volume 5, *Technical Guide*, and Volume 4, the article "California's Groundwater Update 2013."

Key Water Supply and Water Use Definitions

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

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

Instream environmental. Instream flows used only for environmental purposes.

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

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

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

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

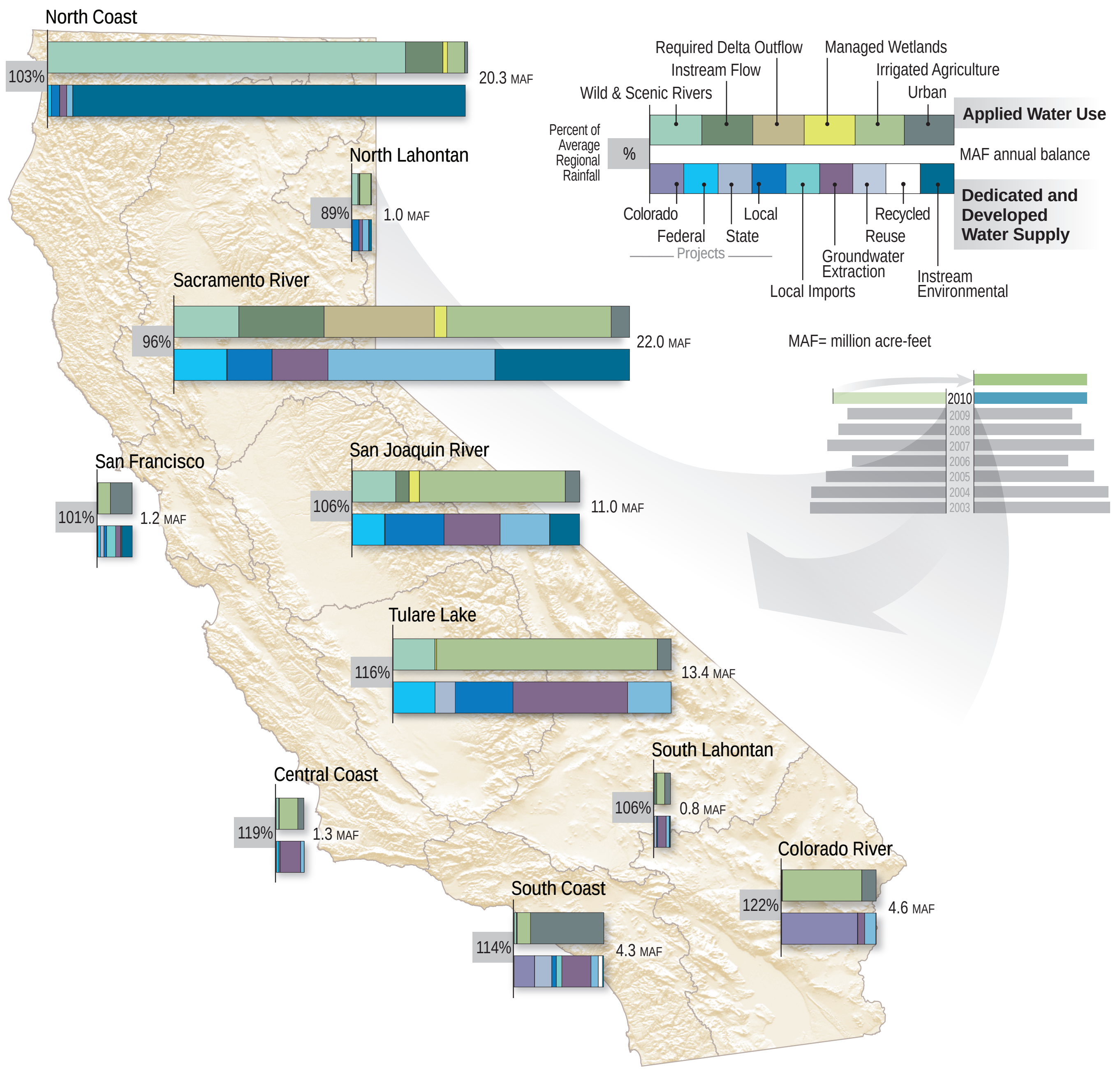
Urban water use. The use of water for urban purposes, including residential, commercial, industrial, recreation, energy production, military, and institutional classes. The term is applied in the sense that it is a kind of use rather than a place of use.

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

California Water Balance by Water Year Data Table (MAF)

	2001 (72%)	2002 (81%)	2003 (93%)	2004 (94%)	2005 (127%)	2006 (127%)	2007 (62%)	2008 (77%)	2009 (77%)	2010 (104%)
Applied Water Use										
Urban	8.6	9.1	9.0	9.5	9.0	9.5	9.6	9.3	8.9	8.3
Irrigated Agriculture	33.7	35.9	32.8	36.1	31.2	33.3	36.9	37.0	36.0	32.9
Managed Wetlands	1.3	1.6	1.5	1.6	1.4	1.6	1.6	1.6	1.5	1.5
Req Delta Outflow	4.5	4.8	6.4	6.5	7.0	10.1	4.5	4.5	4.7	5.3
Instream Flow	6.8	6.6	6.9	7.0	7.8	8.5	6.5	6.2	6.3	6.8
Wild & Scenic R.	9.8	21.9	29.5	23.0	26.2	44.8	18.1	19.5	18.1	25.1
Total Uses	**64.7**	**79.9**	**86.1**	**83.7**	**82.6**	**107.9**	**77.1**	**78.0**	**75.5**	**79.8**
Depleted Water Use (stippling)										
Urban	7.0	6.7	6.3	6.4	6.1	6.2	6.2	6.1	5.8	5.2
Irrigated Agriculture	26.0	26.2	24.3	26.8	22.7	24.2	27.1	27.6	26.6	23.8
Managed Wetlands	0.9	0.8	0.7	0.8	0.7	0.8	0.9	1.1	0.8	1.0
Req Delta Outflow	4.5	4.8	6.4	6.5	7.0	10.1	4.5	4.5	4.7	5.3
Instream Flow	2.2	2.6	2.7	2.7	3.3	6.1	4.4	2.2	4.1	4.4
Wild & Scenic R.	6.9	17.5	22.8	18.9	18.7	33.8	14.7	15.4	13.2	18.5
Total Uses	**47.5**	**58.6**	**63.2**	**62.1**	**58.5**	**81.3**	**57.8**	**56.8**	**55.2**	**58.3**
Dedicated and Developed Water Supply										
Instream	8.0	29.9	34.7	32.7	32.3	49.2	22.8	21.2	21.4	27.4
Local Projects	15.4	2.6	4.2	3.2	6.0	9.3	8.0	8.8	7.9	8.8
Local Imported Deliveries	0.8	0.8	0.8	0.8	0.9	1.1	1.5	1.2	1.3	1.1
Colorado Project	5.2	5.0	4.5	4.8	4.2	4.6	4.7	4.9	4.6	4.7
Federal Projects	6.8	7.3	7.1	6.9	7.2	7.4	6.6	6.1	5.7	6.4
State Project	2.1	2.9	3.1	3.2	3.4	3.7	3.3	1.9	1.8	2.2
Groundwater Extraction	17.6	17.5	15.5	17.7	12.0	13.1	18.8	20.0	20.1	14.7
Inflow & Storage	0.0	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Reuse & Seepage	8.5	13.6	15.8	14.0	16.3	19.2	11.1	13.5	12.3	14.1
Recycled Water	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
Total Supplies	**64.7**	**79.9**	**86.1**	**83.7**	**82.6**	**107.9**	**77.1**	**78.0**	**75.5**	**79.8**

Figure 3-11 Water Balance by Region for Water Year 2010



Note: Regional water portfolios provide information about annual Water Supply and Water Use balances for California's 10 hydrologic regions. The regional water balances depicted at the right of each bar show conditions for water year 2010. Update 2013 presents regional and statewide water balances for years 2001 through 2010. Water balances can be used to compare how water supplies and uses can vary between wet, average, and dry hydrologic conditions throughout the regions and how each region's water balance can vary from year to year. For more information, see Volume 2, *Regional Reports.*

for the hydrologic regions for year 2010, considered an average water year statewide. Water balances can be used to compare how water supplies and uses vary between wet, average, and dry hydrologic conditions by region and how each region's water balance varies from year to year.

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 3-12 shows inflows and outflows between California's hydrologic regions by using data from current base year 2010, a near average water year.

For Update 2013, additional information specifically relating to groundwater supply and use was compiled. Statewide groundwater use information is provided as the 2005-2010 average annual use by hydrologic region (, "2005-2010 Groundwater Supply Volume and Percent of Total Supply Met by Groundwater"), as the 2002-2010 annual trend of groundwater and surface water use (Figure 3-14, "Groundwater and Surface Water Supply Trends"), and as the 2002-2010 annual trend of groundwater pumping by type of use (3-15, "Annual Groundwater Supply Trend by Type of Use"). Additional groundwater information by region is provided in Volume 2, *Regional Reports*, and in Volume 4, *Reference Guide*.

While some types of groundwater uses are reported for some California basins, the majority of groundwater users are not required to monitor or report their annual groundwater extraction amount. Groundwater use estimates for this report are based on water supply and balance information derived from DWR land use surveys, and from groundwater use information voluntarily provided to DWR by water purveyors or other State agencies. The total water supply estimates provided in Figures 3-13 through 3-15 include groundwater plus surface water plus reused/recycled water. Instream environmental supplies are not included in the total water supply estimate.

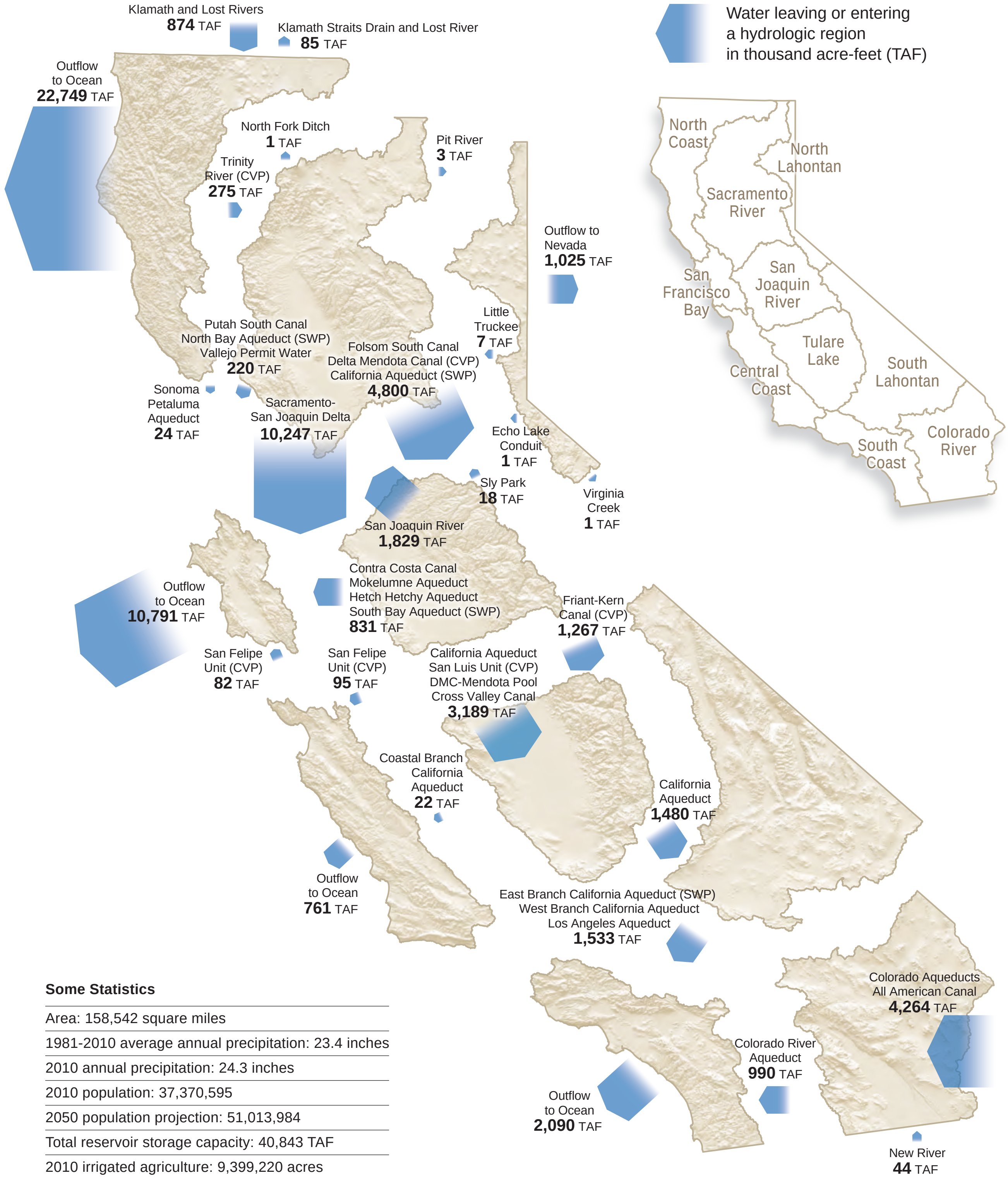
Annual groundwater extractions in California averaged about 16,500 taf and contributed to about 39 percent of the state's total water supply. Evaluation of the statewide groundwater supply by type of use indicates that California's groundwater supplies account for 39 percent of the total annual agricultural water supply, 41 percent of the total urban water supply, and about 18 percent of the managed wetlands total water supply.

Evaluation of groundwater use by regions indicates that the three Central Valley hydrologic regions (Tulare Lake, San Joaquin River, and Sacramento River) account for about 75 percent of California's average annual groundwater use, with groundwater extraction in the Tulare Lake region totaling just under 6.2 maf, nearly double that of the next largest regional groundwater user.

Not only is the Tulare Lake region the largest groundwater user, it is also the third most groundwater-reliant region, with groundwater contributing about 53 percent of their total water supply. Groundwater status reports from Tulare Lake groundwater management groups acknowledge that the average annual groundwater extraction in the Tulare Lake region commonly exceeds safe aquifer yield.

The South Coast region is the fourth largest groundwater user, extracting about 1.6 maf per year, or 10 percent of the average annual statewide total. The two most groundwater-reliant regions are

Figure 3-12 Regional Inflows and Outflows, Water Year 2010



Some Statistics

Area: 158,542 square miles
1981-2010 average annual precipitation: 23.4 inches
2010 annual precipitation: 24.3 inches
2010 population: 37,370,595
2050 population projection: 51,013,984
Total reservoir storage capacity: 40,843 TAF
2010 irrigated agriculture: 9,399,220 acres

Figure 3-13 The Importance of Groundwater to California Water Supply

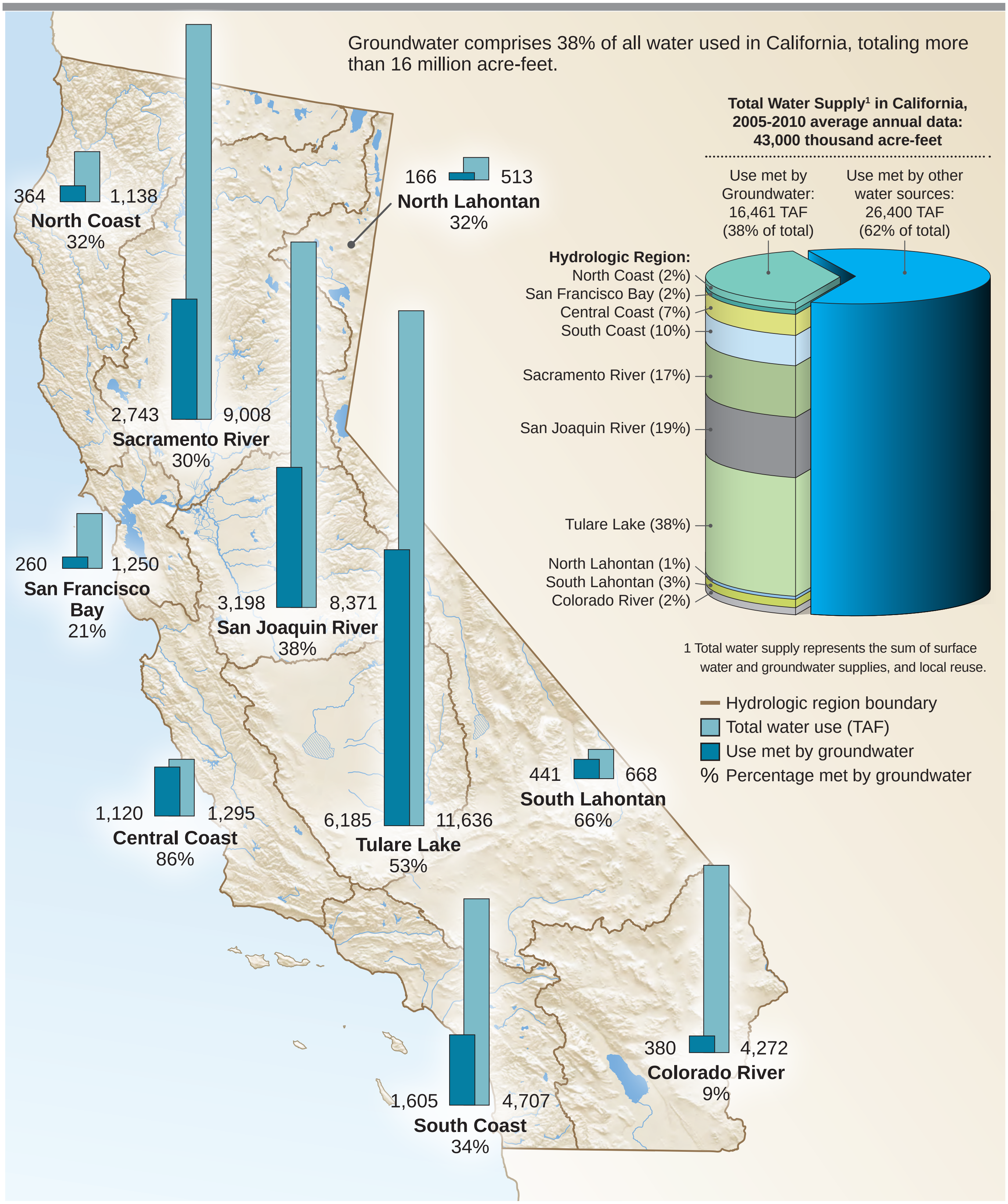


Figure 3-14 **Annual Groundwater and Surface Water Supply Trends**

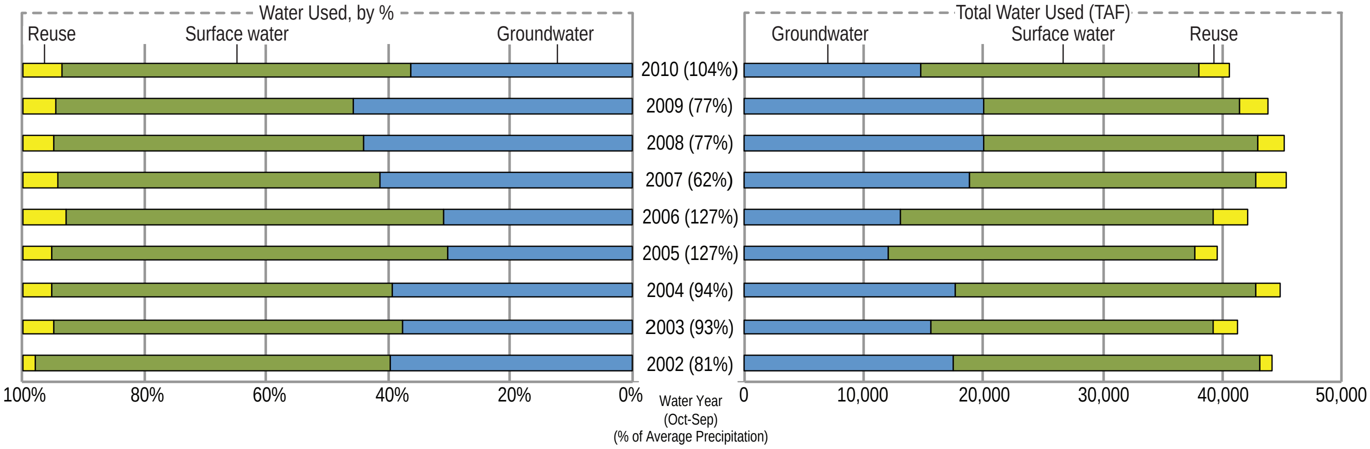
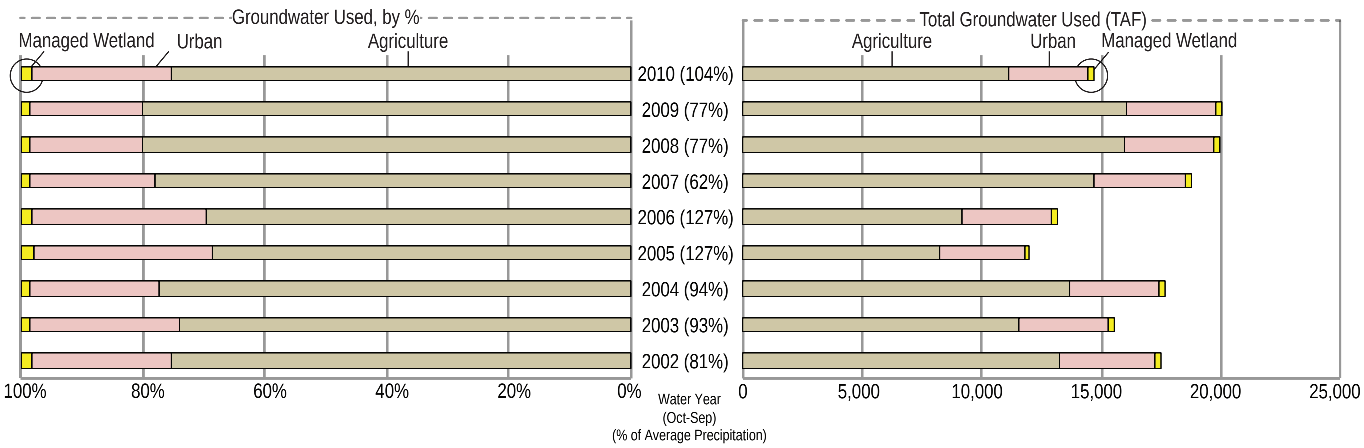


Figure 3-15 **Annual Groundwater Supply Trend by Type of Use**



the Central Coast (86 percent) and the South Lahontan (66 percent), though volumetrically these regions combine for only for 10 percent of California's average annual groundwater use.

Evaluation of groundwater supplies by type of use indicates that about 76 percent of the average annual groundwater extraction goes toward agricultural uses, with about 22 and 2 percent going toward urban and managed wetland uses, respectively.

Between 2002 and 2010, groundwater supplies to meet local agricultural, urban, and managed wetland uses ranged from 12 to 20 maf, and contributed to between 30 and 46 percent of California's overall annual supply between years of wet and dry hydrology. Dry conditions and regulatory reduction of imported surface water between 2007 and 2009 significantly increased the agricultural demand for groundwater during these years.

The percentage of California groundwater extraction used to meet agricultural water supply ranged from a low of 69 percent in 2005, to a high of 80 percent in 2008 and 2009. The 11 percent increase in groundwater extraction to meet agricultural uses resulted in almost a doubling of the total amount of groundwater extracted in 2005 (8,260 taf) versus 2009 (16,100 taf). About 63 percent (5,200 taf) of the 8,260 taf increase in statewide groundwater extraction for agricultural uses between wet and dry years is attributed to the Tulare Lake region. High agricultural demand for water and the trend toward increased permanent cropping contributes to large increases in Tulare Lake groundwater use during years of surface water supply cutbacks.

Groundwater pumping going toward urban water use ranged from about 3,370 taf to about 4,000 taf, and equaled between 19 and 29 percent of the total groundwater supply. Compared with agricultural and urban uses, the application of groundwater supplies for managed wetlands use is fairly minor. Managed wetland use of groundwater ranged from 210 to 310 taf, and equaled about 1 to 2 percent of the total groundwater use. In an average year, groundwater contributes to about 18 percent of the total managed wetlands water supply.

California's groundwater conditions fluctuate seasonally and annually, based on local management practices, hydrology, and aquifer conditions. Long-term groundwater level hydrographs help evaluate seasonal and long-term variability of groundwater levels over time and help identify ongoing trends associated changing management practices or hydrologic conditions. Based on evaluation of these trends, groundwater management practices can be modified to ensure aquifer sustainability.

Long-term groundwater level hydrographs were developed for each of California's 10 hydrologic regions to help tell a story about the local aquifer response to changes in groundwater management and hydrology. Figure 3-16 highlights a small subset of the hydrographs provided in Volume 2, *Regional Reports*, and it groups the hydrographs according to five simple themes associated with aquifer demand versus recharge.

- Theme 1. Long-term groundwater levels remain reasonably stable as a result of limited demand and adequate recharge.
- Theme 2. Long-term decline in groundwater levels as a result of annual demand being consistently greater than annual recharge.
- Theme 3. Long-term decline in groundwater levels that have stabilized but not recovered, resulting from reduced demand.
- Theme 4. Long-term decline in groundwater levels that have stabilized and improved, resulting from reduced demand and increased recharge.
- Theme 5. Long-term groundwater levels remain reasonably stable as a result of proactive recharge, prior to long-term declines.

In addition to grouping by theme, the hydrographs in Figure 3-16 are color-coded according to their regional location. This statewide selection of groundwater-level hydrographs helps characterize the highly variable nature of groundwater conditions, by region and management practices. The full story associated with changing groundwater level trends versus groundwater management practices is provided in Volume 2, *Regional Reports*.

