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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 to provide 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 through the development of 48 regional planning entities, allocation more than $10 billion of general obligation 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.

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 contained in Update 2013.

## Social Diversity

California has an 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 is various cultures, organizations, and individuals naturally assign different values and priorities to IWM-related assets, services, and benefits. They 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, the sustainability of natural resources, and the general quality and supply of water for human uses. Disparate IWM priorities, practices, and resource consumption rates support and define California's rich social diversity. [NOTE: consider pull quote]

While there is not always a clear distinction, for the purposes of IWM planning, various cultures/communities can be generally defined by either place or by resource dependencies and practices. Update 2013 reflects an objective, equitable opportunity for cultures/communities to be recognized, provide input into the California Water Plan, and benefit from future IWM policies and actions. This is a companion concept to the beneficiary pays principle, which is discussed in Chapters 7 and 8 in this volume.

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 in-stream 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 there is too much water causing floods. Figure 3-1 below provides an example of the magnitude and frequency of variability in California's hydrology.

**PLACEHOLDER Figure 3-1 Feast or Famine**

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

## Climate and Water Availability

The amount and variability of precipitation, as well as temperatures, 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. In general, wet, average, and dry conditions presented for the entire state are not 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/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 is a map of California with major rivers, water conveyance, and storage facilities.

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

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

Generally, during a single dry year or two, surface water and groundwater storage supplies most water deliveries, but dry years result in critically low water reserves. In addition to loss of habitat, the loss of wetlands compared to 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 results in high costs for many users and more groundwater overdraft. 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 2007-09 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. Impacts of the 2007-09 drought are described in the DWR summary report on that event (California Department of Water 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 NOAA Climate Prediction Center's seasonal outlooks, can be used to explore research approaches associated with ISI forecasting, but it is not suitable for decision-making. A single dry year like 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. Figures 3-3, 3-4, and 3-5 illustrate the variability in types of flooding, as well as the spectra of water uses, and ecosystems.

**PLACEHOLDER Figure 3-3 Variable Flood Risk**

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

**PLACEHOLDER Figure 3-4 Types of Water Use**

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

**PLACEHOLDER Figure 3-5 Examples of Water-Dependent Ecosystems**

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

## Hydrologic Regions and Areas

The California Water Plan (CWP) divides California into 10 hydrologic regions corresponding approximately to the state's major water drainage basins (Figure 3-6). 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 3-1About Update 2013 Regional Reports for a description of each hydrologic region and the river basins that they include.

**PLACEHOLDER Figure 3-6 Hydrologic Regions of California, the Sacramento-San Joaquin Delta, and Mountain Counties Area**

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

**PLACEHOLDER Box 3-1 About Update 2013 Regional Reports**

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

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 River Delta (the 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 integrated regional water management (IRWM) groups.

Regions are also appropriate for flood management planning. Flood management planning for watershed regions 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. The *Central Valley Flood Protection Plan* is conducting planning for multiple planning regions within the Sacramento and San Joaquin river basins. Statewide flood management planning will occur for other large watersheds.

## IRWM Planning Regions

The geophysical variability and social diversity described in the next subsection influence selection of IRWM (Integrated Regional Water Management) 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 or modifying IRWM plans. These IRWM planning regions are generally 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.

DWR received 10 RAP submittals from three proposed IRWM regions and seven previously conditionally approved IRWM regions in 2011. DWR reviewed these submittals, released the draft RAP decisions for a public review and comment, and granted final approval of the RAP decisions and IRWM regional boundaries (Figure 3-7). The 48 approved regions will be eligible for the next round of IRWM grant funding, and conditionally approved regions may have restricted eligibility for future funding.

**PLACEHOLDER Figure 3-7 Map of Integrated Regional Water Management Planning Regions**

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

## Land Use and Development Patterns

The distribution, type, and extent of land uses all have a significant effect on virtually every aspect of integrated water management. 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, 1960-2010, 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.

**PLACEHOLDER Table 3-1 California Population Change from 2005 to 2010 by Hydrologic Region**

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

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 (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 levees in California's Central Valley were originally constructed to aid navigation and protect low-value agriculture. Since the late 1800s, more people have moved into the floodplains along with shifts to high-value agriculture. These land use changes now demand more flood protection than can be provided by the existing flood management system. 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 Chapter 24, "Land Use Planning and Management," in Volume 3, *Resource Management Strategi*es) means that less water is needed for landscaping, polluted runoff water is minimized, and there are more opportunities for local and floodplain management strategies.

The Legislature adopted policies and supports programs to further the integration of land use and water management. In spite of 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 SB 375 (Statues of 2008) linking land use and transportation. The required community sustainable plans may benefit water management because of the general preference in 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, since 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 region-specific and region-appropriate in order to be effective and to support both bio- and anthrodiversity.

State government has sought to provide broad policy since the 1960s for regional planning that is sustainable with State regional agencies, such as Tahoe Regional Planning Agency and the California Coastal Commission, but it has more typically 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 through transportation and water grants and limited State resources for technical assistance. The legislative intent through enabling legislation for land use planning to local government, general plans, and more recently AB 857 and SB 375, seeks to integrate sustainable development, resources, and land use.

**PLACEHOLDER Box 3-2 Land Use Jurisdiction**

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

## 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, attenuating flooding 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 Dept. 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 of applied water. The acreage estimate includes irrigated pasture, but excludes unirrigated pasture and rangeland. The 9 million acres estimate includes non-bearing orchard and vineyard acres, and 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 to be about 540,000 acres in 2005 by the

*California Water Plan 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, each having 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 in flood management strategies (see Chapter 23, "Forest Management" in Volume 3, *Resource Management Strategies*).

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

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

## Tribal Lands

California is home to more people of Native American heritage than any other state in the country. 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 those that 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 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 which 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 that 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 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*.

Senate Bill 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 known 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 BLM, the federal government also holds most of the water rights (in volume) in the state, more than 112 million acre-feet of water rights, mainly through the CVP, which yields an annual average delivery of 7 million acre-feet.

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 employs approximately 236,000 personnel and contributes 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 in a project-by-project basis. This lack of systemic planning and management approaches 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 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 integrated water management 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 including traditional or structural flood protection projects, nonstructural measures such as land use practices, and reliance on natural watershed functions to create an integrated flood management system.

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.

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 and 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, nor does it 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 with excessive precipitation, agricultural and urban landscape (outdoor) water demands are lower due to the high amount of rainfall that 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 the very dry water years, demands for water are reduced as a result of urban and agriculture water conservation practices and because the available surface water supplies is at less-than-average levels for use.

An indicator of California's hydrology and the annual surface water supplies is the amount of water that flows into 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 Figure 3-8 and Figure 3-9, these two river 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 that are available to many agricultural and urban regions of the state.

**PLACEHOLDER Figure 3-8 Sacramento Four Rivers Unimpaired Runoff, 1906-2012**

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

**PLACEHOLDER Figure 3-9 San Joaquin Four Rivers Unimpaired Runoff, 1906-2012**

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

## 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 million acre-feet on average, which becomes snowmelt, which ultimately feeds and replenishes the surface water reservoirs. A projected reduction in this snowpack due to climate change will have a severe impact on California water management (see Climate Change subsection under Critical Challenges).

Water year 2012 was another dry year for California. Figure 3-10 shows statewide runoff in percentage 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.

**PLACEHOLDER Figure 3-10 Total Statewide Runoff and Key Reservoir Storage, End of Water Years 2006-2012**

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

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 and the federal Central Valley Project depending on the water year type. These export pumping restrictions continue to have a significant impact on water supply, most recently in February 2013.

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 dependence on unreliable water sources, which commonly are groundwater in fractured rock or small 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 are difficult. 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.

As surface water supplies continue to decrease due 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 (Box 3-4 Groundwater Overdraft) or naturally occurring contaminants. Management of groundwater resources is more complex than management of surface water resources because groundwater is not visible. The quality of water in private wells is unregulated and, thus, private well owners are often unaware of the potential water quality threats in their drinking water.

**PLACEHOLDER Box 3-4 Groundwater Overdraft**

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

## State Water Project Deliveries

Initial SWP deliveries in 2012 were only 60 percent of contractual amount, although 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 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.

The total water year 2012 deliveries for the CVP are estimated at ?? million acre-feet. Historically, the CVP annually supplies about seven million acre-feet of water for agriculture, cities, and the environment.

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 due to 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 California's State Water Project, 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 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:

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

The report is available 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 seven million acre-feet 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 1 million households (U.S. Bureau of Reclamation 2009). The total water year 2012 deliveries for the CVP are estimated at 5.7 million acre-feet. 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

Prior to 2003, California's annual use of Colorado River water ranged from 4.5 million to 5.2 million acre-feet. In recent years, Arizona has begun 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 million acre-feet in average years. A record eight-year drought in the Colorado River basin has reduced current reservoir storage throughout the river system to just over 50 percent of total storage capacity.

### Local Water Supplies

Local water supplies are highly variable throughout the state. Local agencies use some of the water supplies listed in the above subsections 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 2005. Data for years 1998, 2000, and 2001 were presented in Update 2005. For Update 2009, the same data structure and water portfolio concepts have been used to assemble and present statewide information for the additional years (see Box 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.

**PLACEHOLDER Box 3-5 Water Portfolio Concept and Key Definitions**

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

Statewide balances are available for 10 years, 2001-2010 (Figure 3-11, "California Water Balance by Year, 2001-2010," and Table 3-2, "California Water Balance Summary, 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.

**PLACEHOLDER Table 3-2 California Water Balance Summary, 2001-2010**

**(Numbers in Million Acre-Feet)**

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

**PLACEHOLDER Figure 3-11 California Water Balance by Year, 2001-2010**

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

**PLACEHOLDER Figure 3-12 Water Balance by Region for Water Year 2010**

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

The statewide water balance, Figure 3-11, demonstrates the state's variability for water use and water supply. Water use shows how applied water was used by urban and agricultural sectors and dedicated to the environment and water supply shows where the water came from each year to meet those uses.

California, in an average water year like 2010, receives nearly 200 million acre-feet of water from precipitation and imports from Colorado, Oregon, and Mexico. Approximately 50 to 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, and salt sinks like saline groundwater aquifers and the Salton Sea. The remaining 40 to 50 percent, identified as dedicated or developed water supplies, as shown in the Figure 3-11 and Table 3-2, is distributed among urban and agricultural uses for protecting and restoring the environment, or as storage in surface water and groundwater reservoirs for later use. In any year, some of the dedicated supply includes water that is used multiple times (reused water) and water that is held in storage from previous years. Ultimately, about 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 summary provide regional data. Comparing them to the statewide figure helps to understand how individual regions compare to the statewide distribution. Figure 3-13 depicts water balances 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 3-14

shows inflows and outflows between California's hydrologic regions using data from current base year 2010, an average water year.

**Figure 3-13 Water Balances for the Hydrologic Regions for Year 2010**

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

**PLACEHOLDER Figure 3-14 Regional Inflows and Outflows, Water Year 2010**

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

## Water Quality

Because California's population is more than 38 million, which continues to increase 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 State Water Resources Control Board and the nine Regional Water Quality Control Boards, under the umbrella of the California Environmental Protection Agency, are responsible for protecting California's water resources. The Department of Public Health is responsible to ensure 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 which is evident as described 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 Website (http://www.mywaterquality.ca.gov/), asks, "Are our aquatic ecosystems healthy?" and answers it by including 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 are in the Central Valley and Chaparral regions which are the foothills of the Sierra Nevada and Coast Ranges (Ode, Kincaid, et al. 2011).

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

**PLACEHOLDER Table 3-3 State Water Quality Database Web sites**

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

## Project Operation and Reoperation

California depends on vast statewide water management systems to provide clean and reliable water supplies, protect lives and property from floods, withstand drought, and sustain environmental values. These water management systems include physical facilities and their operational policies and regulations. These 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 might depend 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 more 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 controls 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, 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 independently managed. 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 which 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 many years passed, new laws and court decisions about water having an 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 State Water Resources Control Board manages water rights and water quality through regulation. The California Department of Public Health'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-mandated coequal goals for the Delta by providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem.

DWR formally recognized the multiple levels of water-related interests and mandates by establishing the California Water Plan'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 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, California Farm Bureau Federation, and 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.

**PLACEHOLDER Box 3-6 Current Conflicts over California's Water**

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

## 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, and other cultural practices associated with tribal lands and uses. The many needs of California's 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. See 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.

Placeholder bullets for a few short paragraphs discussing:

- Collaboration of comments received from the 2013 Tribal Water Summit
  - The 2013 2nd Statewide Tribal Water Summit, with the theme "We All Come from the Same Water," held on April 24 -25, 2013 in Sacramento.
- Traditional Ecological Knowledge
- Indigenous right to clean water, access, cultural practices, etc.
- Watershed and land management

Outreach and coordination between tribes and agencies

## 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 3-15 summarizes the key events from the 1850s to the present. The history of IWM financing is divided into five historical periods including the Reclamation, Federal, Infrastructure, Environmental and Public Trust, and Bond periods. Each of these periods relied on a different water management financing strategy which, when taken with the discussion in the previous section, outlines the history of water management in California.

**PLACEHOLDER Figure 3-15 Key Events and Historical Spending, 1850s – present**

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

### 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 management in the future. Innovative financing alternatives may warrant further consideration. Particular attention is paid to water bonds 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/bi-monthly 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. G.O. 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 into improving water management for their operations. In some cases, donations from non-government organizations 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 like unsecured business loan and longer term debt like G.O. bonds. It is important to note that the spending data, summarized in following subsections, does not capture the cost of borrowing. Furthermore, spending source categories may appear to overcomplicate the essentially two main revenue sources – taxes or fees – regardless of funding construct. Debt service costs for G.O. bonds are summarized in this subsection.

### State Bonds

This subsection 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 G.O. bond debt, including schools and other infrastructure, in order 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 G.O. bond financing of water projects and this is increasing as a portion of total G.O. 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 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.

Although State G.O. bonds have become an important source of water and flood management funding, they are available only at discrete times due 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 due to Propositions 1E and 84. Current G.O. bonds are expected to be fully allocated by the year 2018.

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 integrated management.

Very little of the total State IWM funding allows discretion or flexibility. Bond and legislative language designates funding purposes. G.O. 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 expenditures, averaging $18 billion per year, followed 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 have a one-time increase for shovel-ready projects due to the passage of American Recovery and Reinvestment Act (ARRA).

Chapter 7, “Finance Planning Framework” in 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 a unique characteristics and costs.
- Currently authorized G.O. bonds and federal funding comprised two-thirds of total IWM State spending in fiscal year 2011/2012. Current G.O. 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.
- 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 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, and reduced water supplies exacerbate the effects of drought periods. Climate change is reducing snowpack storage and increasing floods. Court decisions and new regulations have resulted in the reduction of Delta water deliveries by 20 to 30 percent (NOTE Need Citation). 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 underground and surface waters 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.

