CALIFORNIA

WATER PLAN

UPDATE 2013

Investing in Innovation & Infrastructure

VOLUME 1

The Strategic Plan

State of California
Natural Resources Agency
Department of Water Resources

CALIFORNIA WATER PLAN UPDATE 2013

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Investing in Innovation & Infrastructure

VOLUME 1
The Strategic Plan

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Foreword

The release of *California Water Plan Update 2013* (Update 2013) comes as severe drought leaves farms and communities across much of the state struggling to conserve and manage water supplies for basic needs. This drought is making news around the country and the world. Millions of Californians rank water as a top concern.

In crisis, there is opportunity. Even as we work to anticipate, mitigate, and document the effects of the current drought, we also must work with a longer view to build the relationships and policies that will help California survive the next inevitable drought — and flood — and safeguard the water supplies necessary to allow the state to thrive economically and ecologically.

Since 1957, the California Water Plan has served as the strategic plan for developing and managing the state's limited water resources. Update 2013 documents California's water management challenges and charts a strategic approach to moving forward, as with past updates, but it also echoes a call for action.

Update 2013 reflects the clear path Governor Edmund G. Brown Jr. forged with his *California Water Action Plan.* Released in January 2014, the five-year plan outlines a set of actions that together bring reliability, restoration, and resilience to California water resources, even as the state's population is expected to grow from 38 million to 50 million by 2049.

Three related themes distinguish Update 2013 from Update 2009. The past five years have only reinforced the value of integrated water management, and this plan closely examines the practices and policies that allow water managers to combine flood management, environmental stewardship, and surface water and groundwater supply actions to deliver multiple benefits across a region. Fundamental to that integrated approach is better alignment in the management of data, planning, policy-making, and regulation across local, State, tribal, and federal governments. Put simply, we need to do a better job of coordinating to achieve our goals.

Finally, Update 2013 features an in-depth discussion of principles and strategies for creating stable, effective sources of financing for water resources, so that funding is not haphazard or inconsistent, but instead encourages investment in innovation and infrastructure.

Drought is but one of many challenges facing California water resource managers today. Update 2013 seeks to create a common awareness of our many challenges. All Californians have a stake and must come together — from a planning and policy-making standpoint — to achieve balanced and effective solutions.

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Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
AB	Assembly Bill
ACEEE	American Council for an Energy-Efficient Economy
ACWA	Association of California Water Agencies
AFTF	Alluvial Fan Task Force
ALS	Agricultural Land Stewardship
AMI	Advanced Metering Infrastructure
ARB	California Air Resources Board
ARRA	American Recovery and Reinvestment Act of 2009
ASCE	American Society of Civil Engineers
AWE	Alliance for Water Efficiency
AWMP	agricultural water management plan
BDCP	Bay Delta Conservation Plan
BIA	Bureau of Indian Affairs
BLM	U.S. Bureau of Land Management
BMPs	best management practices
BTEX	benzene, toluene, ethyl benzene, and xylene
BTH	California Business Transportation and Housing Agency
Cal EMA	California Emergency Management Agency
CAL FIRE	California Department of Forestry and Fire Protection
Cal OES	California Governor's Office of Emergency Services
Cal/EPA	California Environmental Protection Agency
Cal-HR	California Department of Human Resources
California State Parks	California Department of Parks and Recreation
CALVIN	California Value Integrated Network Model
CalWEC	California Water and Energy Coalition
CalWEP	California Water and Energy Program
CASGEM	California Statewide Groundwater Elevation Monitoring
CAT	Climate Action Team
CBC	California Biodiversity Council
CCP	Center for Collaborative Policy
CCST	California Council for Science and Technology
CDFA	California Department of Food and Agriculture
CDPH	California Department of Public Health

Acronyms and Abbreviations continued

CEC	California Energy Commission
CEDEN	California Environmental Data Exchange Network
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation, & Liability Act
CFD	Community Facility District
CII	Commercial, Institutional, and Industrial
CIMIS	California Irrigation Management Information System
CLCA	California Land Conservation Act
CNRA	California Natural Resources Agency
COGs	Regional Councils of Governments
COPA	California Ocean Protection Act
CORP	California Outdoor Recreation Plan
CPUC	California Public Utilities Commission
CRB	Colorado River Board of California
CSLC	California State Lands Commission
CTP	California Transportation Plan
CUWCC	California Urban Water Conservation Council
CVFPB	Central Valley Flood Protection Board
CVFPP	Central Valley Flood Protection Plan
CVP	Central Valley Project
CVPM	Central Valley Project Model
CWC	California Water Code
CWEMF	California Water and Environmental Modeling Forum
CWH	Council for Watershed Health
CWP	California Water Plan
CWSIF	California Water Sustainability Indicators Framework
DAC	disadvantaged community
DBCP	agricultural soil fumigant 1,2-dibromo-3-chloropropane
DBW	California Division of Boating and Waterways
Delta	Sacramento-San Joaquin Delta
DFW	California Department of Fish and Wildlife
DOC	California Department of Conservation
DOD	Department of Defense
DOI	U.S. Department of the Interior

Acronyms and Abbreviations continued

DPC	Delta Protection Commission
DPR	California Department of Pesticide Regulation
DRMS	Delta Risk Management Strategy
DRMS 2009	Delta Risk Management Strategy Phase I
DSC	Delta Stewardship Council
DSS	Decision Support System
DST	Decision Support Tool
DTSC	Department of Toxic Substances Control
DWR	California Department of Water Resources
EFT	environmental flow target
EGPR	Environmental Goals and Policy Report
EIR/EIS	environmental impact report/ environmental impact statement
EJ	environmental justice
EM	emergency management
EOCs	emerging organic contaminants
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
ERP	Ecosystem Restoration Program
EWMPs	efficient water management practices
FAN	Water Plan Federal Agency Network
FCSSR	Flood Control System Status Report
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
Framework	Finance Planning Framework
FRAP	Fire and Resource Assessment Program
FRPA	Fish Restoration Program Agreement
FY	fiscal year
GAC	granular activated carbon
GGERP	Greenhouse Gas Emissions Reduction Plan
GHG	greenhouse gas
GIS	geographic information system
GO	General Obligation (bond)
GPCD	gallons per capita per day
GRACE	Gravity Recovery and Climate Experiment

Acronyms and Abbreviations continued

GWMP	groundwater management plan
ICWT	International Center for Water Technology
IFR	instream flow requirement
IHS	Indian Health Services
IPCC	Intergovernmental Panel on Climate Change
IRWM	integrated regional water management
IRWM Strategic Plan	Strategic Plan for the Future of Integrated Regional Water Management in California
ISI forecasting	interannual climate forecasting
IWM	integrated water management
IWRIS	Integrated Water Resources Information System
IX	ion exchange
KSA	knowledge, skills, and abilities
LEED	Leadership in Energy & Environmental Design
LID	low-impact development
LPA	local primacy agency
maf	million acre-feet
MCL	maximum contaminant level
mgd	million gallons per day
MPa	megapascal
MTBE	methyl tertiary butyl ether
MWh/af	million watt-hours per acre-foot
NAHC	Native American Heritage Commission
NASA	National Aeronautics and Space Administration
NAWCA	North American Wetlands Conservation Act of 1989
NEPA	National Environmental Policy Act
NGO	nongovermental organization
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRC	National Research Council
NRCS	U.S. Department of Agriculture, Natural Resources Conservation Service
NRDC	Natural Resources Defense Council
NWIS	National Water Information System

Acronyms and Abbreviations continued

NWQI	National Water Quality Initiative
O&M	operations and maintenance
OPC	Ocean Protection Council
OPR	California Governor's Office of Planning and Research
OWOW2.0	One Water One Watershed 2.0
OWTS	onsite wastewater treatment systems
P3s	public-private partnerships
PGI	plant growth index
PIER	Public Interest Energy Research Program
POE	point-of-entry
POU	point-of-use
PPCPs	pharmaceuticals and personal care products
PRC	Public Resources Code
psig	pounds per square inch gauge
RAP	Regional Acceptance Process
RCD	Resource Conservation District
RCRA	Resource Conservation and Recovery Act
RDM	Robust Decision-Making
RMS	resource management strategy
RWQCB	regional water quality control board
SAWPA	Santa Ana Watershed Project Authority
SB	Senate Bill
SCG	Strategic Growth Council
SCS	Sustainable Communities Strategy
SEMS	Standardized Emergency Management System
SHMP	State Multi-Hazard Mitigation Plan
SHMP 2010	Enhanced State of California Multi-Hazard Mitigation Plan
SIWRO	Secretary's Indian Water Rights Office
SLR	sea level rise
SMP	Suisun Marsh Habitat Management, Preservation, and Restoration Plan
SMUD	Sacramento Municipal Utility District
SNC	Sierra Nevada Conservancy
SPFC	State Plan of Flood Control