Depth-to-water measurements collected from a particular well over time can be plotted on a graph (hydrograph). Hydrographs allow analysis of seasonal and long-term groundwater level variability and trends over time. Because of the highly variable nature of the aquifer systems

Figure 3-16 California Groundwater Level Trends

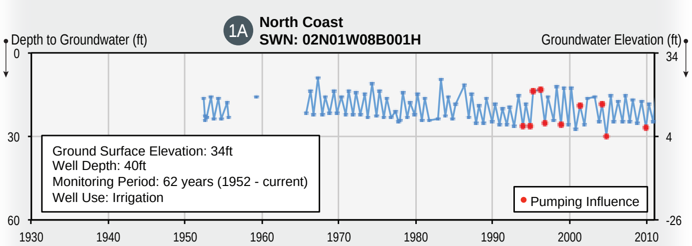
Aquifer response to changing demand and management practices

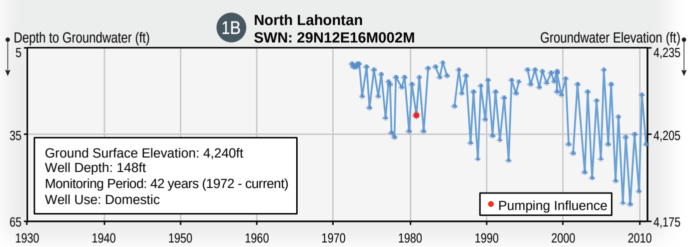
Hydrographs were selected to help tell a story of how local aquifer systems respond to changing groundwater demand and resource management practices. Additional details are provided in the Volume 2 Regional Reports and Volume 4 Reference Guide article, "California's Groundwater Update 2013."

• Pumping Influence: *A questionable measurement due to recent pumping of the well or nearby pumping during the measurement.*

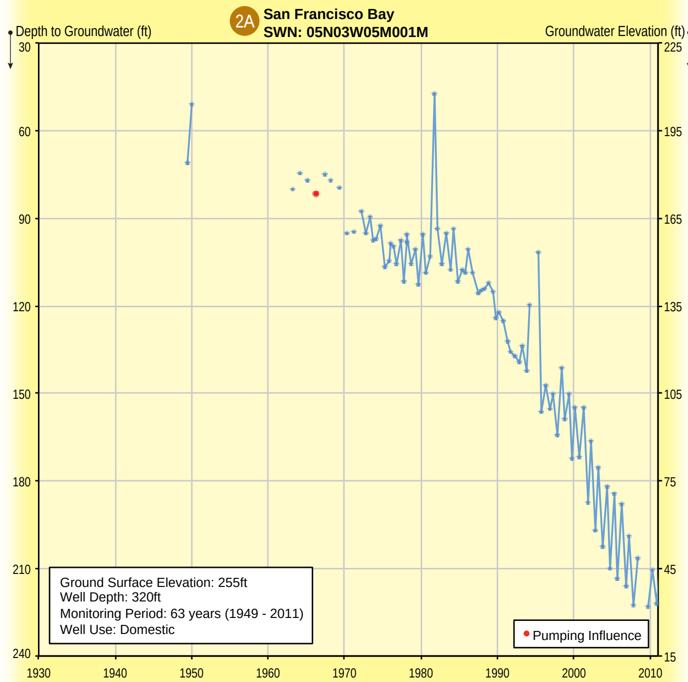
Well Location Map

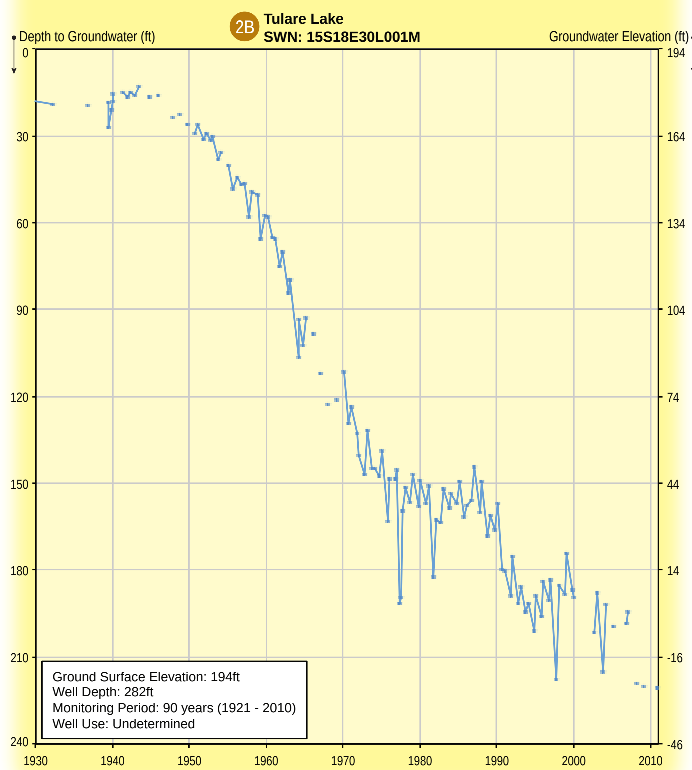
Theme 1: Long term groundwater levels remain reasonably stable due to limited demand and adequate recharge.



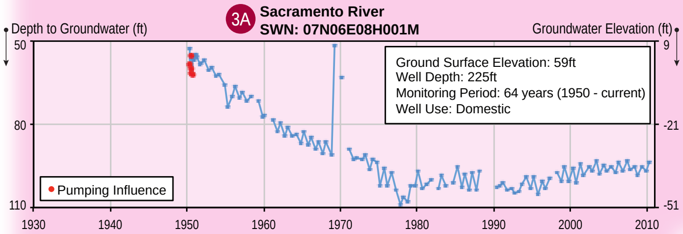


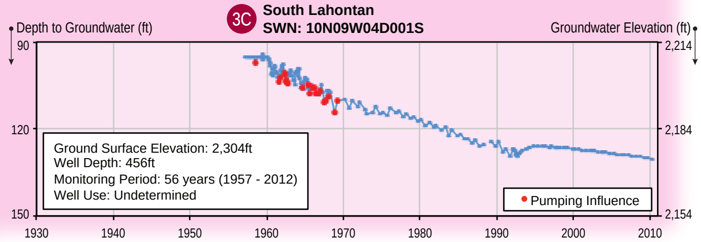
Theme 2: Long-term decline in groundwater levels due to annual demand being consistently greater than annual recharge.

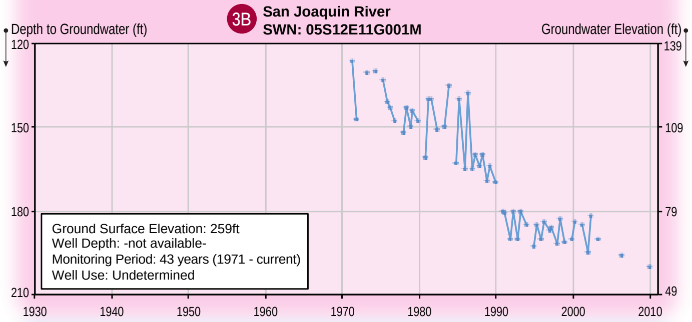




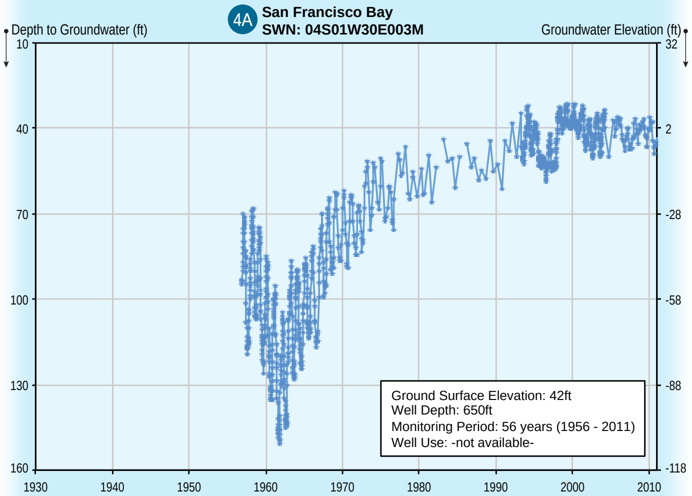
Theme 3: Long-term decline in groundwater levels that have stabilized but not recovered, due to reduced demand.

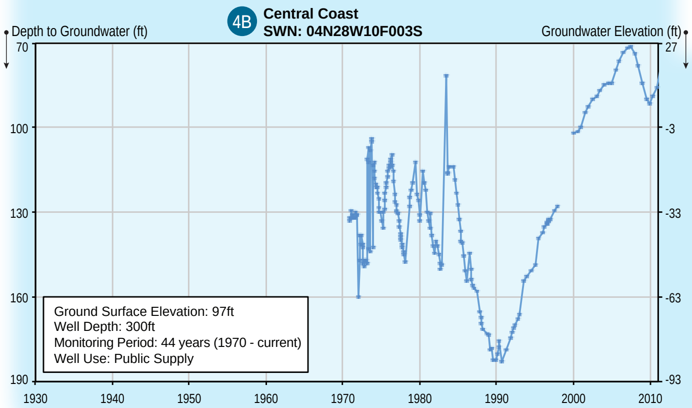




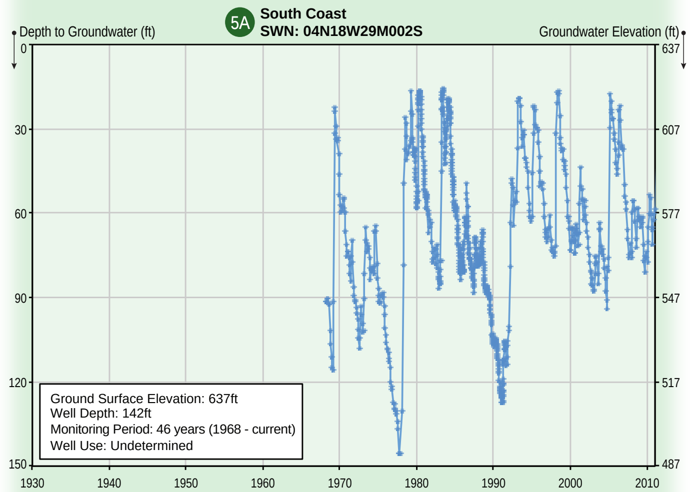


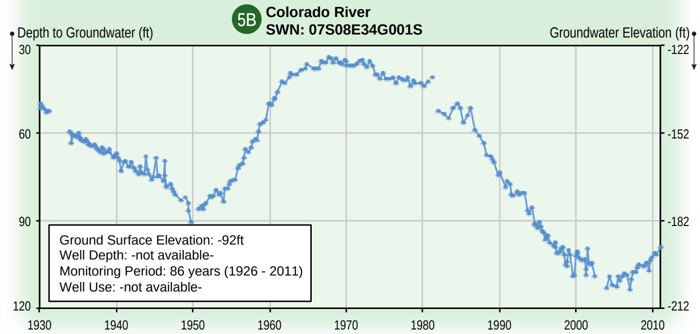
Theme 4: Long-term decline in groundwater levels that have stabilized and improved, due to reduced demand and increased recharge.

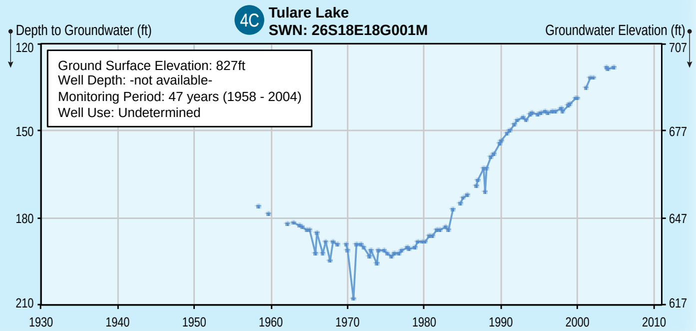




Theme 5: Long-term groundwater levels remain reasonably stable due to proactive recharge, prior to long-term declines.







within each groundwater basin, and because of the variable nature of annual groundwater extraction, recharge, and surrounding land use practices, the hydrographs selected for discussion do not attempt to represent average aquifer conditions over a broad region. Rather, the following hydrographs were selected to help tell a story of how the local aquifer systems respond to changing groundwater extractions and resource management practices. The hydrographs are identified according to the State Well Number system.

Water Quality

Because California's population is more than 38 million and increasing, and because of the state's limited supply of fresh water, the protection of water quality for beneficial uses has become a paramount concern for all Californians. The SWRCB and the nine regional water quality control boards (RWQCBs), under the umbrella of the California Environmental Protection Agency (Cal/EPA), are responsible for protecting California's water resources. The California Department of Public Health (DPH) is responsible for ensuring that safe drinking water is delivered by public water systems.

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, point sources are sewer outfalls and other easily identifiable sources, such as pipes. An even greater challenge is pollution resulting from non-point sources. For example, runoff and drainage from urban areas, agriculture, timber operations, mine drainage, and other sources where there is no single point of discharge are non-point sources. Non-point-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 non-point sources — specific constituents and circumstances vary from region to region, as is made evident in each regional report.

One method to determine whether non-point-source programs are effective in protecting and restoring water quality is to assess the ecological health of streams. The California Water Quality Monitoring Council's "My Water Quality" Web site (http://www.mywaterquality.ca.gov/) asks, "Are our aquatic ecosystems healthy?" The site answers the question by providing data and reports on this topic. A recent assessment by the SWRCB Surface Water Ambient Monitoring Program (SWAMP) of benthic macroinvertebrates or bugs in perennial streams indicates that approximately 50 percent of California's total stream length appears to be in good biological condition, approximately 27 percent is in degraded condition, and 23 percent is in very degraded condition. The assessment also noted that all regions have streams in good biological condition except the Central Valley, and all regions have streams with degraded biology. The highest percentage of degraded streams is in the Central Valley and Chaparral regions, the latter referring to the foothills of the Sierra Nevada and Coast Ranges (Ode et al. 2011).

Since water quality covers a large number of constituents, further information on individual constituents is available in Table 3-3, which shows State water-quality database Web sites. Most have interactive Web-based maps.

Table 3-3 State Water Quality Database Web Sites

Water Quality Web Site	Type of Water Quality Information
My Water Quality http://www.mywaterquality.ca.gov/index.shtml	Web portal developed by the California Water Quality Monitoring Council that brings together water quality and ecosystem health information from a variety of organizations.
Water Boards Impaired Water Bodies Web-based Interactive Map http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml	Interactive web-based map developed by the State Water Resources Control Board to show assessed and impaired waters in the state. This is a biennial assessment required under Section 303(d) of the federal Clean Water Act.
Water Boards GeoTracker GAMA (Groundwater Ambient Monitoring and Assessment) Database http://geotracker.waterboards.ca.gov/gama/	Interactive web-based map developed by the State Water Resource Control Board that allows users to search a number of groundwater quality databases. Data sets are from State agencies/departments including State and Regional Water Quality Control Boards, Department of Public Health, Department of Water Resources, Department of Pesticide Regulation, U.S. Geological Survey, and Lawrence Livermore National Laboratory.
State Water Resources Control Board SWAMP (Surface Water Ambient Monitoring Program) http://www.waterboards.ca.gov/water_issues/programs/swamp/ SWAMP water quality information is available at CEDEN (California Environmental Data Exchange Network) http://www.ceden.us/AdvancedQueryTool	Interactive web-based map developed by the California Environmental Data Exchange Network that provides a central location to find and share information about California's water bodies including streams, lakes, rivers, and coastal/ocean waters. Many groups in California monitor water quality, aquatic habitat, and wildlife health to ensure good stewardship of California's ecological resources. CEDEN aggregates these data and makes them accessible to environmental managers and the public.

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. Those water management systems include physical facilities and their operational policies and regulations. The facilities include more than 1,200 State, federal, and local reservoirs, as well as canals, treatment plants, and levees. These systems are often interconnected. The proper operation of one system sometimes depends on the smooth operation of another. The successful operation of the complete system becomes vulnerable if any parts fail. See Chapter 7, "System Reoperation," in Volume 3, *Resource Management Strategies*, for further details.

Conditions today are much different from those when most of California's water systems were constructed. Upgrades have not kept pace with changing conditions, especially considering increasing population, changing society values, regulations, 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 a tightened credit market may delay new projects and programs.

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.

Institutional Setting and Governance

California's water system is extremely complex. Chapter 4, "Strengthening Government Alignment," and Volume 4, *Reference Guide*, provide detailed information on water rights, regulations, and agencies responsible for California public resource management. An intricate system of common law principles, constitutional provisions, State and federal statutes, court decisions, contracts, and/or agreements control California water use and supplies. While all of these components constitute the institutional framework that protects the public interest and balances it with private claims in California's water allocation and management, water governance structure and practices remain fragmented and often delay, preclude, or reduce cost-effectiveness of IWM solutions. In addition, there are more than 2,300 public resource management agencies at four primary levels of government (local, regional, State, and federal). Misalignment of plans, priorities, and polices has been an impediment to achieving IWM benefits.

California's water-related assets and services are provided by many interdependent systems that have historically been managed independently. Lack of systemic planning and management approaches complicates resource management. For example, surface and groundwater resources are largely managed as separate resources, when they are, in fact, a highly interdependent system of watersheds and groundwater basins. Water quality, land use, and flood management are also integral to the effective management of these systems.

This system that governs the distribution of water and the related scheduling was created more than a century ago, primarily to meet the needs of agriculture and urban dwellers, and it ignored environmental impacts. 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 (Article X, Section 2). As the years passed, new laws and court decisions addressing water's effect on the environment constrained that same water allocation (Little Hoover Commission 2010).

In 2012, there are more than 2,300 agencies that have jurisdiction over California's water, which makes California water management an enormously tangled web. This phenomenon sometimes leads to collaborative and mutually beneficial water projects among agencies, but more often it is conducive to conflicting priorities. In particular, there are many State agencies involved in California water management. For example, DWR is responsible for water delivery, water supply, flood planning, and infrastructure development. The SWRCB manages water rights and water quality through regulation. DPH's Drinking Water Program regulates public water systems, oversees water recycling projects, issues water-treatment device permits, certifies drinking water treatment and distribution operators, and supports water system security.

The Delta Protection Commission protects, maintains, and where possible restores the overall quality of the Delta environment. The Delta Stewardship Council was created by legislation to achieve the State's coequal goals for the Delta of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem.

Although California law does not require local agencies to adopt or implement groundwater management plans (GWMPs) or governance, legislation has been created that provides incentives for local agencies to develop GWMPs that include information promoting effective and sustainable groundwater management. One of the more common vehicles for groundwater governance is covered under Section 10750 et seq. of the California Water Code (CWC) and is frequently referred to as AB 3030. Other approaches include local ordinances, formation of special districts, and adjudications.

The majority of California's high-use groundwater basins are covered under AB 3030 GWMPs; however, 20 years after the initiation of AB 3030 legislation, fewer than 20 percent of groundwater basins are covered by groundwater management plans that include all of the components required to qualify as a GWMP, with respect to eligibility for State funding.

Groundwater extraction at rates and volumes that far exceed natural aquifer recharge, or the ability to actively recharge via conjunctive management practices, has resulted in long-term economic benefits and enabled California to become one of the world's most productive agricultural regions. These economic benefits have not gone without a broader cost to the infrastructure affected by land subsidence, to the quantity and quality of groundwater resources, to the increased energy required to pump groundwater, and to the decline in ecosystem services provided by the interaction of groundwater and surface water resources. Agricultural and urban water managers are being forced to critically evaluate the broader long-term costs and risks associated with unsustainable groundwater pumping versus the short-term value that it provides. Mitigation against further escalation of groundwater-pumping-related impacts will require more aggressive actions to adjust current land and water resource management practices in high-use areas characterized by unsustainable groundwater extraction.

Despite the recognized challenges associated with local implementation of sustainable groundwater management practices, general consensus among State, regional, and local resources managers is that regional development and implementation of groundwater management, coupled with State financial support and technical guidance, holds the best opportunity for sustainable groundwater management and governance. Emerging evidence also indicates that improved coordination and inclusion of local groundwater management goals and objectives into those of the overlying IRWM planning is needed to help advance sustainable groundwater management practices.

DWR formally recognized the multiple levels of water-related interests and mandates by establishing the CWP's Steering Committee, comprised of 29 State agencies and departments, and collaborates with federal and other non-State agencies. See more discussion of this collaboration in Volume 1, Chapter 1, "Introduction," and Chapter 4, "Strengthening Government

Alignment." Federal agencies, such as the U.S. Geological Survey (USGS), U.S. Army Corps of Engineers (USACE), and the U.S. Bureau of Reclamation (USBR), also make significant contributions to California's water supply, water quality, and flood control. Additionally, there are many non-State agencies (e.g., Association of California Water Agencies [ACWA], California Farm Bureau Federation, resource conservation districts) that are stakeholders in the California water scenario and whose input is important. Box 3-6 provides an accurate characterization of conflicts occurring in California water planning and management.

Tribal Water Management

California Native American Tribes have many diverse water needs, which include domestic purposes, fisheries, wildlife, agriculture, exercising aboriginal water rights, water resources, flood management, and other cultural practices associated with tribal lands and uses. The many needs of California Native American Tribes are as varied as the state's diverse water community. Some tribes lack basic clean, affordable drinking water in their domiciles. Water is a critical necessity for tribes, and its members need a reliable and adequate water supply and water systems. Water management on tribal land is sometimes administered through the tribal government or a defined department, which would have the primary responsibility to oversee all water-related matters within the exterior boundaries of the reservation. Administrative duties and responsibilities include local and regional water-related matters, water rights compliance, management of local resources, land use planning, and ensuring the tribe is in compliance with all current regulations and laws. (For more information, see the article "Tribes and Tribal Water Issues" in Volume 4, *Reference Guide*.) Regional reports list tribal concerns expressed at CWP regional workshops and plenary meetings to support the California Tribal Water Summit held in April, 2013. Proceedings of this summit are in Volume 4.

IWM Funding and Expenditures

This section contains a description of historical federal, State, and local funding practices and expenditures as context for planning future State IWM investment. It includes a variety of information to help provide an understanding of debt levels, funding sources, expenditures, and administrative constraints. Given that State, federal, and local funding and expenditures are occurring throughout California, all three levels of government are included in this section.

Resource Management from 1850-Present

This subsection provides a brief overview of the history of water management institutions and financing in California from 1850 to the present. It provides the context for recommending future IWM investment and cost-sharing methodologies. It also characterizes historical funding practices and cost-sharing.

Figure 3-17 summarizes the key events from the 1850s to the present. The history of IWM financing is divided into five historical periods, including

Chumash ceremonial leader Mati Waiya performs a water blessing ceremony in Malibu, CA. The Chumash historically inhabited the central and southern coastal regions of California and three of the Channel Islands. The water blessing ceremony is performed as an act of respect for the tribe's ancestors.

Box 3-6 Current Conflicts over California's Water

"Current conflicts over California's water are wide-ranging and reflect the diverse landscape, climate, economies, ecosystems, and cultures of the state. The struggles to remove four dams on the Klamath River, improve flood protection for Sacramento, find a solution to the decline of the Salton Sea, resolve aquifer overdraft in Central Coast basins, dispose salt in the Santa Ana basin, and manage the Sacramento-San Joaquin Delta for both water supply and ecosystem health all seem to be local and unique problems. Yet these and myriad other water conflicts in California have important common and interrelated elements."

Source: Hanak et al. 2011.

the Reclamation, Federal, Infrastructure, Environmental and Public Trust, and Bond periods. Each of these periods relied on a different water management financing strategy that, when taken with the discussion in the previous section, outlines the history of water management in California.

Historical IWM Funding

Projects are typically financed through bonds, taxes, or user fees with recent funding relying heavily on bonds. The political climate for new public debt and increasing debt service ratio in California may make it difficult to issue bonds for water and flood management in the future. Innovative financing alternatives may warrant further consideration. Particular attention is given to water bonds in this chapter, since these have become a significant source of funding in recent years.

Urban water agencies typically finance water management through user fees in the form of monthly/bimonthly water bills. Reclamation districts also collect user fees to finance levees and other water management projects. State taxes support water management through the General Fund and other special funds. GO bonds typically support capital outlay for projects, mandated by Government Code Section 16727, but these are allowed to include administrative costs associated with new projects. Many private land owners invest their own money in improving water management for their operations. In some cases, donations from NGOs are made available for investment in water resource management.

For any given year, there are essentially two funding strategies: cash on-hand and borrowing. Cash on-hand is money directly available in funds for appropriation in a given year. Borrowing includes short-term options, such as unsecured business loans and longer term debt (e.g., GO bonds). It is important to note that the spending data, summarized in following subsections, does not capture the cost of borrowing. Furthermore, multiple spending categories and revenue sources may appear to overcomplicate what are essentially the two main revenue sources — taxes or fees — regardless of funding construct. Debt service costs for GO bonds are summarized in this section.

Figure 3-17 Key Events and Historical Spending, 1850-Present

1850	1900	1950
Development and Growth	**Federal Period**	**Infrastructure Period**
• Construction of levees for transportation, agriculture and water supply occurred throughout this period in the Central Valley, Bay Area and, most notably, in the Sacramento/San Joaquin Delta. • By 1871, 1,115 miles of levees were constructed in the Delta protecting 700,000 acres; mostly financed by land owners through reclamation districts. • Taxpayers approved bond issues in 1917 and 1924 to build major dams. After two more destructive floods in the 1930s, the Army Corps of Engineers took a lead role in channelizing rivers. • The federal Flood Control Act of 1917 funded about half the costs of California's flood control projects.	• Federal agencies entered the field of water resource development in California in a large way in the financing and construction of projects for water conservation, irrigation, navigation, and flood control, and for the protection of wildlife. Both the U.S. Army Corps of Engineers and the Bureau of Reclamation outlined comprehensive proposals, including the Central Valley Project • The Flood Control Act of 1928 put the U.S. Army Corps of Engineers firmly in charge of flood control projects in California and throughout the nation • The Central Valley project was constructed during this period.	• State Water Project constructed using revenue and general obligation bonds repaid by water contractors. • Continued local residential and commercial water supply and wastewater development largely funded by local utility rates, revenue bonds, and fees. • The National Flood Insurance Act of 1968. • In 1973, State statute was changed to one of state-local cost sharing for flood damage prevention.