**PLACEHOLDER Box 3-7 The Diamond-Water Paradox**

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

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, and 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 impact water bodies, but compared to other sources, pollution from these point-source discharges has been largely controlled. Discharges from agricultural lands, including irrigation return flow, flows from tile drains, and 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 the 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 due to 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. In order to make informed decisions on streamflow timing and to improve water quality and the health of streams, California needs to 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 pretreated. 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

Due to 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. 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 this resource can maintain its multiple beneficial uses.

The California Department of Public Health 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 human-made and/or naturally occurring pollutants. The State Water Resources Control Board estimates that 682 communities serving more than 21 million people use at least one contaminated groundwater well for their supply source (State Water Resources Control Board 2012) (see http://www.waterboards.ca.gov/gama/ab2222/docs/cmntes_rely_gw.pdf). As a result, these communities incur significant additional costs to remove groundwater contaminants for 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 that are the focus of environmental justice concerns (State Water Resources Control Board 2012).

## Multi-year Dry Periods (Drought)

Impacts of drought are typically felt first by those most reliant on annual rainfall – ranchers engaged in dryland grazing, rural residents relying on wells in low yield rock formations, or small water systems lacking a reliable source. Drought impacts increase with the length of a drought as carry-over supplies in reservoirs are depleted and water levels in groundwater basins decline (see Figure 3-16) Potential Impacts of Continuing Drought).

**PLACEHOLDER Figure 3-16 Potential Impacts of Continuing Drought**

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

Climate change could extend and make California's drought periods worse. Warming temperatures and changes in rainfall and runoff patterns may exacerbate the frequency and intensity of droughts. Regions that rely heavily upon surface water (rivers, streams, and lakes) could be particularly affected as runoff becomes more variable and more demand is placed on groundwater. Combined with urbanization that is 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 upon its groundwater to supplement other depleted supplies. Moreover, groundwater resources will not be immune to climate change. In fact, historical patterns of groundwater recharge may change considerably because of climate change. Because climate change may exacerbate droughts, more efficient groundwater basin management will be necessary to avoid additional groundwater overdraft and to take advantage of opportunities to store water underground and eliminate existing overdraft. For some localities whose aquifers are contaminated, the option of using groundwater for conjunctive use can be limited or would require remediation of the aquifer before being used for such purpose.

While desalination is currently a small contributor to the water supply, it is a potential new source of water supply and has been looked at for short-term supplies during droughts. A more in-depth discussion of desalination is in Chapter 10, "Desalination – Brackish and Sea Water," Volume 3, *Resource Management Strategies*.

## Floods and Flooding

The need for flood management improvements is more critical now than ever before. Over the years, major storms and flooding have taken many lives, caused significant property losses, and resulted in extensive damage to public infrastructure. However, a combination of recent factors has put public safety and the financial stability of State government at risk. California's flood protection system, composed of aging infrastructure with major design deficiencies, has been further weakened by deferred maintenance caused by funding shortfalls and regulatory obstacles. Escalating development in floodplains has increased the potential for loss of life and flood damage to homes, businesses, and communities.

Every region of the state must deal with flood risk. At least one flood disaster has been declared in every county. 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.

### PLACEHOLDER Box 3-8 Understanding Hydrologic Changes over Time

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

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. Further, 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.

Due to lack of funding and environmental concerns, both the State and local agencies in all regions of California have found it increasingly difficult to carry out adequate maintenance programs using established methods. Habitat can be negatively impacted by levee maintenance. Environmental regulations require that local and State agencies develop new approaches to deal with the backlog of maintenance activities. The time and resources needed to complete environmental permitting processes could delay prompt 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 of the Sierra Nevada watersheds to contribute to peak storm runoff. High-frequency flood events (e.g., 10-year and larger floods) in particular may increase with changing climate. Along with changes in the amount of the snowpack and accelerated snowmelt, scientists project greater storm intensity, resulting in more direct runoff and flooding, which is exacerbated in urban areas by impervious land surfaces such as asphalt and traditional impervious concrete. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As streamflows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildland fires due to climate change, there is, in turn, a potential for more floods following fire, which will increase sediment loads and degrade water quality.

## Environment/Ecosystem

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

As an example, nearly all California waterways are controlled to reduce the natural seasonal variation in flow. Larger rivers are impounded to capture water from winter runoff and spring snowmelt and release it 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. 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. Exotics have become prevalent, often because they are better able to use the greater or more stable summer moisture and flow levels than the drought-adapted natives (see 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 meaning operating 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. Including 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 had levees built to retain them, they have been drained, or both have occurred. 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 of 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. 100 years of fire suppression has produced unusually dense stands of small trees that are much more susceptible to combustion during wildfires than larger, old-growth trees. They provide uncharacteristically large fuel loads that cause large and severe wildfires. The result is that huge 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 will melt the Sierra snowpack earlier and drive the snowline higher, resulting in less snowpack to supply water to California users and the environment. Intense rainfall events will continue to affect the state, with more frequent and/or more extensive flooding. Droughts are likely to become more frequent and persistent this century. Storms and snowmelt may coincide and produce higher winter runoff, while accelerating sea-level rise will produce higher storm surges during coastal storms. Rising sea levels increase susceptibility to coastal and estuarine flooding. Together, higher winter runoff and sea level rise will increase the probability of levee failures in the Sacramento-San Joaquin Delta and other coastal areas. Sea level rise will also place additional constraints on management and water exports from the Sacramento-San Joaquin Delta.

### 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 to 2o F (0.6 to 1.1 $^{o}$C) in mean temperature in the past century. Both minimum and maximum annual temperatures have increased, but the minimum temperatures [+1.5 to 2.5 $^{o}$F (0.9 to 1.4 $^{o}$C)] have increased more than maximums [+0.4 to 1.6 $^{o}$F (0.2 to 0.9 $^{o}$C)]. Future projections of temperatures across California are being modeled using ever-advancing techniques known as downscaling, which allow scientists to refine 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 $^{o}$F (1.9 to 2.7 $^{o}$C) higher across the state than they were in the period 1985-94. Seasonal trends indicate a greater increase in the summer months [4.1 to 6.5 $^{o}$F (2.3 to 3.6 $^{o}$C)] than in winter months [2.7 to 3.6 $^{o}$F (1.5 to 2.0 $^{o}$C)] by 2070 (for regional observational and projected temperature trends, see *Regional Reports*, Volume 2).

To assess hydrologic impacts, it is important to look at the precipitation record in addition to the temperature record. Changes in precipitation across California, either in form (rain instead of snow), timing, or total amount result in changes in runoff volume and timing, which affect water supply availability. Over recent decades, there has been a trend 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 3-17 Rain/Snow Historical Trends and "Estimating Historical California Precipitation Phase Trends Using Available Gridded Precipitation, Precipitation Phase, and Elevation Data," for more on background and methodology, Volume 4, *References*).

**PLACEHOLDER Figure 3-17 Rain/Snow Historical Trends**

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

Additional changes can be seen in the hydrologic record. Snowmelt provides an annual average of 15 million acre-feet 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 upon, a system based on historical hydrology, but managing to historical trends will no longer work. Peak flows along major California Rivers have shown an increasing trend in the 20th century.

**PLACEHOLDER Figure 3-18 Rivers: Sacramento, Feather, and American River Runoff Historical Annual Maximum Three-day Flow [**

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

Climate change is anticipated to bring warmer storms that result in less snowfall at lower elevations, reducing the total snowpack and shifting the timing of associated runoff. Based upon historical data and modeling, researchers at Scripps Institution of Oceanography project that by the end of this century, the Sierra snowpack will experience a 48 to 65 percent loss from its average at the end of the previous century (see Figure 3-19, "Snowpack Projections Historical and Projected Decreasing California Snowpack"). Due to the relatively lower elevation of the northern Sierra, more snowpack reduction is likely in the northern Sierra than in the southern Sierra.

**PLACEHOLDER Figure 3-19 Snowpack Projections - Historical and Projected Decreasing California Snowpack**

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

As the atmosphere warms, the associated runoff into reservoirs will shift from spring to winter months, earlier than the current timing. One study that has bearing on all major water export systems is a simulation of the State Water Project. Increasing temperatures were simulated in the Feather River Basin to gauge the sensitivity of the SWP using a rainfall runoff model (Figure 3-20 SWP Impacts (from BDO) 6-month Average Inflow Change into Oroville Relative to Historical). 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. 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.

**PLACEHOLDER Figure 3-20 Climate Change Impacts on State Water Project Inflow to Oroville**

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

Climate model projections yield other disturbing indications. Disparity in precipitation amounts across the various parts of the state will be even greater in the future. Projections are not all in agreement, but a

majority of them project drier conditions in the southern part of California and nearly all indicate warmer winter precipitation throughout the state, including California's mountainous catchments. Intense rainfall events and rapid snowmelt will also reduce the region's water supply by making water more difficult to capture in reservoirs or retain for groundwater recharge. Recreation and tourism in the region are also likely to suffer due to 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. 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 using a range of climate scenarios indicate the dual impact of this geography and higher temperatures. As California's climate warms over 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% to 150% of historical magnitudes. Recent computer downscaling techniques also indicate that California flood risks from warm-wet, atmospheric river type storms may increase beyond those that we have known historically, mostly in the form of occasional more-extreme-than-historical storm seasons (see *Regional Reports*, Volume 2).

There also will be impacts to agriculture due 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 the degree of cooling that occurs at night. The implications for crops depend on type, and there may be some positive impacts to 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 occur due to 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 of time. Projections for precipitation are less certain, but indicate that patterns will also become more variable. Irrigation can alleviate some climate stresses (altered temperature or precipitation), but during reduced water supply, additional irrigation water might not be available.

Climate change is also expected to impact 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 that is needed for the irrigation of certain crops, urban landscaping, and environmental needs. Warmer temperatures will also increase evaporation from reservoirs, lakes and rivers. 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 non-irrigated rangeland, and recreation. Additionally, water demand shifts may occur due to human population changes in response to climate change itself.

For additional discussion on the indications of climate change, see the California Environmental Protection Agency report *Indicators of Climate Change in California*.

Figure 3-21, How Earlier Runoff Effects Water Availability, shows conceptually how the hydrologic changes described above place additional stress on water supply systems, increasing the volume of runoff

that arrives at reservoirs during the flood protection season and reducing the water in storage available to meet summer time peaks in water demand at the same time as higher temperatures are increasing demand for water. This schematic 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, please see the Responses and Opportunities section of this chapter.

**PLACEHOLDER Figure 3-21 How Earlier Runoff Effects Water Availability**

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

## Sea Level Rise

A warming climate causes sea level to rise by warming the oceans, which causes the water to expand, and the melting of land ice, which transfers water to the ocean. Recent satellite data shows that the rate of sea-level rise is accelerating, with melting of land ice now the largest component of global sea-level rise (about 65%), largely because ice loss rates are increasing. The impacts to California's coast, infrastructure, and water management will be substantial, based on global and local projections.

For the Earth as a whole, tide gages and satellite altimetry show that global sea level has risen about seven inches in the 20$^{th}$ century. Figure 3-22 connects the historic sea-level rise trend and a set of projections to 2100 from the National Academy of Sciences. Although various methods of projecting future global sea level yield a range of values by the end of the century, the trend toward higher sea level in the future is well accepted by the scientific community.

**PLACEHOLDER Figure 3-22 Sea Level Rise Global, Historic, and Projected**

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

Sea-level rise is uneven; specifically along the California coast 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. Over the last century, sea level at the Golden Gate Bridge in San Francisco has shown a seven inch rise. The NAS report estimates sea level rise (SLR) along the California coast south of Cape Mendocino at 2 to 12" (4 to 30cm) by 2030, 5 to 24" (12 to 61 cm) by 2050, and 17 to 66" (42 to 167cm) by 2100, relative to 2000 levels (Figure 3-23). Areas north of Cape Mendocino, including the States of Washington and Oregon anticipate lesser rise, or possibly a fall in sea level in early projection years, due 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 SLR relative to the land surface.

**PLACEHOLDER Figure 3-23 Sea Level Rise CA Study Bars**

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

The west coast sea-level rise estimates made by NAS are substantially higher than projections made by the United Nation's Intergovernmental Panel on Climate Change (IPCC) in 2007 because the NAS projections include additional data and research that were not available to the IPCC authors in 2007 and because the NAS included locally important information such as tectonic movement. 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 implications for California based on the global and west coast projections described above 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 storminess does not increase in the future, sea-level rise itself will magnify the adverse impact of any storm surge and high waves on the California coast. Some observational studies report that the largest waves are already getting higher and winds are getting stronger, but data records are not long enough to confirm whether these are long-term trends.

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 that are 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 will be affected due to saltwater intrusion caused by sea level rise. An increase in the penetration of seawater into the Delta will further degrade drinking and agricultural water quality and alter ecosystem conditions. Sea level rise may also affect drinking water supplies for coastal communities due to the intrusion of seawater into overdrafted coastal aquifers.

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.

### Climate Change and the Water-Energy Nexus

Water and energy have a complex relationship with multiple interdependencies. This water-energy relationship is often called the water-energy nexus.

Energy is used throughout the water sector to extract, convey, treat, distribute, and heat water. The amount of energy used or embedded in water is known as the water's energy intensity. 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. Studies by the California Energy Commission (CEC) and the California Public Utilities Commission (CPUC) concluded that water systems and users in California accounted for about 20 percent of statewide electricity consumption. Between 60 and 75 percent of this electricity consumption is by water end-users including water heating and cooling, advanced treatment by industrial users, and onsite pumping and pressurization for irrigation and other purposes. The other 25-40 percent of

water sector electricity consumption occurs in water and wastewater system operations including water extraction, conveyance, treatment, distribution, wastewater collection, and wastewater treatment. Most electricity generation results in Greenhouse Gas (GHG) emissions related to climate change. Reducing energy intensity in any consumption area reduces total GHG emissions in the water sector. This is known as 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, as the working fluid for hydropower, the working fluid and cooling in thermal generation systems, and water used for irrigating biofuels. Water requirements for energy systems are highly variable and depend on many factors. A considerable amount of water is used for cooling thermoelectric power plants, agricultural production of biofuels, and extracting oil and natural gas. Environmental impacts from energy production have been evaluated for multiple relationships, including water-intensive renewable energy; water uses and related environmental impacts from oil shale development; and water pollution and environment effects from energy development involving increased sedimentation, and the release of chemicals used in drilling activities or from accidental spills.