Acronyms and Abbreviations continued

STORET	U.S. Environmental Protection Agency, STOrage and RETrieval Data Warehouse
SVP	Shared Vision Planning
SWAMP	Surface Water Ambient Monitoring Program
SWAN	Statewide Water Analysis Network
SWP	State Water Project
SWRCB	State Water Resources Control Board
taf	thousand acre-feet
TMDL	total maximum daily load
UC Davis	University of California, Davis
Update 2005	California Water Plan Update 2005
Update 2009	California Water Plan Update 2009
Update 2013	California Water Plan Update 2013
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USDA Forest Service	U.S. Department of Agriculture Forest Service
USDA RD	Rural Development (U.S. Department of Agriculture)
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UWMP	urban water management plan
Water PIE	Water Planning Information Exchange
WaterSMART	Sustain and Manage America's Resources for Tomorrow
WDR	waste discharge requirement
WEAP	Water Evaluation and Planning
WERF	Water Environment Research Foundation
WETCAT	Water-Energy Team of the Climate Action Team
WGA	Western Governors' Association
WQP	Water Quality Portal
WRDA	Water Resources Development Act
WRI	Water Resources Institute
WRIMS	Water Resource Integrated Modeling System (formerly known as CALSIM)
WST Notice	Interim Well Stimulation Treatment Notice
WSWC	Western States Water Council

Metric Conversion Factors

Quantity	To Convert from Metric Unit	To Customary Unit	Multiply Metric Unit By	To Convert to Metric Unit Multiply Customary Unit By
Length	millimeters (mm)	inches (in)	0.03937	25.4
	centimeters (cm) for snow depth	inches (in)	0.3937	2.54
	meters (m)	feet (ft)	3.2808	0.3048
	kilometers (km)	miles (mi)	0.62139	1.6093
Area	square millimeters (mm^2)	square inches (in^2)	0.00155	645.16
	square meters (m^2)	square feet (ft^2)	10.764	0.092903
	hectares (ha)	acres (ac)	2.4710	0.40469
	square kilometers (km^2)	square miles (mi^2)	0.3861	2.590
Volume	liters (L)	gallons (gal)	0.26417	3.7854
	megaliters (ML)	million gallons (10)	0.26417	3.7854
	cubic meters (m^3)	cubic feet (ft^3)	35.315	0.028317
	cubic meters (m^3)	cubic yards (yd^3)	1.308	0.76455
	cubic dekameters (dam^3)	acre-feet (af)	0.8107	1.2335
Flow	cubic meters per second (m^3/s)	cubic feet per second (ft^3/s)	35.315	0.028317
	liters per minute (L/mn)	gallons per minute (gal/mn)	0.26417	3.7854
	liters per day (L/day)	gallons per day (gal/day)	0.26417	3.7854
	megaliters per day (ML/day)	million gallons per day (mgd)	0.26417	3.7854
	cubic dekameters per day (dam^3/day)	acre-feet per day (af/day)	0.8107	1.2335
Mass	kilograms (kg)	pounds (lbs)	2.2046	0.45359
	megagrams (Mg)	tons (short, 2,000 lb.)	1.1023	0.90718
Velocity	meters per second (m/s)	feet per second (ft/s)	3.2808	0.3048
Power	kilowatts (kW)	horsepower (hp)	1.3405	0.746
Pressure	kilopascals (kPa)	pounds per square inch (psi)	0.14505	6.8948
	kilopascals (kPa)	feet head of water	0.32456	2.989
Specific capacity	liters per minute per meter drawdown	gallons per minute per foot drawdown	0.08052	12.419
Concentration	milligrams per liter (mg/L)	parts per million (ppm)	1.0	1.0
Electric conductivity	microsiemens per centimeter (μS/cm)	micromhos per centimeter (μmhos/cm)	1.0	1.0
Temperature	degrees Celsius (°C)	degrees Fahrenheit (°F)	(1.8X°C)+32	0.56(°F-32)

Planning for Environmental, Economic, and Social Prosperity

Vic Fazio Wildlife Preserve at Sacramento.
This natural flood control channel contains wetlands; vernal pools; grazing for cattle; winter rice field habitat for waterfowl, birding, educational tours, and hunting; and provides safety and flood protection for homes and valuable business assets.

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Chapter 1. Planning for Environmental, Economic, and Social Prosperity

About This Chapter

The California Water Plan (CWP) is the State's strategic plan for managing and developing water resources statewide for current and future generations. The CWP is required by the California Water Code but does not create mandates or authorize funding. This chapter provides an overview of *California Water Plan Update 2013* (Update 2013), the 11th in a series of such plans prepared since 1957. Specifically, the chapter begins with a summary of the water resource issues facing the State — a call for action. The remainder of the chapter summarizes major concepts that advance this plan beyond *California Water Plan Update 2009* (Update 2009), significantly advancing the State's commitment to integrated water management (IWM).

Figure 1-1 illustrates the role of the CWP in supporting informed decisions about the future of California's water resources. Since the CWP does not create mandates or authorize funding, policy-makers and other water leaders must take the next steps to prioritize investment and authorize funding to achieve results.

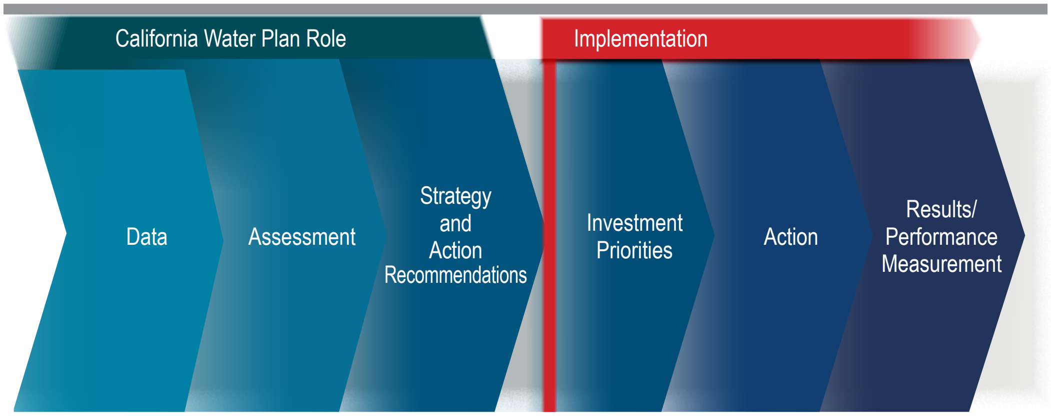
Readers are encouraged to review "Navigating Water Plan Update 2013" within this volume to learn more about the organization of the various contents and topics contained in Update 2013.

A Call for Action

Despite significant physical improvements in water resource systems and in system management over the past few decades, we still face unacceptable risks from flooding, unreliable water supplies, continued depletion and degradation of groundwater resources, and habitat and species declines. Our interconnected system for using and managing water is extremely complex and subject to continually changing natural and human-made conditions. Moreover, our water resources provide critical support for the success of other dynamic systems: our ecosystems, social systems, and economic and market systems. Many of California's ecosystems and much of our water supply and flood protection infrastructure are no longer functioning properly or have exceeded their life cycles. For example, many communities depend on aging water supply and flood management infrastructure badly in need of maintenance or replacement; many essential species and ecosystems are rapidly declining; and some Californians do not have access to safe, clean drinking water. To compound the situation, such stressors as climate change, earthquakes, and lack of stable funding further threaten the integrity and reliability of the state's water supply, flood protection, and environmental systems.

Collectively, our biggest problem may be how we pay for necessary water resource management improvements. Past successful investments in water use efficiency, groundwater management, flood management, ecosystem improvements, and many other important resource management actions have provided a down payment and a good basis for further improvements. However,

Figure 1-1 Integrated Water Management Planning and Implementation



State government investments in our water resources have not been stable or effective enough to maintain, much less improve, our personal safety, financial stability, and way of life. Given the current global financial problems, strapped government budgets (local, State, and federal), and the State's high indebtedness and reduced ability to pay, it is unlikely that California can afford all necessary system improvements. Prioritization that reflects our values will be the key to making investments.

California still depends on many remnants from World War II-era investments and innovations. This practice is borrowing against opportunities for the prosperity of current and future generations. If this practice continues, some degree of foreclosure on our future prosperity will occur in the form of societal catastrophes, such as floods, droughts, and species/habitat extinction. Because our water resource system is very complex, making further improvements is complicated by several issues and challenges. Some of these issues and challenges apply statewide and others apply only to certain areas of the state:

- A growing population, which may increase flood risk and water demands.
- Diversity in societal needs, priorities, and expectations.
- Habitat and species declines.
- Degraded surface water and groundwater quality.
- Declining groundwater levels.
- High groundwater depletion rates (and resulting land subsidence) in some areas of the state.
- Sustained drought conditions in the western United States.
- Seasonal, year-to-year, and geographical variability between water sources and locations of water uses.
- Uncertainties about current and future climate change impacts on floods, groundwater and surface water supplies, ecosystems, and sea level.
- Aging and obsolete water infrastructure.
- System maintenance that has been deferred because of lack of funding or difficulty in meeting regulations.
- Sporadic funding that ebbs and flows with the occurrence of floods or droughts and that lacks the predictability and reliability required for effective implementation.

- General Obligation (GO) bond debt levels that are near an all-time high.
- Misaligned, complex, and often internally inconsistent government planning, policy, and regulation.
- Conflicting roles and responsibilities related to overlapping and narrow authorities and governance.