State Bonds

This section summarizes data for California water bonds issued between 1970 and the present. While most of these were not labeled as IWM bonds, they covered activities that are considered IWM today. This section also includes a summary of other GO bond debt, including schools and other infrastructure, to put the level of water bond debt into context. Water-related bonds make up a larger portion of total bond debt in recent years. Revenue bonds are also an important source of financing for capital projects, which are not supported by the General Fund and are generally used by local agencies, but are not included in this subsection summary. The general trend shows an increase in GO bond financing of water projects, and this is increasing as a portion of total GO bonds in the state.

In constant 2010 dollars, a total of $32.4 billion in water bonds (see Chapter 7, "Finance Planning Framework," and Volume 4, *Reference Guide*, for a list of bonds) have been approved by California voters since 1970 — approximately 71 percent of these bonds were approved since 2000. This emphasizes the increased reliance on bonds for financing water infrastructure. Accordingly, the cost of bond debt service has been increasing, from approximately 8 percent in fiscal year (FY) 2001 to almost 36 percent in FY 2010 of General Fund spending for resources and environmental programs. The debt service ratio (ratio of debt service to annual revenues) is near 6 percent as of FY 2010.

2000 | **Current** | **Forward**

Environmental/ Public Trust Period

- Several state and federal environmental laws enacted (Clean Water Act, Endangered Species Act, California Endangered Species Act, California Environmental Quality Act).
- California has allocated funds garnered through the federal Clean Water Act to make great strides in cleaning up its rivers, lakes, groundwater aquifers, and coastal waters.
- State has financed portions of Delta levee maintenance and emergency response and recovery.
- The Water Resources Development Act is enacted within this period.

Bond Period

- 2000: Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Bond Act ($1.97 Billion).
- 2000: Safe Neighborhood Parks, Clean Water, Clean Air …
- … and Coastal Protection Bond Act ($2.0 Billion).
- 2002: California Clean Water, Clean Air, Safe Neighborhood
- Parks, and Coastal Protection Act of 2002 ($2.6 billion).
- 2002: Water Security, Clean Drinking Water, Coastal and Beach Protection Act ($3.4 Billion).
- 2006: Disaster Preparedness and Flood Protection Bond ($4.09 Billion).
- 2006: Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond act ($5.39 Billion) costs of California's flood control projects.

Integration Period

Innovation actions

- Governance improvements
- Planning & public engagement improvements
- Agency alignment (data, plans, policies & regulations)
- Information technology (data & tools)
- Water technology / R&D

Infrastructure improvements:

- natural (green) & human (grey)
- Regional projects
- Inter-regional projects
- Statewide systems

Although State GO bonds have become an important source of water and flood management funding, they are available only at discrete times owing to the nature of bond approval and sale. This raises questions about the future sustainability of bond financing for water projects. In 1999, total water bonds were $3.8 billion, accounting for approximately 10 percent of total authorized State bonds. This increased to $22.9 billion by 2011, or 18 percent of total authorized bonds, largely as a result of Propositions 1E and 84. Current GO bonds are expected to be fully allocated by the year 2017.

Annual debt service for outstanding water bonds is approaching $80 per household, as water bonds make up a larger proportion of flood and water funding. Total State annual debt service is $365 per household. Rising debt levels increase pressure to develop alternative financing strategies that capitalize on local, State, and federal cost-sharing and IWM.

Very little of the total State IWM funding allows discretion or flexibility. Bond and legislative language designates funding purposes. GO bonds backed by property taxes and the General Fund are required to be used for capital projects. Revenue and lease-revenue bonds, typically used by local agencies, offer more flexibility. In general, the discrete nature of bond money makes this financing source better suited for one-time investments.

Local, State, and Federal Expenditures, 1995 to 2010

Local agencies account for the largest portion of water-related expenditures, averaging $18 billion per year, followed by State agencies at $1.9 billion and federal agencies at $805 million per year. Expenditures vary over time, depending on factors such as State and federal appropriations and bond measures.

Between 1995 and 2010, annual project expenditures for water management in California ranged from approximately $12.5 billion to $21.7 billion. This includes total expenditures for flood management in California by local, State, and federal agencies. Between 1995 and 2010, there were significant short-term bond infusions of funding for specific State projects. In FY 2008/2009, federal expenditures had a one-time increase for shovel-ready projects supported by the passage of the American Recovery and Reinvestment Act (ARRA).

Chapter 7, "Finance Planning Framework," of Volume 1, provides more detail on California's water financing history, including recent investments by State, federal, and local agencies.

Important Observations about Current IWM Funding

- Funding sources are diverse, complicated, and each has unique characteristics and costs.
- Currently authorized GO bonds and federal funding comprised two-thirds of total IWM State spending in FY 2011/2012. Current GO bonds will be fully allocated by 2018, and future federal funding is highly uncertain in terms of amounts and constructs (e.g., cost-sharing methods and their related requirements and flexibility to meet State IWM objectives).
- Very little of the total State IWM funding allows discretion or flexibility to adapt to changing priorities and opportunities. The same limitations can exist with regional and local funding, such as how rate or tax revenues can be used.
- Water and flood bond debt is at an all-time high.
- There are primarily two basic sources of funding — taxes and fees. Private funding and donations provide for some specific local investments in IWM.
- For any given year, there are two main funding strategies — cash on-hand and borrowing.
- Although water supply, flood control, and ecosystem projects are managing a common resource (land and water), often in the same location, funding has been and continues to be conducted in a manner that is not conducive to integrate these resources or to improve the funding process.
- Local agency investments remain the primary source of funding for water supply.
- Federal investment has historically been the primary source of funding for flood management projects with cost-sharing by State and local agencies.
- Funding strategies and constructs change over time.

Critical Challenges

California is encountering one of the most significant water crises in its history, a crisis that has a wide range and significant effects because it has so many aspects. An increasing population, development patterns (that can affect demand for outdoor water use), and reduced water supplies exacerbate the effects of drought periods. Climate change is reducing snowpack storage and changing precipitation patterns. Court decisions and new regulations have resulted in the reduction of Delta water deliveries by 20 to 30 percent. Increased reliance on groundwater to meet California's increasingly inflexible demand for water has resulted in alarming declines of groundwater levels, reductions in groundwater quality, increased land subsidence, long-term stream depletion, and reduction in ecosystem services once provided by groundwater. Development within floodplains continues to court the chance of flooding that is among the highest in the nation. Key fish species continue to decline. In some areas, ecosystems and quality of groundwater and surface water are unhealthy. The current global financial crisis and increasing debt levels are making it even more difficult to invest in solutions. Box 3-7 provides a practical characterization of the economic value of water relative to current investment trends.

The challenge is to make sure that water is in the right place at the right time, particularly during dry years. During dry years, less water is available from rainfall for all uses, which results in a greater reliance on groundwater, impacts on the environment, higher costs, and perhaps rationing for many users. At the same time, those who have already increased water-use efficiency may find it more challenging to achieve additional water-use reductions.

Protect and Restore Surface Water Quality

The quality of California water is a particular and growing concern. Water bodies may be impaired from various sources. Discharges from municipal and industrial facilities can affect water bodies, but compared with 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 stormwater runoff — can affect water quality by transporting pollutants, including pesticides, sediment, nutrients, salts, pathogens, and heavy metals from cultivated fields into surface waters. Stormwater 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. These flows carry pollutants downstream, which often end up on beaches and in coastal waters.

Changes in temperature and precipitation patterns caused by climate change will affect water quality. Higher water temperatures result in reduced 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 resulting from runoff. In addition, more frequent and intense rainfall may overwhelm existing pollution control facilities that have been designed to handle sewage and stormwater runoff under assumptions anchored in historical rainfall patterns.

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 in reservoirs, 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 non-point-source pollution. To make informed decisions on streamflow timing and improve water quality and the health of streams, California needs to

Box 3-7 The Diamond-Water Paradox

"The Diamond-Water Paradox is taught in many introductory economics courses. The paradox is that although water is much more central to life than diamonds, diamonds are more expensive than water. Up to this moment, American households and businesses have never had to contemplate how much they would be willing to pay for water if it were to become hard to obtain. Economic analyses have not contemplated the impacts of exceptionally high costs for water and wastewater treatment on the national economy."

Source: American Society of Civil Engineers 2013.

integrate and coordinate monitoring efforts by various federal, State, regional, and local entities. This coordination would assist regional watershed planning efforts to improve the health of streams.

Degraded water quality can limit or make some water supply uses or options very expensive because the water must be pre-treated. Furthermore, water managers increasingly recognize that the water quality of various supplies needs to be matched with its use. Challenges persist for California water management at statewide, regional, and local levels. Water quality challenges and opportunities on a regional level are addressed in the more detail in each regional report in Volume 2.

Protect and Restore Groundwater Quality

Because of California's significant current and future reliance on groundwater, contamination of this resource has a far-reaching consequence on municipal and agricultural water supplies. California's reliance on groundwater increases during times of drought and continues to increase with the growing demand from municipal, agricultural, and industrial sources. Discharges from municipal and industrial facilities can affect groundwater. Discharges from agricultural lands, including irrigation return flow, can affect water quality by transporting pollutants, such as nitrates from cultivated fields, into groundwater supplies. Changes in surface water availability resulting from climate change may further increase groundwater's role in California's future water budget. Therefore, protection of groundwater aquifers and proper management of contaminated aquifers is critical to ensure that this resource can maintain its multiple beneficial uses.

The DPH estimates that 85 percent of California's community water systems serve more than 30 million people who rely on groundwater for a portion of their drinking water supply. Many groundwater basins throughout California are contaminated with salts, industrial chemicals, and/or naturally occurring pollutants. The SWRCB estimates that 682 communities, which serve more than 21 million people, use at least one contaminated groundwater well for their supply source (State Water Resources Control Board 2012a). As a result, these communities incur significant additional costs of removing groundwater contaminants from drinking water that is below primary drinking-water standards before delivering it to their customers. Where treatment and alternative water supplies are not available, some small community water systems deliver contaminated groundwater until an affordable solution can be implemented.

Large community water systems are generally in a better position to deal with contaminated groundwater supplies because these systems can absorb the additional costs associated with treatment or alternative solutions that address the contamination. Small community water systems typically lack the infrastructure and the economies of scale of larger water systems, and in some cases they cannot afford to treat or find alternative solutions for a contaminated drinking water source. As a result, small community water systems are more vulnerable to delivering contaminated groundwater to their customers. Some of these communities are small, rural, and disadvantaged communities (DACs) that are the focus of environmental justice (EJ) concerns (State Water Resources Control Board 2012a).

Multi-Year Dry Periods (Drought)

Impacts of drought are typically felt first by those most reliant on annual rainfall — ranchers engaged in dry land 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 (see Figure 3-18, “Potential Impacts of Continuing Drought”).

Climate change could extend California’s drought periods and make them worse. Warming temperatures and changes in rainfall and runoff patterns may exacerbate the frequency and intensity of droughts. Regions that rely heavily on surface water (i.e., 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 and make them more vulnerable to pests, disease, and changes in species composition. Along with drier soils, forests may experience more frequent and intense fires that result 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 on its groundwater to supplement other depleted supplies. Increased reliance on groundwater to supplement drought and regulatory cutbacks in surface water supplies is already having impacts on some groundwater basins; moreover, groundwater-related impacts from climate change have the potential to affect future groundwater sustainability. In addition, climate change has the potential to significantly alter historical patterns of groundwater recharge and exacerbate drought conditions. More effective groundwater basin management will be necessary to mitigate existing groundwater overdraft and avoid additional overdraft driven by the changing climate. In regions with contaminated groundwater basins, some additional steps may be required to remediate the aquifer before implementing active recharge and conjunctive use.

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 hundreds of 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

Figure 3-18 **Potential Impacts of Continuing Drought**

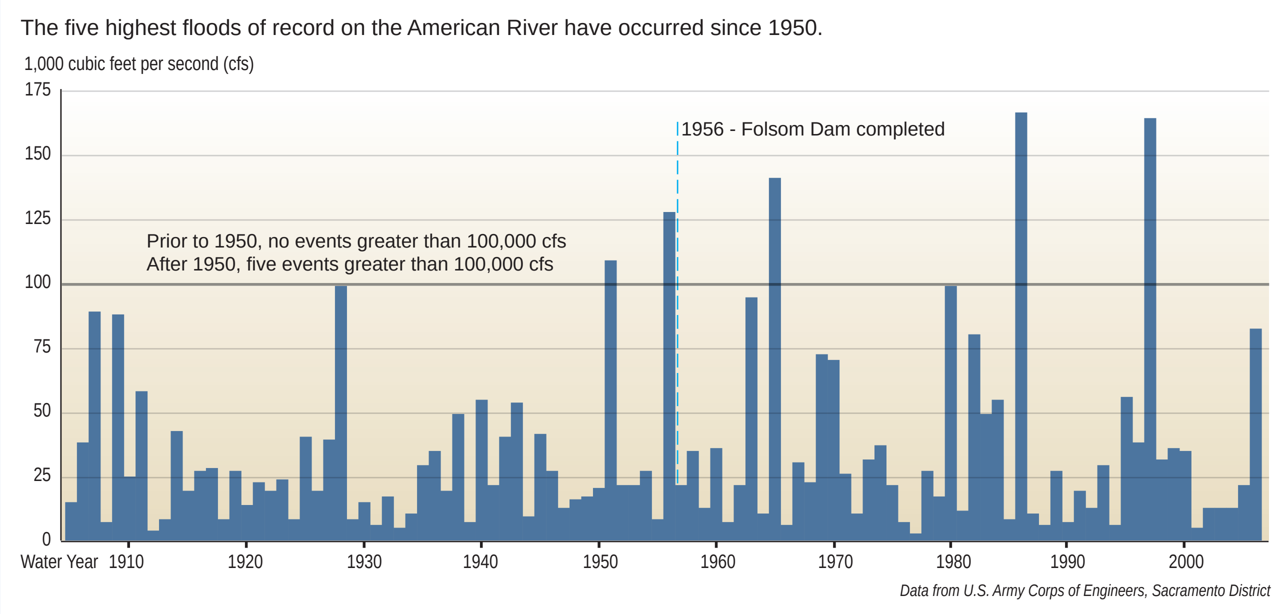
obstacles. Escalating development in floodplains has increased the potential for loss of life and flood damage to homes, businesses, and communities.

Every region of the state must deal with flood risk. At least one flood disaster has been declared in every county in the last 20 years. The Central Valley is a deep floodplain that historically was inundated at regular intervals. Coastal rivers and streams might overflow their banks during winter storms. Debris flows to areas downstream of hillsides on charred or denuded ground can cause life-threatening floods. Southern California is vulnerable to infrequent but devastating flooding. Development on alluvial fans encounters unpredictable and changing paths of flood flows. 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. (For an example of how understanding of flood event magnitude has changed over time, see Box 3-8.)

Box 3-8 Understanding Hydrologic Changes over Time

Understanding of 100-year flood event magnitude on the American River has changed substantially over time. In the early 1900s, a 100-year flood was estimated to equate to a peak flow of just over 200,000 cubic feet per second (cfs) at what is now Folsom Dam. The estimate with current data is more than 300,000 cfs.

Figure A American River at Folsom Dam



California's population growth and current development patterns present a major challenge to the State's flood management system. 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 used by public agencies are decades old and do not reflect the most accurate information regarding potential flooding.

Catastrophic flooding in multiple locations throughout the state could equal or exceed the economic, social, and environmental damage caused by Hurricane Katrina in 2005. More than 7 million people live in California's floodplains, and this population continues to increase. Moreover, State government's 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, exacerbates the financial consequences of flooding to all Californians.

As a consequence of 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 by using established methods. Habitat can be negatively affected by some levee maintenance practices, such as vegetation removal or filling burrow holes. Environmental regulations require that local and State agencies develop new approaches to deal with the backlog of maintenance activities. While there is value in the environmental permitting process, the time and resources needed to complete the process can delay maintenance of critical public safety infrastructure.

Climate change may increase 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 Sierra Nevada watersheds to contribute to peak storm runoff. Flood events, such as the 10-year and larger floods, may increase with the 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 will be 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 resulting from climate change, there is, in turn, a potential for more floods following fire, which will increase sediment loads and degrade water quality.

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 on at least partial restoration of physical processes that are driven by water. In riverine habitats, these processes include floodplain inundation, natural patterns of erosion and deposition of sediment, a balance between infiltration and runoff, and substantial variation in seasonal streamflow. In a balanced system, groundwater systems also contribute to ecosystem services through streamflow augmentation, discharge to wetland areas, and provision of a critical source of water to valley oaks and other groundwater-dependent vegetation. The diminution of these physical processes often leads to impacts on native species, thus presenting another huge barrier to ecosystem restoration.

As an example, nearly all California waterways are controlled to reduce the impacts associated with large fluctuations in seasonal flow. Larger rivers are impounded to capture winter runoff and spring snowmelt, reduce the downstream effects of peak-flow events, and provide a measured release of high-quality water during 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. Other streams that were once perennial have become seasonally dewatered owing to nearby groundwater pumping, resulting in streamflow depletion. Groves of valley oaks in the San Joaquin and Tulare Lake regions have diminished to a fraction of their original number as a result of significant lowering of groundwater levels. The Delta has become more like a year-round freshwater lake than the seasonally brackish estuary it once was. In each case, native species have declined or disappeared. Exotic species 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 Chapter 22, "Ecosystem Restoration," in Volume 3, *Resource Management Strategies*).

Water supply and flood management projects that preserve, enhance, and restore biological diversity and ecosystem processes are likely to be more sustainable, that is, operate as desired, with less maintenance than those that do not. Projects are more sustainable when they work with, rather than against, natural processes that distribute water and sediment. The inclusion of ecosystem restoration in a project usually requires a degree of return to more natural patterns of erosion, sedimentation, flooding, and streamflow, among others. This, in turn, makes it much harder for catastrophic natural processes to disrupt such projects and also makes them easier and less costly to maintain.

As an example, the *Central Valley Flood Protection Plan* outlines the State's proposed response to a predicted climate regime of larger and more frequent floods. Part of that response is to increase the use of floodwater bypasses by making new ones and widening the existing set. This is important because nearly all of California's natural floodplains have had levees built to retain them or have been drained, or both. Beyond their role in flood protection, bypasses return floodplains to a more natural function and allow re-establishment of native floodplain vegetation. In turn, this helps to stabilize soils; increase groundwater infiltration and storage; and reduce floodwater velocities, bank erosion, and sedimentation in streams. Furthermore, because a return to a more natural floodplain function makes more room for peak flood flows in valleys, it allows for the dedication of more reservoir capacity to water supply instead of setting it aside for floodwater storage.

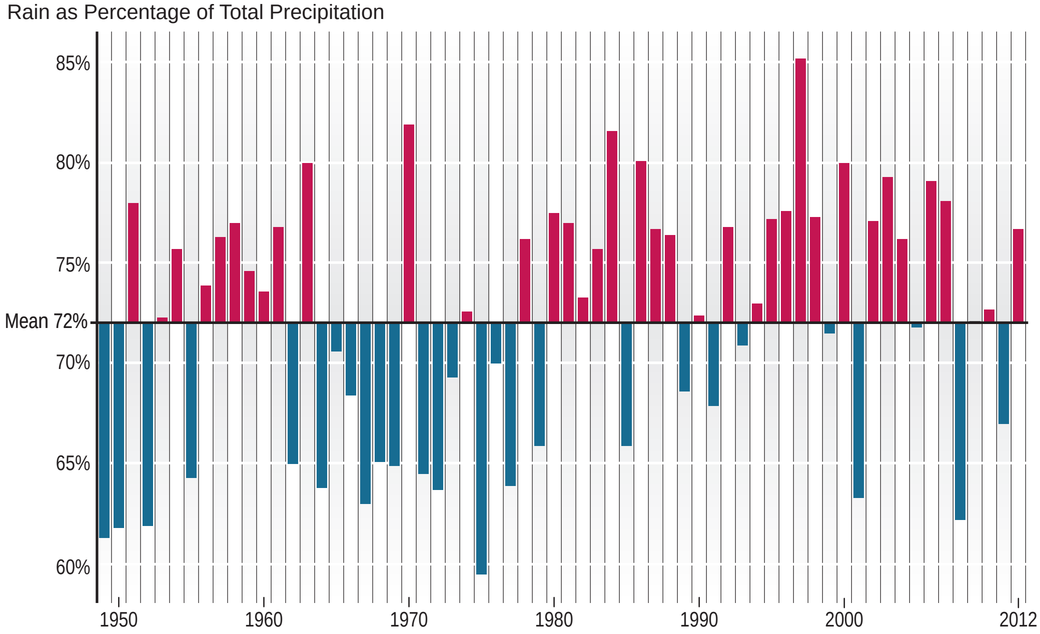
A second example concerns forest management in the mountain watersheds that supply the bulk of California's water. One hundred years of fire suppression has produced unusually dense stands of small trees, which are much more susceptible to combustion during wildfires than larger, old-growth trees. They provide uncharacteristically large fuel loads that cause extensive and severe wildfires. The result is that massive wildfires occur much more often than a century ago. After such fires, the bare soil on burned-over hill slopes quickly erodes during rainstorms and sends large pulses of sediment into streams, reservoirs, and groundwater recharge basins. Landslides also become more frequent, producing the same result.

Current efforts to improve forest management aim to reduce the incidence of catastrophic wildfires and subsequent soil erosion and water pollution. This should reduce the need to remove silt and debris from reservoirs and recharge basins, make more space for water supply storage and hydropower generation capacity, and increase the economic value of these activities. Furthermore, better forest management, including thinning of even-aged single-species stands, should increase the diversity of tree species and associated animal life in an area.

Climate Change

Climate change creates critical challenges for California water resources management. The vulnerability of the water sector to climate change stems from a modified hydrology that affects the frequency, magnitude, and duration of extreme events, including flooding and drought, which, in turn, affect water quantity, quality, and infrastructure. Higher temperatures may melt the Sierra snowpack earlier in the year and drive the snowline higher, resulting in less water storage as snowpack for California users and the environment. Intense rainfall events will continue to affect the state, possibly leading to more frequent and/or more extensive flooding. Droughts are likely to become more frequent and persistent during this century. Storms and snowmelt may coincide and produce higher winter runoff, while acceleration of sea level rise will produce higher storm surges during coastal storms. Rising sea levels increase susceptibility to coastal and estuarine flooding and increase salt water intrusion into coastal groundwater aquifers. Together, higher winter runoff and sea level rise will increase the probability of levee failures in the Delta and other coastal areas. Sea level rise will also place additional constraints on management and water exports from the Delta.

Figure 3-19 Rain/Snow Historical Trends



Note: Percentage of precipitation falling as rain over the 33 main water-supply watersheds of the State is shown for water years ending 1949 through 2012 (Oct. 1948-Sept. 2012), using Western Region Climate Center historic precipitation and freezing level re-analysis (http://www.wrcc.dri.edu).

These watersheds experience a mean of 72 percent of precipitation as rain; years with red bars have a higher percentage of rain than the mean, and years with blue bars have a lower percentage of rain than the mean. Years with a higher percentage of rain are more common in the later period of record, in agreement with expectations under a warming climate and previous studies. There is substantial annual variability resulting from climate signals that occur on annual and decadal scales.

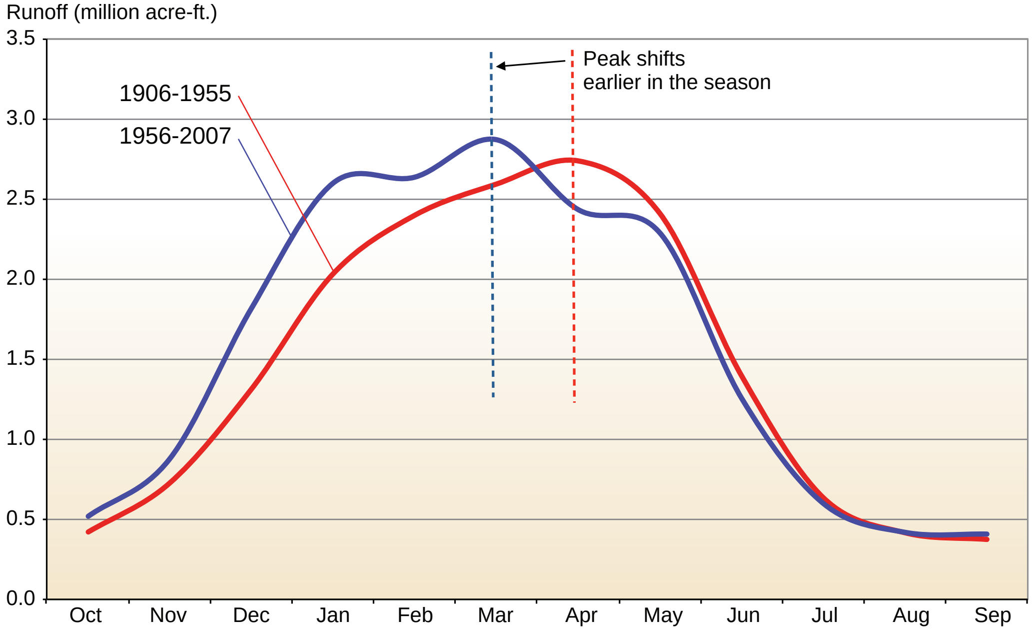
For data and analysis methodology, see the article "Estimating California Snowfall Trends Using Available Gridded Precipitation and Freezing Level Data" (Volume 4, *Reference Guide*).