The energy sector is also vulnerable to potential impacts of climate change. This vulnerability has been evaluated by a modeling study simulating hydropower generation under regional climate warming in the Sierra Nevada. This study indicates the most substantial decrease of the mean annual hydropower generation will be in the northern Sierra Nevada watersheds as a result of declining runoff. Hydropower generation will be reduced by approximately 8 percent with 10.8°F warming with no change in precipitation. The study 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 energy sectors to address these challenges efficiently.

Understanding the relationship of water and energy is important for decision-making in order to use limited water and energy supplies efficiently to meet increasing future demands. The cross-connections between these sectors should be kept in mind when making resource and planning decisions. Figure 3-24 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 yellow light bulbs. The energy intensity of these two elements of water use is calculated for primary water supply sources for each region in each of the Regional Reports in Volume 2.

**PLACEHOLDER Figure 3-24 The Water Energy Connection**

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

## Delta Vulnerabilities

The Sacramento-San Joaquin Delta (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 Water Code 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 (DRMS 2009) identified concerns with the Delta levee system including the following:

- A major earthquake 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 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 issues such as:

- Demands on water supply.
- Entrainment.
- Levees.
- Nonnative 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 left untended, the decline of Delta facilities has area, 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 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, although DWR provides some uniformity. The U.S. Army Corps of Engineers has oversight authority only for

those levees that meet its standards. Local entities have responsibility for evacuations. While many agencies currently have emergency operation plans for their own and coordinated activities, there is always room for improving the planning for catastrophic events do the extreme consequences that can occur.

## 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.

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 integrated water management and a systems approach to freshwater withdrawals, use, and disposal that considers physical, chemical, biological, social, behavioral, and cultural aspects. Water law, economic incentives, public awareness, public education, and sensitivity to differences in value systems are cornerstones of effective water resource management. These require data and analytical tools that are greater than are currently available to water managers. (See the further discussion in Chapter 6, "Integrated Data and Analysis," 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 to communities associated with proposed water programs and projects (see Volume 4, *Reference Guide*, article "Environmental Justice in California Government").

Most water, wastewater, and flood projects are not developed for disadvantaged and underrepresented communities, yet these have an impact on them. Even projects that convey general public benefit may not benefit environmental justice or disadvantaged communities proportionally. For example, water conservation programs that are heavily dependent upon toilet and washing machine rebates will have greater 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 those fixtures.

## Funding

At a time when flood management maintenance and improvement efforts should be increased, investments in water, water quality, and infrastructure have been stressed by budget limitations at local government levels. 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," will further define the funding problems and address them.

## Responses and Opportunities

This section presents a representative sampling of recent achievements and emerging opportunities in California resource management. Due to the large number activities underway in the state, only a sampling of State and federal IWM activities can be described. These demonstrate that management agencies are placing more emphasis on integrated water management. Many more 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., Water Code 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 manage projects effectively that integrate natural resource protection into infrastructure and services that have been traditionally provided.

With the increasing reliance on partnerships, stewardship is taking on a community focus, one in which government, the private sector, and non-profit corporations come together to work in concert towards specific ends. This requires that goals and objectives are clearly stated so that all parties have an understanding of the needs and limitations for 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 towards 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, the Department of Water Resources has established two new policies based on a new vision to guide future planning approaches — a Sustainability Policy and an Environmental Stewardship Policy that includes a statement of Environmental Stewardship Principles (Box 3-9) that 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.

**PLACEHOLDER Box 3-9 DWR Environmental Stewardship Principles**

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

### 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. 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.

### 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.swrcb.ca.gov/water_issues/hot_topics/20x2020/index.shtml. Also, see Senate Bill No. 7 (SBX7-7) Statewide Water Conservation as part of the 2009 Comprehensive Water Package discussed later under the Recent Legislation subsection. Figure 3-25 shows statewide urban water use baseline and 2020 targets.

**PLACEHOLDER Figure 3-25 Urban Water Use – Baseline and 2020 Targets**

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

There are approximately 450 urban water suppliers in California. By the July 2011 deadline for submitting 2010 Urban Water Management Plans, more than 290 plans were submitted to DWR for review. More plans were submitted to DWR since 2011. Some water suppliers have coordinated efforts and submitted regional urban water management plans. 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 to reduce water use and consequently this water use reduction may impact 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. In the 1980s, concerns for protecting the environment were manifested in strong new laws and regulations. These regulations affected the ability of interregional water projects to deliver water. The resulting uncertainty also contributed to hesitancy to invest in additional facilities for these interbasin systems and forced water agencies to make difficult decisions about how to provide a reliable water supply.

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

With integrated regional water management (IRWM), regions have been able to take advantage of opportunities that are not always available to individual water suppliers:

- Reduce dependence on imported water and make better use of local supplies.
- Enhance use of groundwater with greater ability to limit groundwater overdraft.
- Increase supply reliability and security.
- Improve water quality and reduce flood risk.

The extent to which regions have carried these out has been driven by considerations like economics, environment, engineering, and institutional capacity.

Throughout California, stakeholders are working together to develop regional and watershed programs that cover multiple jurisdictions and provide multiple resource benefits. In several regions, agencies have formed partnerships to combine capabilities and share costs. IRWM has become established and continues to increase (see Box 3-10 Examples of Regional Water Management).

**PLACEHOLDER Box 3-10 Examples of Regional Water Management**

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

On September 30, 2008, Governor Schwarzenegger signed SB 1 (SBx2 1) (http://www.leginfo.ca.gov/pub/07-08/bill/sen/sb_0001-0050/sbx2_1_bill_20080930_chaptered.pdf). SBx2 1 contains replacement language for the Integrated Regional Water Planning Act of 2002 (California Water Code Sections 10530 et seq.) as well as the first appropriations for the IRWM grant program from Propositions 84 and 1E (see Propositions and Bonds subsection 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 better resolve regional needs, especially when paired with statewide water management systems. Regional water management options can reduce physical and economic risks and provide regional control over water supplies. More is being done to meet water demands with water conservation, reoperation of facilities, water recycling, groundwater storage and management, transfer programs, 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 (Senate Bill X7-7, California Water Code 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, nongovernmental organizations, local, State, federal, and tribal planners are potential users of this methodology. The methods are not intended for non-irrigated 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 includes $15 million in Proposition 50 grants. A proposal solicitation package was released in 2012.

According to the California Energy Commission, end use of water is the most energy intensive portion of the water use cycle in California. Measures to increase water use efficiency and reuse will reduce electricity demand from the water sector, which in turn can reduce 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 af water savings. Is this savings is achieved, it is equivalent to 190,000 MWh (million Watt-hour/acre-feet) per year and 90,000 metric tons of GHG emissions reduction. (This calculation assumes an average energy intensity of 1 MWh/af, 0.475 metric ton $CO_2$ 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 (3,000 acre-feet/year or serving 300 customers) must prepare Urban Water Management Plans (UWMPs) that evaluate water supplies and demands over a 20-year period and are updated every five years (California Water Code Sections 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, Assembly Bill 162 (AB 162) was passed. This bill specifically requires 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 comply with AB 162.

## 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.

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

In November 2009, the Legislature enacted SBX7 1 (Delta Reform Act). The Act became effective on February 3, 2010 which:

- 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 Department of Fish and Wildlife and the State Water Resources Control Board 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. Restructured the Delta Protection Commission.

### Bay Delta Conservation Plan (BDCP)

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. To be incorporated into the Delta Plan and for public funds to be

available for public restoration benefits, the BDCP must be approved by the Department of Fish and Wildlife as a Natural Community Conservation Plan. The Department of Fish and Wildlife must determine that the BDCP otherwise meets the requirements of Water Code Section 85320 for inclusion into the Delta Plan.

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 further 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: http://baydeltaconservationplan.com.

### Delta Stewardship Council

Created by the Legislature in the Delta Reform Act of 2009, the Delta Stewardship Council is charged with writing the Delta Plan and updating it 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 longstanding 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.
- Protects and enhances the Delta ecosystem by identifying and protecting high-priority restoration areas and setting a deadline for the State Water Resources Control Board to take actions that support the coequal goals by updating flow standards water quality objectives, including flow objectives, for the major rivers and tributaries of the Delta.
- Protects and enhances the Delta as a place by recognizing that all actions must be achieved in a manner that protects and enhances the values and unique but evolving characteristics of the Delta.
- 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 (DRMS)

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.delta.dfg.ca.gov/erpdeltaplan/.

### 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 to 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 5,000 to 7,000 acres proposed for tidal marsh restoration under the SMP contribute to the recovery of listed endangered species. It could be implemented under BDCP or any other habitat restoration efforts in the Marsh and it would not limit those efforts. The EIS/EIR 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 consisting 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 risks of flood damages to California communities, loss of life, homes and 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, California Department of Fish and Wildlife, U.S. Army Corps of Engineers (USACE), Federal Emergency Management Agency, U.S. Fish and Wildlife Service, the National Oceanic Atmospheric Administration, tribal entities, and many local sponsors and other stakeholders. DWR will continue to work closely with key partners and stakeholders to accomplish the FloodSAFE vision.

Major FloodSAFE accomplishments since Update 2009 include both statewide and Central Valley studies and facility/program improvements. The collaborative effort between DWR and the U.S. Army Corps of Engineers produced *California's Flood Future: Recommendations for Managing the State's Flood Risk* in 2013 to evaluate statewide flood risk. The evaluation found that more than 7 million people and $580 billion in assets (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 towards 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 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

The passage of Senate Bill X7 6 (SB X7 6) in November 2009 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 July 12, 2012, DWR received monitoring notifications for more than 300 basins and subbasins. DWR has designated 56 Monitoring Entities who are now monitoring and reporting groundwater elevations for 97 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 retrieving this information. The CASGEM Online System allows public access to groundwater elevation data for groundwater basins.

As required by the Water Code, 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 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.

**PLACEHOLDER Table 3-4 CASGEM Program Progress 2009-2012**

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

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.

*Short-term Activities (2012)*

- 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 Water Code.
- Continue with program outreach and expand focus to include public users.
- As staff and funding are available, design and develop additional capabilities and features to the CASGEM Online System.

*Long-term Activities*

SB X7 6 establishes a permanent, statewide groundwater elevation monitoring program. This new law recognizes that basin-wide coverage and long-term records of information are necessary to develop sound analyses and to manage and sustain groundwater and integrated regional water resources effectively. The following long-term activities are necessary to establish an effective permanent program and to analyze the program's results and will continue 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.
- Monitor groundwater elevations in basins where no local party has performed the monitoring functions.
- Conduct groundwater basin assessments and identify regional trends.
- 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, California Water Plan, and groundwater recharge areas as required by AB 359 (Chapter 572, Statutes of 2011).

## Drought Response

State-level response actions to California's statewide drought of 2007-09 included governor's executive orders and emergency proclamations. In June 2008, the governor issued Executive Order S-06-08, directing State agencies and departments to take immediate action to address the serious drought conditions and water delivery reductions. The governor also issued an emergency proclamation for nine Central Valley counties (Sacramento, San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare, and Kern) to address urgent water needs. The governor subsequently issued an emergency proclamation on water shortage in February 2009, followed by Executive Order S-11-09 in June 2009 regarding temporary supplemental assistance for food banks in drought-affected areas. In July 2009, the governor issued an emergency proclamation specific to Fresno County related to food banks and suspended the one-week waiting period for unemployment insurance applications. These latter directives related to social services assistance were particularly aimed at small agricultural communities on the west side of

the San Joaquin Valley, where economic recession combined with land fallowing due to water shortages had resulted in high unemployment rates and socioeconomic impacts..

DWR's actions in response to the 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). The actions include development of water conservation outreach materials in partnership with the Association of California Water Agencies (Save Our Water campaign materials), operation of a 2009 drought water bank described below, and acceleration of State bond-funded financial assistance programs that could assist in mitigating drought impacts. Additionally, DWR and CWP staff and the State Agency Steering Committee prepared a five-year Statewide Drought Contingency Plan as part of Update 2009. The purpose of the plan was to articulate a coordinated State government strategy for preparing for, responding to, and recovering from drought in the context of the emergency proclamations then in place (see Volume 4, *Reference Guide*).

Drought conditions can set the stage for major wildfires and some of the largest economic losses from drought. Also, the largest State emergency response costs can occur as a result of wildfires. This proved to be the case in 2007 when a massive outbreak of wildfires occurred in Southern California. Beyond the immediate CAL FIRE response actions to these fires, multiple agencies including DWR participated in subsequent sustained efforts to reduce the risk of flooding and debris flows from the burned areas. Other State assistance that was provided included California Department of Public Health Proposition 84 emergency grants to assist small water systems in Southern California and elsewhere whose infrastructure was damaged by wildfire.

A comprehensive package of water legislation enacted in November 2009 contained provisions that were too late to be applicable during the 2007-09 drought, but are highly important for response to subsequent droughts. This legislation, among other things, created a requirement for local agency monitoring of groundwater levels. DWR is now using CASGEM data to track the effects of a dry water year 2012 on statewide groundwater conditions.

#### *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 acre-feet 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 that were at risk of experiencing water shortages in 2009 due to drought conditions and required supplemental water supplies to meet anticipated demands.

### California Water Commission

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 State Water Project. 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 that is tasked with coordinating the activities of State agencies to:

- Improve air and water quality.
- Protect natural resource and agriculture lands.
- Increase the availability of affordable housing.
- Improve infrastructure systems.
- Promote public health.
- 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, California Environmental Protection Agency, the California Natural Resources Agency, 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. See http://www.sgc.ca.gov/meetings/20120510/StaffUpdate.pdf.

A vital economy, a healthy environment, and a reliable water supply require substantial investments in water management activities. In May 2012, the California Strategic Growth Council awarded $45.3 million in local assistance grants that will lead to more sustainable communities. 93 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. 2012 awards are listed at http://www.sgc.ca.gov/planning_grants.html.

## Adapting to Climate Change

As shown in Figure 3-24, above, water availability will be affected by climate change 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; it 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. Long-standing issues related to water management, ecosystems, water quality, and public safety in the Sacramento-San Joaquin 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 Bay Delta Conservation Plan, which provides an approach that substantially improves resiliency to climate change and provides additional system flexibility.

Since California contains multiple climate 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 of the Regional Reports in Volume 2. 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, Resources Legacy Fund, and the U.S. Army Corps of Engineers, the *Climate Change Handbook for Regional Water Planning* provides a framework for considering climate change in water planning. 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, in addition to its Third Assessment Report on climate change, "Our Changing Climate, 2012 Vulnerability & Adaptation to the Increasing Risks from Climate Change in California," which explores local and statewide vulnerabilities. The Report includes vulnerability and adaptation studies which are the latest climate change research findings for California. The State is also developing an update to the 2009 California Adaptation Strategy, which will provide guidance for the water sector.