PUBLIC SAFETY

- ***Reduce flood risk Statewide.***
- ***Provide safe drinking water.***
- ***Improve water quality for fisheries and recreation.***
- ***Clean, safe water supplies.***

ENVIRONMENTAL STEWARDSHIP

- ***Enhance Bay-Delta ecosystem.***
- ***Restore terrestrial and aquatic habitats.***
- ***Improve watershed management.***
- ***Raise awareness and increase stewardship.***

ECONOMIC STABILITY

- ***Enhance State economic output.***
- ***Contribute to job creation and security.***
- ***Promote food production security.***
- ***Provide stable funding for infrastructure.***

These issues place significant risks on public safety, unique ecosystems, and the vital California economy. Everyone in California is affected to some degree by these issues and will benefit from system improvements that reduce impacts. For example, even if a given home is not inundated during a flood, the home's owner may not be able to get to work or may experience a disruption in services. Also, as ratepayers and taxpayers, California's citizens are affected by damages and business disruptions as the State invests to recover from the disaster.

The stakes are immense, as future investment decisions will significantly affect:

- Types and levels of economic activity (including the fates of existing businesses, as well as the fates of employees and their families).
- Future levels of flood risk to people's lives and assets.
- The sustainability of natural resources (including the potential prosperity or extinction of species/habitats and the ecosystem services they provide society).
- The sustainability and efficiency of surface water reservoirs and groundwater basins to provide reliable water supply to meet municipal and agricultural demands, and support ecosystem services.
- California's $2 trillion economy, which has significant value both nationally and globally but is dependent on effective local, State, federal, and private natural resource policies and practices.

In recent years, regional and local entities have been investing in water resources management at a rate of about $18 billion per year. This constitutes the majority of the statewide investments, which total about $22 billion per year in local, State, federal, and private expenditures (more information and citations to source materials can be found in Chapters 2 and 7 within this volume and in Volume 4). This regional focus for water resource planning and implementation begs for a better definition of the role of State government in supporting regional activities and in promoting statewide policies and initiatives that recognize differences in needs from region to region. Investments in innovation and infrastructure (water and flood systems, as well as ecosystems) need to focus on regionally derived, multi-objective actions; consider all resource development costs; and be fairly allocated among beneficiaries.

State, federal, and local agencies need to step up efforts to enhance California's business and finance climate by increasing the certainty that flood damages will be averted, that surface water and groundwater supplies will be reliable and predictable, and that recreational opportunities and environmental sustainability will be improved. Beginning with the three themes presented in the next section, Update 2013 provides a guide for strategic planning and investment that helps planners and policy-makers overcome the complicated physical and institutional barriers to effective water resource management described earlier in this chapter.

Themes for Update 2013

Update 2013 contains a large variety of information, in five volumes. Although these volumes contain many refinements from Update 2009, Update 2013 also has significantly advanced the State's strategic plan in three critical areas. To address challenges and build upon past successes, Update 2013 focuses additional planning and recommendations regarding (1) IWM, (2) government agency alignment, and (3) strategies to invest in innovation and infrastructure.

These three topics can be considered themes for creating the strategic plan contained in Update 2013 (see Figure 1-2). These themes are interconnected and are never considered separately. IWM provides a set of principles and practices that include government agency alignment (and hence efficiency) through a collaborative and transparent planning process. This leads to stakeholder and decision-maker support for focused, cost-effective investment in various aspects of resource management. The Update 2013 strategic plan embraces these three themes as the basis for developing tools, plans, and actions and achieving results. Society's willingness and ability to pay for all government functions and services is decreasing, so these themes do not necessarily call for increased investment so much as for smarter, more efficient, and more effective planning and investment.

The following sections provide a summary of each of the three themes that advance Update 2013 beyond Update 2009.

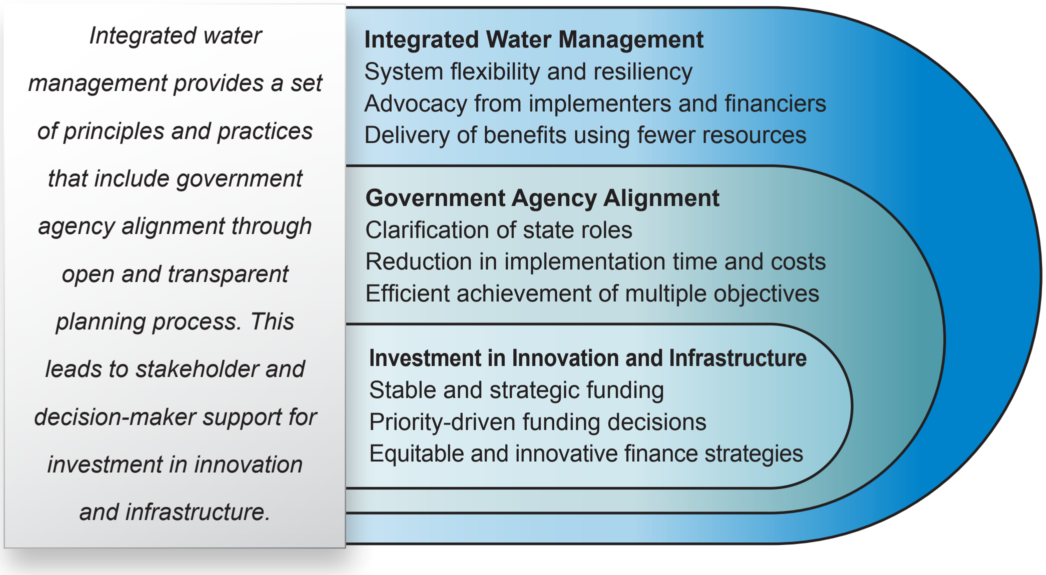
Integrated Water Management

The first theme for Update 2013 is to build upon the foundation for IWM presented in Update 2009. IWM is a strategic approach to planning and implementing water management programs that combines flood management, environmental stewardship, and surface water and groundwater supply actions to deliver multiple benefits across watershed and jurisdictional boundaries.

IWM and integrated regional water management (IRWM) practices have made strides over the past 10 years, and Update 2013 encourages continuation and expansion of these practices. Chapter 2 of this volume, "Imperative to Invest in Innovation and Infrastructure," elaborates on the application of IWM in prioritizing future investments.

Houses near a levee on the Sacramento River, with the Delta in the background.

Figure 1-2 Themes of California Water Plan Update 2013



Update 2013 further clarifies and defines (using an outcome-based approach) the scope and focus of multi-objective IWM. Key IWM outcomes include improved system flexibility and resiliency, increased advocacy for multi-benefit projects from potential implementers and financiers, and delivery of benefits at a faster pace, using fewer resources than is possible from single-benefit projects. While IWM seeks to leverage multiple benefits and partners, IWM does not promote the exclusion of single-purpose projects. In many localities, such projects can and do deliver cost-effective benefits.

Government Agency Alignment

The second theme for Update 2013 is to improve government agency alignment, a key process necessary for successful IWM. Update 2013 includes alignment strategies and actions to build on this concept that was introduced in Update 2009.

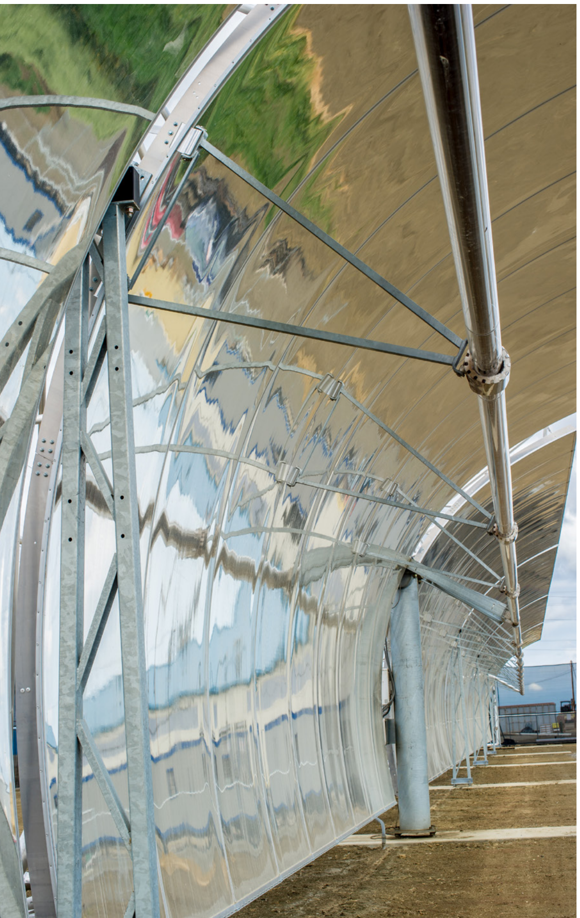
The primary purpose for better aligning local, State, and federal government agencies is to expedite the implementation of resource management strategies (RMSs) (see Volume 3) and help ensure efficient achievement of multiple objectives. This includes collaboration with regulatory agencies to reduce the time and costs required to implement IWM projects. Alignment would not alter agencies' authority or responsibility, but it would facilitate agencies working better together.