Temperature Trends, Hydrologic Impacts, and Projections

California temperatures have shown a warming trend in the past century. According to the Western Region Climate Center, the state has experienced an increase of 1.1 to 2 degrees Fahrenheit (°F) (0.6 to 1.1 degrees Celsius [°C]) in mean temperature in the past century (Abatzoglou et al. 2009). Both minimum and maximum annual temperatures have increased, but the minimum temperatures (+1.6 to 2.5 °F [0.9 to 1.4 °C)]) have increased more than maximums (+0.4 to 1.6 °F [0.2 to 0.9 °C]). Future projections of temperatures across California are being modeled using downscaling, a process that refines global climate change projections to smaller-scale detail for statewide and regional projections. A recent study by Scripps Institution of Oceanography using these new techniques indicates that by 2060-2069, mean temperatures will be 3.4 to 4.9 °F (1.9 to 2.7 °C) higher across the state than they were in the period 1985-94 (Pierce et al. 2012). Seasonal trends indicate a greater increase in the summer months (4.1 to 6.5 °F [2.3 to 3.6 °C]) than in winter months (2.7 to 3.6 °F [1.5 to 2.0 °C]) by 2060-2069. For regional observational and projected temperature trends, see Volume 2, *Regional Reports*.

To assess hydrologic impacts, it is important to look at the precipitation record as well as the temperature record. Changes in precipitation across California caused by climate change could result in changes in type of precipitation (rain or snow) in a given area, in timing or total

Figure 3-20 Monthly Average Runoff of Sacramento River System



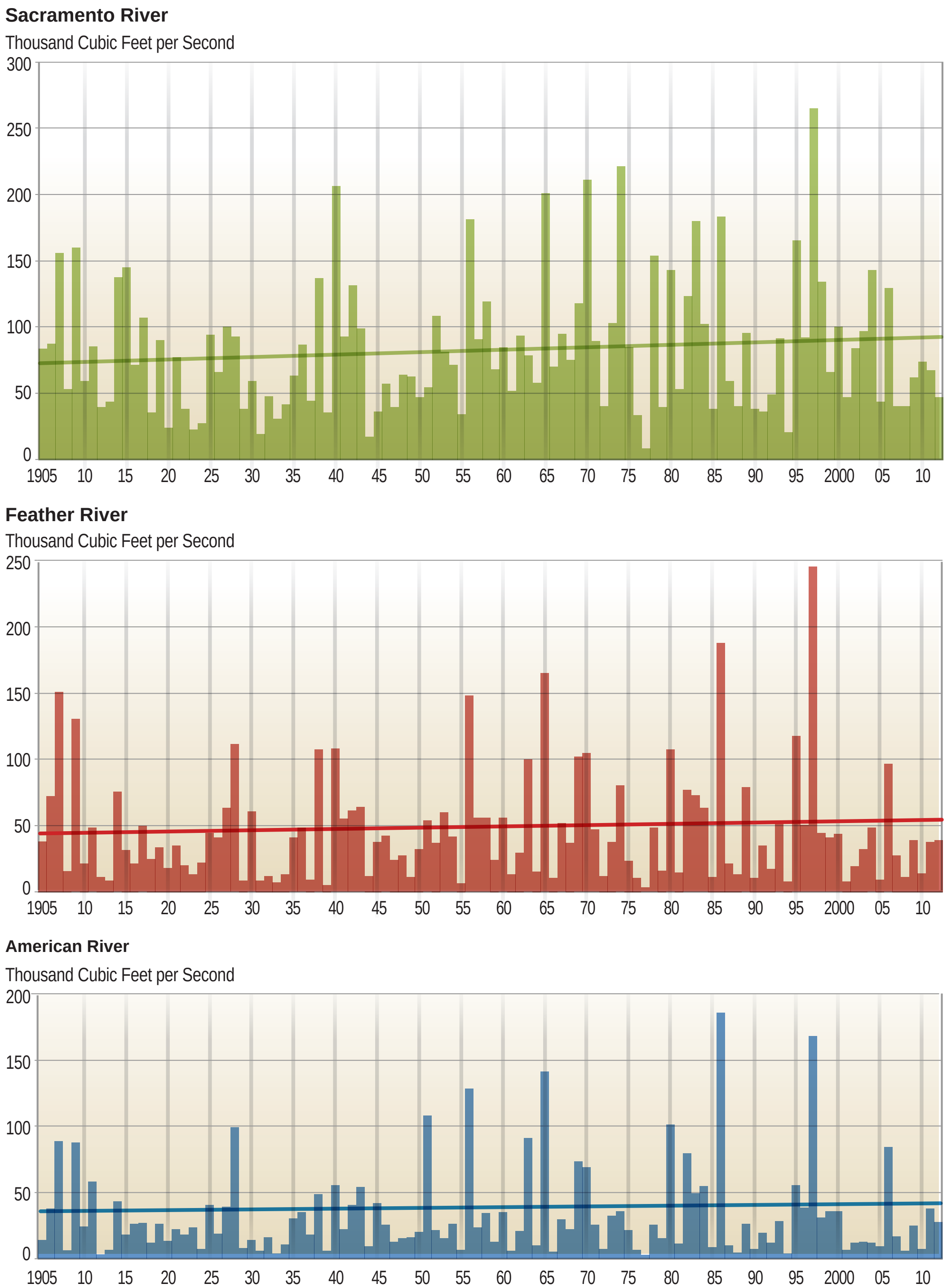
Note: Average monthly runoff in the Sacramento River System is a critical component of California's water supply. Flood protection and water supply infrastructure have been designed and optimized for historical conditions. However, the timing of peak monthly runoff between 1906-1955 (redline) and 1956-2007 (blue line) has shifted nearly a month earlier, indicating that this key hydrology metric is no longer stationary. Timing is projected to continue to move earlier in the year, further constraining water management by reducing the ability to refill reservoirs after the flood season has passed.

amount, and in surface runoff timing and volume. In recent decades, the trend has been toward more rain versus snow in the total precipitation volume over the state's primary water supply watersheds, consistent with expectations under a warming atmosphere (Figure 3-19; and for more on background and methodology, see the article "Estimating Historical California Precipitation Phase Trends Using Available Gridded Precipitation, Precipitation Phase, and Elevation Data," in Volume 4, *Reference Guide*).

Additional changes can be seen in the hydrologic record. Snowmelt provides an annual average of 15 maf of water, slowly released by melting 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. The water management community has invested in, and depends on, a system based on historical hydrology, but managing to historical trends will no longer work. Historical hydrology may no longer provide an accurate picture of future conditions. Figure 3-20 shows the timing of runoff has changed during the last 100 years in California's largest water supply watershed, the Sacramento River System.

Peak flows along major California Rivers have also shown an increasing trend in the 20th century. Figure 3-21, "Rivers: Sacramento, Feather, and American River Historical Annual Maximum Three-day Flow," shows that the three largest flow events since 1905 occurred after the mid-century.

Figure 3-21 **Rivers: Sacramento, Feather, and American River Historical Annual Maximum Three-Day Flow**



Note: Annual unregulated three-day maximum flows on the Sacramento, Feather, and American rivers over the past century showed an increasing trend in the 20th century. The State's water infrastructure will have to be modified to accommodate higher flows from more powerful individual storm events in a warmer atmosphere.

Additional observational trends that indicate climate change is already occurring in California are discussed on the Web site, “Indicators of Climate Change in California” (Office of Environmental Health Hazard Assessment 2013).

While the observed trends highlighted above indicate that California’s climate is already changing and having significant impacts on water resources, future climate change is anticipated to bring even larger and potentially accelerated rates of change. Based on historical data and modeling research at Scripps Institution of Oceanography, the Sierra snowpack may experience a 48-65 percent loss from the 1961-1990 average by the end of this century (Pierce and Cayan 2013) (Figure 3-22). Because of the relatively lower elevation of the northern Sierra, more snowpack reduction is likely in the northern Sierra than in the southern Sierra.

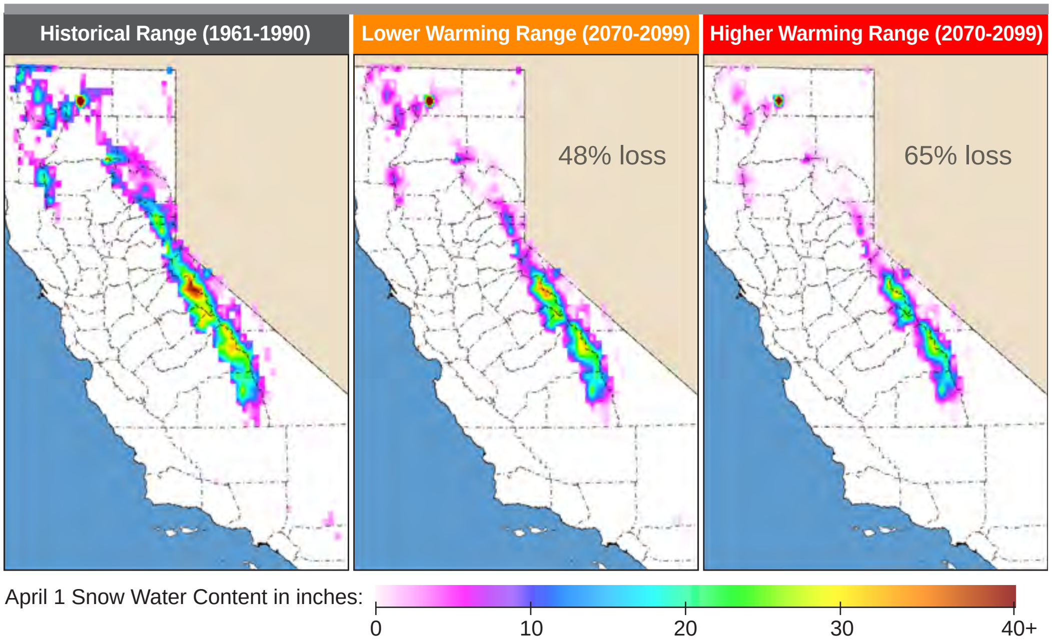
If the atmosphere undergoes additional warming, runoff could continue to shift earlier in the year. One study that has bearing on all major water export systems is a simulation of the SWP. Increasing temperatures were simulated in the Feather River basin to gauge the sensitivity of the SWP to increasing degrees of climate change (Figure 3-23). Even moderate warming applied to historical rainfall patterns substantially affects the natural storage of water as snow, causing earlier runoffs into Oroville reservoir. More extreme warming would have extremely problematic effects. The operations of all systems are susceptible to climate shifts and may have to be modified for flood control, water supply, hydropower, and environmental needs as well as coordination with other projects.

Climate model projections yield other disturbing indications. Disparity in precipitation amounts across the various parts of the state could be even greater in the future. Precipitation projections from climate models are not all in agreement, but most anticipate drier conditions in the southern part of California. For the northern part of California, models suggest the total amount of precipitation may not increase, but could occur in warmer, heavier bursts (Pierce et al. 2012). Intense rainfall events and rapid snowmelt would reduce overall water supply by making water more difficult to capture in reservoirs or retain for groundwater recharge. Recreation and tourism may also suffer as a result of lower water levels in waterways and reservoirs during spring and summer, and declining snowpack in winter and spring.

Increased flood risk will be another challenge of climate change. Several of the models show a tendency for greater amounts of precipitation during large storm events (Dettinger 2011; Cayan et al. 2009). California’s unique geography contains mountains that accumulate snowpack, low-elevation valley floors that collect snowmelt, and areas of the Delta that are below sea level. Simulations of California’s hydrology that use a range of climate scenarios indicate the dual impact of this geography and higher temperatures. As California’s climate warms during the 21st century, these simulations produce larger-than-historical floods, statistically increased flood magnitudes, and likely higher frequency of flood events. By the end of the 21st century, the magnitudes of the largest floods increase to 110-150 percent of historical magnitudes (Das et al. 2011; Pierce et al. 2012). Recent computer downscaling techniques also indicate that California flood risks from warm-wet, atmospheric-river-type storms may increase beyond those that are known historically, mostly in the form of occasional more-extreme-than-historical storm seasons (Dettinger 2011; Cayan et al. 2009).

There also will be impacts on agriculture owing to a more variable hydrologic regime and temperatures that differ from historical trends. Climate change will alter seasonal temperature patterns, leading to changes in average temperatures, the timing of the onset of seasons, and

Figure 3-22 Snowpack Projections



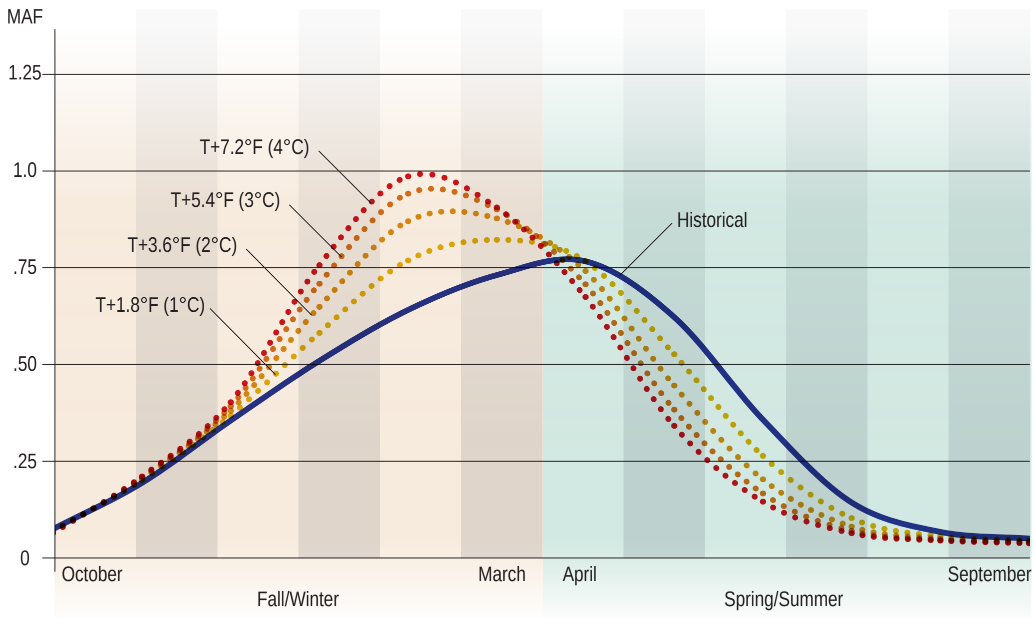
Note: Historical and projected April 1st snow-water content for the Sierra for lower and higher warming scenarios depicting the effect of human-generated GHGs and aerosols on climate. By the end of this century, the Sierra snowpack is projected to experience a 48-65 percent loss from its average at the end of the previous century (Pierce and Cayan 2013).

the degree of cooling that occurs at night. The implications for crops depend on type, and there may be some positive impacts on certain species. Winter reduced-chill hours would be harmful for the stone-fruit and nut industries. Crops that thrive in specific ecological conditions, such as wine grapes, will also be vulnerable. Additional agricultural loss could result from an increase in invasive and destructive pests, whose populations were previously limited by cold winters. In addition to new seasonal temperature patterns, drought and heat waves are projected to occur more frequently and/or last for longer periods. Projections for precipitation are less certain, but indicate that patterns will also become more variable. Irrigation can alleviate some climate stresses (e.g., altered temperature or precipitation), but during reduced water supply, additional irrigation water might not be available.

Climate change may also affect water demand for both agricultural and urban use. Warmer temperatures are likely to extend growing seasons and also increase evapotranspiration, thereby increasing the amount of water needed for the irrigation of certain crops, urban landscaping, and environmental needs. Reduced soil moisture and surface flow will affect the environment and other water users that rely heavily on annual rainfall, such as rainfed agriculture, livestock grazing on nonirrigated rangeland, and recreation. Additionally, water demand shifts may result from human population changes in response to climate change itself.

Environmental water supplies would need to be retained in reservoirs for managing instream flows to maintain habitat for aquatic species throughout the dry season. Currently, Delta pumping restrictions are in place to protect endangered aquatic species. Climate change is likely to further constrain the management of these endangered species and the State's ability to provide water for other uses. This would further reduce supplies available for import through the SWP during the non-winter months (Cayan et al. 2008; Hayhoe et al. 2004).

Figure 3-23 Climate Change Impacts on State Water Project Inflow to Oroville



Note: Climate warming will cause substantial reductions in the natural storage of water in the accumulation and melt of seasonal snowpack. Earlier runoff during the spring snowmelt period will occur. Monthly average natural stream inflows to Lake Oroville (water year 1922-2010), before being regulated by reservoir operation and diversions, were simulated with a rainfall-runoff model (SWAT). The results shown in this figure indicate that the reduction in spring snowmelt runoff for water supply can only be recovered and captured by additional reservoir storage as air temperature increases.

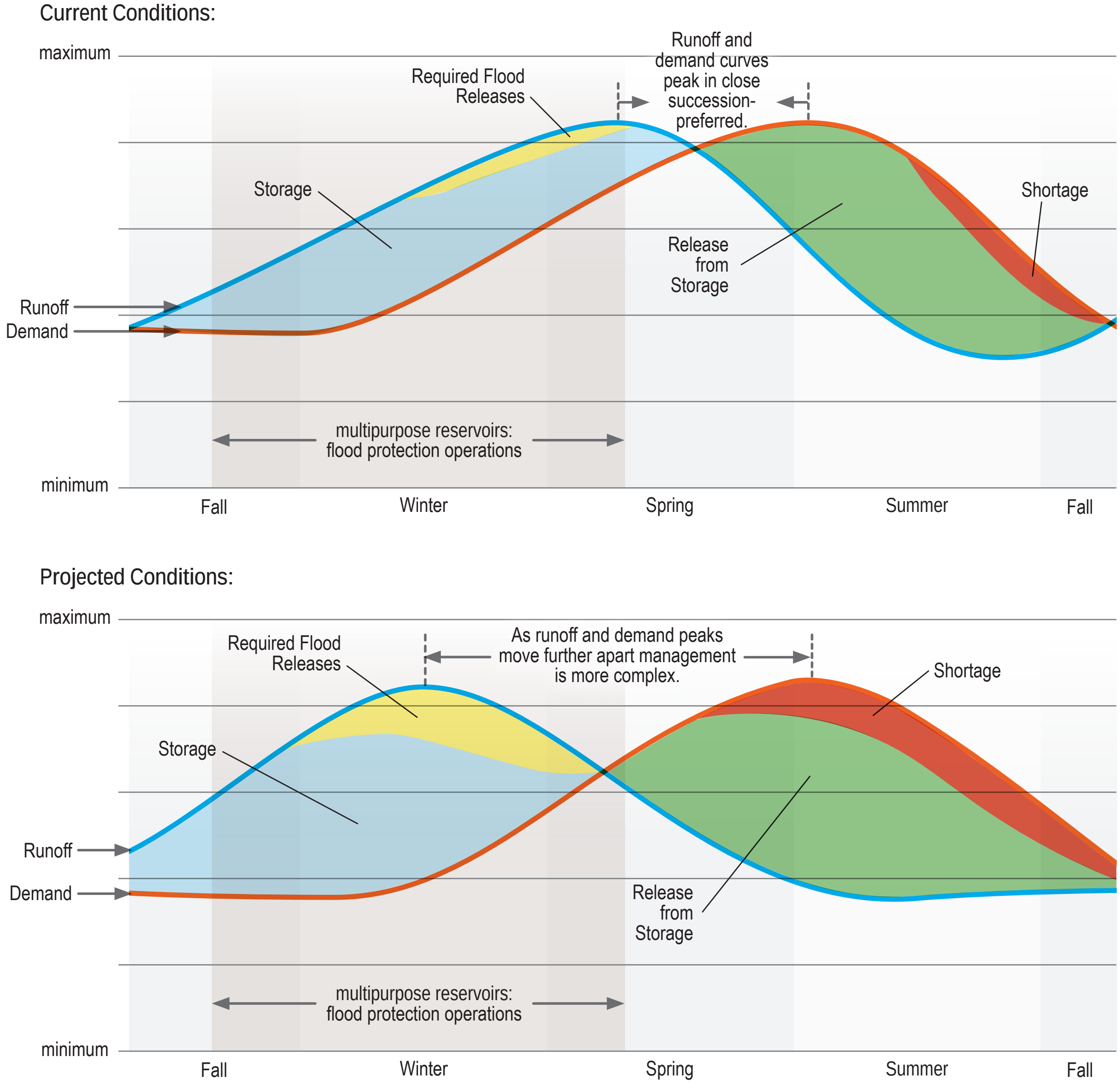
Warmer temperatures would also increase evaporation from reservoirs, lakes, and rivers. With increasing temperatures, net evaporation from reservoirs is projected to increase by 15-37 percent (Medellin-Azuara et al. 2009; California Natural Resources Agency 2010).

Figure 3-24 shows conceptually how the hydrologic changes described above place additional stress on water supply systems. These changes increase the volume of runoff that arrives at reservoirs during the flood protection season and reduce the stored water available to meet summer peaks in water demand. At the same time, higher temperatures, resulting from climate change, increase peak summer demands beyond historical levels. The schematic in Figure 3-24 indicates the climate change challenge for water resource management in California. Existing infrastructure will need to be adapted to the new timing of runoff, as well as accommodate higher flows from more powerful individual storm events in a warmer atmosphere. Flexibility needs to be incorporated into water infrastructure and operations. For more on adapting to water supply and demand under a changing climate, see the "Responses and Opportunities" section of this chapter.

Sea Level Rise

A warming climate causes sea level to rise by warming the oceans, which causes the water to expand, and land ice to melt, which transfers water to the ocean. Recent satellite data shows that

Figure 3-24 How Earlier Runoff Affects Water Availability



Note: The conceptual impact of earlier runoff and increased summertime water demand is shown in the two curves. The curves show the general shape and timing of runoff and demand in California (individual watersheds each have unique characteristics). Under "Current Conditions" (top box), runoff peaks in early spring only a few months before demand peaks in early summer. Much of the difference between high runoff and low demand in fall and winter can be captured and stored in the state's existing surface and groundwater storage facilities. That storage meets most of the demands later in spring and summer, and shortages are minimal. Under "Projected Conditions" (lower box), runoff peaks in mid-winter, months before demand peaks in spring and summer. Summertime demand is higher owing to higher temperatures, and high demand lasts longer into early fall as a result of longer growing seasons. Earlier runoff is captured in storage facilities; however, because the runoff arrives while reservoirs are being managed for flood protection, much of the runoff must be released to maintain flood protection storage space in reservoirs. In spring and summer, demand far exceeds runoff and releases from storage, making shortages much more common.

the rate of sea level rise is accelerating, with melting of land ice now the largest component of global sea level rise (about 65 percent), largely because ice loss rates are increasing.

During the last century, sea level at the Golden Gate in San Francisco has shown a 7-inch rise, similar to global measurements. Future sea level rise along the California coast may be uneven. Models indicate that it depends on the global mean sea level rise and regional factors, such as ocean and atmospheric circulation patterns; melting of modern and ancient ice sheets; and tectonic plate movement. A 2012 report, *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*, estimates sea level rise along the California coast south of Cape Mendocino at 2-12 inches (4-30 centimeters [cm]) by 2030, 5-24 inches (12-61 cm) by 2050, and 17-66 inches (42-167 cm) by 2100, relative to 2000 levels (National Academy of Sciences 2012) (see Figure 3-25). Areas north of Cape Mendocino, including Washington and Oregon, anticipate lesser rise, or possibly a fall in sea level in early projection years, owing to plate tectonics. However, a large earthquake along the Cascadia Subduction Zone north of Cape Mendocino could suddenly lower land elevations by 3-7 feet, resulting in severe and rapid sea level rise relative to the land surface.

The estimates made by the National Research Council are substantially higher than projections made by the United Nation's Intergovernmental Panel on Climate Change (IPCC) in their Fourth Assessment Report (Intergovernmental Panel on Climate Change 2007). These new sea-level-rise projections will serve as planning guidance for the State, replacing previous Interim Guidance established by the Ocean Protection Council in 2011.

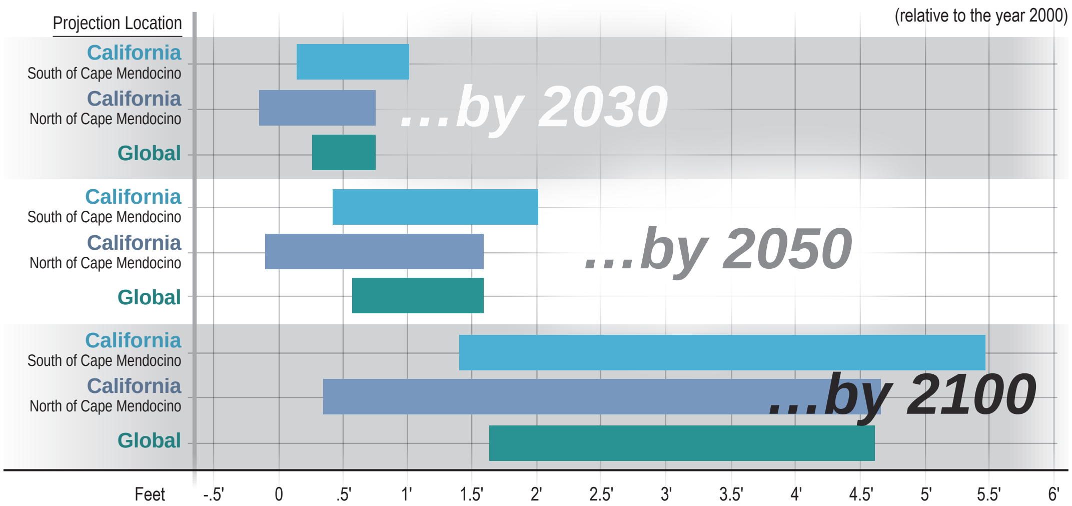
The sea-level-rise implications for California include increased risk of storm surge and flooding for coastal residents and infrastructure, including many of the state's low-lying coastal wastewater and recycled water treatment plants. Most coastal damage from sea level rise is caused by the confluence of large waves, storm surges, and high astronomical tides during strong El Niño conditions. The state is vulnerable to these impacts, some of which are projected to increase under climate change. Even if storms do not become more intense and/or frequent, sea level rise itself will magnify the adverse impact of any storm surge and high waves on the California coast (National Research Council of the National Academies 2012). Some observational studies report that the largest waves are already getting higher and winds are getting stronger, but data records do not go back far enough to confirm whether these are long-term trends.