The Assessment of Climate Change in the Southwest U.S., prepared for the National Climate Assessment, can be a valuable resource for water managers. Released in 2013, it 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 Intergovernmental Panel on Climate Change (IPCC) releases its 5$^{th}$ Assessment Report (AR) in 2013 and 2014 on the scientific, technical and socio-economic aspects of global climate change, and impacts on specific geographic regions, and various resource sectors. AR5 will be the most comprehensive assessment of scientific knowledge on climate change since 2007. 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.

## Mitigation of Greenhouse Gas

### *Emissions*

From all indications, the impact of climate change on hydrology and water resources management will continue to be significant, as will the push to mitigate GHG emissions by reducing energy consumption

and using renewable energy sources. There are significant challenges for California to meet future water and energy demands for population growth, power generation, and industrial and agricultural uses under a changing climate. Both adaptation and mitigation are needed to manage risks, which are often complementary and overlapping. Coordinating these actions presents a significant challenge for water and energy since there may be unintended consequences if these efforts are not coordinated (California Natural Resources Agency, 2010).

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 and information gaps between water and energy. They 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 nature resources management.

### State Legislation, Policies, and Related Actions

There is statewide legislation in place related to climate change mitigation and water management. The California Global Warming Solutions Act of 2006 (Assembly Bill 32 – AB32) mandated 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. The Scoping 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. WETCAT (the Water Energy Team of the Governor's Climate Action Team) was formed to coordinate State-level water and energy planning. 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 7-7 (SBX7-7) 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 State Water Project (SWP), the largest State-run water and power system in the U.S. The 700 mile-long SWP moves water from Northern California rivers to the San Francisco Bay Area, Silicon Valley, 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, roughly equivalent to the emissions of 730,000 cars during one year.

In 2012, DWR adopted its Greenhouse Gas Emissions Reduction Plan (GGERP*)*. The plan dramatically curtails DWR's GHG emissions in 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 State Water Project 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 State Water Project 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 to 50 percent of the department's operational emissions.
- Increasing the efficiency of pumps and turbines throughout the State Water Project 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 Greenergy program, which will ensure that much of DWR's office space in Sacramento is powered by renewable sources.
- Buying 2,580 metric tons of carbon offsets each year of the next decade to fund projects that help reduce GHG emissions.

The Department of Water Resources 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 SBX7-7.
- Developed a methodology for calculating the urban water use target of SBX7-7.
- Developed a regulation for agricultural water measurement and a guidebook to assist agricultural water suppliers to prepare agricultural water management plans, and received and reviewed agricultural water management plans to comply with SBX7-7.
- Developed a guidebook to assist urban water suppliers to prepare urban water management plans, received and reviewed Urban Water Management Plans (UWMPs), and provided a report on the progress toward achieving a 20 percent per capita urban water use reduction.

DWR convened a task force consisting of academic experts, urban retail water suppliers, environmental organizations, and commercial, industrial, and institutional water users to develop best management practices (BMP) for the Commercial, Institutional and Industrial (CII) water sector (2012). This CII report identified technologies, the technical feasibility and BMP s cost, and recommended BMP's for water use efficiency in industry.

In 2012, Sacramento County honored DWR with its Sacramento Area Sustainable Business Award for business practices that save energy.

DWR also issued Integrated Regional Water Management (IRWM) Grant Program Guidelines that require regional planning agencies and organizations throughout the state to consider the nexus of water and energy as well as climate change in their Integrated Regional Water Management Plans (IRWMPs), see Chapter 28, "Economics Incentives - Loans, Grants, and Water Pricing," in Volume 3, *Resource Management Strategies*. The comprehensive scope includes identifying water management actions that could reduce energy consumption and associated GHGs within the respective planning regions by changing systems, facilities, processes, and end uses of water.

### Actions from other Agencies and Organizations

The California Public Utilities Commission (CPUC) oversees the portfolio of energy efficiency programs currently administered by the investor-owned energy utilities. The CPUC funds energy audits and energy efficiency projects implemented by their commercial public/municipal and investor-owned water sector customers. The CPUC completed pilot programs for embedded energy in water programs to test the potential to achieve meaningful energy efficiency savings in the water cycle. The CPUC directed energy utilities, local government partners, and others to include the water-energy nexus in energy efficiency programs.

The California Energy Commission (CEC) administered the Public Interest Energy Research Program (PIER) which has a broad mandate to research the environmental effects of energy technology, energy production, delivery, and use. The ultimate goal of this program area is to improve California's overall environmental quality. CEC also established the Power Plant Cooling Water- Recycled Water Offset Program to promote the use of recycled water for cooling water as part of the permitting process.

The U.S. Environmental Protection Agency (USEPA) regional office established the California Water and Energy Program (CalWEP) to assist water and wastewater utilities in identifying and developing energy and water efficiency and renewable energy projects. Water and energy audits have been conducted for many water and wastewater agencies with assistance from this program. The CalWEP program also includes climate-ready utilities, climate resilience evaluation and assessment tools, and tabletop exercise tools for water systems, and an Energy Star program to track progress.

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

### Energy Intensity of Water

This is the first CWP to include specific energy intensity related to water management actions. Each Regional Report, other than the overlay areas of the Delta and Mountain Counties, includes regional energy intensity for raw water extraction and conveyance for primary water sources (See Figure 3-27 for the Water-Energy Nexus in the Critical Challenges Section, and Volume 2, *Regional Reports* for regional energy intensity of water supplies). When making water management choices at a program level, the energy intensity of individual supplies can become part of the decision-making process. Portfolio management for water supplies includes utilizing water from various water sources, such as State Water Project, groundwater, a local water project, and perhaps transfers or exchange agreements. For each water source in the portfolio, there are associated costs, water quality considerations, opportunity costs, environmental impacts, energy requirements, reliability, 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. The energy intensity information provided will not be of sufficient detail for actual project level analysis, in most cases, nor does it include end use energy requirements. The information can be used in more detailed evaluations using tools such as WeSim, which allow water managers to model their water systems and simulate outcomes for energy, GHGs, and other metrics of water supply choices. The energy intensity of desalination and recycled water are discussed in the

*Resource Management Strategies* (RMS), Volume 3. In addition, each RMS includes an assessment of its potential contribution toward, or detriment to energy demand and GHG reduction efforts.

### Water Footprint of the Energy Sector

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

Electric power generation is typically produced through thermoelectric processes by combustion or fission process, in which the heat energy or radioactive energy is converted to electric energy. Thermoelectric generation accounts for approximately 40% of freshwater withdrawals nationally. Water withdrawals in California for thermoelectric power use accounted for 28% 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. The Electric Power Research Institute (EPRI) evaluated water uses and related technologies including strengths, limitations and costs for increasing water use efficiency in thermoelectric plants (2008). This research could be useful to develop best management practice to reduce the water footprint of power generation. The power industry has engaged in conserving water using the following 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.

Future water needs should be evaluated for different energy futures to identify a growing risk of conflicts between electricity production and water availability in California. A global analysis of water consumption for energy production (WCEP) indicated fossil fuels and biofuels production from corn, sugar beet, soybean, and rapeseed corps had greater water footprint compared to the water requirement of other energy production technologies. Recent studies of water for energy in the American West assessed water uses in fossil fuels such as coal, oil shale, and water-intensive renewable such as concentrated thermal solar power and bioenergy. A future risk of conflicts between electricity production and water availability has been evaluated for the Intermountain West. The impacts of the future water supply in the energy sector should be addressed in the State policies and management.

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. A Guide to California's Renewable Policies and Programs has been developed by CPUC, which provides an overview of California's renewable energy programs, the renewable portfolio standard and operational and cost challenges (2012). But statewide and regional data to assess water footprint for renewable energy production in California is still lacking. Future research in this direction could support the decision making process to select less water-intensive renewable energy sources for California regional resource management portfolios.

Climate change may limit future freshwater availability for population growth, power generation, and industrial and agricultural uses. BMP strategies for water use efficiency in the energy sector will be helpful to both adapt and mitigate for climate change. These strategies include increasing electricity generation efficiency and adapting energy efficiency measures; selecting less water-intensive renewable energy sources; using dry and hybrid cooling systems, and recirculation or reuse water in power plants;

and using recycled water and alternative water sources in energy generation, including using waste water treatment discharge, storm water flow, agricultural runoff, water produced in oil/gas extraction, and saline aquifers.

### State Water Resources Control Board (SWRCB)

The State Water Resources Control Board 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 acre-feet per year, 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 Onsite Wastewater Treatment Systems (OWTS) 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 Regional Water Quality Control Boards (RWQCB) 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 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.

## Recent Litigation

California's water rights system incorporates riparian doctrine, prior appropriation doctrine, ground water use, and pueblo rights. The State's water law is the California Water Code at http://www.legininfo.ca.gov. Information on water litigation and legislation since Update 2009, is in Volume 4, *Reference Guide*.

## Recent Legislation

### 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 Regional Water Quality Control Boards 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, 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 bill 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 Water Use Efficiency subsection).
- **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 staffing at the SWRCB 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**. Declared that it is the policy of the State and that everyone has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes. It directed 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**. Defined key terms relating to rainwater capture and authorize the installation of rainwater capture systems.
- **AB 1965 Land Use: Flood Protection**. Revised previous provisions included in SB 1278 (Wolk 2012, see below) related to planning and zoning for flood protection in the Sacramento-San Joaquin Valley.
- **AB 2230 Recycled Water**: **Car Washes**. Required 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 eliminated 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**. Extended 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 would revert to 50 percent.
- **SB 1278 Planning and Zoning**: **Flood Protection: Sacramento-San Joaquin Valley.** Changed existing local flood protection requirements, extending by one year the timeframe under which cities and counties must incorporate flood risk information into their general plans and zoning ordinances. Also required 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**. Exempted 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 SBX7 1 in 2009.

### Strengthening Flood Protection

In October 2007, the governor signed several pieces of legislation aimed at strengthening flood protections in California. The legislative package lead 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 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 that are subject to flooding as identified by floodplain mapping prepared by the Federal Emergency Management Agency 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 storm water 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 approved a series of bonds to preserve and improve the state's natural resources. Propositions 12, 13, 40, and 50 made a total of $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.

Box 3-11 lists Integrated Water Management Grants Accomplishments since 2009).

**PLACEHOLDER Box 3-11 Integrated Regional Water Management (IRWM) Grants Accomplishments Since 2009**

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

### Proposition 1E – Disaster Preparedness and Flood Protection Bond Act

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

The bond funds will fund four critical flood protection projects:

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

### Proposition 84

In November 2006, voters approved The Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006 (Proposition 84) authorizing $5.4 billion in general obligation bonds for natural resources purposes. 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 including:

- Tahoe Conservancy's 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.
- Department of Fish and Wildlife to restore Bay-Delta and coastal fisheries.
- Wildlife Conservation Board to preserve and protect forests, wildlife habitat, rangeland, grazing land and grasslands, and oak woodlands.
- 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 natural water resources and for a wide array of expenditures to improve flood protection around the state.
- State Water Resources Control Board 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

The 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 State Legislature, on July 5, 2012 approved a bill to take the measure off the 2012 ballot and put it on the 2014 ballot. Discussion are underway in 2013 on what to include in the bond measure – some are pushing for approximately $11 billion and others want to make it [Update as needed]

## Federal Government

### American Recovery and Reinvestment Act of 2009

Since its initial awards in 2009, The U.S. Department of the Interior 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 the Department'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 – Central Valley Project. 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 U.S Bureau of Reclamation 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 Sacramento-San-Joaquin 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 resist seismic loadings better from earthquakes increasing disaster protection to the Sacramento area.
- Klamath River Sedimentation Sampling/Analysis. Study quantifies the potential benefits, liabilities, environmental risks, and effects on downstream resources resulting from removing four hydropower dams as requested by California, Oregon, and three Native American tribes.
- Red Bluff Fish Passage – Central Valley Project. 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 – Central Valley Project. 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, allow for maintenance and repair activities, and provide the flexibility to respond to Central Valley Project and State Water Project 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. The U.S. Department of the Interior (DOI) established the WaterSMART (Sustain and Manage America's Resources for Tomorrow) program in February 2010 which will be administered by the U.S. Bureau of Reclamation. Under WaterSMART, all DOI bureaus will work with states, tribes, local governments, and non-governmental organizations 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. However, due to limited funding for WaterSMART, USBR will not award System Optimization Reviews, Climate Analysis Tools, and Advanced Water Treatment grants in fiscal year 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 farmer 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 due to a physical disaster or an agricultural production disaster. The U.S. Small Business Administration (SBA) administers these loans.

### Proposed Legislation to Regulate Hydraulic Fracturing

The U.S. Bureau of Land Management (BLM) proposed a rule in 2012 to regulate hydraulic fracturing (aka fracking) on public and Native American land. The 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 way 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 there is a potential for groundwater pollution. [This section will be updated with status of pending legislation for the final draft of Update 2013.]

### National Water Quality Portal

The U.S. Geological Survey (USGS), the U.S. Environmental Protection Agency, and the National Water Quality Monitoring Council (NWQMC) recently developed The Water Quality Portal (WQP). This Web site integrates publicly available water quality data from the USGS National Water Information System (NWIS) and the EPA STOrage and RETrieval (STORET) Data Warehouse. The two links contain current and historical data about chemical, physical, and microbiological data from states, tribes, watershed groups, other federal agencies, volunteer groups, and universities. The WQP combines all the data into one Web site. See the WQP at 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 U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, the U.S. Department of Agriculture, and the Department of the Interior, 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.

### 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 SRWCB are Council 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 in order 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.