Currently, project implementers must navigate and comply with California's labyrinth of laws and regulations, developed by multiple agencies that sometimes operate in silos. This can lead to project delays and mounting planning and compliance costs. These challenges ultimately create significant difficulties in meeting basic community safety and water supply needs and also create difficulties in meeting the goals outlined in the CWP. It is important to acknowledge that regulations also provide basic community safety and water supply needs and help meet many CWP goals. Update 2013 promotes innovation for all IWM tools, including regulation and administrative tools.

At the same time, planning a project within the current regulatory environment is very technically and administratively complex, making it difficult for a single entity to comprehend all aspects of resource management and planning. For example, California has a wide variety of climates, landforms, and institutions, as well as a very diverse, place-based range of cultures that can best be described as constituting *anthrodiversity* (e.g., the human aspect of biodiversity that denotes the public interest and value of varied human habitats, such as rural, suburban, and urban communities). (For more information, see Chapter 3, "California Water Today," in this volume.) Accordingly, data management, planning, policy-making, and regulation must occur in a very collaborative manner, with the ultimate product being a composite of input and data from a large variety of elected officials, influencers, stakeholders, scientists, and subject experts.

Strides have been made to improve alignment, such as the formation and engagement of the CWP's State Agency Steering Committee and Federal Agency Network and of 48 regional water management groups. However, local, State, and federal governments simply do not collaborate enough (and hence are often not aligned) to effectively manage the complexities described above. Impacts of insufficient alignment include the fact that planning and permitting of projects frequently exceed the implementation and operational costs for many infrastructure and ecosystem enhancement activities. In many cases, program and project implementation have yet to occur despite decades of planning activities.

Government agencies must institute a more coordinated, crosscutting, outcome-based, and regionally appropriate approach to achieve desired outcomes. The Update 2013 process was also designed to provide timely and meaningful participation by stakeholders. Update 2013 continued to develop new efforts to communicate, share information, and obtain feedback from California Native American tribal governments, federal agencies, topic-based caucuses, communities, academia, individuals, and organizations.



Investment in Innovation and Infrastructure

The third theme for Update 2013 is to create more stable and disciplined/strategic investment in innovation and infrastructure. A stable, effective funding stream is an essential component for successful water resource implementation. One of the most significant new features of the Update 2013 is a description of principles and strategies for future water financing.

The California Department of Water Resources has determined that, statewide, nearly $600 billion in assets and more than 7 million people are at risk of flooding. There are also several thousand water supply projects and other types of projects identified within the 48 IRWM plans, urban water management plans, and capital improvement plans. In total, resource management actions would require hundreds of billions of dollars of investment over the next few decades to reduce flood risk, provide reliable and clean water supplies, reverse degraded and declining groundwater basins and contain localized and regional land subsidence, and enhance ecosystems and their services. Funding for these investments remains fragmented, unstable, and inefficient, which limits opportunities for further integration. In addition, GO bond debt is near record levels.

Instead of the traditional desalination approach used to treat seawater, Water FX cleans water through use of a Concentrated Solar Still. It uses existing technology, adapting 400-kilowatt parabolic solar troughs originally designed for power generation.

In this volume, Chapter 3, "California Water Today," details existing local, State, and federal IWM spending and debt levels. Historically, projects that tend to be the most implementable, the most consistent with priorities of a particular funding source — or that happen to be at the front of the queue when money becomes available — were often not linked to multifaceted strategic objectives. The approach used for Update 2013 promotes proactive planning and prioritization of activities to drive future investment decisions and funding. See Chapter 7 of this volume, "Finance Planning Framework," for a description of finance strategies, including GO bonds, fees, taxes, and public private partnerships.

Two primary categories of investment are innovation and infrastructure. Innovation includes planning and prioritization improvements, such as the development of new analytical tools. Infrastructure includes structures and facilities that support human activities, but it also includes green infrastructure (e.g., wetlands, riparian habitat, and watershed systems). Both innovation and infrastructure must include initial up-front costs and long-term operation and maintenance costs, which have often been an afterthought to implementation and not adequately financed over a project's useful life. Although innovation investments would help make better decisions and guide infrastructure investments, innovation would cost orders of magnitude less than infrastructure. This indicates that strategic investment in innovation can produce a very high return on investment over the long term by identifying the most cost-effective, robust, and beneficial solutions prior to making large capital investments.

Through intensive collaboration with the Update 2013 Finance Caucus, the investment categories presented in Box 1-1 helped participants toward a common understanding of potential investments. This approach can be used for aligning funding and finance planning processes across more than 2,300 local, State, and federal government agencies, each with its own planning processes and scales.

Guide to Update 2013 Documents — Foundational and New Features

California Water Plan Update 2005 (Update 2005) marked a change in how the State prepared the CWP. For the first time, the document included a strategic plan prepared in a collaborative process that brought together DWR with an advisory committee representing urban, agricultural, and environmental interests. Update 2005 was the first CWP to explicitly include a strategic plan with a vision, a mission, goals, recommendations, and an implementation plan. Update 2009 updated and expanded these strategic plan elements. Update 2013 further updated the strategic plan.

Since the structure of these previous plans has proven useful, several foundational components have been continued for Update 2013 (see Figure 1-3). Foundational components include topics required by statute, as well as recurring features that were identified by stakeholders and CWP users as useful and important to maintain continuity across updates. All volumes contain material that has been updated since Update 2009 was released.

Update 2013 presents the strategic plan in Volume 1. Within it, **Chapter 2, "Imperative to Invest in Innovation and Infrastructure,"** elaborates on the three themes introduced in Chapter 1 and describes the conditions and challenges that constitute an urgency to act. It also lays out the future role of State government in IWM. **Chapter 3, "California Water Today,"** includes

Box 1-1 **State Integrated Water Management Investment Categories**

Innovation:

- Governance of State integrated water management (IWM) improvements.
- Planning and public engagement improvements.
- Strengthening government agency alignment.
- Information technology (data and analytical tools) improvements.
- Water technology and science advancements.

Infrastructure (human and ecosystem), implemented at the following scales:

- Local.
- Groundwater basin.
- Watershed.
- Regional.
- Interregional.
- State.
- Interstate.
- International.
- Tribal.

a comprehensive description of current conditions, challenges, and initiatives for managing California's extreme and variable resources. Chapter 3 also details water uses and supplies (water portfolios) on a statewide basis. Moreover, a central feature of Update 2013 is the oversight of a 28-member State Agency Steering Committee. The steering committee's membership represents the complex and many-faceted nature of governing California's water resources at the State level. The committee's participation helped identify companion State plans that have a direct connection with the CWP, as discussed in **Chapter 4, "Strengthening Government Alignment."** The approach to defining and examining numerous future resource management scenarios through 2050 is outlined in **Chapter 5, "Managing an Uncertain Future."** Chapter 5 summarizes potential future water demand and supply conditions and evaluates the use of RMSs for three hydrologic regions (RMSs are covered in Volume 3 of Update 2013, and California's hydrologic regions are covered in Volume 2). **Chapter 6, "Integrated Data and Analysis: Informed and Transparent Decision-Making,"** contains information and data analysis, as well as key actions, needed to improve and implement strategies for use of water resources. **Chapter 7, "Finance Planning Framework,"** a new part of Update 2013, presents an approach for prioritizing State IWM investments, the role of State government and public funding, an estimate of future investments, and several strategies for financing improvements. **Chapter 8, "Roadmap For Action,"** sets forth the strategic vision, goals, objectives, and principles that guided the preparation of Update 2013 and that provide the ideals for its implementation. This chapter also describes the future actions required to implement Update 2013 and related IWM plans.

Figure 1-3 Foundational Components of California Water Plan Update 2013

Strategic Plan Volume 1	• Goals, Objectives and Related Actions • State and Federal Companion Plans • Water Portfolios • Future Scenarios
Regional Reports Volume 2	• Reports for 10 Hydrologic Regions • Reports for 2 areas with common water interests
Resource Management Strategies Volume 3	• Reports for 30 resource management strategies
Reference Guide Volume 4	• Detailed reference material related to information presented in Volumes 1, 2, and 3
Technical Guide Volume 5	• Web portal to document assumptions, data, analytical tools, and methods