Sea level rise will increase erosion of beaches, cliffs, and bluffs, causing social, economic, and resource losses to recreation, access ways, parks, trails, and scenic vistas. Local and regional investments in water and flood management infrastructure, as well as wetland and aquatic restoration projects, are also vulnerable to rising seas.

For the millions who rely on drinking water or agriculture irrigated by Delta exports, the most critical impact of rising seas will be additional pressure on an already vulnerable levee and water delivery system, which protects numerous islands currently below sea level and sinking. Catastrophic levee-failure risk continues to increase, with the potential to inundate Delta communities and interrupt water supplies throughout the state.

Even without levee failures, Delta water supplies and aquatic habitat may be affected at times, owing to more seawater intrusion caused by sea level rise. Without additional releases of freshwater from reservoirs to repel higher sea levels, sea water will penetrate further into the

Figure 3-25 **California and Global Sea-Level-Rise Projections**



Reprinted with permission from "Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future," 2012, from the National Academy of Sciences, Courtesy of the National Academies Press, Washington, D.C.

Summary of regional projections of mean sea level rise from a National Research Council of the National Academies (National Research Council 2012) study, sponsored by California, Oregon, Washington, and three federal agencies. The highest observed values of sea level rise will occur during winter storms, especially during El Niño years, when warmer ocean temperatures result in temporarily increased sea levels. Observed values can be much greater than the mean values shown here. For example, observed California sea levels during winter storms in the 1982-83 El Niño event were similar in magnitude to the mean sea levels now being projected for the end of the 21st century.

Delta and will degrade drinking and agricultural water quality and alter ecosystem conditions. Alternatively, releasing additional freshwater from reservoirs to repel the higher sea levels will have impacts on water supply. Figure 3-26 shows the results of a 2009 study that investigated the potential impacts of sea level rise and changes in hydrology on water exports from the Delta, groundwater pumping, and storage left in reservoirs at the end of each year to carry over to the next year (California Department of Water Resources 2009a).

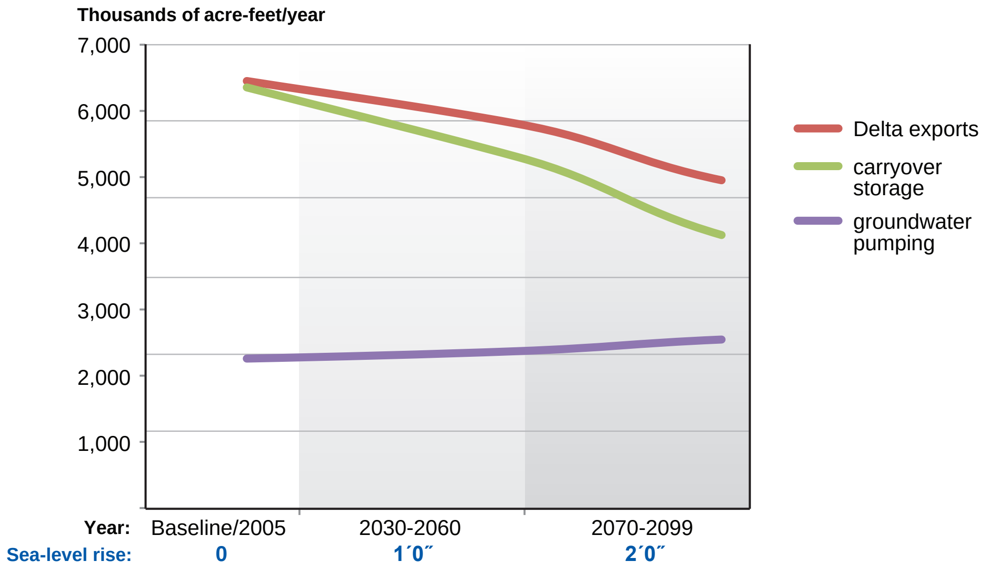
Sea level rise may also affect drinking water supplies for coastal communities owing to the intrusion of seawater into coastal aquifers. As sea levels rise, the lens of salty groundwater penetrates further inland and displaces additional fresh groundwater, as shown in Figure 3-27. This effect can be especially damaging in areas where coastal groundwater basins have been depleted.

Climate Change and the Water-Energy Nexus

Water and energy have a complex relationship with multiple interdependencies, often called the *water-energy nexus*. Energy is used throughout the water sector to extract, convey, treat, distribute, and heat water. Energy intensity is the total amount of energy calculated on a whole-system basis, required for the use of a given amount of water in a specific location.

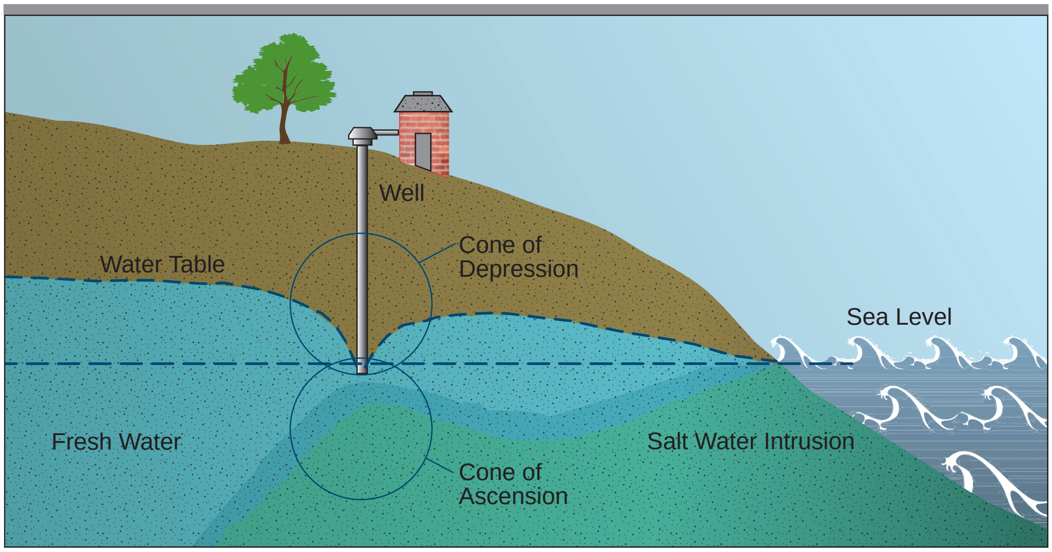
Water-related energy use in California is largely based on the information in a California Energy Commission study. Figure 3-28 depicts water-related energy use in California, including

Figure 3-26 Sea-Level-Rise Impacts on California Water Supply



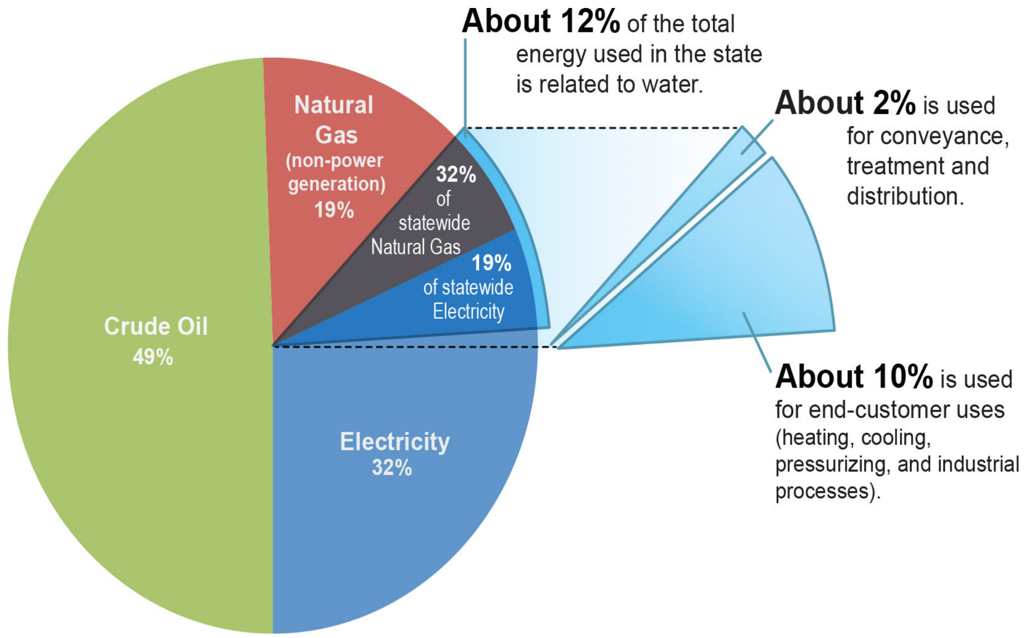
Note: The effects of sea level rise and changes in hydrology driven by climate change were modeled while holding salinity levels in the Sacramento-San Joaquin Delta (Delta) at levels currently required by regulation. The analysis shows that if salinity in the Delta continues to be managed as it currently is, sea level rise would result in some reduction in both Delta exports and carryover storage (the amount of water left in reservoirs at the end of the water year), and could increase groundwater pumping (California Department of Water Resources 2009a). Note that sea-level-rise values used in this study are in the low range of the projections.

Figure 3-27 Sea-Level-Rise Impacts on Coastal Groundwater



Note: In coastal areas, salt water penetrates inland and mixes with fresh groundwater. Because freshwater is lighter than saltwater, fresh groundwater sits on top of the saltwater and creates hydrostatic pressure that reduces the penetration of the saltwater. When fresh groundwater is removed by pumping, the hydrostatic pressure is reduced, allowing saltwater to penetrate further. In addition, groundwater pumping forms a cone of depression at the pump location, thereby creating an area of acute increased saltwater penetration and increasing the risk that freshwater supplies will be contaminated with saltwater.

Figure 3-28 Energy Use Related to Water



Sources: California Energy Commission 2005, 2013; California Public Utilities Commission 2010

electricity, natural gas, and crude oil consumption (California Energy Commission 2005, 2013; California Public Utilities Commission 2010). The California Energy Commission's (CEC's) 2005 study estimated that water systems and users in California accounted for about 19 percent of statewide electricity consumption and 32 percent of statewide natural gas (non-power generation) consumption. Approximately 75 percent of water sector electricity consumption is by water end-users, including water heating and cooling; advanced treatment by industrial users; and on-site pumping and pressurization for irrigation and other purposes. The other approximately 25 percent of water-sector electricity consumption occurs in water and wastewater system operations, including water extraction, conveyance, treatment, distribution, and wastewater collection and treatment (California Public Utilities Commission 2010).

Most electricity generation and energy uses result in greenhouse gas (GHG) emissions related to climate change. Reducing energy intensity and energy uses can reduce GHG emissions in the water sector and contribute to climate change mitigation. For information on mitigation actions being taken by State agencies, see the "Response and Opportunities" section of this chapter.

The other side of the water-energy nexus relates to the amount of water used in producing energy, including water used in the energy sector for extraction of natural gas and other fuels, used as the working fluid for hydropower or the working fluid and cooling in thermal generation systems, and used for irrigating biofuels. Water requirements for energy systems are highly variable and depend on many factors.

The energy sector is also vulnerable to potential impacts of climate change. For example, this vulnerability was highlighted by a modeling study simulating hydropower generation under regional climate warming in the Sierra Nevada (Rheinheimer et al. 2012). This study indicates that the most substantial decrease of the mean annual hydropower generation could be in the northern Sierra Nevada watersheds as a result of declining runoff, and also projects steady declines in hydropower generation in the southern watersheds with warming temperatures. Vulnerability assessment and adaptation to climate change should be managed at local, regional, and watershed levels for both the water and the energy sectors to address these challenges efficiently.

Understanding the relationship of water and energy is important for decision-making, with regard to using limited water and energy supplies efficiently to meet increasing future demands. The connections between these sectors should be kept in mind when making resource and planning decisions. Figure 3-29 shows the multiple ways that water and energy sectors are interwoven in California. Connections where water is used in the generation of energy are highlighted in blue, while connections where energy is expended in the use of water are highlighted in orange. The energy required for extraction and conveyance of water are indicated with green hatches and yellow light bulbs. The energy intensity of these two elements of water use is estimated for primary water supply sources for each region in Volume 2, *Regional Reports*.

Delta Vulnerabilities

The Delta is an expansive inland river delta and estuary in Northern California. Freshwater originating in the Sacramento River and San Joaquin River basins flows to the Delta, which is at the confluence of the Sacramento and San Joaquin rivers. The confluence is unique because the two river deltas merge into an inland delta. The Delta is the largest estuary on the West Coast of North and South America and is a unique natural resource of local, state, and national significance. The Delta is a vitally important ecosystem and home to hundreds of aquatic and terrestrial species, many of which are unique to the area. It is also a critical part of California's water conveyance system; is a significant agricultural region; and offers numerous opportunities for recreation, such as boating, fishing, hiking, birding, and hunting. The Delta received its first official boundary in 1959 with the passage of the Delta Protection Action and is defined in CWC Section 12220.

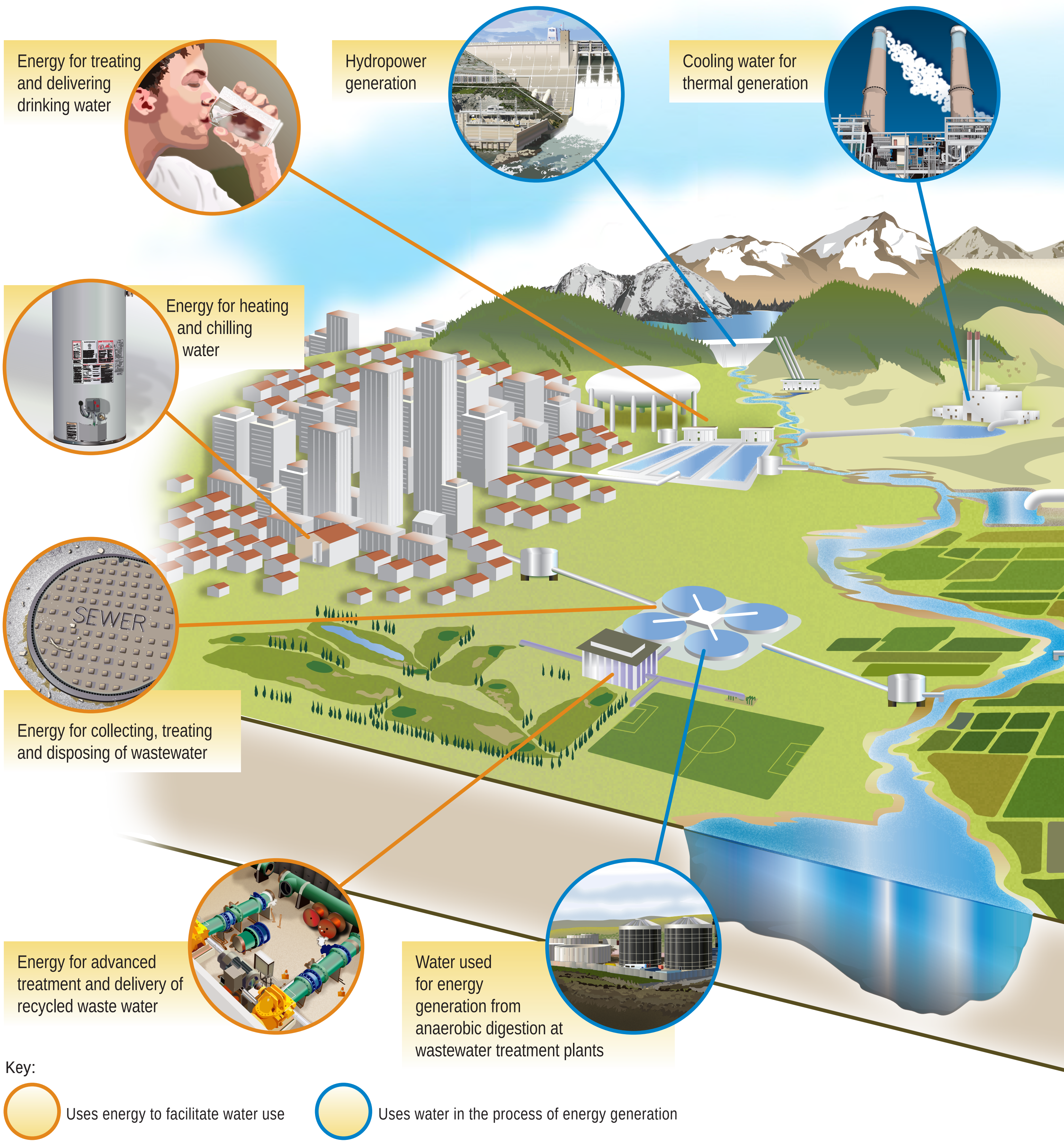
Much of the land in the Delta region is below sea level and is protected by an extensive system of levees. Since many of the Delta's 1,330 miles of levees were built in the late 1800s and early 1900s, they were not designed or constructed using modern engineering practices. The Delta levees are critical for protecting the various assets, resources, uses, and services that Californians obtain from the region, including water supply conveyance.

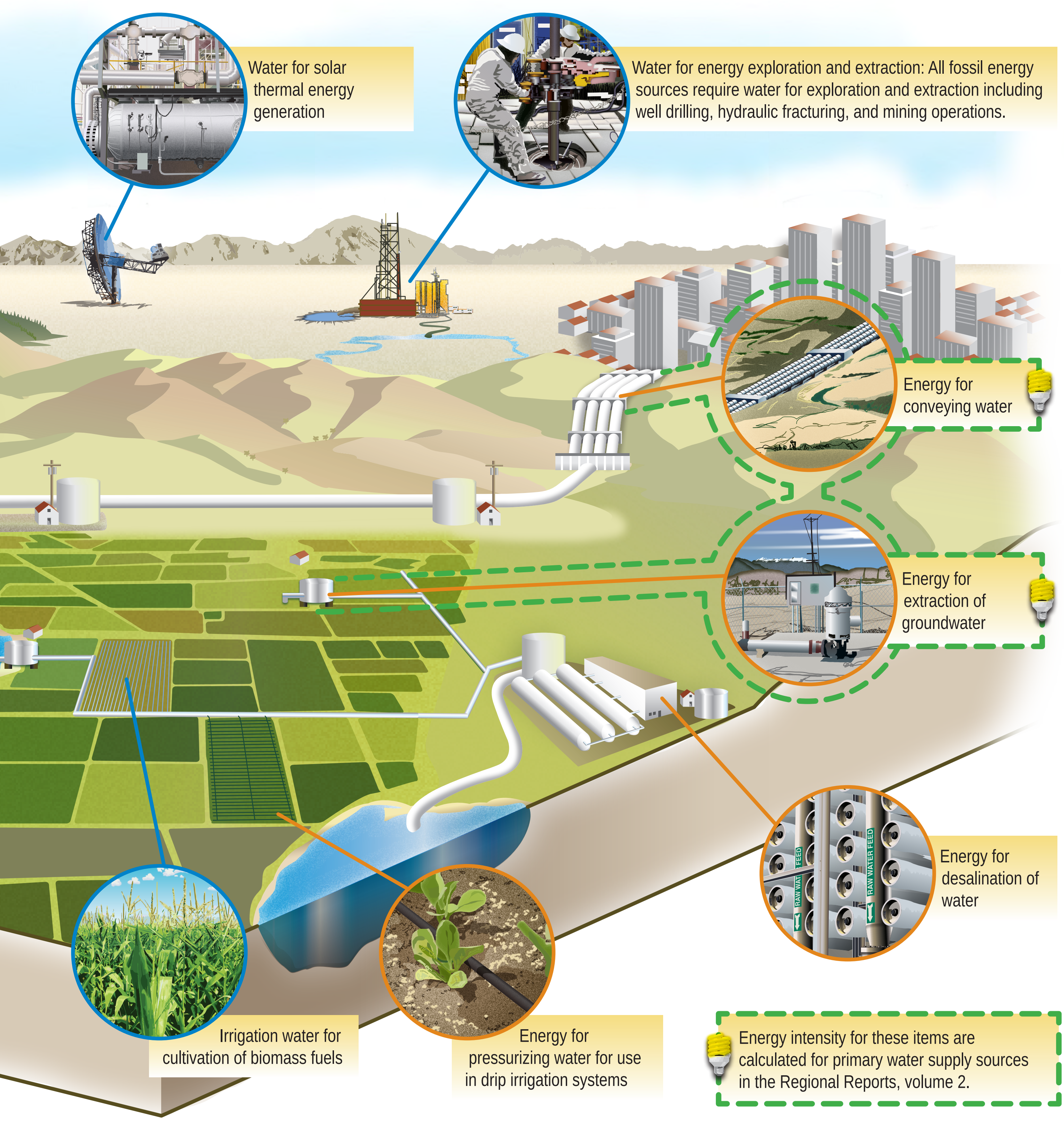
Since completion of the initial facilities of the SWP in 1975, levee failures during high water and dry weather have caused Delta islands to be flooded 37 times. Some islands have been flooded and recovered multiple times. A few islands, such as Franks Tract that flooded in the 1930s, have never been recovered.

Delta Risk Management Strategy Phase I (California Department of Water Resources 2009b) identified concerns with the Delta levee system, including the following:

- A major earthquake with a magnitude of 6.7 or greater in the vicinity of the Delta region has a 62 percent probability of occurring sometime between 2003 and 2032. This event could cause multiple levee failures, fatalities, and extensive property destruction. If the earthquake

Figure 3-29 The Water Energy Connection




Water for solar thermal energy generation
Water for energy exploration and extraction: All fossil energy sources require water for exploration and extraction including well drilling, hydraulic fracturing, and mining operations.
Energy for conveying water
Energy for extraction of groundwater
Energy for desalination of water
RAW WATER FEED
Irrigation water for cultivation of biomass fuels
Energy for pressurizing water for use in drip irrigation systems
Energy intensity for these items are calculated for primary water supply sources in the Regional Reports, volume 2.

occurred in a dry year, the loss of exports would contribute to adverse economic impacts of $15 billion or more.

- Winter storms and related high-water conditions are the most common cause of levee failures in the region. The State typically spends at least $6 million per year in moderately successful attempts to prevent levee failures resulting from winter storms. High-water conditions could cause about 140 levee failures in the Delta during 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.

The Delta is the heart of California in many respects. Among many things, the Delta is a water supply hub of diverse ecosystems and an indispensable resource. Improving the Delta ecosystem is a legally required condition of providing a reliable water supply and ecosystem restoration. The natural conditions of the watershed and the Delta have been significantly altered during the past 150 years. Reservoirs, river diversions, downstream exports, agricultural development, and land reclamation have significantly altered how water flows through the Delta, changing water quantity, water quality, and flow direction. Future water exports from the Delta are subject to uncertainty and constraints, in particular from such issues as:

- Demands on water supply.
- Entrainment.
- Levees.
- Non-native species.
- Pelagic organism decline.
- Salinity.
- Suspended sediments.
- Subsidence.
- Water quality.

The use of levees to protect Delta land areas has eliminated the dynamic land-water interfaces crucial for aquatic species, and reclamation of land for human needs has greatly reduced habitat for riparian plants and animals. These same levees are necessary to convey fresh water to State and federal water project facilities for export.

More than half of Californians rely on water conveyed through the Delta’s 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 land in the nation is in this watershed, including the southern San Joaquin Valley.

All Delta services could be negatively affected by multiple levee failures, especially from a major earthquake. If a failure lasts long enough or gets large enough to affect water supply, then much larger portions of the state will feel the consequences. While short-term impacts are largely local to the Delta, if Delta facilities are left untended their decline will have local, regional, and statewide effects through loss of water supply benefits and ecosystem loss.

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.

Catastrophic Events and Emergency Response

Planning for catastrophic events and emergency response is critically important because no measure of planning or facility improvements will totally eliminate the chance of major catastrophes. While dams are designed to comply with stringent safety standards and are inspected regularly, maintenance is sometimes required and aging infrastructure may need to be replaced or decommissioned to help manage risk. On the other hand, levees are far more prone to catastrophic failure from a major earthquake, undetected structural deficiencies, or erosion. For example, the failure of a Delta levee could cause further catastrophic impacts by cutting off water supply to many urban and agricultural users for long periods. Effective emergency preparedness and other actions are needed to reduce risks to people, property, and other state interests. Preparedness includes the plans for how agencies will respond during an actual emergency and how they will participate in recovery of areas that may flood. The California Emergency Management Agency (Cal EMA) augments safety and disaster preparedness in California. DWR's emergency response responsibilities are derived from many authorities defined by codes, executive orders, and other documents. Local water and flood agencies, local governments, and federal agencies also have emergency-operations plans and actions.

Emergency response for levees is divided among several different entities, including fire districts, sheriff departments, and police departments. During high water, these local entities direct flood fights, though DWR provides some uniformity. USACE has oversight authority only for those levees that meet its standards. Local entities have responsibility for evacuations. While many agencies currently have emergency operations plans for their own and coordinated activities, many plans do not provide adequate public safety or protection of assets. This is particularly true considering that there is always room for improvement in the planning for catastrophic events resulting from the extreme consequences (e.g., loss of life and high recovery costs) that can occur. When necessary, the State government activates its Standardized Emergency Management System (SEMS), which is the primary component of California's emergency response system. It provides a fundamental structure for the response phase of emergency management. The system unifies all elements of California's emergency management community into a single, integrated system and standardizes key elements.