### 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:
  - By June 30, 2012, setting aggressive permit decision-making and review schedules 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 U.S. Army Corps of Engineers 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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**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%** |

Source: California Department of Water Resources 2012

**Table 3-2 California Water Balance Summary, 2001-2010 (Numbers in Million Acre-Feet)**

| | 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 | 9 | 9 | 10 | 9 | 9.5 | 9.6 | 9.3 | 8.9 | 8.0 |
| Irrigated Agriculture | 34 | 36 | 33 | 36 | 31 | 34.0 | 36.9 | 37.0 | 36.0 | 33.1 |
| Managed Wetlands | 1 | 2 | 2 | 2 | 1 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 |
| Req Delta Outflow | 5 | 5 | 6 | 7 | 7 | 10.1 | 4.5 | 4.5 | 4.7 | 5.3 |
| Instream Flow | 7 | 6 | 7 | 7 | 8 | 8.5 | 6.5 | 6.2 | 6.3 | 6.8 |
| Wild & Scenic R. | 10 | 22 | 30 | 23 | 26 | 44.8 | 18.1 | 19.5 | 18.1 | 25.1 |
| Total Uses | 65 | 80 | 86 | 85 | 83 | 109 | 77 | 78 | 75 | 80 |
| **Depleted Water Use (stippling)** | | | | | | | | | | |
| Urban | 7 | 7 | 6 | 6 | 6 | 6.2 | 6.2 | 6.1 | 5.8 | 5.2 |
| Irrigated Agriculture | 26 | 26 | 24 | 27 | 23 | 24.7 | 27.1 | 27.6 | 26.6 | 23.9 |
| Managed Wetlands | 1 | 1 | 1 | 1 | 1 | 0.8 | 0.9 | 1.1 | 0.8 | 1.0 |
| Req Delta Outflow | 4 | 5 | 6 | 7 | 7 | 10.1 | 4.5 | 4.5 | 4.7 | 5.3 |
| Instream Flow | 2 | 3 | 3 | 3 | 3 | 6.1 | 4.4 | 2.2 | 4.1 | 4.4 |
| Wild & Scenic R. | 7 | 18 | 23 | 19 | 19 | 33.8 | 14.7 | 15.4 | 13.2 | 18.5 |
| Total Uses | 48 | 59 | 63 | 62 | 59 | 82 | 58 | 57 | 55 | 58 |

| | 2001 (72%) | 2002 (81%) | 2003 (93%) | 2004 (94%) | 2005 (127%) | 2006 (127%) | 2007 (62%) | 2008 (77%) | 2009 (77%) | 2010 (104%) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Dedicated and Developed Water Supply** | | | | | | | | | | |
| Instream | 11 | 27 | 35 | 33 | 32 | 49 | 23 | 21.2 | 21 | 27 |
| Local Projects | 12 | 5 | 4 | 1 | 6 | 9 | 8 | 9 | 8 | 9 |
| Local Imported Deliveries | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1.1 | 1 | 1 |
| Colorado Project | 5 | 5 | 5 | 5 | 4 | 5 | 5 | 4.9 | 5 | 5 |
| Federal Projects | 7 | 8 | 7 | 9 | 7 | 7 | 7 | 6.1 | 6 | 6 |
| State Project | 2 | 3 | 3 | 3 | 3 | 4 | 3 | 2.0 | 2 | 2 |
| Groundwater Extraction | 18 | 17 | 16 | 18 | 12 | 14 | 19 | 20.0 | 20 | 15 |
| Inflow & Storage | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 |
| Reuse & Seepage | 8 | 13 | 16 | 14 | 16 | 19 | 11 | 13.5 | 12 | 14 |
| Recycled Water | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 |
| Total Supplies | 64 | 79 | 86 | 84 | 82 | 109 | 77 | 78 | 75 | 80 |

**Table 3-3 State Water Quality Database Web sites**

| Water quality web site | Type of water quality information |
|---|---|
| My Water Quality<br>http://www.waterboards.ca.gov/mywaterquality/ | 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.<br>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<br>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)<br>http://www.waterboards.ca.gov/water_issues/programs/swamp/<br>SWAMP water quality information is available at CEDEN (California Environmental Data Exchange Network)<br>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. |

Source: Department of Water Resources 2012

**Table 3-4 CASGEM Program Progress 2009 – 2012**

| CASGEM schedule | DWR activities | Local entity activities |
|---|---|---|
| 2009 | • November 6 - Legislature passes historic water bills including SBx7 6 (CASGEM) | |
| 2010 | • Developed program design, initiated outreach, identified project resources, and defined database requirements<br>• Created CASGEM Web site<br>• Partnered with ACWA and conducted ten workshops throughout the state<br>• Worked with local agencies to educate them and encourage program participation<br>• Solicited public comments<br>• Finalized reporting requirements, guidelines, and FAQs<br>• Launched Phase 1 of CASGEM Online System for notifications | • Local entities attended CASGEM workshops<br>• Local entities collaborated to identify prospective Monitoring Entities<br>• 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<br>• Released Phase 2 for submitting well information, monitoring plans, and shape files<br>• Initiated review of notifications for designation of Monitoring Entities<br>• Developed CASGEM Online System user manuals for both Monitoring Entities and public<br>• Released final Phase 3 of CASGEM Online System that includes groundwater elevation data submissions and allows public access to the system<br>• Conducted user training sessions for DWR staff and Monitoring Entities | • Prospective Monitoring Entities submitted notifications online to DWR<br>• Prospective Monitoring Entities worked with DWR to submit shape files of monitoring areas<br>• Monitoring Entities developed and submitted monitoring network plans to DWR<br>• Monitoring Entities conducted groundwater elevation monitoring |
| 2012 | • Submitted program status report to governor and Legislature<br>• Started review of alternative groundwater monitoring plans specified in AB 1152<br>• Continue review of submissions and designation of Monitoring Entities<br>• Continue conducting outreach to Monitoring Entities and public users<br>• Currently testing basin prioritization system for release to the public in 2012 | • Monitoring Entities submitted first CASGEM groundwater elevation data to CAGEM Online System |

Source: California Department of Water Resources 2012

**Figure 3-1 Feast or Famine Timeline**

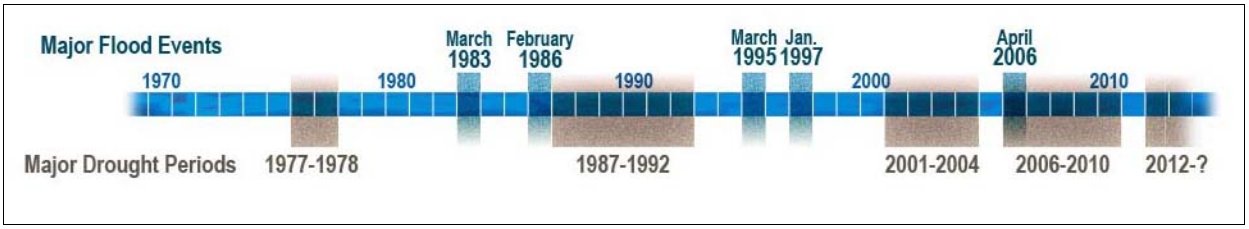


**Figure 3-2 Map of California with Major Rivers and Facilities**

**Figure 3-3 Variable Flood Risk**

**Figure 3-4 Types of Water Uses**

[figure to come]

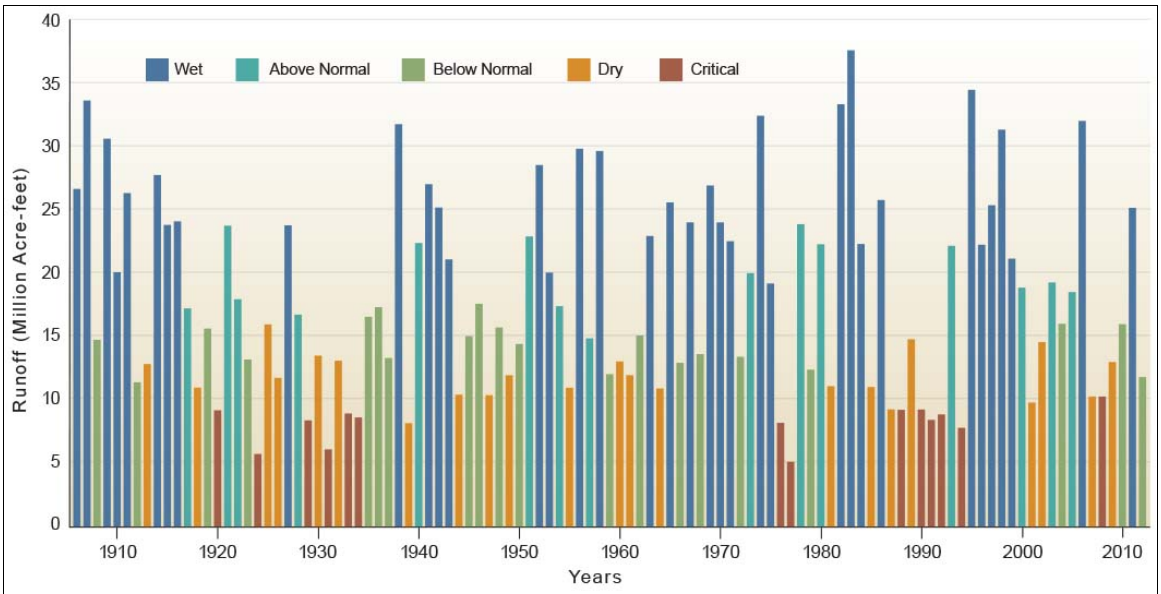
**Figure 3-5 Examples of Water-Dependent Ecosystems**

[figure to come]

**Figure 3-6 Hydrologic Regions of California, the Sacramento-San Joaquin Delta and Mountain Counties Area**

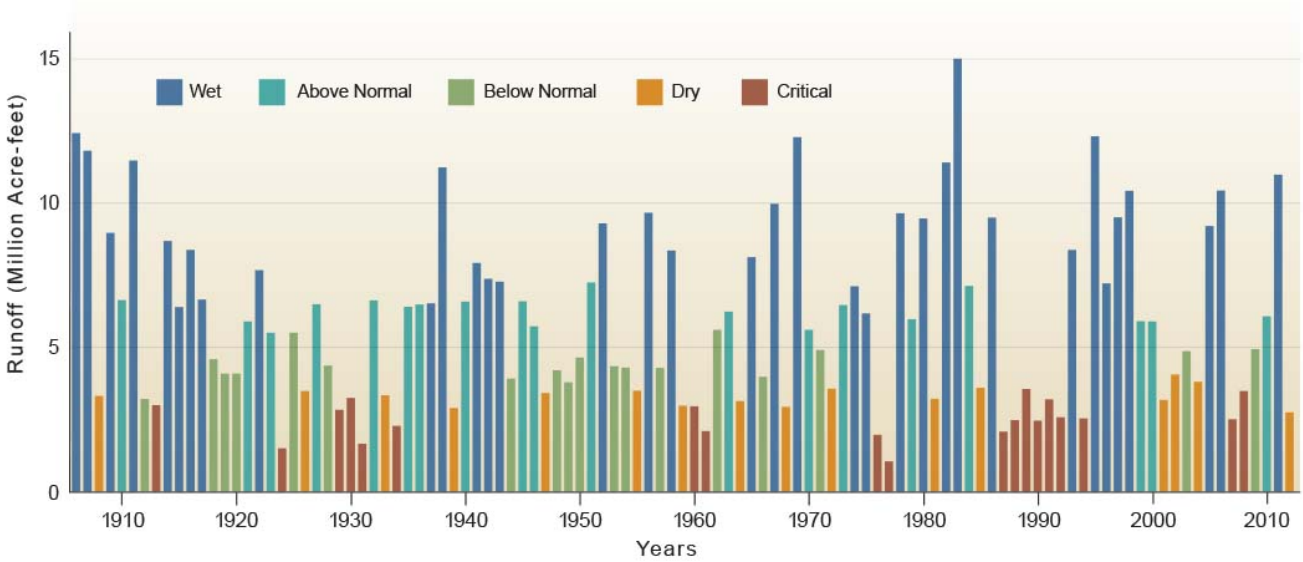
**Figure 3-7 Map of Integrated Regional Water Management Planning Regions**

**Figure 3-8 Sacramento River Four Rivers Unimpaired Runoff, 1906-2012**



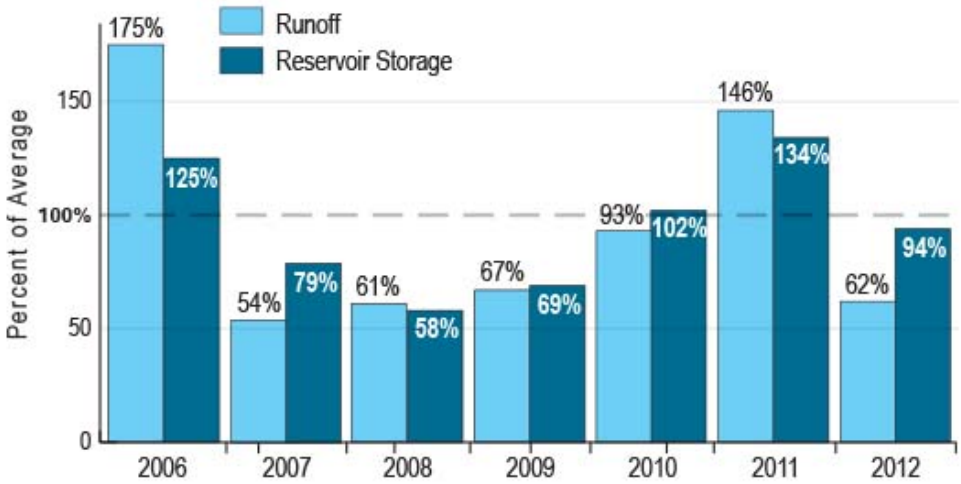

The Sacramento Four Rivers are: Sacramento River above Bend Bridge, near Red Bluff; Feather River inflow to Lake Oroville; Yuba River at Smartville; American River inflow to Folsom Lake