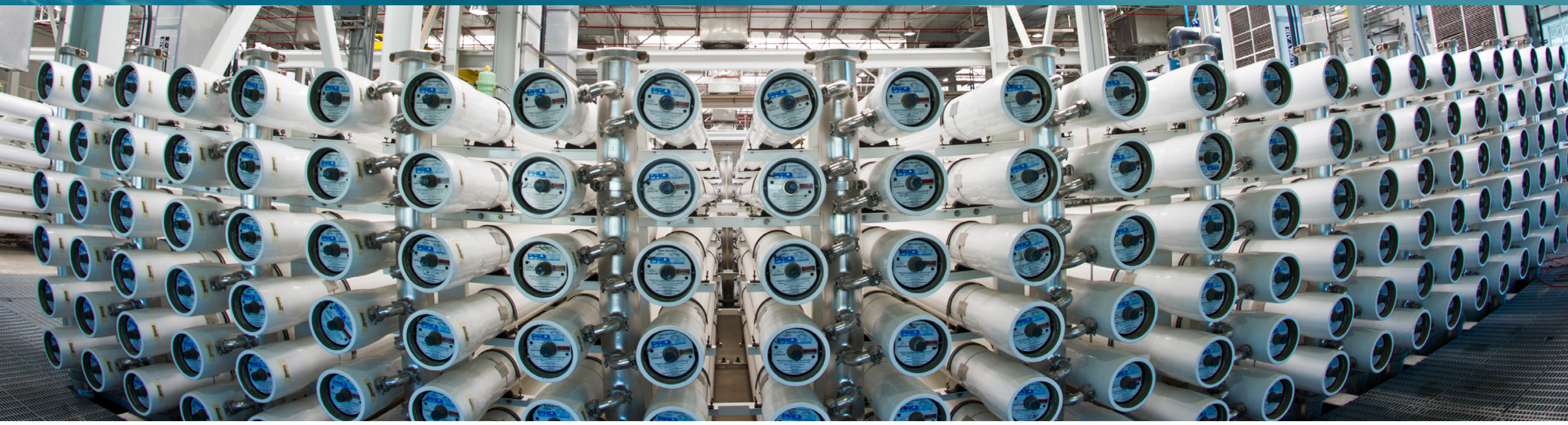
Enhancements to Update 2013 — Adapting to Changing Decision-Support Needs

Update 2013 builds on and advances the evolution in planning that began with the Update 2005 process. As described earlier in this chapter, the major enhancements for Update 2013 compared with Update 2009 are the emphasis on the three overarching themes of IWM, government agency alignment, and investment in innovation and infrastructure.

In addition, during the Update 2013 scoping process in 2010, the many advisory bodies and the public suggested enhancements for Update 2013. The suggestions can be broadly grouped into five categories, for improvements in:

- New and expanded topics.
- Regional planning.
- Collaboration.
- Data, metrics, and analyses.
- Adaptive management.

Detailed descriptions of each proposal are provided in Volume 4, *Reference Guide.* Although all proposals for enhancements could not be accommodated within the scope of Update 2013, they serve as a starting point for scoping the next update of the CWP, to be released in 2018.



Orange County Water District (OCWD) manages the large groundwater basin that provides reliable, high-quality groundwater to 19 municipal and special water districts that serve 2.4 million customers in northern and central Orange County.

After an extensive collaborative process of screening and prioritization, the following enhancements for Update 2013, identified as critical for ensuring relevant and useful decision support, have been incorporated into the strategic plan by Update 2013 staff and stakeholders.

- New and expanded topics:
  - **Finance planning framework.**
    - Critical State investment priorities for water supply, water quality, flood planning and management, and environmental stewardship activities were identified.
    - Innovative, stable, equitable, and fiscally responsible financial strategies and revenue sources were recommended.
  - **New resource management strategies (RMSs)** — New RMSs were added for sediment management, outreach and education, and water and culture.
  - **Flood management** — Flood management, in the form of IWM, was incorporated throughout the CWP. This effort included thorough incorporation of the report California's Flood Future: Recommendations for Managing the State's Flood Risk, which presents a call to action and recommendations for reducing flood risk statewide.
  - **Surface and groundwater quality** — Regional and statewide water quality challenges were highlighted, and strategies were recommended to protect and improve water quality to safeguard public health and the environment and to improve water supply reliability.
  - **Groundwater conditions and management** — Data, basin descriptions, and other information about statewide and regional groundwater conditions and change in storage were expanded, and existing groundwater governance structures were evaluated for better understanding of groundwater management alternatives and, ultimately, more informed decisions.
  - **Water technology and science** — Information was identified and expanded relating to statewide and regional water technology needs, opportunities, and challenges for implementing new technologies in California. Development of Update 2013 was supported through in-depth discussions and deliberations of innovation, technology, applied research, science, and development topics and issues.
- Regional planning:
  - **Emphasis on planning at a regional scale** — Regional outreach was expanded, the scope of regional reports was broadened to include regional RMSs, and recognition of IRWM plans and priorities was increased.

- ○ **Near-coastal resources** — Topics and issues were added to include near-coastal interfaces with regard to several issues with a nexus to the management of fresh water, such as: desalination brine disposal, the influence of freshwater runoff in near-coastal ocean environments, and the interface of ocean and freshwater habitats (i.e., anadromous fisheries).

- Collaboration:
  - **Expanded outreach and collaboration** — Seven topic-based caucuses were established, a Federal Agency Network was launched, five State agencies were added to the State Agency Steering Committee, and a new Tribal Advisory Committee was formed.
- Data, metrics, and analysis:
  - **Sustainability indicators** — An analysis framework was developed to identify, compute, and evaluate sustainability indicators that would help monitor progress toward reaching the goals and objectives of Update 2013.
  - **Improved data, metrics, and analysis methodologies** — Data and methods for quantifying alternative scenarios of future water demand and supply conditions were improved and were used to evaluate the performance of potential water management responses for Update 2013.
- Adaptive management:
  - **Update 2013 *Progress Report*** — A new, mid-process progress report was added, to assess progress on Update 2009 recommendations and suggest areas of focus for Update 2013.
  - **Climate change** — Greater detail and more regionally specific climate change information was provided for Update 2013 than was provided within Update 2009. This included regionally appropriate and statewide adaptation and mitigation strategies, RMSs, and climate change scenario decision support.

Progress Toward Implementing Update 2009 Objectives

Update 2009 included an "Implementation Plan" chapter with objectives and related near- and long-term actions. By statute, the CWP has no powers to mandate that its recommendations be funded or implemented. The plan must be furthered by agencies or voting bodies that can implement its tools, plans, and actions. IWM entities at the local, State, and federal level have initiated and completed many of these actions, and they continue to make progress on other actions. Generally speaking, notable progress includes better interagency communication and collaboration, improved understanding of climate change, and new analytical approaches and tools to help manage resources into the future.

Progress toward implementing Update 2009 is detailed in the Update 2013 *Progress Report* (Progress Report). The Progress Report assessed whether and to what extent the 13 objectives (and 115 related actions) of Update 2009 have been implemented. It also identified key implementation impediments, as well as better ways to articulate more measurable objectives for Update 2013. This information can be used to direct the attention and resources of decision-makers, planners, and stakeholders to actions that are not progressing. The Progress Report also helped make Chapter 8, "Roadmap For Action," of Update 2013 more implementable and measureable (for reporting in the Update 2018 Progress Report). Table 1-1 is a summary of progress on the implementation of Update 2009 objectives and actions from the Progress Report.

Table 1-1 Progress Report on Implementation of Update 2009

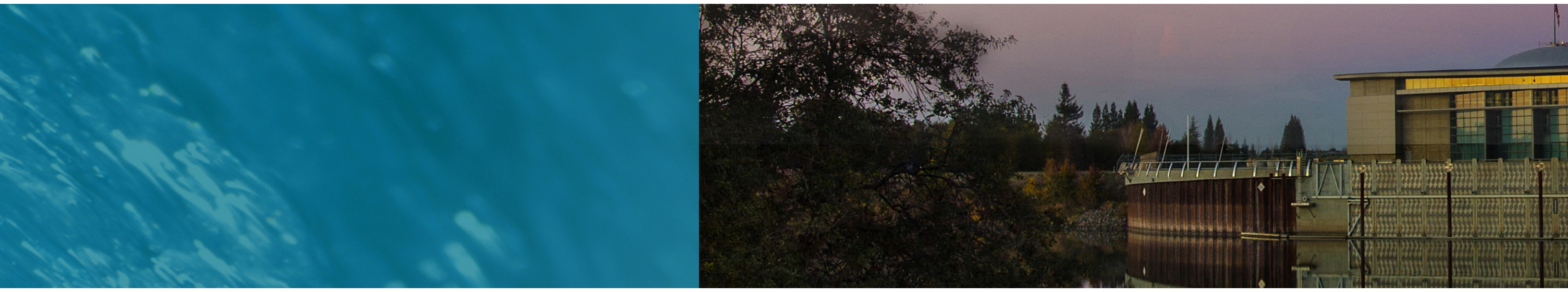
Update 2009 Objective	Status	Trend
1. Expand Integrated Regional Water Management	Good	Neutral
2. Use and Reuse Water More Efficiently	Requires attention	Good
3. Expand Conjunctive Management of Multiple Supplies	Requires attention	Good
4. Protect Surface Water and Groundwater Quality	Requires attention	Good
5. Expand Environmental Stewardship	Requires attention	Neutral
6. Practice Integrated Flood Management	Good	Good
7. Manage a Sustainable California Delta	Good	Good
8. Prepare Prevention, Response, and Recovery Plans	Neutral	Requires attention
9. Reduce Energy Consumption of Water Systems and Uses	Neutral	Neutral
10. Improve Data and Analysis for Decision-making	Good	Good
11. Invest in New Water Technology	Good	Good
12. Improve Tribal Water and Natural Resources	Neutral	Requires attention
13. Ensure Equitable Distribution of Benefits	Unavailable	Unavailable

In addition to progress made specifically toward implementing the Update 2009 objectives and related actions, many related significant accomplishments have been made or are ongoing since 2009. For example, the 2009 water legislation package (described further in Chapter 3 of this volume, "California Water Today") represents major steps toward ensuring a reliable water supply for future generations, as well as restoring the Delta and other ecologically sensitive areas. There has been significant progress in implementing this legislation. Regional water management groups and water communities have continued to advance IRWM through the development of 48 regional planning entities, and since 2009 a large portion of the more than $10 billion in State GO bonds has been invested in IRWM activities. State agencies have continued to seek alignment of data, plans, policies, and regulation. Almost universally across all programs, data and technology have greatly improved Californians' ability to better manage water resources and plan for future improvements. More complete descriptions of implementation progress can be found in the Progress Report; in Chapter 3, "California Water Today"; in Chapter 4, "Strengthening Government Alignment"; and in Volume 4, *Reference Guide*.