Data Gathering and Exchange

An increasing population, stressed ecosystems, and California's economic future and its reliance on agriculture, industry, and technology all rely on the state's limited water resources. At the same time, uncertainty in climate change, energy sectors, and other drivers of future change require California to 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. They also improve understanding and ability to communicate flood risks.

Government reports have concluded that a key role for science and technology is to expand options for management and use of water resources. Scientists and water managers must employ

IWM and a systems approach that considers physical, chemical, biological, social, behavioral, and cultural aspects. These require data and analytical tools that are more sophisticated than currently available to water and flood managers. See the further discussion in Chapter 6, “Integrated Data and Analysis: Informed and Transparent Decision-Making,” in this volume.

Disadvantaged Communities

Californians from disadvantaged, small, and underrepresented communities continue to deal with 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 the State planning processes, programs, funding for water allocation, improving water quality, and determining how to mitigate potential adverse impacts on communities associated with proposed water programs and projects (see Volume 4, *Reference Guide*, the article “Environmental Justice in California Government”).

Most water, wastewater, and flood projects are not developed for disadvantaged and under-represented communities, yet these projects have an impact on them. Even projects that convey general public benefit may not benefit EJ communities or DACs proportionally. For example, water conservation programs that depend heavily on toilet and washing machine rebates will have greater impact on middle- and upper-class communities than they will on poorer communities, because those residents purchase such items less frequently and cannot afford the initial outlay for them.

Funding

At a time when water and flood system maintenance and improvement efforts should be increased, investments in water, water quality, and infrastructure have been stressed by budget limitations at local government levels. A survey by DWR and ACWA, regarding local groundwater management, identified adequate funding as the leading challenge toward implementing effective groundwater management and planning. It addition, debt levels in California have been steadily increasing in recent years. Even if funds become available for new capital improvements, a sustainable flow of funding for annual operation and maintenance is often unavailable. Chapter 7, “Finance Planning Framework,” further defines the funding problems and addresses them.

Responses and Opportunities

This section presents a representative sampling of recent achievements and emerging opportunities in California resources management. Only a sampling of State and federal IWM activities can be described, given the large number of those activities occurring in the state. Yet the described activities demonstrate that management agencies are placing more emphasis on IWM. Many more IWM activities by local agencies are also underway.

Stewardship and Sustaining Natural Resources

Preserving California's natural resources is increasingly important and increasingly difficult. Many recent laws dealing with water management (e.g., CWC Section 9616) direct the State to improve the quantity, diversity, and connectivity of natural habitats. Stewardship of water resources involves managing the full complement of natural resources along with water quality and quantity. The directive to preserve and protect nature is broadening the scope of effort for traditional water and flood management agencies. In response, many agencies are turning to partnerships in order to assemble the authorities and expertise needed to effectively manage projects that integrate natural resource protection into infrastructure and services that traditionally have been provided.

With the increasing reliance on partnerships, stewardship is taking on a community focus, bringing together government, the private sector, and non-profit corporations to work in concert toward specific ends. This requires that goals and objectives are clearly stated so that all parties have an understanding of the needs and limitations of water projects. Often groups are formed to focus on specific watersheds or projects and serve as a venue to develop plans, designs, and management approaches. These collaborative approaches can produce integrated management solutions that preserve and enhance the habitats and ecosystems from which the state derives its water resources.

The movement toward more collaborative management and reliance on groups to make key decisions is leading many agencies to develop their own definitions of stewardship and public engagement. For example, DWR has established two new policies based on a new vision that will guide future planning approaches — a Sustainability Policy and an Environmental Stewardship Policy, that latter including a statement of Environmental Stewardship Principles (see Box 3-9) that will guide DWR's work. The new policies establish DWR's approach and business ethic "to create human systems consistent with natural systems, where each is ultimately sustainable" and the "responsibility to protect and restore the environment." Restoring the environment "is the process of reestablishing, to the extent possible, the structure, function and composition of the natural environment."

A concept underlying these new initiatives in sustainability and stewardship is that paying closer attention to how nature works is not just a nice thing to do, but it also makes business sense. These approaches will result in less costly projects over time and will allow the systems to be adaptable to change, lowering the risk and overall costs of damage from extreme events. That, in turn, increases community well-being, decreases demands on public funds, and improves public safety and the quality of California life.

Watershed and Resource Restoration Programs

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. (For more specific information, see http://www.conservation.ca.gov/dlrp/wp/Pages/Index.aspx.) In the same vein, the California Watershed Indicators Council was formed to begin developing a framework for assessing the health of watersheds throughout the state.

Box 3-9 DWR Environmental Stewardship Principles

- **Sustainability** — Incorporate a long-term vision that maintains and improves social, ecological, and economic viability, and meets long-term objectives with minimal maintenance under existing and expected future climate conditions.
- **Early and Integrated Environmental Planning** — Integrate environmental planning and communications internally and with resources agencies and stakeholders to provide project cost savings, increase environmental benefits, and support environmental compliance and permitting early and consistently through the project planning and design phases.
- **Multiple Ecological Benefits** — Integrate environmental planning to provide multiple ecological benefits, such as:
  - Dynamic and more natural hydrologic and geomorphic processes.
  - Habitat quantity, diversity, and connectivity.
  - Increased native and listed species populations.
  - Biotic community diversity.
  - Multiple ecosystem services.
  - Climate change adaptation.
- **Multiple Geographic Scales and Time Frames** — Integrate ecosystem functions at multiple geographic scales (including regional, landscape or river corridor, and local project levels) and over multiple timeframes (near to long term). Consider the need for regional solutions while being sensitive to the environment and specific local conditions.
- **Variety of Approaches** — Use a variety of approaches and analyses for achieving goals and multi-benefit objectives, such as structural and nonstructural approaches for incorporating, maintaining, or restoring systemwide river and landscape ecosystem functions as integrated design parameters for projects.
- **Inclusive Cost-Benefit Analyses** — Identify costs and benefits for the full spectrum of impacts over the entire life of a project, such as:
  - Operations and maintenance.
  - Public safety.
  - Public resources, including environment and agriculture.
  - Systems reliability, for more comprehensive evaluation of project alternatives.
- **Science-based Solutions, Ecological Monitoring, and Adaptive Management** — Use structured monitoring and adaptive management to achieve goals based on the best available science, and continually improve the scientific basis of planning and management decisions. Develop evaluation criteria to document project performance and guide adaptive management decisions.

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. (See http://www.waterboards.ca.gov/

water_issues/hot_topics/20x2020/index.shtml. See also Senate Bill No. 7 [SB X7-7], Statewide Water Conservation, as part of the 2009 Comprehensive Water Package discussed later under the "Recent Legislation" section of this chapter.) Figure 3-30 shows statewide urban water use baseline and 2020 targets.

There are approximately 450 urban water suppliers in California. By the July 2011 deadline for submitting 2010 urban water management plans (UWMPs), more than 290 plans were submitted to DWR for review. Additional plans have been submitted to DWR since 2011. Some water suppliers have coordinated efforts and submitted regional UWMPs. The average baseline water use reported in the 2010 plans was 198 gallons per capita per day (GPCD) and the average 2020 target will be 166 GPCD. The statewide reduction target calculated from the 2010 plans is approximately 16 percent. Urban water suppliers have implemented a menu of best management practices (BMPs) to reduce water use, and as a consequence that water use reduction may affect water supplier revenues.

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.
- Providing grant funding for local water conservation projects.

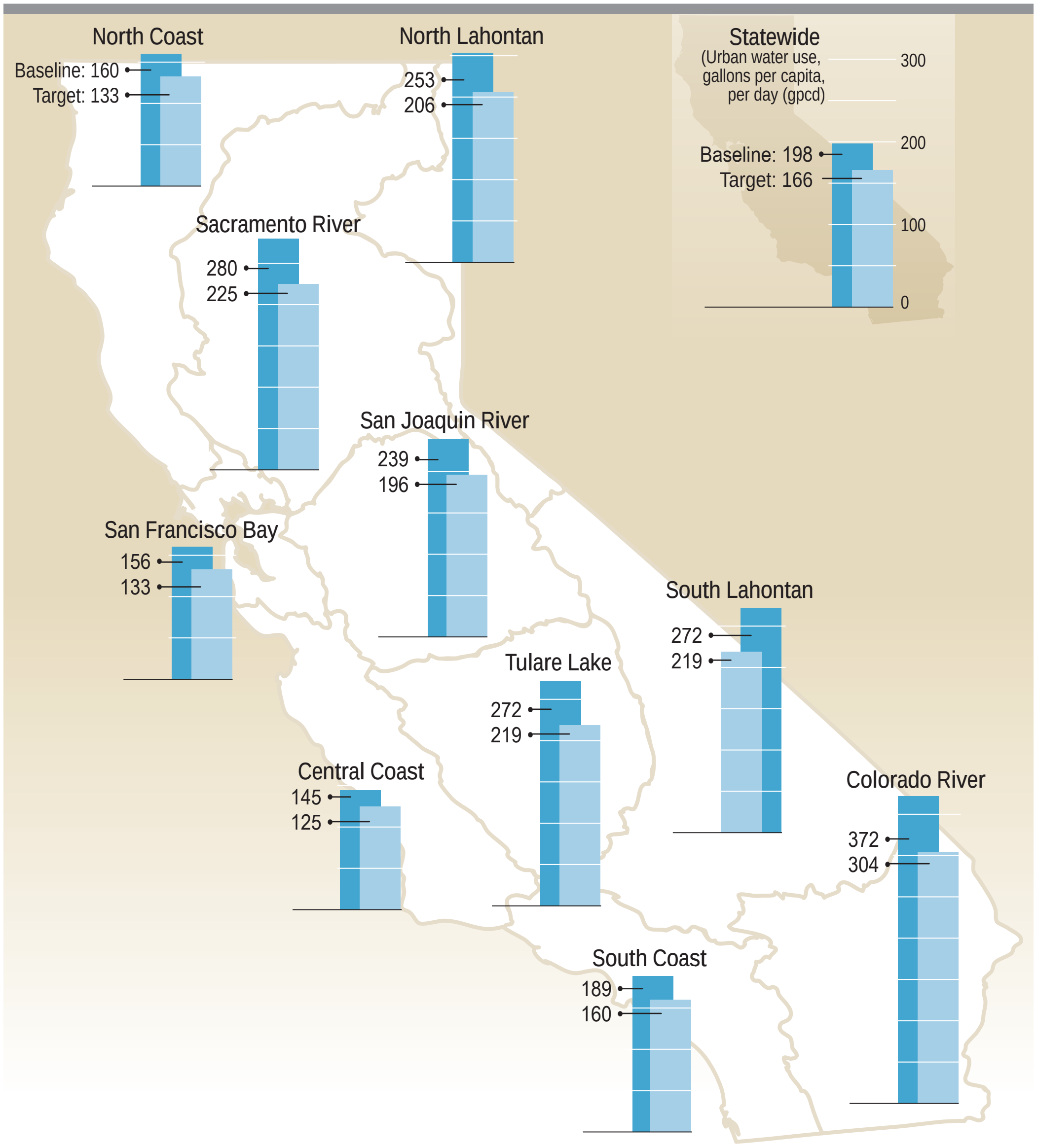
Regional/Local Planning and Management

Water managers have learned that even though imported supplies will continue to be important, they cannot be relied on to satisfy future water demands. Additional imported water supplies will likely not be available to meet increasing future water demands. Starting in the 1970s, concerns about 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 the 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 have been developing local water management programs and projects, such as water conservation, recycling measures, and groundwater storage, to increase regional self-reliance. Water managers increasingly plan for more sustainable water management by implementing actions that address multiple resource objectives (e.g., flood protection, water use efficiency, water quality protection, and environmental stewardship). Water managers must also consider broad needs, such as public safety, economic growth, environmental quality, and social equity.

Using IRWM, regions have been able to take advantage of opportunities that are not always available to individual water suppliers. Some of these opportunities are:

Figure 3-30 Urban Water Use — Baseline and 2020 Targets



Source: California Department of Finance 2006.

- Reducing dependence on imported water and making better use of local supplies.
- Enhancing use of groundwater with greater ability to limit groundwater overdraft.
- Increasing supply reliability and security.
- Improving water quality and reducing flood risk.

Integration of the goals and objectives associated with local urban, agricultural, groundwater, and watershed management plans needs to be incorporated into the local IRWM planning to achieve the maximize efficiencies and implement sustainable water management. The extent to which regions have carried these out has been driven by such considerations as economics, environment, engineering, and institutional capacity.

Stakeholders are working together throughout California 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 become established and continues to increase.

On September 30, 2008, Governor Schwarzenegger signed SB 1 (Statutes of 2008) (http://www.leginfo.ca.gov/pub/07-08/bill/sen/sb_0001-0050/sbx2_1_bill_20080930_chaptered.pdf). SB 1 contains replacement language for the Integrated Regional Water Planning Act of 2002 (CWC Section 10530 et seq.) as well as the first appropriations for the IRWM grant program from Propositions 84 and 1E (see the “Propositions and Bonds” section below).

Water agencies in many regions are successfully employing a mix of resource management strategies, many having State and federal incentives. Experience is showing that these regional efforts can resolve regional needs better, 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; stormwater capture projects; and, in limited cases, regional or local surface storage reservoirs (see Volume 3, *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.

Water Use Efficiency

The Water Conservation Act of 2009 (SB X7-7, CWC Section 10608.48[i]) required DWR to adopt an agricultural water measurement regulation that water suppliers may use to measure water deliveries to their customers. DWR conducted multiple agricultural stakeholder committee meetings and public hearings during 2011 to develop this regulation. The proposed methodology will help evaluate current conditions and plan for strategies for improving agricultural water management. Farmers, water, suppliers, regional water management groups, NGOs, local, State, federal, and tribal planners are potential users of this methodology. The methods are not intended for nonirrigated agriculture, such as dairy farms, on-farm processing, or other agricultural operations that are not part of irrigated land. The California Water Commission adopted this regulation; it received formal approval by the Office of Administrative Law on July 11, 2012, and is in effect.

During 2012, DWR assisted agricultural water suppliers by providing guidance, conducting workshops, and offering financial assistance to help comply with the water management planning requirements. DWR will also provide information on how agricultural water suppliers may meet the requirements of the Agricultural Water Measurement Regulation, how to complete the associated compliance documentation, and how to prepare an Aggregated Farm-Gate Delivery Report. The DWR financial assistance program in 2012 included $15 million in Proposition 50 grants. A proposal solicitation package was released in 2012.

Another benefit of increased water-use efficiency is reduced energy use. According to the CEC, 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 GHG emissions. DWR has funded many water-use efficiency projects. Implementation of 124 agricultural and urban water-use efficiency projects is expected to achieve 190,000 acre-feet per year (af/yr.) of water savings. If this savings are achieved, it will be equivalent to 190,000 million watt-hours per acre-foot (MWh/af) per year and 90,000 metric tons of GHG emissions reduction. This calculation assumes an average energy intensity of 1 MWh/af, or 0.475 metric ton of CO_2 equivalent per 1 MWh.

Coordination of Water and Land Use Planning

Several general plan updates (e.g., Marin County, Solano County) have included local climate action plans that establish local policies to reduce GHG emissions and adapt to the potential effects of climate change. The areas of local government influence and authority for reducing GHG emissions include community energy use, waste reduction and recycling, water and wastewater systems, transportation, and site and building design.

Large water purveyors (supplying 3,000 af/yr. or serving 300 customers) must prepare UWMPs) that evaluate water supplies and demands over a 20-year period and are updated every five years (CWC Section 10610 et seq.).

One of the most effective ways to reduce vulnerability to potential flood damage is through careful land use planning that is fully informed by applicable flood information and flood management practices. Federal, State, and local agencies may construct and operate flood protection facilities to reduce flood risks, but some amount of flood risk will remain for those residing in floodplains. Because some risk remains, increasing flood risk awareness can help ensure that Californians recognize the potential threat of flooding and are better prepared to implement flood management activities.

In 2007, as part of a package of six bills addressing flood risk management and flood protection in California, AB 162 was passed. This bill specifically required additional consideration of flood risk in local land-use planning throughout California and designated DWR as a source for floodplain information and technical data that local governments will need to ensure compliance with the requirements of AB 162.

California's increasing reliance on groundwater resources has also increased interest in protecting groundwater recharge areas from contamination and development. In 2011, California Assembly Bill 359 established new groundwater recharge mapping requirements for agencies conducting groundwater management planning. This bill requires local groundwater management entities to notify and provide local agencies with a copy of the groundwater recharge maps for their groundwater management area. A key goal behind the AB 359 legislation is to improve coordination between land use planners and water resource managers in order to help minimize impervious land use construction in potential aquifer recharge areas, limit land use activities that could lead to aquifer contamination, and dedicate a portion of aquifer recharge areas for active recharge projects.

Delta and Suisun Marsh Planning

State government is involved in a number of major planning efforts to evaluate the Delta and Suisun Marsh ecosystems and water reliability issues. It is essential to achieve the dual goals of restoring the Delta's ecosystem and ensuring a reliable water supply for California. These planning efforts include:

- Bay Delta Conservation Plan (BDCP).
- Delta Plan.
- Delta Risk Management Strategy (DRMS).
- Delta Regional Ecosystem Restoration Implementation Plan.
- Suisun Marsh Plan.

Each program's description is below. These overlapping concurrent efforts are forging strategies and actions that will be comprehensive, cohesive, and will build upon one another to improve the Delta ecosystem and water supply reliability in response to climate change impacts.

In November 2009, the Legislature enacted SB X7-1 (Delta Reform Act). Becoming effective on February 3, 2010, the act:

- Created the Delta Stewardship Council as an independent State agency whose mission is to help achieve the two coequal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta's ecosystem.
- Ensured the DFW and the SWRCB identify the water supply needs of the Delta estuary for use in determining the appropriate water diversion amounts associated with the BDCP.
- Established the Sacramento-San Joaquin Delta Conservancy to implement ecosystem restoration activities within the Delta and restructured the Delta Protection Commission.

Bay Delta Conservation Plan

The BDCP will provide the basis for the issuance of endangered species permits for the operation of the SWP and CVP. The BDCP is a long-term conservation strategy that sets forth actions needed for a healthy Delta, building upon the framework set forth through the CALFED Program and Delta Vision processes. In February 2008, Governor Schwarzenegger directed DWR to proceed with the National Environmental Policy Act/California Environmental Quality Act (NEPA/CEQA) analysis of the alternatives for Delta conveyance. For the BDCP to be incorporated into the Delta Plan and for the public benefits associated with the BDCP to be eligible for State funding, DFW must approve the BDCP as a Natural Community Conservation Plan and determine that the BDCP otherwise meets the requirements of CWC Section 85320.

The BDCP represents a departure from the species-by-species approach used in previous efforts to manage Delta-specific species and habitats. Instead, the BDCP will utilize a holistic, ecosystem approach to improve the health of the Delta's ecological system. The BDCP is being developed in compliance with the federal Endangered Species Act, the California Endangered Species Act, and the California Natural Community Conservation Plan, and will function to achieve the State's coequal goals of protecting and restoring the Delta ecosystem and providing a more reliable water supply for California. The BDCP will:

- Provide for a more reliable water supply for California by modifying conveyance facilities to create a more natural flow pattern.
- Provide a comprehensive restoration program for the Delta.
- Provide the basis for permits under federal and State endangered species laws for activities covered by the plan based on the best available science.

- Identify sources of funding and new methods of decision-making for ecosystem improvements.
- Provide for an adaptive management and monitoring program to enable the plan to adapt as conditions change and new information emerges.
- Streamline permitting for projects covered by the plan.

More information related to the BDCP, including current plan documents, can be found at the BDCP Web site at http://baydeltaconservationplan.com.

Delta Stewardship Council

The Delta Stewardship Council was created by the Delta Reform Act of 2009 to achieve the state-mandated, coequal goals of providing a more reliable water supply for California, as well as to protect, restore, and enhance the Delta ecosystem. Those two goals must be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place. On May 16, 2013, the Council adopted the Delta Plan, California's resource management plan for resolving the Delta's long-standing issues, prepared in consultation with, and to be carried out by, all State agencies, including the SWRCB, DWR, DFW, and the Delta Protection Commission. The Delta Plan and its regulatory requirements must be updated at least every five years. The Delta Plan:

- Increases California's water supply reliability by calling for more regional water supply development and setting a deadline for successful completion of the BDCP, which is intended to improve water conveyance through the Delta and improve habitat for threatened and endangered species.
- Is consistent with the long-standing water rights in California, because it also reduces reliance on the Delta watershed by recommending that all local agencies implement local plans to diversify water supplies, improve efficiency, and plan for drought and interruption of supplies in an inherently volatile system. For those State and local agencies undertaking certain covered actions, the Delta Plan requires a decreased reliance on the Delta for water supply.
- Protects and enhances the Delta ecosystem by identifying and protecting high-priority restoration areas and setting a deadline for the SWRCB to take actions that support the coequal goals by updating flow standards and water quality objectives, including flow objectives, for the major rivers and tributaries of the Delta.
- Protects the Delta as an evolving place by promoting awareness of the Delta and its values, including agriculture, recreation, natural resources, and unique culture, and by requiring the actions of State and local agencies be achieved in a manner that protects these values.
- Improves water quality by prioritizing State and regional actions to deal with high-priority, Delta-specific water quality problems.
- Reduces flood risk by requiring new development in and around the Delta to have adequate flood protection, protects and preserves floodplains, and promotes setback levees to increase habitat and reduce flood damage.
- Sets an example by using the best available science and adaptive management and requires that others do the same so that projects can move forward in a way that is efficient and allows decision-making in uncertain conditions.

Delta Risk Management Strategy

The DRMS evaluates the risks from Delta levee failures and ways to reduce those risks. Preliminary evaluations show that there are substantial levee-failure risks from earthquakes and floods, and these are expected to increase in the future. In Phase 1, DRMS evaluated 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 evaluated strategies and actions that can reduce these risks and potential consequences. Additional information is available at http://www.water.ca.gov/floodsafe/fessro/levees/drms/.

Delta Regional Ecosystem Restoration Implementation Plan

The *Delta Regional Ecosystem Restoration Implementation Plan* identifies restoration opportunities within the Delta and Suisun Marsh ecological restoration zones. It applies the Ecosystem Restoration Program Conservation Strategy to the Delta, refines existing plans, and develops new Delta restoration actions. It also includes a conceptual model, implementation guidance, program tracking, performance evaluation, and adaptive management feedback. Additional information is available at http://www.science.calwater.ca.gov/drerip/drerip_index.html.

The Suisun Marsh Plan

The Suisun Marsh Habitat Management, Preservation, and Restoration Plan (SMP) is a comprehensive 30-year plan designed to address various conflicts regarding use of resources in the Suisun Marsh. The SMP focuses on achieving an acceptable multi-stakeholder approach to habitat conservation by providing the stakeholder coordination and environmental compliance foundation for 5,000-7,000 acres of tidal marsh restoration, managed wetland enhancements, and DWR maintenance and repair activities in the Suisun Marsh. The SMP was prepared in coordination with other related resource planning. The majority of the acres proposed for tidal marsh restoration under the SMP contribute to the recovery of listed endangered species. The plan's tidal restoration will be conducted independently of the Fish Restoration Program Agreement (FRPA) and BDCP. However, FRPA and BDCP tidal restoration projects may use some SMP regulatory documents for their projects, given that they comply with all mitigation measures and BMPs, and coordinate regarding physical and biological monitoring. The environmental impact statement/environmental impact report is available online at http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=781.

Statewide and Interregional Planning and Response

History has shown that solutions to California's water management issues are best planned and carried out on a regional basis. At the same time, State government has led collaborative efforts to find solutions to water issues having broad public benefits, such as protecting and restoring the Delta, Klamath Basin, Salton Sea, Lake Tahoe, and Mono Lake. Statewide and interregional responses to water resource emergencies and management needs are summarized in this subsection, including programs, task forces, reports, water bonds, legislation, and federal programs.

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* (2005), DWR outlined the flood problems that California encounters and offered specific recommendations for administrative action and legislative changes.

Since that time, California has begun the long process to improve flood management systems, which consists of 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.

1. **Reduce Flood Risks.** Reduce risk of flood damage to California communities, which includes loss of life, homes, property, agricultural/rural areas, and critical public infrastructure.

2. **Protect and Enhance Ecosystems.** Improve flood management systems in ways that protect, restore, and, where possible, enhance ecosystems and other public trust resources.

3. **Promote Flood System Resiliency,** Flexibility, and Sustainability. Take actions that improve flood system flexibility and resiliency, such that the system is capable of safely accommodating climate change and potentially larger floods in the future and can rapidly recover from flooding.

4. **Promote Economic Growth.** Provide continuing opportunities for prudent economic development that supports robust regional and statewide economies without creating additional flood risk.

Success of the FloodSAFE program depends on active participation from many key partners, such as Cal EMA, Central Valley Flood Protection Board, DFW, USACE, FEMA, U.S. Fish and Wildlife Service, NOAA, 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.

Major FloodSAFE accomplishments since Update 2009 include both statewide and Central Valley studies and facility/program improvements. The collaborative effort between DWR and USACE produced *California's Flood Future: Recommendations for Managing the State's Flood Risk* in 2013 that evaluates statewide flood risk. The evaluation found that more than 7 million people and $580 billion in assets (i.e., crops, buildings, and public infrastructure) are exposed to flooding hazards. The report presented seven goals with accompanying strategies for making improvements in flood management. DWR completed the *Central Valley Flood Protection Plan* that was adopted by the Central Valley Flood Protection Board in June 2012. DWR is now working toward implementation of major flood management improvements within the Central Valley through two basin-wide feasibility studies — one for the Sacramento River basin and one for the San Joaquin River basin. At the same time, a conservation strategy for ecosystem protections and enhancements is being developed.