**Figure 3-9 San Joaquin Four Rivers Unimpaired Runoff, 1906-2012**




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

**Figure 3-10 Total Statewide Runoff and Key Reservoir Storage, End of Water Years 2006-2012**

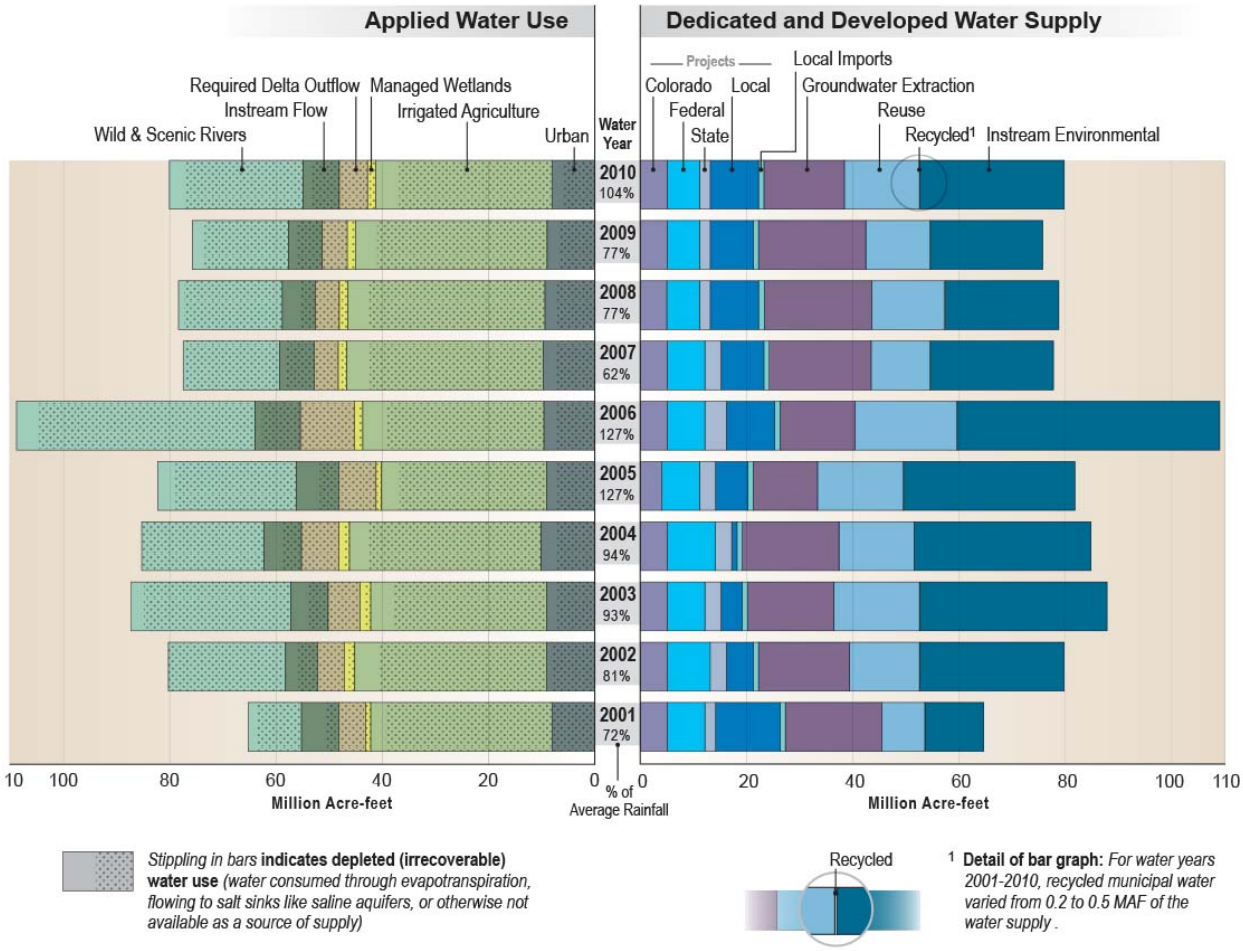



Statewide runoff totals and end-of-water-year storage, 2006 to 2012, for key reservoirs (Trinity, Shasta, Oroville, Folsom, Don Pedro, New Melones, and San Luis) as a percentage of average.

*Source: DWR 2012*

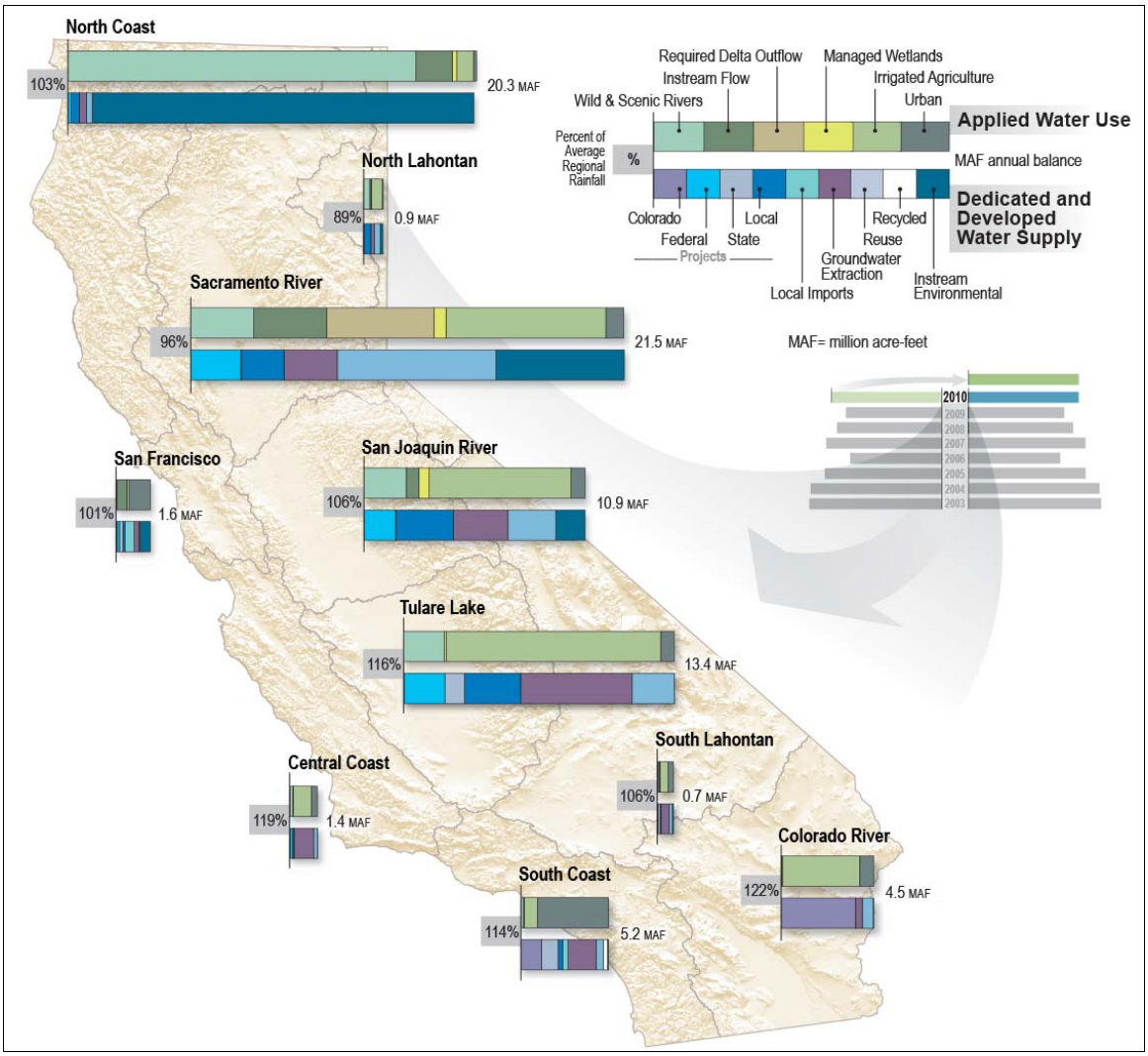
**Figure 3-11 California Water Balance by Water Year, 2001-2010**

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 Table 1.3-X). 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.




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

**Figure 3-12 Water Balance by Region for Water Year 2010**




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 through the regions and how each region's water balance can vary from year to year.

**Figure 3-13 Water Balances for the Hydrologic Regions for Year 2010**

[figure to come]