VOLUME 1 – THE STRATEGIC PLAN

CHAPTER 2

Imperative to Invest in Innovation and Infrastructure



Freeport Intake Facility on the Sacramento River. In 2002, after years of conflict, the Freeport Water Authority began a successful collaborative effort to build the Freeport Regional Water Project. The Intake Facility includes a state-of-the art fish screen and a drinking water distribution system that benefits over 40,000 customers in Sacramento County. In addition, the project will serve 1.3 million customers in Alameda and Contra Costa counties during dry years.

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Chapter 2. Imperative to Invest in Innovation and Infrastructure

About This Chapter

This chapter describes the urgency behind continuing to invest in integrated water management (IWM) in California. Strategic investments in both innovation and infrastructure (human-made and natural) will provide for future public safety enhancements, environmental stewardship, and economic stability. This course of action will help avert several foreseeable societal catastrophes, such as loss of life and property from floods, unreliable water supplies, and adverse impacts of droughts; depletion of groundwater basins; irreversible land subsidence; and declining ecosystems.

The primary purpose of this chapter is to guide strategic, disciplined investment and remove implementation impediments by working to achieve the California Water Plan's (CWP's) vision, mission, goals, and objectives, which are described herein. This chapter (in conjunction with more specific actions in Chapter 8, "Roadmap For Action") will help reduce uncertainty and improve the reliability of the California's watersheds and water systems for all uses. In turn, California's business climate and quality of life will be improved. An open and transparent planning process will lead to stakeholder and decision-maker support for investment in various areas of resource management.

This chapter describes the following:

- A Critical Time to Invest.
- Fundamental Lessons.
- Focus of Update 2013 — Three Overarching Themes.
- Role of State Government in Integrated Water Management.
- Looking to the Future.

A Critical Time to Invest

Water planners, managers, and stakeholders throughout California agree that our state is facing a convergence of unprecedented challenges. Such challenges range from social (e.g., complicated governance, divergent priorities among stakeholders, unwillingness or inability to pay for public infrastructure or services) to geophysical (e.g., climate change, limitations of natural resources, limitations of existing physical infrastructure). State, federal, and local agencies need to step up efforts to enhance California's business and finance climate by increasing the certainty that flood damages will be averted, surface water and groundwater supplies will be reliable and predictable, and recreational opportunities and environmental sustainability will be improved.

Resolving these challenges is becoming more difficult as time passes. While many of the most cost-effective system infrastructure improvements have already been constructed, past implementation did not always adequately account for costs of ecosystem or other improvements that society values today. As a result, future system improvements are going to cost more. Adequate funding will be further complicated by the lingering effects of the financial crisis that State, federal, and local agencies have faced in recent years.

California still faces many of the conditions that were highlighted in *California Water Plan Update 2009* (Update 2009). While the drought that the state faced in 2009 has passed, January and February 2013 (when much of the snowpack should accumulate) were observed as the driest January and February since 1921, indicating a high probability that California is entering another critical drought. In many cases, the effects of the challenges described below can combine to create problems larger than their sum. Over the longer term, climate change has the potential to reduce our snowpack storage, increase sea level, and degrade water quality in the estuaries — all of which reduce water supply reliability. In addition, the timing, magnitude, and duration of precipitation and snowmelt runoff in some areas may increase flood risk and reduce seasonal recharge and long-term aquifer storage. Court decisions and regulations have resulted in the reduction of water deliveries from the Sacramento-San Joaquin Delta (Delta) by about 20 to 30 percent. Key fish species continue to decline. In some areas of the state, our ecosystems and quality of underground and surface waters are unhealthy.

California needs to increase and sustain investment in innovation and infrastructure (constructed and ecosystem) as described in *California Water Plan Update 2013* (Update 2013) (see Chapter 7, "Finance Planning Framework") or live with an unacceptable reduction in public safety, quality of life, and environmental stewardship for generations to come. The challenges identified in Chapter 3, "California Water Today," though often interrelated, can be viewed as independent issues facing water management. Combinations of these challenges can be summarized as the critical conditions discussed below, the potential consequences of which make this a critical time to invest. For example, population, land use, and geophysical variability, as well as other factors that can pose challenges, have an impact on how droughts affect each region.

Greater Drought Impacts

Droughts cause economic harm to urban and rural communities and loss of crops, heighten the potential for species collapse and extreme fire danger, degrade water quality, and increase stresses on groundwater aquifers. Even a single dry year can negatively affect activities that are wholly dependent on unmanaged water supplies, such as dryland farming, livestock grazing, and many recreational water uses. Multiple consecutive dry years have and will continue to occur, a condition that exponentially increases impacts of reductions in available surface and groundwater supplies. Vulnerabilities to drought are increasing due to the several factors, including population growth, increases in permanent crops, aging or limited water distribution

Folsom Lake bed in the summer of 2013.

infrastructure, previous implementation of the most cost-effective or implementable resource management strategies (e.g., water users who have already increased efficiency may find it more challenging to achieve additional water use reductions during droughts), more volatile and unpredictable climate patterns, and ecosystems that are already struggling as a result of other factors. During dry years, water management becomes more complex when various water users may seek to use the same diminished water supply. (See Figure 2-1, "Historical Droughts in California.")

Figure 2-1 Historical Droughts in California

Increasing Flood Risk

The California Department of Water Resources has estimated that nearly $600 billion of assets (buildings, crops, and public infrastructure) and over 7 million people are at risk of flooding. Flooding can affect California at different times of year and in different forms, such as stormwater flooding and alluvial fan flooding (see Figure 2-2). Every Californian, however, is exposed to the significant impacts that result from flooding, including disruption of commerce, emergency response and the secondary impacts that ripple through the state's economy (e.g., redirection of funding from other State government services). In effect, all California taxpayers participate in recovery from floods. People continue to move into floodplains and flood-prone areas throughout the state. Sacramento, California's capital, has one of the lowest levels of flood protection of any major city in the nation. Under certain circumstances, some urbanized communities in the region could be flooded by more than 20 feet of water. The threat of catastrophic flooding, especially in the deep floodplains of the Central Valley and the Delta, is a continuing concern. If not proactively managed in the future, devastating economic, environmental, and social impacts resulting from catastrophic flood events will occur, as experienced in other areas of the country as a result of Hurricanes Sandy and Katrina.

Depleting Groundwater Basins

California's groundwater supplies and aquifer storage capacities play a very significant role in IWM. Thirty million Californians depend on groundwater for a portion of their drinking water supply. Reliance on groundwater will continue to increase as the population grows, as limitations on available surface water continue, and as potential impacts of climate change occur. Groundwater provides about 40 50 percent of total annual agricultural and urban water uses. Some cities, coastal basins, and rural areas are 100-percent dependent on groundwater for their water supply. A number of groundwater basins in California have experienced alarming declines in groundwater levels, degradation in

Figure 2-2 Types of Flooding in California

Tsunami Flooding

Example Crescent City, 1964

Engineered Structure Flooding

Example Sweetwater Dam Failure,1916

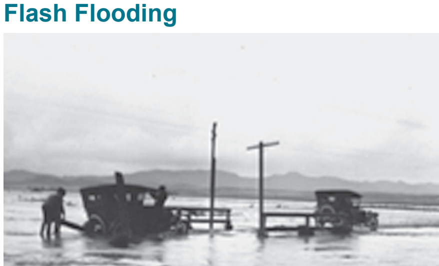
Coastal Flooding

Example Point Mugu, 1983

Debris Flow Flooding

Example Laguna Canyon Channel, 1969

Flash Flooding



Example Perris, 1916

Slow Rise Flooding

Examples Yuba City, 1955

Sacramento, 1878

Salinas River Basin, 1969

Alluvial Fan Flooding

Example Borrego Palm Canyon, 1979

Stormwater Flooding

Example Borrego Springs, 2003

water quality, irreversible land subsidence, decreases in base-flow contribution to surface water systems, and subsequent loss of vital ecosystem services.