DWR has made the following major improvements in its flood management programs:

- Flood system risk assessment, engineering, and feasibility.
- Flood Emergency Response Program.
- Flood management planning.
- Floodplain risk management.
- Flood system operations and maintenance.
- Flood risk reduction projects.

In addition, DWR continues to partner with USACE and local partners to develop projects. There are currently 10 active construction/design projects and 14 feasibility studies related to the State Plan of Flood Control where the State is sharing costs with the USACE. See the *FloodSAFE California 2012 Accomplishments Report* in Volume 4, *Reference Guide,* for more information on FloodSAFE accomplishments.

California Statewide Groundwater Elevation Monitoring Program

Passed in November, 2009, SB X7-6 required statewide collection and publication of groundwater elevations for the first time in California's history. SB X7-6 directs local agencies, with the assistance of DWR, to monitor and report the elevation of their groundwater basins to help manage the resource better during both average water years and drought conditions.

To implement these groundwater monitoring requirements, DWR created the California Statewide Groundwater Elevation Monitoring (CASGEM) Program. The purpose of the CASGEM Program is to establish a permanent, locally managed program of regular and systematic monitoring to track seasonal and long-term trends in groundwater elevations in all of California's 515 alluvial groundwater basins and to make this information readily and easily available to the public. The CASGEM Program relies and builds upon the many established groundwater monitoring and management programs conducted by local entities throughout the state. The establishment of a statewide groundwater elevation monitoring program represents a fundamental step toward the assessment and sustainability California's groundwater resources.

DWR worked cooperatively with local entities to designate the CASGEM Monitoring Entities to review and help develop groundwater elevation monitoring plans and to provide public access to the submitted groundwater elevation and related data. As of December 02, 2013, DWR received monitoring notifications for more than 395 basins and subbasins. DWR has designated 124 Monitoring Entities who are now monitoring and reporting groundwater elevations for 152 basins and subbasins.

DWR established the CASGEM Program Web site (http://www.water.ca.gov/groundwater/casgem/) and an online system for data submission, viewing, and retrieval of this information. The CASGEM Online System allows public access to groundwater elevation data for groundwater basins.

As required by the CWC, DWR submitted the *2012 CASGEM Status Report* to the Legislature and governor, which provided the background of the CASGEM program and described the first two years of its implementation. The report is available on the CASGEM Web site. Subsequent

Table 3-4 CASGEM Program Progress 2009-2012

CASGEM Schedule	DWR Activities	Local Entity Activities
2009	• Legislature passes historic water bills on November 6 including SB X7-6 (CASGEM).	
2010	• Developed program design, initiated outreach, identified project resources, and defined database requirements. • Created CASGEM Web site. • Partnered with Association of California Water Agencies and conducted ten workshops throughout the state. • Worked with local agencies to educate them and encourage program participation. • Solicited public comments. • Finalized reporting requirements, guidelines, and FAQs. • Launched Phase 1 of CASGEM Online System for notifications.	• Local entities attended CASGEM workshops. • Local entities collaborated to identify prospective monitoring entities. • Local entities worked with their boards/organizations for approval to be monitoring entities that notify DWR.
2011	• Testified at Assembly Water, Parks, and Wildlife Committee Oversight Hearing on management of California's groundwater resources. • Released Phase 2 for submitting well information, monitoring plans, and shape files. • Initiated review of notifications for designation of monitoring entities. • Developed CASGEM Online System user manuals for both monitoring entities and public. • Released final Phase 3 of CASGEM Online System that includes groundwater elevation data submissions and allows public access to the system. • Conducted user training sessions for DWR staff and monitoring entities.	• Prospective monitoring entities submitted notifications online to DWR. • Prospective monitoring entities worked with DWR to submit shape files of monitoring areas. • Monitoring entities developed and submitted monitoring network plans to DWR. • Monitoring entities conducted groundwater elevation monitoring.
2012	• Submitted program status report to governor and Legislature. • Started review of alternative groundwater monitoring plans specified in AB 1152. • Continue review of submissions and designation of monitoring entities. • Continue conducting outreach to monitoring entities and public users. • Currently testing basin prioritization system for release to the public in 2012.	• Monitoring entities submitted first CASGEM groundwater elevation data to CASGEM Online System.

Notes:

AB = Assembly Bill, CASGEM = California Statewide Groundwater Elevation Monitoring, DWR = California Department of Water Resources, FAQs = frequently asked questions, SB = Senate Bill reports are required to be submitted every five years, beginning in 2015. Table 3-4 summarizes the progress of the CASGEM program since it began.

CASGEM legislation also requires DWR to identify the current extent of groundwater elevation monitoring within each of the alluvial groundwater basins defined under Bulletin 118-03 and to prioritize those basins to help identify, evaluate, and determine the need for additional groundwater-level monitoring. The basin prioritization process directs DWR to consider, to the extent it exists, all of the following data components:

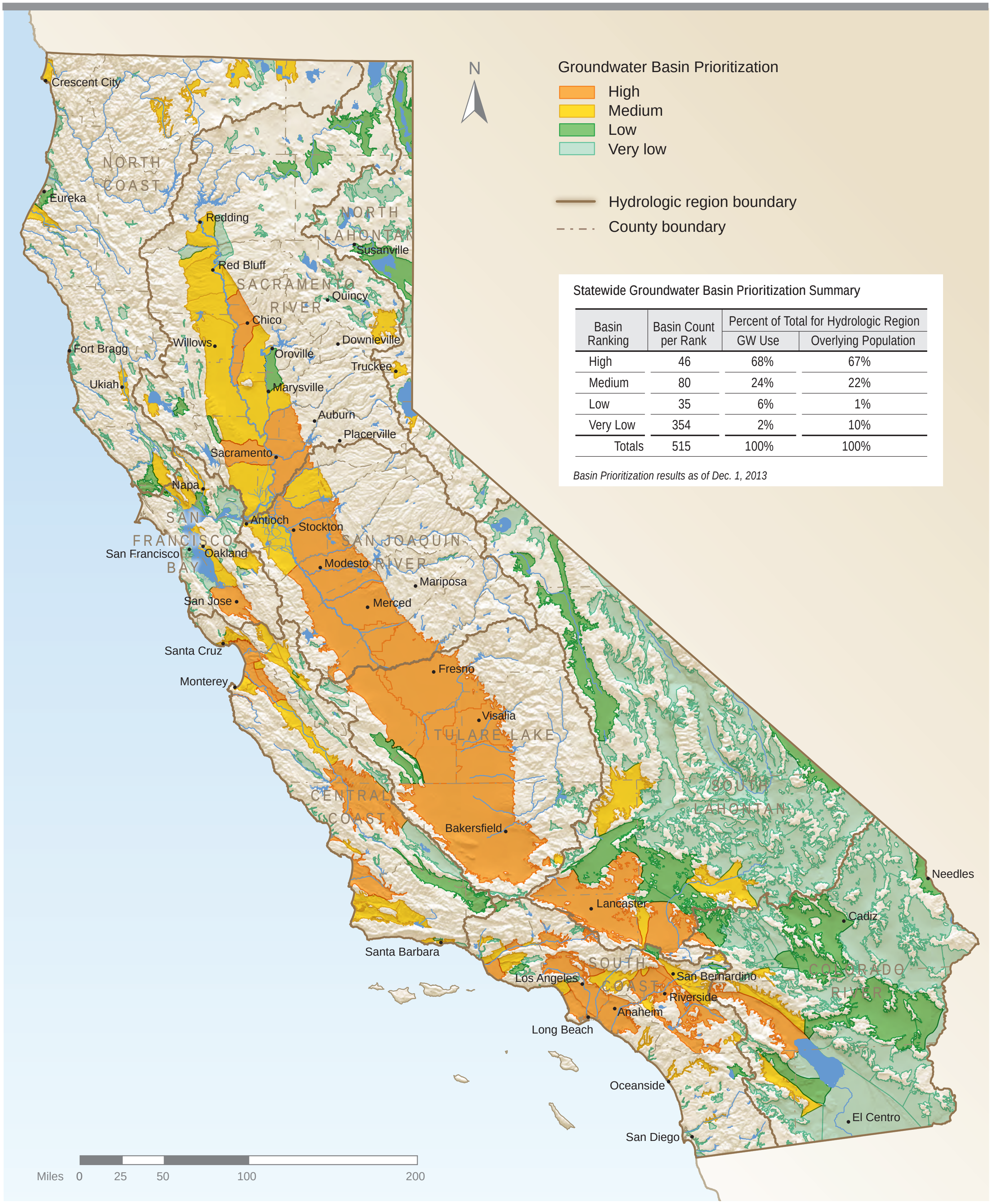
1. The population overlying the basin.
2. The rate of current and projected growth of the population overlying the basin.
3. The number of public supply wells that draw from the basin.
4. The total number of wells that draw from the basin.
5. The irrigated acreage overlying the basin.
6. The degree to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

Using groundwater reliance as the leading indicator of basin priority, DWR evaluated California's 515 groundwater basins identified in Bulletin 118-03 and prioritized them into four categories: High, Medium, Low, and Very Low (California Department of Water Resources 2003). Final basin prioritization results indicate that 43 basins are identified as high priority, 84 basins as medium priority, 27 basins as low priority, and the remaining 361 basins as very low priority. The 127 basins designated as high or medium priority account for 96 percent of the annual groundwater use and 88 percent of the 2010 population overlying the groundwater basin area. CASGEM final basin prioritization results are presented in Figure 3-31. Additional information regarding CASGEM basin prioritization is provided with respect to hydrologic region in Volume 2, *Regional Reports*, and in Volume 4, *Reference Guide*.

As described above, the primary intent of basin prioritization is to assist DWR in implementing the CASGEM Program. Additionally, the comprehensive set of data included in the analysis allows basin prioritization to serve as a valuable statewide tool to help evaluate, focus, and align limited resources to implement effective groundwater management practices and to improve the statewide reliability and sustainability of groundwater resources. Programs that promote implementation of sustainable groundwater resource management would benefit by initially focusing their technical, institutional, and financial assistance on the CASGEM high- and medium-priority basins.

The following summarizes ongoing work and identifies the CASGEM Program's short- and long-term milestones. Meeting these goals will be contingent on funding availability to complete the tasks.

Figure 3-31 **CASGEM Final Basin Prioritization Results**



Statewide Groundwater Basin Prioritization Summary

Basin Ranking	Basin Count per Rank	Percent of Total for Hydrologic Region: GW Use	Percent of Total for Hydrologic Region: Overlying Population
High	46	68%	67%
Medium	80	24%	22%
Low	35	6%	1%
Very Low	354	2%	10%
Totals	515	100%	100%

Basin Prioritization results as of Dec. 1, 2013

Short-Term Activities

- Continue reviewing submittals to designate Monitoring Entities.
- Review reports from agencies seeking designation via alternate monitoring methods as a result of enactment of AB 1152, effective January 1, 2012.
- Prioritize groundwater basins statewide, based on criteria in the CWC.
- Continue with program outreach and expand focus to include public users.
- As staff and funding come available, design and develop additional capabilities and features to include in the CASGEM Online System.

Long-Term Activities

The following long-term activities are necessary to establish an effective permanent program and to analyze the program's results, and their continuance will be contingent on funding availability.

- Continue to work cooperatively with Monitoring Entities and potential Monitoring Entities to build and maintain the CASGEM program statewide.
- Evaluate the extent of statewide groundwater monitoring.
- Conduct groundwater basin assessments for the highest priority groundwater basins. Identify basins that are subject to overdraft based on pumping and recharge patterns.
- Prepare periodic reports of program findings to the governor and the Legislature every five years beginning in 2015.
- Upgrade and integrate the CASGEM Online System with other data sources and systems (e.g., Water Data Library, CWP, and groundwater recharge areas as required by AB 359 [Statutes of 2011]).

Drought Response

Water years 2012 and 2013 were dry statewide, especially in parts of the San Joaquin Valley and Southern California. Water year 2014, which began October 1, 2013, continues this trend. Precipitation in some areas of the state is tracking at about the driest year on record. Calendar year 2013 closed as the driest year in recorded history for many areas of California. On January 17, 2014, Governor Edmund G. Brown, Jr. declared a drought state of emergency and directed State officials to take all necessary actions in response.

Immediately thereafter, DWR announced several actions to protect Californians' health and safety from more severe water shortages. Those actions include dropping the anticipated allocation of water to customers of the SWP from five percent to zero; notifying long-time water rights holders in the Sacramento Valley that they may be cut by 50 percent, depending on future snow survey results; and asking the SWRCB to adjust requirements that hinder conservation of currently stored water. This marks the first zero allocation announcement for all customers of the SWP in the 54-year history of the project.

Governor Brown directed State officials to take all necessary actions to prepare for water shortages. CAL FIRE recently announced it hired additional firefighters to help address the increased fire threat, the DPH identified and offered assistance to communities at risk of severe drinking water shortages, and DFW restricted fishing on some waterways owing to low water flows that have become much worse during the drought. Also in January, the California Natural

Resources Agency (CNRA), Cal/EPA, and the California Department of Food and Agriculture released the *California Water Action Plan*, which will guide State efforts to enhance water supply reliability, restore damaged and destroyed ecosystems, and improve the resilience of our infrastructure.

Governor Brown has asked all Californians to voluntarily reduce their water usage by 20 percent and the Save Our Water campaign has announced four new public service announcements that encourage residents to conserve. In December 2012, the governor formed a Drought Task Force to review expected water allocations and California's preparedness for water scarcity. In May 2013, Governor Brown issued an executive order to direct State water officials to expedite the review and processing of voluntary transfers of water. As of February 2014, there was no end in sight for this extreme drought condition.

In many areas of the state, drought conditions also mean a shift toward greater reliance on groundwater to meet agricultural demands. In 2008 and 2009, the statewide precipitation was 77 percent of the 30-year average. Dry conditions resulted in a 26 percent increase in the statewide agricultural groundwater use from the 2002-2010 average of 12.7 maf, and a 95 percent increase from the 2005 use of 8.2 maf (2005 precipitation was 127 percent of the 30-year average). Regionally, the switch to groundwater was even more staggering. In the Tulare Lake region, the 2009 agricultural groundwater use increased by 38 percent from the 2002-2010 average of 5.8 maf, and by 175 percent from the 2005 use of about 3.0 maf.

The drought-related increase in groundwater demand also resulted in a large increases in well drilling and installation. Installation of large capacity production wells in 2008 and 2009 were the highest since 1991 — another critically dry year.

Efforts to assess impacts associated with the 2008 and 2009 drought-related well drilling and groundwater extraction were hampered by the lack of publically available groundwater-level data, delays in the filing and processing of well completion reports, and the lack of tools necessary to compare changes in groundwater levels and aquifer storage for drought versus normal water-year conditions.

DWR's actions in response to earlier (2009 and 2010) executive orders and emergency proclamations, together with a detailed review of drought impacts, are summarized in *California's Drought of 2007-09, An Overview* (California Department of Water Resources 2010).

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 approximately 74,000 af of water from willing sellers who were primarily water suppliers upstream of the Delta. This water was transferred using SWP or CVP facilities to water suppliers at risk of experiencing water shortages in 2009 due to drought conditions and required supplemental water supplies to meet anticipated demands.

Folsom Lake bed during severe drought, January 26, 2014.

California Water Commission

The California Water Commission advises the director of DWR on matters within the department's jurisdiction, promulgates rules and regulations, and monitors and reports on the construction and operation of the SWP. California's comprehensive water legislation, enacted in 2009, gave the commission new responsibilities regarding the distribution of public funds set aside for the public benefits of water storage projects, and developing regulations for the quantification and management of those benefits.

Strategic Growth Council

In September 2008, SB 732 became law, creating the Strategic Growth Council (SCG). The council is a cabinet-level committee 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.
- Assist State and local entities in the planning of sustainable communities and meeting AB 32 (Global Warming Solutions Act of 2006) goals.

The council is composed of agency secretaries from Business Transportation and Housing, California Health and Human Services, Cal/EPA, the CNRA, the director of the Governor's Office of Planning and Research, and a public member appointed by the governor. The council released its *Strategic Plan Implementation Update* on May 12, 2012 (Strategic Growth Council 2012). (See http://www.sgc.ca.gov/docs/strategicplan-01-24-12.pdf.)

A vital economy, a healthy environment, and a reliable water supply require substantial investments in water management activities. In May 2012, the SGC awarded $45.3 million in local assistance grants that will lead to more sustainable communities. Ninety-three cities, counties, regional and local agencies, and nonprofit partners received grants. Voter-approved Proposition 84 (Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act) bond allocations funded all awards. This is the second round of funding by the SGC. In 2013, the SGC will solicit applications for a third funding round.

Western States Water Council

The Western States Water Council (WSWC) is an organization consisting of representatives appointed by the governors of 18 western states. DWR and SWRCB are WSWC members. The Western Governors' Conference created the WSWC in 1965. Its purposes are:

- Accomplish effective cooperation among western states in the conservation, development, and management of water resources.
- Maintain vital State prerogatives, while identifying ways to accommodate legitimate federal interests.
- Provide a forum for the exchange of views, perspectives, and experiences among member states.

- Provide analysis of federal and State developments to assist member states in evaluating impacts of federal laws and programs and the effectiveness of State laws and policies.

Because the WSWC was created by the governors and because the members serve at their respective governor's pleasure, the Council sees itself as being accountable to the Western Governors' Association (WGA). WSWC members and staff work closely with the WGA staff on water policy issues of concern to the governors. Much of WSWC's work is accomplished under the auspices of its three working committees, which meet three times a year — the Water Resources Committee, the Water Quality Committee, and the Legal Committee.

Adapting to Climate Change

Over the longer term, climate change has the potential to reduce California snowpack storage, increase sea level, and degrade water quality in the estuaries, all of which reduce water supply reliability. In addition, the timing, magnitude, and duration of precipitation and snowmelt runoff in some areas may increase flood risk and reduce seasonal recharge and long-term aquifer storage.

As shown in Figure 3-24, "How Earlier Runoff Affects Water Reliability," climate change impacts occur on many levels. Supply and demand changes will require adaptation by the entire water sector, especially the large-scale delivery systems. California's current water resource infrastructure is already strained to meet competing objectives for water supply, flood control, ecosystem health, water quality, hydropower, and recreation. Climate change places an additional burden on the system of reservoirs, canals, floodplains, and levees. All of these must be modified and managed differently for greater flexibility during exacerbated droughts and floods. Flood systems must also be enhanced to accommodate higher variability of flood flow magnitude and frequency. Also, long-standing issues related to water management, ecosystems, water quality, and public safety in the Delta beg for resolution, as well. 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. Changes in upstream and in-Delta diversions, exports from the Delta, and conveyance through or around the Delta may be needed. A specific example of a broader scale policy effort is the BDCP, which provides an approach that substantially improves resiliency to climate change and provides additional system flexibility.

Since California contains multiple climatic zones, each region of the state will experience a combination of impacts from climate change unique to that area — sea level rise, saltwater intrusion, watershed health, reduced water supply reliability, or increased flood risk. Because economic and environmental effects depend on location, adaptation strategies must be regionally and locally suited. Scientific detail is not yet available for small-scale, localized precipitation and temperature changes. This means that estimates for local and regional water-supply reliability under a changing climate are uncertain. Regions that depend heavily on water imports may need robust strategies to increase regional self-reliance and cope with greater uncertainty in their future supply. Fortunately, water managers in California have multiple tools and institutional capabilities that can limit vulnerability to changing conditions under a wide range of climate scenarios, including conservation, water use efficiency, and conjunctive use. Specifically tailored regional adaptation strategies are set forth in each regional report in Volume 2, *Regional Reports*. In addition, each resource management strategy in Volume 3 includes an assessment of potential to benefit climate change adaptation.

Several guidance materials and studies are available to assist water managers as they prepare to deal with the impacts of climate change. Developed cooperatively by DWR, the U.S. Environmental Protection Agency (EPA), Resources Legacy Fund, and the USACE, the *Climate Change Handbook for Regional Water Planning* provides a framework for considering climate change in water planning (California Department of Water Resources, U.S. Environmental Protection Agency, Resources Legacy Fund, and U.S. Army Corps of Engineers 2011). Key decision considerations, resources, tools, and potential management strategies are presented to guide resource managers and planners as they develop options for adapting their programs to a changing climate. Additionally, DWR has dedicated regional climate-change specialists available to work with local water planners.

The State released the *2012 California Adaptation Planning Guide* (California Emergency Management Agency and California Natural Resources Agency 2012), a step-by-step process for local and regional climate vulnerability assessment and adaptation strategy development, and the Third Assessment Report on climate change, *Our Changing Climate, 2012 Vulnerability & Adaptation to the Increasing Risks from Climate Change in California*, which includes the latest climate change research findings for California (California Climate Change Center 2012). The State has also released the public draft of *Safeguarding California: Reducing Climate Risk, An Update to the 2009 California Climate Adaptation Strategy*, which provides multi-sector strategies for adapting to climate change (California Natural Resources Agency 2013).

The *Assessment of Climate Change in the Southwest United States*, prepared for the National Climate Assessment, can be a valuable resource for water managers (Garfin et al. 2013). Released in 2013, this report provides a comprehensive approach by looking at climate and its effects on scales ranging from states to watersheds and across ecosystems and regions, links between climate and resource supply and demand, effects on the water sector, the vulnerabilities to climate changes, and the responses and preparedness plans that society may choose to make.

The IPCC releases its *Fifth Assessment Report* in 2013 and 2014 on the scientific, technical, and socioeconomic aspects of global climate change, as well as the impacts on specific geographic regions and various resource sectors (Intergovernmental Panel on Climate Change 2013). This will be the most comprehensive assessment of scientific knowledge on climate change since the 2007 IPCC report. This series of reports provides helpful policy guidance regarding climate change adaptation, including scenarios and extreme events, which are of particular interest to water managers.

California Native American Tribes are closely connected to the environment and many tribes continue to depend on natural resources for their food, medicine, ceremonial practices, and customs. Water plays an especially critical role in their culture, spirituality, and livelihoods. Severe weather events affecting water quality and quantity make tribal communities particularly vulnerable to climate change, more so than the general population. In response, California Native American Tribes are including climate change in their considerations of current and future water supply and reliability. Vulnerability assessments and strategies for climate change can include tribal components, the use of tribal ecological knowledge, and planning approaches that tribes may already be considering. Further discussion on incorporating tribal ecological knowledge to adapt to climate change can be found in the 2013 Tribal Water Summit proceedings. Proceedings of this summit are in Volume 4, *Reference Guide*.

Mitigation of Greenhouse Gas

Emissions

California's water sector has a role to play in reducing GHG emissions from its activities, while meeting significant challenges of population growth; power generation; and industrial, residential, and agricultural uses in a changing climate. As shown in Figure 3-28, "Energy Use Related to Water," improvements in water use efficiency and conservation that are focused on specific types of water uses can yield energy savings and thus reduce (mitigate) GHG emissions. Both adaptation and mitigation are needed to manage risks, which are often overlapping, but can be either complementary or conflicting. Coordinating these actions presents a significant challenge for water and energy since there may be unintended consequences if these efforts are not coordinated.

A better understanding of the relationship between water and energy is important for developing sustainable resource management strategies. Policies and management actions across the water and energy sectors should involve development of water and energy efficiency technologies; integrated management strategies; and bridging policy, data, and information gaps between water and energy. Water, energy management, and policy should also address water use issues regarding fossil fuels and biofuels with high water intensity. Scientific and technical research in the water and energy sectors should focus on improvement and development of less costly technologies and procedures for conserving water. Additional baseline data is needed for managing water and energy portfolios in California. Future studies, data collection, and policy also should address water quality and other environmental issues for sustainable natural resources management.

State Legislation, Policies and Related Actions

There is statewide legislation in place related to climate change mitigation and water management. California's Global Warming Solutions Act of 2006 (AB 32) mandated statewide reductions in GHG emissions to 1990 levels by 2020. In 2008, the California Air Resources Board adopted the *AB 32 Climate Change Scoping Plan*, which describes how California will achieve the emissions reductions in all sectors (California Air Resources Board 2008). The plan requires 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 improve public health. The Water Energy Team of the Governor's Climate Action Team (WETCAT) was formed to coordinate State-level water and energy planning, including the water-related measures in the AB 32 Scoping Plan and the Climate Action Team's Research Plan. The next Scoping Plan Update will provide policy and additional future guidance to mitigate climate change through GHG reduction and related measures, including guidance for the water sector.

Additional legislation includes Senate Bill X7-7 (SB X7-7) of 2009, which mandates the reduction of per-capita urban water-use consumption statewide by 20 percent by 2020, and requires agricultural entities to apply efficient water management practices to reduce water demand.

Department of Water Resources Actions

DWR uses and generates large amounts of electrical energy to move water through the SWP, the largest state-run water and power system in the United States. The 700-mile-long SWP moves water from Northern California rivers to the San Francisco Bay Area, Southern California cities, and Central Valley farms. The project provides water to an estimated 25 million Californians and 750,000 acres of irrigated farmland. DWR estimates that its total GHG emissions in 1990 were almost 3.5 million metric tons.