**Figure 3-14 Regional Inflow and Outflows, Water Year 2010**

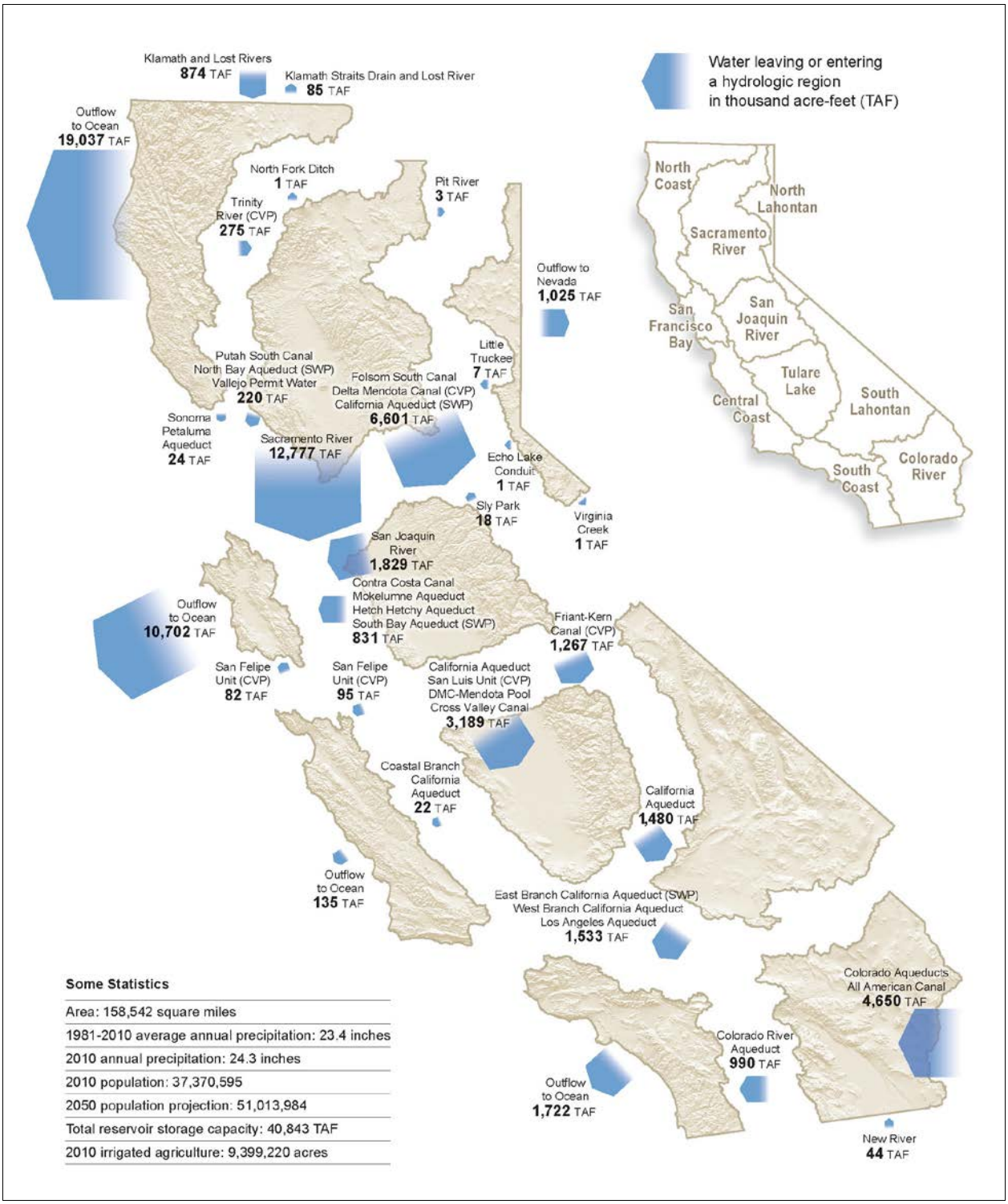


**Figure 3-15 Key Events and Historical Spending, 1850s - Present**

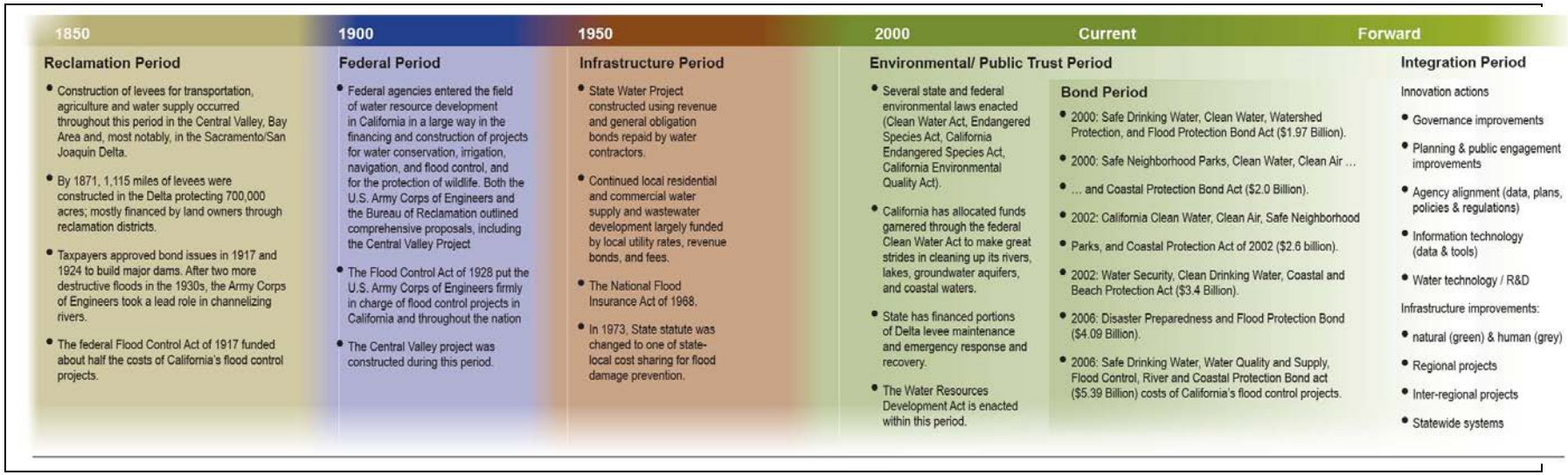


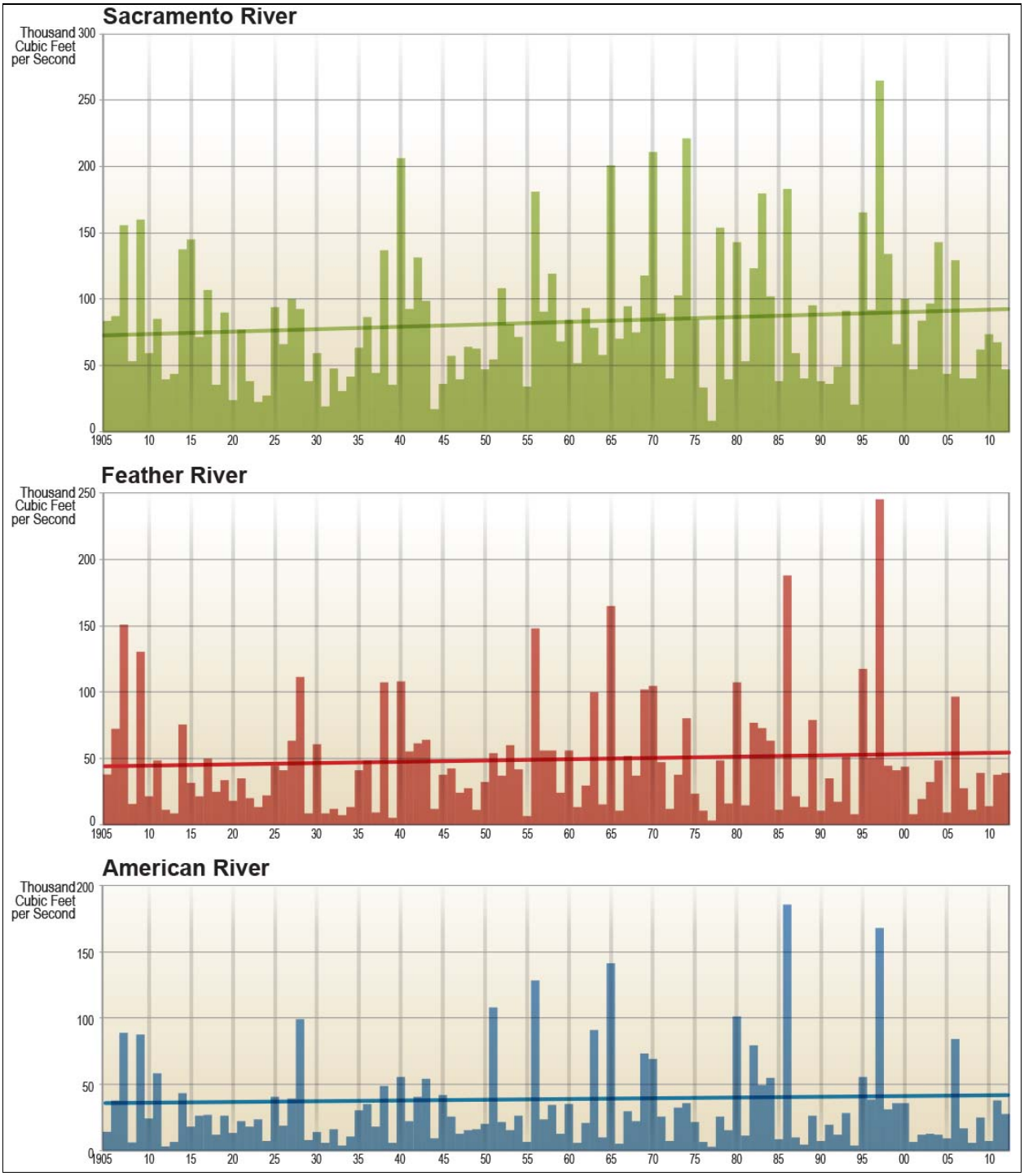
**Figure 3-16 Potential Impacts of Continuing Drought**

[figure to come]

**Figure 3-17 Rain/Snow Historical Trends**

[figure to come]

**Figure 3-18 Rivers: Sacramento, Feather, and American River Runoff Historical Annual Maximum Three-day Flow**

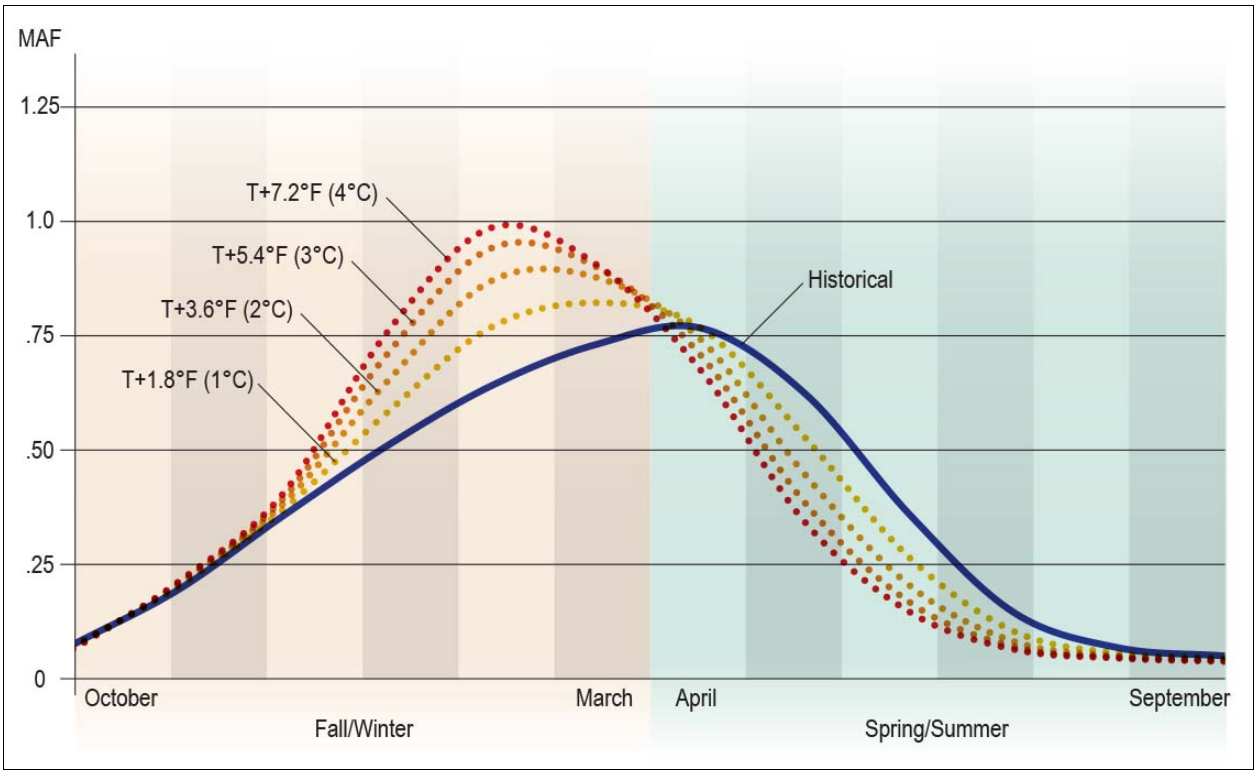



Annual unregulated 3-day maximum flows on the Sacramento, Feather and American Rivers over the past century have shown an increasing trend in the 20th century. The State's water infrastructure will have to be modified to accommodate higher flows from more powerful individual storm events in a warmer atmosphere

**Figure 3-19 Snowpack Projections — Historical and Projected Decreasing California Snowpack**

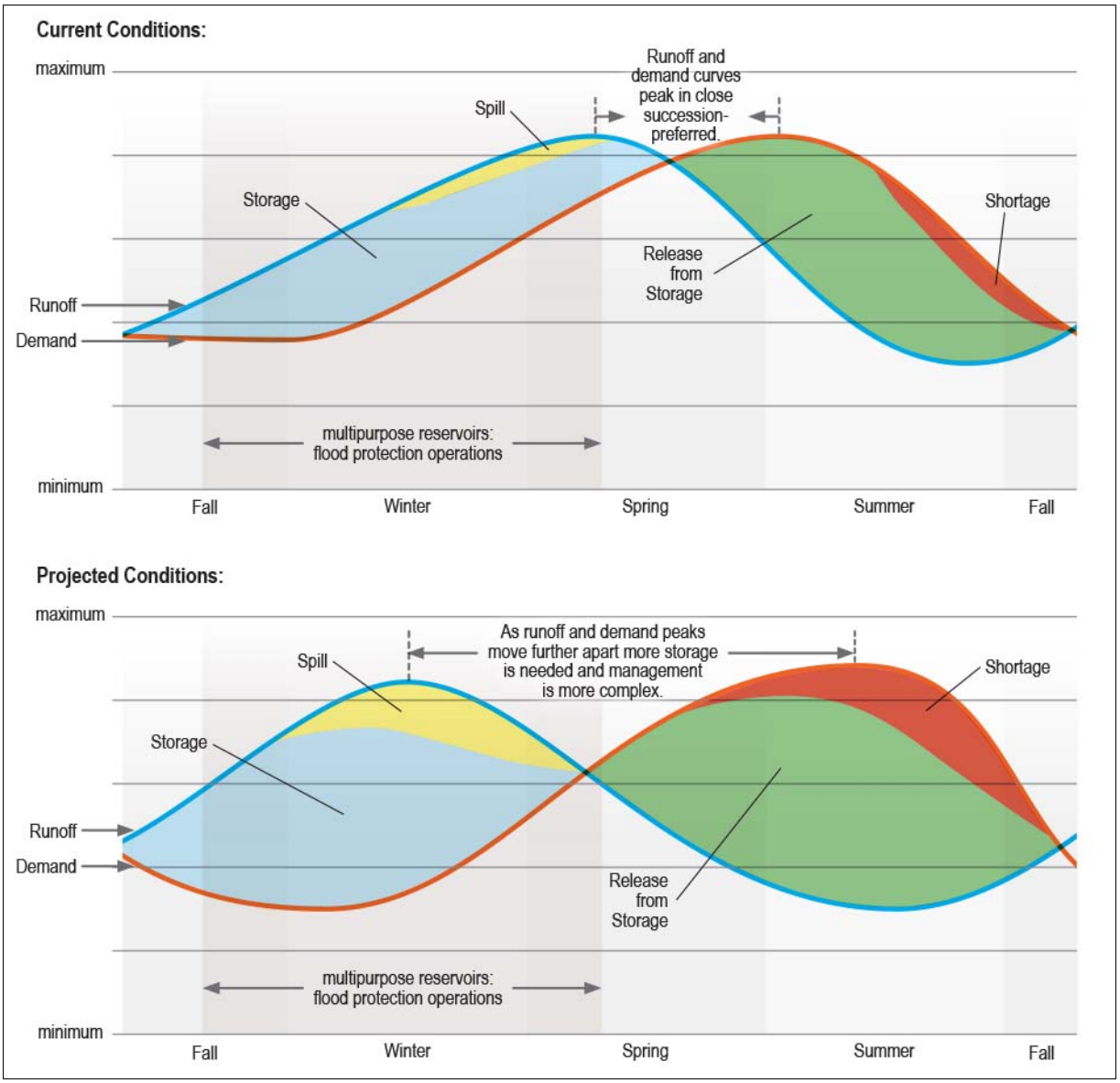
[figure to come]

**Figure 3-20 Climate Change Impacts on State Water Project Inflow to Oroville**



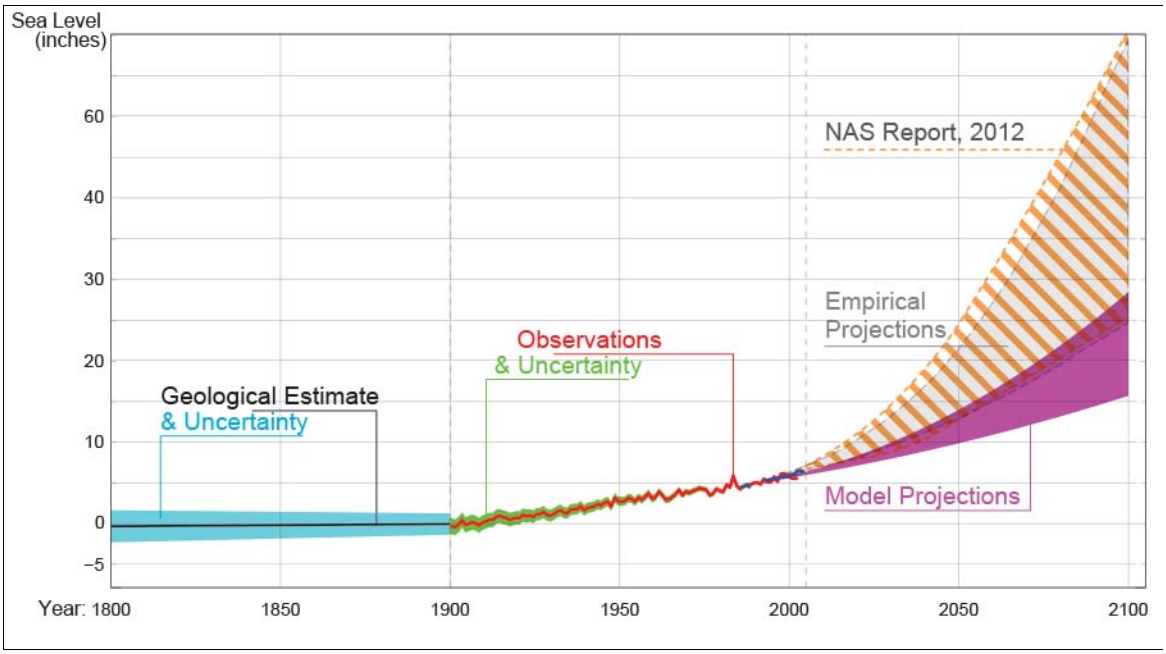

Climate warming will cause substantial reductions in the natural storage of water in the accumulation and melt of seasonal snowpack. Earlier runoff during spring snowmelt period will occur. Monthly average natural stream inflow to Lake Oroville (Water year 1922-2010), before regulated by reservoir operation 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.

**Figure 3-21 How Earlier Runoff Affects Water Availability**



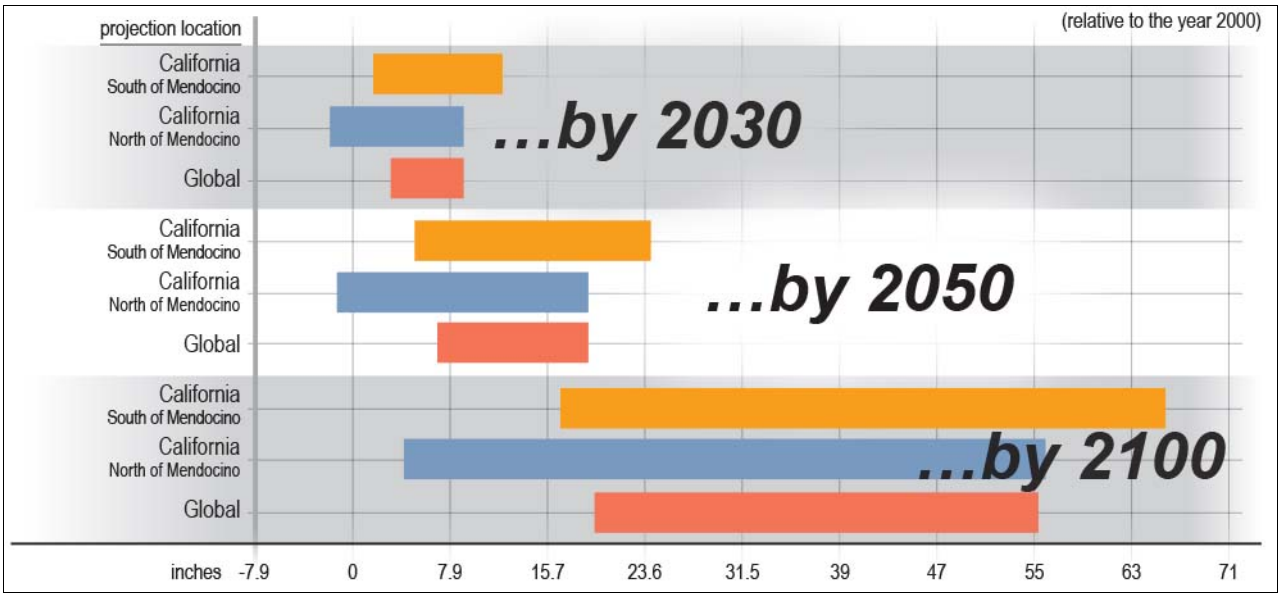

The conceptual impact of earlier runoff and increased summertime water demand is shown in the two curves. The curves show the general shape and timing of runoff and demand in California (individual watersheds will each have unique characteristics). Under "Current Conditions" (top box) runoff peaks in 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. Summer-time demand is higher due to higher temperatures and high demand lasts longer into early fall due to longer growing seasons. Much of the earlier runoff is captured in storage facilities, but because the runoff arrives while reservoirs are being managed for flood protection, much of the runoff is spilled. In spring and summer demand far exceeds runoff and releases from storage, making shortages much more common.