The Central Valley aquifer of California is the second most pumped aquifer in the U.S. and contributes 7 percent of the total U.S. food supply ($21 billion annually) and contains one-sixth of the nation's irrigated land. Groundwater storage depletion in the Central Valley aquifer from 2005 to 2010 ranges between 5.5 and 13.0 million acre-feet. Declines in groundwater levels in Tulare Lake hydrologic region have reached 25 feet for the same period (refer to Figure 2-3). (See Chapter 3, "California Water Today," for more detailed information on groundwater conditions.) Update 2013 advanced and applied a method for calculating the change in the amount of water stored in the aquifer. The purpose of applying this method is to better inform the actions needed to help align statewide policy, focus limited financial resources, and ultimately improve groundwater and surface water management practices. Linking the local management of the two inseparable resources of groundwater and surface water, within the context of a broader IWM plan, will be an important step toward the goal of creating a sustainable and resilient water portfolio for the future. (See Chapter 6, "Integrated Data and Analysis," for more information.)

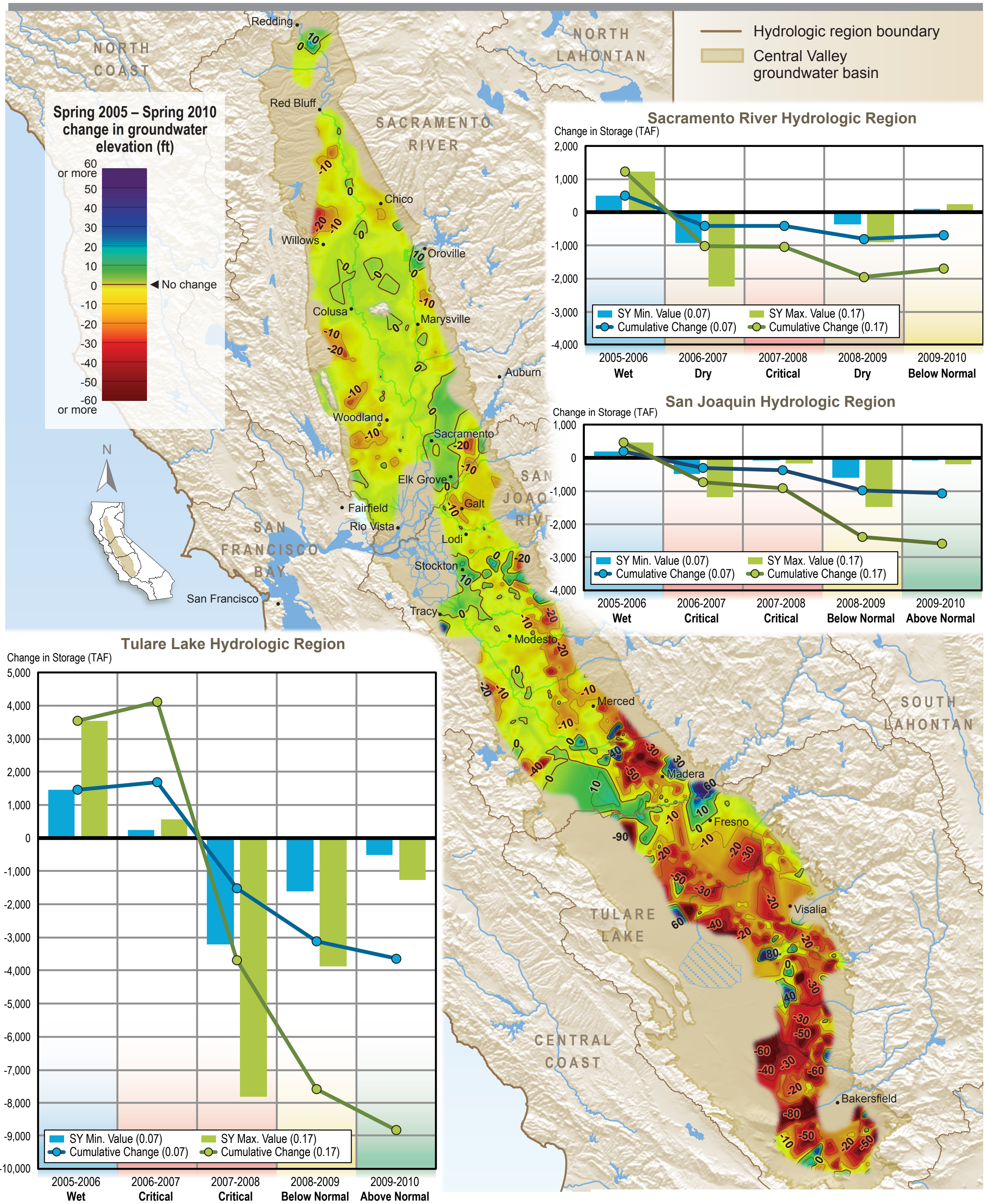
Declining Ecosystems

California has lost more than 90 percent of the wetlands and riparian forests that existed before the Gold Rush. Successful restoration of aquatic, riparian, and floodplain species and communities ordinarily depends on at least partial restoration of physical processes that are driven by water. The diminution of these physical processes often leads to displacement of native species, presenting another huge barrier to ecosystem restoration. The ecosystems in many areas of the state have declined; many species have been listed as threatened or endangered. Watershed health, including lack of suitable habitat, competition with invasive species, pollution, and water management activities contribute to the decline. One of the most obvious examples of an ecosystem in crisis is the Delta. Salmon, delta smelt, and other species are at their lowest levels since records were first kept about 50 years ago. This decline has led to court restrictions and new regulations on Delta diversions. (Refer to Figure 2-4, "State-Listed and Federally Listed Species in California.")

Degraded Surface and Groundwater Quality

The quality of groundwater and surface waters varies significantly throughout the state. Degradation is occurring naturally and as a result of human activities. Improvements must be made in drinking water treatment, cleanup of polluted groundwater, salt management, and urban runoff management. High priority must be given to creating healthy watersheds to keep source water free of pollutants, such as pathogens and chemicals that are regulated or will be regulated in the near future. Recently, some unregulated chemicals and pollutants have emerged as actual or potential contaminants. They can occur in pharmaceuticals and personal care products, byproducts of fires and fire suppression chemicals and agents, or discarded elements of technology.

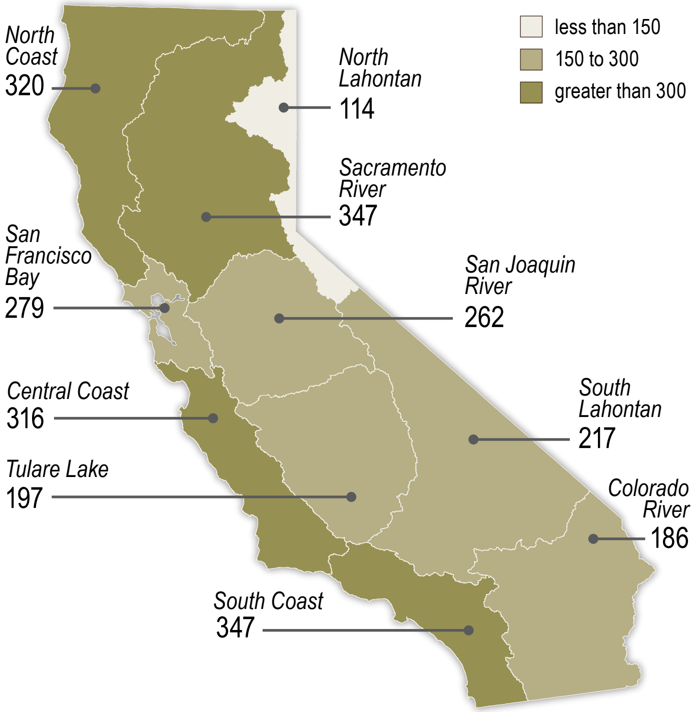
Figure 2-3 Change in Groundwater Storage in the Central Valley Aquifer of California (2005-2010)



Aging Infrastructure

Conditions today are much different than when most of California's water system was constructed, and upgrades have not kept pace with changing conditions, especially considering the growing population; changing societal values, regulations, and operational criteria; and the future challenges accompanying climate change. Many of California's water supply and flood protection systems are composed of aging infrastructure with decades of accumulated maintenance deficiencies. To compound the problem, State and regional budget shortfalls and a tightened credit market may delay new projects and programs.

Figure 2-4 State-Listed and Federally Listed Species in California



Changing Water Demands

California's changing and potentially competing demands for water come from many sectors. All uses generally can be characterized as urban, agricultural, or environmental. The state's population continues to grow and the trend has been faster growth in warmer inland regions. From 1990 to 2010, California's population increased from about 30 million to about 37.3 million. The California Department of Finance projects that this trend means a state population of roughly 51 million by 2050. Chapter 5, "Managing an Uncertain Future," presents scenarios of future changes in water demand through 2050 that consider uncertainties surrounding future population growth, land use decisions, and climate change. Although these uncertainties can affect future demand for water supply, future urban water demands, under many scenarios, could increase by several million acre-feet.

Physical Variability and Social Diversity

Providing solutions under the critical conditions described above becomes more difficult in the face of physical variability and social diversity. California is often recognized as a land of extremes in relation to its diversity of cultures, ecosystems, geography, and water resources. Precipitation, which is a primary source of California's water supplies, varies from place to place, season to season, and year to year. Most of the state's snow and rain fall in the northern mountains and eastern regions, and the most water is used in the valleys and along the coast.