In 2012, DWR adopted its Greenhouse Gas Emissions Reduction Plan (GGERP), part of its Climate Action Plan. The plan dramatically curtails DWR's GHG emissions in the coming decades and describes how the department will reduce GHG releases linked to global warming by 50 percent below 1990 levels within the next seven years. The plan also sets the stage for an 80-percent emissions reduction by 2050. DWR's GGERP will cut annual emissions from operation of the SWP by more than 1 million metric tons of GHGs by 2020, and by more than 2 million tons by 2050. GHG reduction actions outlined in the GGERP include:

- Boosting the proportion of electricity consumed by the SWP that comes from renewable and high-efficiency, natural-gas-fired sources.
- Exploring ways to develop renewable energy on land owned by DWR, such as installing solar panels on land adjacent to pumping plants.
- Terminating a contract with the Reid Gardner coal-fired power plant in Nevada that accounts for approximately 30-50 percent of DWR's operational emissions.
- Increasing the efficiency of pumps and turbines throughout the SWP system with state-of-the-art design, construction, and refurbishing.
- Changing construction practices to minimize fuel consumption and landfill waste.
- Participating in the Sacramento Municipal Utility District's (SMUD's) Greenergy® program, which will ensure that much of DWR's office space in Sacramento is powered by renewable sources.
- Buying carbon offsets from SMUD for its retail natural-gas use, which will fund projects that reduce GHG emissions.

DWR has also taken the following actions in water conservation and water use efficiency, which will assist GHG mitigation:

- Developed a report with methodologies for reducing urban per-capita water use and adopted a regulation for industrial process water, as required by SB X7-7.
- Developed a methodology for calculating the urban water-use target of SB X7-7.
- Developed a regulation for agricultural water measurement and a guidebook to assist agricultural water suppliers in preparing agricultural water management plans; received and reviewed agricultural water management plans to comply with SB X7-7.
- Developed a guidebook to assist urban water suppliers in preparing urban water management plans (UWMPs), received and reviewed UWMPs, and provided a report on the progress toward achieving an urban water-use reduction of 20 percent per capita.

DWR convened a task force consisting of academic experts, urban retail water suppliers, environmental organizations, and commercial, industrial, and institutional water users to develop BMPs for the commercial, institutional and industrial (CII) water sectors. DWR's forthcoming

"CII Task Force Report to the Legislature" (2014) includes recommended BMPs and their technical and financial feasibility to support water use efficiency and water supply sustainability in CII sectors.

DWR also issued Integrated Regional Water Management (IRWM) Grant Program Guidelines that require regional planning agencies and organizations throughout the state to consider the water-energy nexus, as well as climate change, in their IRWM plans (see Chapter 28, "Economic Incentives — Loans, Grants, and Water Pricing," in Volume 3, *Resource Management Strategies*). These plans can include water management actions that reduce energy consumption and associated GHGs by changing systems, facilities, processes, and end uses of water.

Actions from other Agencies and Organizations

The California Public Utilities Commission (CPUC) oversees a portfolio of energy efficiency programs currently administered by the investor-owned energy utilities. The CPUC completed pilot programs for embedded energy in water to assess the potential to achieve meaningful energy efficiency savings in the water sector. The CPUC has also directed energy utilities, local government partners, and others to include the water-energy nexus in energy efficiency programs.

The CEC administered the Public Interest Energy Research Program (PIER), which has a broad mandate to research the environmental effects of energy technology, production, delivery, and use.

The SWRCB has established a team to work on water-climate issues, using grant and loan funds to support sustainable infrastructure (State Water Resources Control Board 2012b).

The EPA regional office established the California Water and Energy Program (CalWEP) to assist water and wastewater utilities in identifying and developing energy and water efficiency, as well as renewable energy projects. Water and energy audits have been conducted for many water and wastewater agencies with assistance from this program.

The California Water and Energy Coalition (CalWEC) was established by local water agencies and energy utilities to develop collaborative approaches for providing a sustainable and cost-effective supply of water and energy.

Other organizations, universities, and NGOs also have their water-energy and climate change initiatives, such as the Pacific Institute; Water in the West at Stanford University; Center for the Water-Energy Efficiency at University of California, Davis; the Alliance for Water Efficiency; and the California Sustainability Alliance.

Energy Intensity of Water

This is the first CWP update to include specific, energy-intensity actions directly related to water management. Each regional report, other than the Sacramento-San Joaquin Delta and Mountain Counties reports, includes estimated regional energy intensity for raw-water extraction and conveyance for primary water sources. (See Figure 3-29, "The Water Energy Connection," in the "Climate Change and the Water-Energy Nexus" section above, and Volume 2, *Regional Reports*, for information on the energy intensity of water supplies for each region.) When making water management choices, the energy intensity of individual supplies should be part of the decision-making process. Portfolio management for water supplies includes utilizing water from various sources, such as the SWP, groundwater, local water projects, and transfers or exchange agreements. For each water source in the portfolio, there are water quality considerations, environmental impacts, energy requirements, reliability concerns, costs, climate change impacts, and other considerations. The energy intensity comparisons in the regional reports provide local planners an estimate of energy requirements for various water types. However, the energy intensity information provided will not have sufficient detail for actual project-level analysis, in most cases, and will not include end-use energy requirements. The information can be used in more detailed evaluations by using such tools as WeSim, which allow water managers to model their water systems and simulate outcomes for energy, GHGs, and other metrics of water supply choices (Cooley et al. 2012). The energy intensity of desalination and recycled water are discussed in Volume 3, *Resource Management Strategies*. In addition, each resource management strategy includes an assessment of its potential impact on energy demand and GHG reduction efforts.

Water Footprint of the Energy Sector

The production of electricity, from fuel extraction to generation, has impacts on both water availability and quality. Water is mainly heated in power plants to produce steam and also for cooling. The water used in energy production can be called the water footprint of the energy sector.

Electric power generation is typically produced through thermoelectric processes by combustion or fission, in which the heat energy or radioactive energy is converted to electrical energy. Water withdrawals in California for thermoelectric power use accounted for 28 percent of the statewide water withdrawals in 2005, which consisted of 12,600 million gallons per day (mgd) of saline water and 50 mgd of fresh water (U.S. Geological Survey 2009). The power industry has engaged in conserving water by using the following four technologies and approaches: (1) dry/hybrid cooling; (2) use of nontraditional water sources; (3) recycle and reuse of water within plants; and (4) combined cycle, photovoltaic, wind, and gas turbine generation.

The future water needs of different types of energy production should be evaluated to identify potential conflicts between energy production and water availability specifically in California. Recent studies of water for energy in the American West assessed water uses in fossil fuels, including coal; oil shale; and water-intensive renewable, such as concentrated thermal solar power and bioenergy (Kenney and Wilkinson 2011). In addition, a future risk of conflicts between electricity production and water availability has been evaluated for the Intermountain West (Cooley et al. 2011). Recent research has assessed the value, related benefits, costs, and tradeoffs of water for electricity in concentrated thermal solar power, and the status and trends of bioenergy production water requirements. *California's Water Footprint* provides the water footprint associated with energy use (Kenney and Wilkinson 2011; Fulton et al. 2012). The trend for energy-related water footprint has increased since 2001, especially ethanol-related water use. However, regional data to assess water footprint for energy production, such as renewable energy in California, is still lacking. Future research and data collection for water uses in the energy sector could support the decision-making process needed to select less water-intensive renewable energy sources. The impacts of the future water supply in the energy sector should also be addressed in State policies and management.

State Water Resources Control Board

The SWRCB adopted its Strategic Plan Update 2008-2012 on September 2, 2008, and published an additional update in February, 2010. This update described completed strategic actions, progress on other strategic actions, strategic actions temporarily on hold, and the SWRCB's focus for 2011. Among the plan's goals are:

- Improving and protecting groundwater quality in high-use basins by 2030.
- Increasing sustainable local water supplies available for meeting existing and future beneficial uses by 1,725,000 af/yr. in excess of 2002 levels by 2015.
- Ensuring adequate flows for fish and wildlife habitat.
- Comprehensively addressing water-quality protection and restoration.

For details, see http://www.waterboards.ca.gov/water_issues/hot_topics/strategic_plan/docs/2010/final_strategic_plan_update_report_062310.pdf.

On June 19, 2012, the SWRCB approved a statewide policy for the operation and maintenance of septic systems or on-site wastewater treatment systems (OWTSs) to minimize the risks to public health and water quality. The policy also recognizes that responsible local agencies can provide the most effective means to manage OWTS on a routine basis. This policy created a statewide framework to guide RWQCBs and local public health agencies. Standards and enforcement authority will remain with local agencies to ensure existing septic systems do not threaten water bodies already identified as polluted. Nitrates and pathogens (bacteria) leaking from improperly designed or maintained septic systems pose a risk to human health and to aquatic wildlife. This policy focuses on problem septic systems that are possibly contaminating either groundwater or surface waters that serve the public. It also establishes a statewide risk-based tiered approach for the regulation and management of OWTS installations and replacements and sets the level of performance and protection expected from OWTS. In particular, the policy requires actions for identified areas with water bodies where it is known that septic systems are contributing to water quality degradation that adversely affects beneficial uses.

The SWRCB also prepared a draft Groundwater Workplan. The draft workplan includes five key elements:

- Sustainable thresholds.
- Water quality and water-level monitoring and assessment.
- Governance structures and management mechanisms.
- Funding.
- Oversight and enforcement.

The document is located at: http://www.swrcb.ca.gov/water_issues/programs/groundwater/workplan.shtml.

Recent Litigation

Information on water litigation since Update 2009 is included in Volume 4, *Reference Guide*.

Recent State Legislation

Hydraulic Fracturing

On September 20, 2013, Governor Brown signed into law SB 4 (Pavley, Chapter 313, Statutes of 2013). SB 4 requires the Division of Oil, Gas, and Geothermal Resources to regulate well stimulation treatments. With the passage of SB 4, the Public Resources Code (PRC) is amended as of January 1, 2014. One new PRC section, 3161, requires operators to provide the written notice certifying compliance with core SB 4 mandates before conducting well stimulation treatments, such as hydraulic fracture stimulation. To implement the legislation, SB 4 permits the California Department of Conservation (DOC) to promulgate both emergency (interim) regulations and permanent regulations. DOC used the emergency regulation process to set up interim rules commencing on January 2, 2014. These interim rules will remain in effect until November 2014, at which time DOC will adopt permanent regulations by using the rulemaking process.

The interim regulations require an operator to submit a signed Interim Well Stimulation Treatment Notice (WST Notice) before commencing a well stimulation treatment. The WST Notice must include detailed information about the fluids to be used, a groundwater monitoring plan, and a water management plan. Copies of an approved WST Notice must be sent to neighboring property owners and tenants, and water well and surface testing must be provided upon request. SB 4 requires the Division of Oil, Gas, and Geothermal Resources to prepare regulations to ensure that well stimulation is done safely and to require detailed public disclosure about the well stimulation.

The interim regulations address important operational requirements, such as the WST Notice, well evaluation, neighbor notification, and storage and handling of fluids.

2009 Water Legislation Package

In the fall of 2009, the Legislature and the administration worked successfully with stakeholders to develop a plan to begin the process of addressing California's growing water and ecosystem challenges. A comprehensive package of legislation was signed into law as part of the Seventh Extraordinary Session on water of the 2009-2010 legislative session. The package represented major steps toward ensuring a reliable water supply for future generations, as well as restoring the Delta and other ecologically sensitive areas.

The package was composed of four policy bills. It established the Delta Stewardship Council, set ambitious water conservation policy, ensured better groundwater monitoring, and provided funding to the RWQCBs for increased enforcement of illegal water diversions. Some information about individual policy bills are listed below. For more information, see 2009 Water Legislation Package Summary in Volume 4, *Reference Guide*.

- **SB 1 Delta Governance/Delta Plan.** Established a framework to achieve the coequal goals of providing a more reliable water supply to California and restoring and enhancing the Delta ecosystem. The coequal goals will be achieved in a manner that protects the unique cultural, recreational, natural resource, and agricultural values of the Delta.

- **SB 6 Groundwater Monitoring.** For the first time in California's history, this act required local agencies to monitor the elevation of their groundwater basins to help manage the resource better during both average water years and drought conditions.
- **SB 7 Statewide Water Conservation.** Created 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 act required agricultural water suppliers to prepare and submit agricultural water management plans to DWR and implement efficient water management practices. The bill also established a statewide goal for urban water agencies to reduce statewide per-capita water consumption 20 percent by 2020 (see the "Water Use Efficiency" section of this chapter).
- **SB 8 Water Diversion and Use/Funding.** Improved 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 appropriated existing bond funds for various activities to benefit the Delta ecosystem, secured the reliability of the state's water supply, and increased SWRCB staff to manage the duties of this statute.

Also, the following bills were chaptered (became law) at the end of the 2012 California legislative session:

- **AB 685 State Water Policy.** Declares it is State policy that everyone has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes. It directs State agencies to consider this policy when revising, adopting, or establishing policies, regulations, and grant criteria when those policies, regulations, and grant criteria are pertinent to the uses of water described in this bill.
- **AB 1750 Rainwater Capture Act of 2012.** Defines key terms relating to rainwater capture and authorizes the installation of rainwater capture systems.
- **AB 1965 Land Use: Flood Protection.** Revises previous provisions included in SB 1278 (see below) related to planning and zoning for flood protection in the Sacramento-San Joaquin Valley.
- **AB 2230 Recycled Water: Car Washes.** Requires specific new car-wash facilities constructed after January 1, 2014, to reuse at least 60 percent of the water or to use recycled water provided by a water supplier for at least 60 percent of its wash and rinse water.
- **SB 71 State Agencies: Reports.** Specific to DWR activities, this bill eliminates various outdated reports relating to the now-defunct CALFED program and the Bay-Delta Authority, quarterly reporting of expenditures from the Electric Power Fund, and an antiquated reporting requirement from DWR and the California Water Commission.
- **SB 200 Delta Levee Maintenance.** Extends until July 1, 2018, the current State cost-share rate for the Delta Levee Maintenance Subventions Program, which is set at up to 75 percent of the costs in excess of $1,000 per levee mile. After that date, the cost-share will revert to 50 percent.
- **SB 1278 Planning and Zoning: Flood Protection: Sacramento-San Joaquin Valley.** Changes existing local flood-protection requirements, extending by one year the time frame under which cities and counties must incorporate flood risk information into their general plans and zoning ordinances. Also requires DWR, before July 2, 2013, to issue specific floodplain maps and data that will assist local agencies in updating their general plans.
- **SB 1495 Sacramento-San Joaquin Delta Reform Act of 2009.** Exempts two types of actions (certain leases as well as routine dredging operations) from review by the Delta

Stewardship Council as "covered actions" under the Delta Plan, as originally provided for by SB X7-1 in 2009.

- **AB 359 Groundwater Management Plans.** The groundwater legislation requires (1) local agencies to expand notification regarding GWMP preparation and development, and to provide a map identifying recharge areas to local agencies, DWR, and other interested persons; (2) DWR to post GWMPs and information regarding local agencies having jurisdiction to develop GWMPs; and (3) a map identifying the recharge areas for the groundwater basin be included in a GWMP for purposes of the State funding requirements.

Strengthening Flood Protection

In October 2007, the governor signed several pieces of legislation aimed at strengthening flood protections in California. The legislative package led to the development of a comprehensive Central Valley Flood Protection Plan, reformed the California State Reclamation Board to improve efficiency, required cities and counties to increase consideration of flood risks when making land use decisions, and created a new standard in flood protection for urban development in the region. Below are some examples of this legislative package. See Volume 4, *Reference Guide*, for an article on more water-related legislation approved in California since Update 2009.

- **AB 162 Land Use: Water Supply.** Required cities and counties to amend the land use element of their general plans to identify those areas subject to flooding, as identified by floodplain mapping prepared by FEMA or DWR. The act also required, 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 stormwater management.
- **SB 5 Central Valley Flood Protection Act.** Required DWR and the Central Valley Flood Protection Board (formerly the California State Reclamation Board) to prepare and adopt a Central Valley Flood Protection Plan by 2012, and established flood protection requirements for local land-use decisions consistent with the Central Valley Protection Plan.

Propositions and Bonds

In recent years, California voters have approved a series of bonds to preserve and improve the state's natural resources. Propositions 12, 13, 40, and 50 made $12.3 billion available 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 for flood management and approximately $1 billion for IRWM, including wastewater recycling, groundwater storage, conservation, and other water management actions.

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.

Some examples of specific projects include the following:

- 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 GO bonds for natural resources purposes. The bond funds continue to enable the State to invest in important projects and programs that improve water quality and drinking water availability, water supply availability, flood risk reduction, habitat conservation, and resource projects for State and local parks and coastal and ocean protection.

These funds have contributed to programs and projects in 18 State departments, boards, and conservancies. Some of these include:

- **Tahoe Conservancy Environmental Improvement Program** — to help preserve the world-renowned clarity of North America's largest alpine lake.
- **CAL FIRE** — to preserve urban forestry and biomass projects to reduce the State's emissions of GHGs.
- **DFW** — to restore the Bay Delta and coastal fisheries.
- **Wildlife Conservation Board** — to preserve and protect forests, wildlife habitat, rangeland, grazing land and grasslands, and oak woodlands.
- **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 California's use of its water resources and for a wide array of expenditures to improve water resources management around the state.
- **SWRCB** — to leverage federal funds for infrastructure investments to prevent pollution of drinking water supplies and for matching grants to local agencies to reduce stormwater contamination of rivers, lakes, and streams.

Proposed Water Bond

A water bond measure was originally certified to be on the State's 2010 ballot. It was removed and placed on the 2012 ballot. The California Legislature, on July 5, 2012, approved a bill to take the measure off the 2012 ballot and put it on the 2014 ballot. Discussions are underway in 2013 regarding what to include in the bond measure.

Federal Government

American Recovery and Reinvestment Act of 2009

Since its initial awards in 2009, the U.S. Department of the Interior (DOI) will continue to fund $1 billion under the American Recovery and Reinvestment Act of 2009 (ARRA) to bolster the nation's water infrastructure, create jobs, and stimulate the economy. Funding criteria consisted of projects that addressed DOI's highest priority mission needs, generated the largest number of jobs in the shortest time, and created lasting value for the public.

California received $336.6 million for the following projects:

- **CALFED — Battle Creek Salmon/Steelhead Restoration Project.** Reestablishes 42 miles of prime salmon and steelhead habitat on Battle Creek, plus an additional 6 miles on its tributaries; reconstructs the Inskip Powerhouse tailrace (discharge outlet); and constructs a bypass to Coleman Canal on South Fork Battle Creek.
- **CALFED — Bay Delta Conservation Plan.** Supports a cost-share study for planning, preliminary engineering, and environmental analysis and documentation for development of the Bay Delta Conservation Plan.
- **Contra Costa Fish Screen — CVP.** Constructs a fish screen to prevent resident and migratory fish, including the threatened delta smelt and the endangered winter-run Chinook salmon, from entering the Contra Costa Canal intake.
- **Emergency Drought Relief.** Facilitates federal water delivery to USBR contractors through water transfers and exchanges, installs groundwater wells to supply water to wildlife refuges, provides water to agricultural and urban contractors, installs rock barriers in the Delta to meet water quality standards during low flows, and installs temporary water lines to save permanent trees and vines.
- **Folsom Dam Safety — Accelerate Construction.** Modifies spillway gate piers to better resist seismic loadings from earthquakes, increasing disaster protection to the Sacramento area.
- **Klamath River Sedimentation Sampling/Analysis.** Quantifies the potential benefits, liabilities, environmental risks, and effects on downstream resources resulting from removal of four hydropower dams, as requested by California, Oregon, and three Native American tribes.
- **Red Bluff Fish Passage — CVP.** Constructs a screened pumping plant to improve fish passage while ensuring continued water deliveries to 150,000 acres of high-value cropland.
- **Trinity River Restoration — CVP.** Includes floodplain lowering/re-contouring, side channel development, gravel augmentation, large woody debris placement, riparian establishment, and other habitat improvements.

- **Delta-Mendota Canal/California Aqueduct Intertie Pumping Plant and Pipeline.** Constructs an intertie connecting the Delta-Mendota Canal and the California Aqueduct to relieve the canal's conveyance limits, allows for maintenance and repair activities, and provides the flexibility to respond to CVP and SWP emergency water operations.

SECURE Water Act

The SECURE Water Act, which became a law in March 2009, authorizes several federal agencies to work with water managers to plan for climate change and the other threats to national water supplies. It also provides funding for programs that will secure water resources for communities, economies, and ecosystems. DOI established the WaterSMART (Sustain and Manage America's Resources for Tomorrow) program in February, 2010, which will be administered by the USBR. Under WaterSMART, all DOI bureaus will work with states, tribes, local governments, and NGOs to achieve a national sustainable water supply. WaterSMART will provide federal leadership and assistance for water use efficiency, as well as integrating water and energy policies to support the sustainable use of all natural resources, and coordinating the water conservation activities of the various DOI offices. WaterSMART grants totaled $32.2 million in 2012. Nonetheless, because of limited funding for WaterSMART, USBR will not award System Optimization Reviews, Climate Analysis Tools, and Advanced Water Treatment grants in FY 2012.

Natural Resources Conservation Service's Water Quality Improvement Initiative

The USDA Natural Resources Conservation Service (NRCS) is awarding $2.5 million to improve water quality in designated high-priority watersheds in California. This program, part of the National Water Quality Initiative (NWQI), provides financial and technical assistance to farmers and ranchers so they will implement conservation practices that stabilize soil and reduce sediments transport and other pollutants. These activities will ultimately help to provide cleaner water for the watersheds' surrounding areas. State and federal agencies and other conservation partners helped NRCS to identify these high-priority watersheds. Those eligible for assistance in California are Calleguas Creek watershed in Ventura County, Garcia River watershed in Mendocino County, and Salt River watershed in Humboldt County.

U.S. Department of Agriculture Offers Natural Disaster Financial Relief from Drought

On June 5, 2012, the U.S. Department of Agriculture designated Alameda, Marin, and Tehama counties as primary natural disaster areas due to losses caused by drought beginning on Oct. 1, 2011. All qualified farmers and ranchers in these designated areas, including contiguous counties (Butte, Plumas, Sonoma, Contra-Costa, San Joaquin, Stanislaus, Glenn, Santa Clara, Trinity, Mendocino, and Shasta), are eligible for Economic Industry Disaster Loans. These low-interest loans for small businesses, small agricultural cooperatives, and certain private nonprofit organizations become available when the Secretary of Agriculture designates areas that suffered substantial economic injury resulting from a physical disaster or an agricultural production disaster. The U.S. Small Business Administration administers these loans.

Proposed Legislation to Regulate Hydraulic Fracturing

The BLM proposed a rule in 2012 to regulate hydraulic fracturing (also known as “fracking”) on public and Native American land. The proposed rule would (1) provide disclosure to the public of chemicals used in hydraulic fracturing on public land and Indian land, (2) strengthen regulations related to well-bore integrity, and (3) address issues related to flowback water. This rule is necessary to provide useful information to the public and to assure that hydraulic fracturing is conducted in a manner that adequately protects the environment. This is the first proposed federal regulation that requires disclosure of the chemicals used in the process. Some of these chemicals could adversely affect water quality and/or potentially cause groundwater pollution.

National Water Quality Portal

The USGS, the EPA, and the National Water Quality Monitoring Council recently developed the Water Quality Portal (WQP). This Web site integrates publicly available water-quality data from the USGS’s National Water Information System and the EPA’s STOrage and RETrieval (STORET) Data Warehouse. The two links contain current and historical data about chemical, physical, and microbiological data from other federal agencies, states, tribes, watershed groups, volunteer groups, and universities. The WQP combines all the data into one Web site: http://www.waterqualitydata.us/.

Clean Water Act Framework

On April 27, 2011, the Obama Administration released a national Clean Water Framework, which recognizes that clean water and healthy watersheds are important to the economy, environment, and communities. This framework emphasizes that partnerships and coordination with states, local communities, stakeholders, and the public are vital to protect public health and water quality and to promote the nation’s energy and economic security. It also updates the draft guidance of the Clean Water Act. The program, which includes the EPA, USACE, USDA, and DOI, features innovative policies, programs, and initiatives that address the nation’s water quality issues.

The program includes:

- Promoting innovative partnerships.
- Enhancing communities and economies by restoring important water bodies, including the California Bay Delta.
- Developing innovations for more water-efficient communities.
- Ensuring clean water to protect public health.
- Enhancing use and enjoyment of recreational and landscape waters.
- Updating the nation’s water policies.
- Making better use of science to solve water problems.

Executive Orders to Improve Collaboration on Planning and Permitting

On March 27, 2012, the Obama Administration issued Executive Order 13604, “Improving Performance of Federal Permitting and Review of Infrastructure Projects.” This is an initiative to modernize the federal permitting and review process to achieve better projects, improve environmental and community outcomes, and shorten decision-making and review timelines for infrastructure projects. It encompasses interagency process innovations essential to the effective review of complex projects, improved coordination with other governmental jurisdictions and stakeholders that may have vital roles, and mechanisms to bring greater transparency and accountability to routine federal permitting decisions.

The initiative has two overarching goals.

- More efficient and effective review of proposed large-scale and complex infrastructure projects that will result in better projects, improved outcomes for communities, and faster permit decision-making and review timelines, including:
  - Setting aggressive permit decision-making and review schedules by June 30, 2012, for nationally or regionally significant projects that demonstrate how the best practices and innovative processes identified in this initiative can improve performance.
  - Assessing implementation of the federal plan annually, including the extent to which its implementation leads to more expeditious reviews, improved projects, and enhanced community and environmental outcomes.
- Transparency, predictability, accountability, and continuous improvement of routine infrastructure permitting and reviews, including:
  - Benchmarking, tracking, and reporting on consistency with published timelines for all major permitting and review processes related to infrastructure projects.
  - Reviewing, updating, and improving timelines and processes annually to reflect continuous improvement.
  - Reporting annually on performance, including any causes for delay.

Delta Islands and Levees Feasibility Study

The Delta Islands and Levees Feasibility Study will inform the USACE and California's efforts to address a variety of critical issues in the Delta, including ecosystem restoration and flood risk management. The draft environmental impact statement outlining the potential impacts of proposed solutions is scheduled to be available for public review and comment in 2013. The array of potential measures and program alternatives will be determined based on information received during the scoping process and other associated studies.

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