**Figure 3-22 Sea Level Rise Global, Historic, and Projected**




Estimated, observed, and projected global sea-level rise from 1800 to 2100. The pre-1900 record is based on geologic evidence, and the observed record is from tide gages (red line) and satellite altimetry (blue line). Example projections of sea-level rise to 2100 are from IPCC (2007) global climate models (pink shaded area), semi-empirical methods (gray shaded area; Rahmstorf, 2007), and NAS report (yellow banded area, 2012). 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.

**Figure 3-23 Sea Level Rise CA Study Bars**




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 Academy of Sciences study (NAS, 2102), 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.

**Figure 3-24 The Energy Connection**

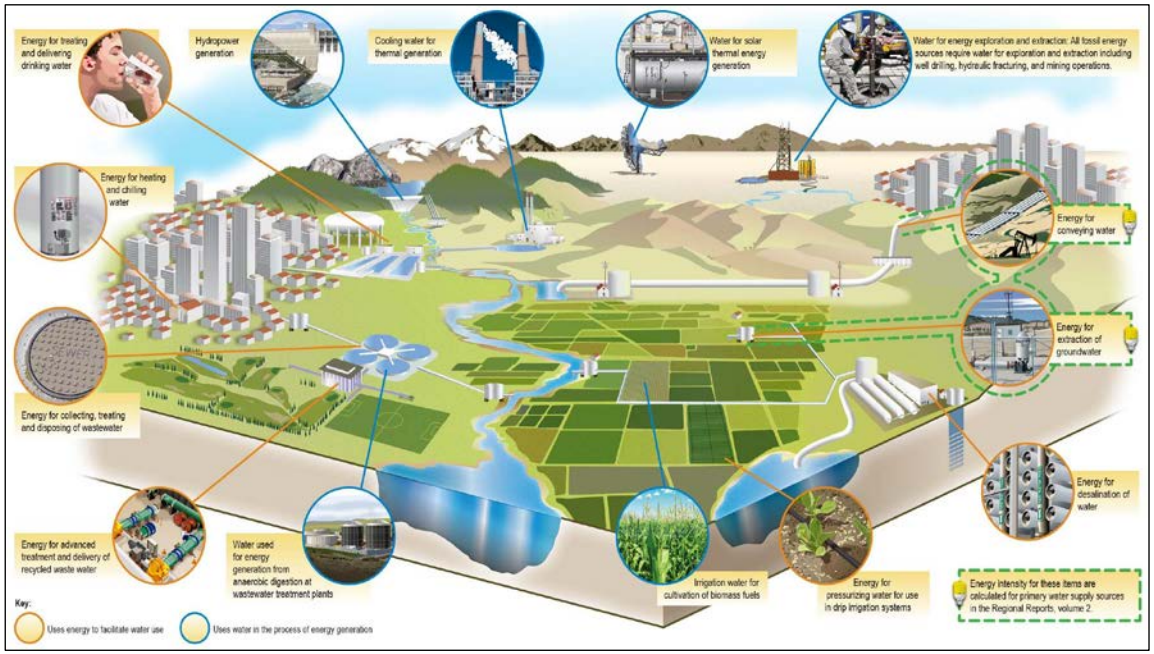
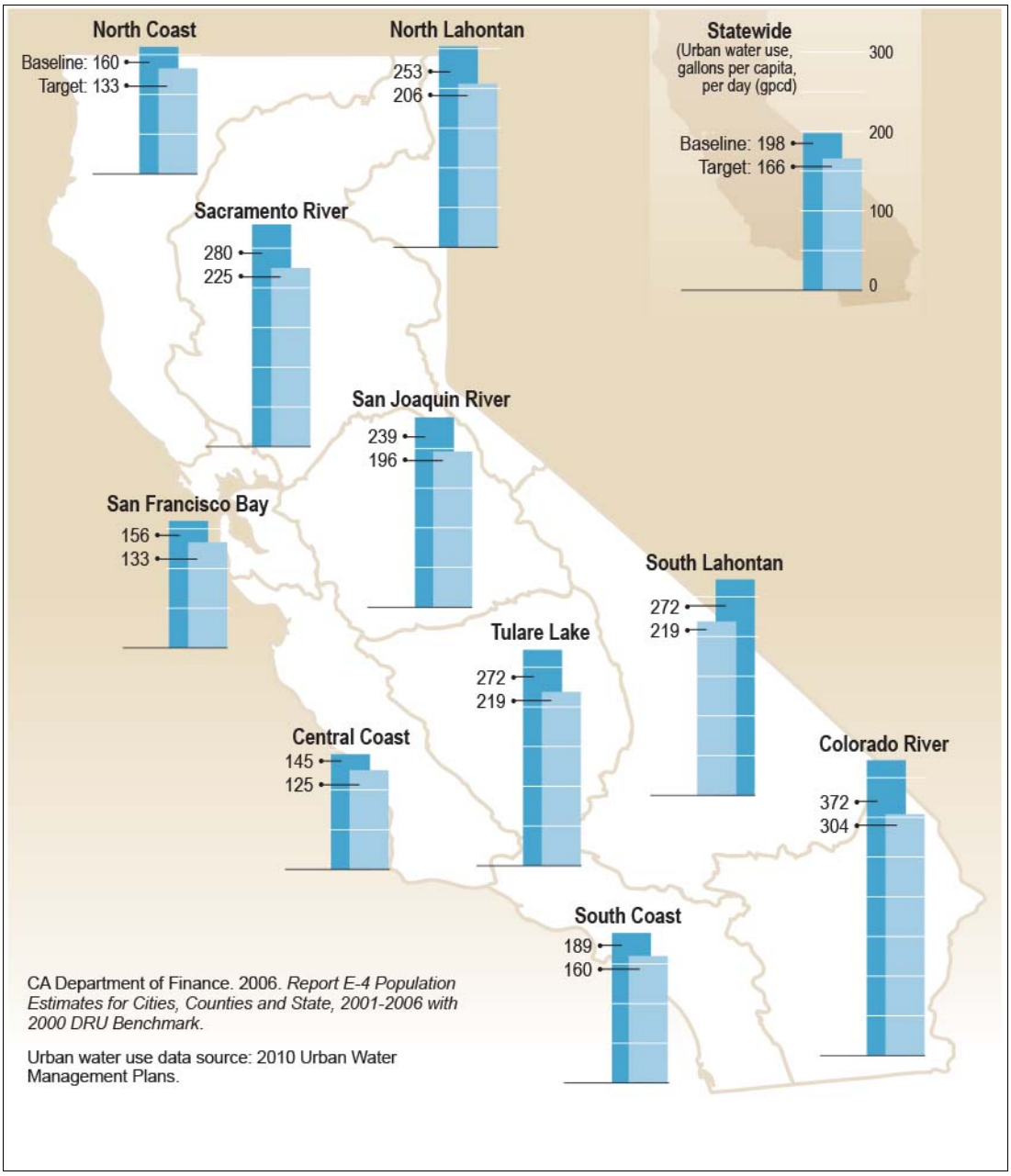


**Figure 3-25 Urban Water Use — Baseline and 2020 Target**



## Box 3-1 About Update 2013 Regional Reports

*California Water Plan Update 2009* expanded the regional reports. Each regional report in 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 ten 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 Mexico border.
- **Sacramento River.** Basins draining into the Sacramento River system in the Central Valley, including the Pit River drainage, from the Oregon border south through the American River drainage basin.
- **San Joaquin River.** Basins draining into the San Joaquin River system from the Cosumnes River basin on the north through the southern boundary of the San Joaquin River watershed.
- **Tulare Lake.** The closed drainage basin at the south end of the San Joaquin Valley, south of the San Joaquin River watershed, encompassing basins draining to Kern lakebed, Tulare lakebed, and Buena Vista lakebed.
- **North Lahontan.** Basins east of the Sierra Nevada crest and west of the Nevada state line from the Oregon border south to the southern boundary of the Walker River watershed.
- **South Lahontan.** The interior drainage basins east of the Sierra Nevada crest, south of the Walker River watershed, northeast of the Transverse Ranges, and north of the Colorado River region. The main basins are the Owens and the Mojave River basins.
- **Colorado River.** Basins south and east of the South Coast and South Lahontan regions, areas that drain into the Colorado River, Salton Sea, and other closed basins north of the 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 in 2006 through 2008. In December 2008, the Delta Vision Committee issued a final implementation report to the Governor and Legislature that includes near-term actions necessary to achieve Delta sustainability and to avoid catastrophe (see Chapter 4 Companion Plans).
- **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.

## 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 to protect the public health, safety, and welfare. Also, several statutes specifically authorize the preparation of local general plans and specific plans. The Governor's Office of Planning and Research provides advisory guidance in the preparation of the State's General Plan Guidelines that assist local governments in land use planning and management.

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

- The California Coastal Commission regulates land use planning and development in the coastal zone together with local agencies (cities and counties).
- The California Energy Commission has exclusive permitting authority for thermal power plants that are 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 although they differ from region to region in organization and regional effectiveness. COGs prepare regional growth plans to meet regional housing and transportation demands.

## 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 July 25, 2012

Much of California agriculture experienced significant negative impacts from the drought and water shortages during 2008 and 2009. On June 4, 2008, the governor issued an executive order proclaiming a statewide drought.

However, some observers claimed that the most effective drought response would be for California agriculture to stop wasting water, increase its water conservation efforts, reduce the acres planted with lower-value, water-intensive crops, (Cooley et al. 2008), and increase the acres of higher-valued crops which use less water.

Representatives of the California agricultural community, as well as state government officials, have disputed these contentions of inefficient 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.*

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 following table is based on water use estimates from DWR Bulletins 160-70, 160-74, and 160-05; 7/12 estimates of 2005 and 2010 California total and/or unit applied water use from DWR Land and Water Use Scientists; and crop acreage and gross agricultural revenue estimates from Department of Food and Agriculture and U.S. Department of Agriculture reports for 1967, 1972, 2000, 2005 and 2010.

| Year | Gross Agricultural Revenue $ Billions (CY dollars) | Gross Agricultural Revenue $ Billions (2010 dollars) | Total Crop Applied Water Million Acre-Feet (maf) | Gross Agricultural Revenue/Acre-Foot (af) of Applied Water $/Acre-Foot (af) (2010 dollars) |
|---|---|---|---|---|
| 1967 | 3.97 | 20.8 | 31.2 | 666 |
| 1972 | 5.1 | 21.2 | 31.7 | 667 |
| 2000 | 27.2 | 34.0 | 31.1 | 1,094 |
| 2005 | 32.4 | 36.0 | 26.1 | 1,378 |
| 2010 | 37.5 | 37.5 | 25.1 | 1,494 |
| % Increase: '67 to 2010 | 844.6 | 80.4 | -19.6 | 124.2 |

The real, inflation-adjusted gross revenue for all of California agriculture increased 80.4 percent between 1967 and 2010, from $20.8 billion (expressed 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 million acre-feet (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 acres estimate includes non-bearing orchard and vineyard acres, and 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. An estimate of California's 2010 multi-cropped acreage is not yet available. It was estimated to be about 540,000 acres in 2005 by the *California Water Plan Update 2009.*

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 40 years. Specifically, in California in 1967 there was $666 (in 2010 dollars) of gross agricultural revenue produced for each acre-foot (af) of water applied to crops. By 2010, this measure of the economic efficiency of agricultural water use in California had risen to $1,494/af. That represents a 124.2 percent 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 past decade. Although such crops may bring in more average gross revenue per acre, they are subject to overproduction and sharp market swings, sometimes resulting in large net losses for the farmers who grow them. Between 2000 and 2010 real gross agricultural revenue per acre-foot of applied water increased about 36.6 percent, from $1,094/af to $1,494/af, expressed in 2010 dollars.

## 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 in order to 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 (DWR 1980). DWR estimated that overdraft is between 1 and 2 million acre-feet annually (DWR 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 follow.

## 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 The Technical Guide.

The primary reason for using water portfolio tables and flow diagrams is to provide an accounting of all water that enters and leaves the state and how it is used and exchanged between the regions. This is important to all water planning activities. Water portfolio data provide information for comparison about how water uses and sources of supply can vary between the wet, average, and dry hydrologic conditions for each of the hydrologic regions. 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 The Technical Guide, which provides a breakdown of the components of developed supplies and uses for agricultural, urban, and environmental purposes. For each of the water years, information is presented as applied water and net water usage, as well as the calculated total water depletion. Much of the environmental water in this table is dedicated to meeting instream flow requirements and in Wild and Scenic rivers, which in some cases can later be reused for other downstream purposes.

**Key Water Supply and Use Definitions**

For consistency with the 1998, 2005, and 2009 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 only on an applied water basis. However, for the subsequent more detailed statewide data tables and each of the individual regional reports, the information has been expanded to 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.

## 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.

*Hanak E, Lund J. et al. 2011. Managing California's Water from Conflict to Reconciliation.*

### 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.

*Failure to Act: The Economic Impact of Current Investment Trends in Water & Wastewater Treatment Infrastructure. American Society of Civil Engineers. 2013.*

## 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.

**PLACEHOLDER Figure A American River at Folsom Dam**

**PLACEHOLDER Figure A American River at Folsom Dam**

[figure to come

## Box 3-9 DWR Environmental Stewardship Principles

- Sustainability – Incorporate a long-term vision that maintains, improves, 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 for more comprehensive evaluation of project alternatives, such as:
  - Operations and maintenance.
  - Public safety.
  - Public resources, including environment and agriculture.

**Box 3-10 Examples of Regional Water Management**

[box to come]

**Box 3-11 Integrated Regional Water Management (IRWM) Grants Accomplishments Since 2009**

[box to come