Moreover, the state's ecosystem, agricultural, and urban water users have variable needs for the quantity, quality, timing, and place of use. The water and flood systems face the dual threats of too little water to meet needs during droughts and too much water during floods — sometimes within the same year. The physical and social realities within California do not allow for a one-size-fits-all approach to water management and planning. California's State, federal, tribal, regional, and local projects and programs must work together to make water available in the right places and times and to safely move floodwaters.

California's *anthrodiversity* (e.g., the human aspect of biodiversity that denotes the public interest and value of varied human habitats, such as rural, suburban, and urban communities) creates additional IWM planning complexities. The state's various cultures, organizations, and individuals naturally assign different values and priorities to IWM-related assets, services and benefits. They also naturally have different reliance on, or rates of consumption of, IWM-related resources. Disparate priorities, practices, and resource consumption rates define California's rich social diversity. To further complicate planning, various regions of the state experience differences in natural hydrology, ecosystem condition, water supply and use, flood risk, and opportunities and needs for system improvements. Therefore, while investments for statewide water management must be made, the focus of planning and investment needs to be on a regional basis.

See Chapter 3, "California Water Today," for a more complete description of variability and diversity throughout California.

Climate Change

The above conditions become more difficult and uncertain given potential future climate change. Water sector vulnerability to climate change stems from changes in hydrology that affect frequency, magnitude, and duration of extreme events, including flooding and drought. In turn, these affect water quantity, quality, and infrastructure. Reduction in snowpack storage affects water supply reliability, hydropower, and the amount of runoff during extreme precipitation that leads to flooding. Rising sea levels increase susceptibility to coastal flooding. These climate change conditions also affect Delta levee integrity and water quality. Changes in Delta water quality and the need to meet water quality requirements may require changes in upstream water management and resultant changes in local water supply reliability and water quality. Recreation and tourism are also likely to suffer due to lower water levels in waterways and reservoirs and declining snowpack. (Refer to Figure 2-5, "Climate Change Effects.")

Specific consequences of climate change are that higher temperatures will melt the Sierra snowpack earlier and drive the snowline higher, resulting in higher peak flood flows and less snowpack to supply water to California users. Rainfall events may become more frequent and intense, contributing to increased flood risk. Droughts may become more frequent and persistent this century. Accelerating sea level rise will produce higher storm surges during coastal storms. Together, higher winter runoff and sea level rise will increase the probability of levee failures in the Delta. Sea level rise will also place additional constraints on water management and exports from the Delta, especially as a

King tides make their way onto Capitola Beach on Wednesday, January 8, 2013.

result of increased salinity from tidal exchange in the Delta. By the end of the 21st century, the magnitudes of the largest floods may increase from 110 to 150 percent of historical magnitudes (Das et al. 2011; Pierce et al. 2012).

Future Uncertainty

California must invest in IWM activities in the face of many uncertainties. There are enormous uncertainties facing water managers in planning for the future. How water demands will change in the future; how ecosystem health will respond to human use of water resources; what disasters may disrupt the water system; and how climate change may affect water availability, water use, water quality, and the ecosystem are just a few uncertainties that must be considered. The goal is to anticipate and reduce future uncertainties, and to develop water management strategies that will perform well despite uncertainty about the future. Uncertainties will never be eliminated, but better data collection and management and improved analytical tools will allow water and resource managers to better understand risks within the system. Chapter 5, “Managing an Uncertain Future,” provides more detail on risk and uncertainty in California water resources management.

The CWP acknowledges that planning for the future is uncertain and change will continue to occur. It is not possible to know for certain how population growth, land use decisions, water demand patterns, environmental conditions, the climate, and many other factors that affect water use and supply may change by 2050. To anticipate change, the approach to water management and planning for the future needs to consider and quantify uncertainty, risk, and sustainability. IWM promotes a diversified portfolio of management actions, along with seeking flexibility in water management. This approach helps ensure that water supply reliability and other IWM actions are effective under a wide range of possible water futures (i.e., resilient solutions).

Consequences of Foregone Investment

The opportunity provided by IWM includes a future in which water demands are met, the quality of surface-water and groundwater sources and supplies are improved, system flexibility and resiliency are improved to deal with droughts and floods, and ecosystems are restored and enhanced to sustain our natural resources. Insufficient investment in IWM, on the other hand, would bring severe threats to public safety, environmental stewardship, and economic stability. (See Box 2-1, which underscores the importance of timely investment.) Just as a car needs to be regularly maintained and rehabilitated to avoid risking an unsafe or costly breakdown, IWM requires continuous investment even to sustain current levels of performance and avoid a costly and less prosperous future that puts businesses and investments at risk, destroys cherished ecosystems, and makes communities less safe and less desirable. Much of the state’s vital water infrastructure was the result of investments made by previous generations. California cannot afford to sacrifice the future by failing to invest in water today. Volume 4, “Reference Guide,” provides more information on the cost of forgone investment.

Fundamental Lessons

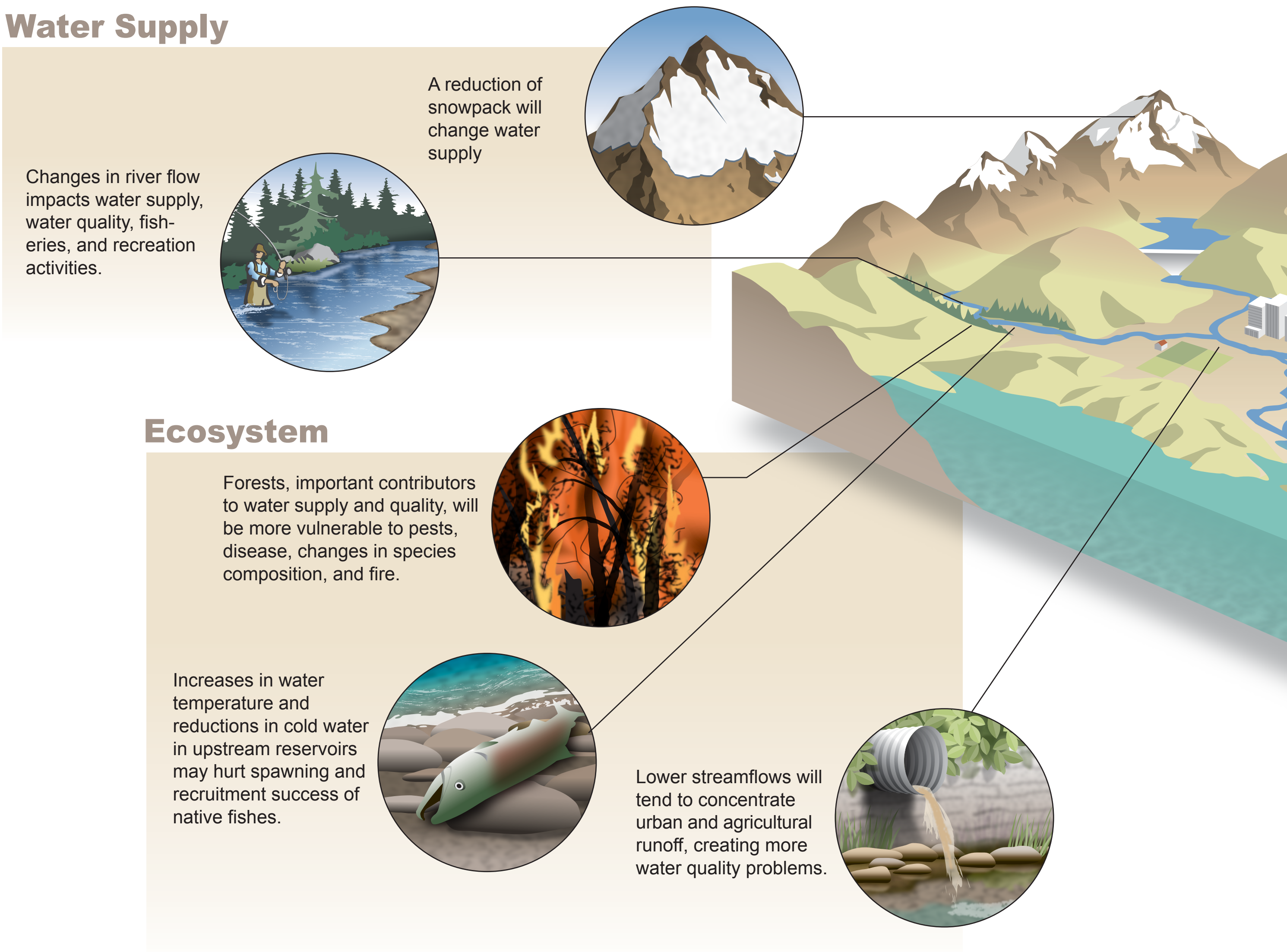
The Update 2013 strategic plan sets an urgent course for action that is informed by fundamental lessons learned by California’s water community through the experience of recent years. Update 2013 embodies these fundamental lessons:

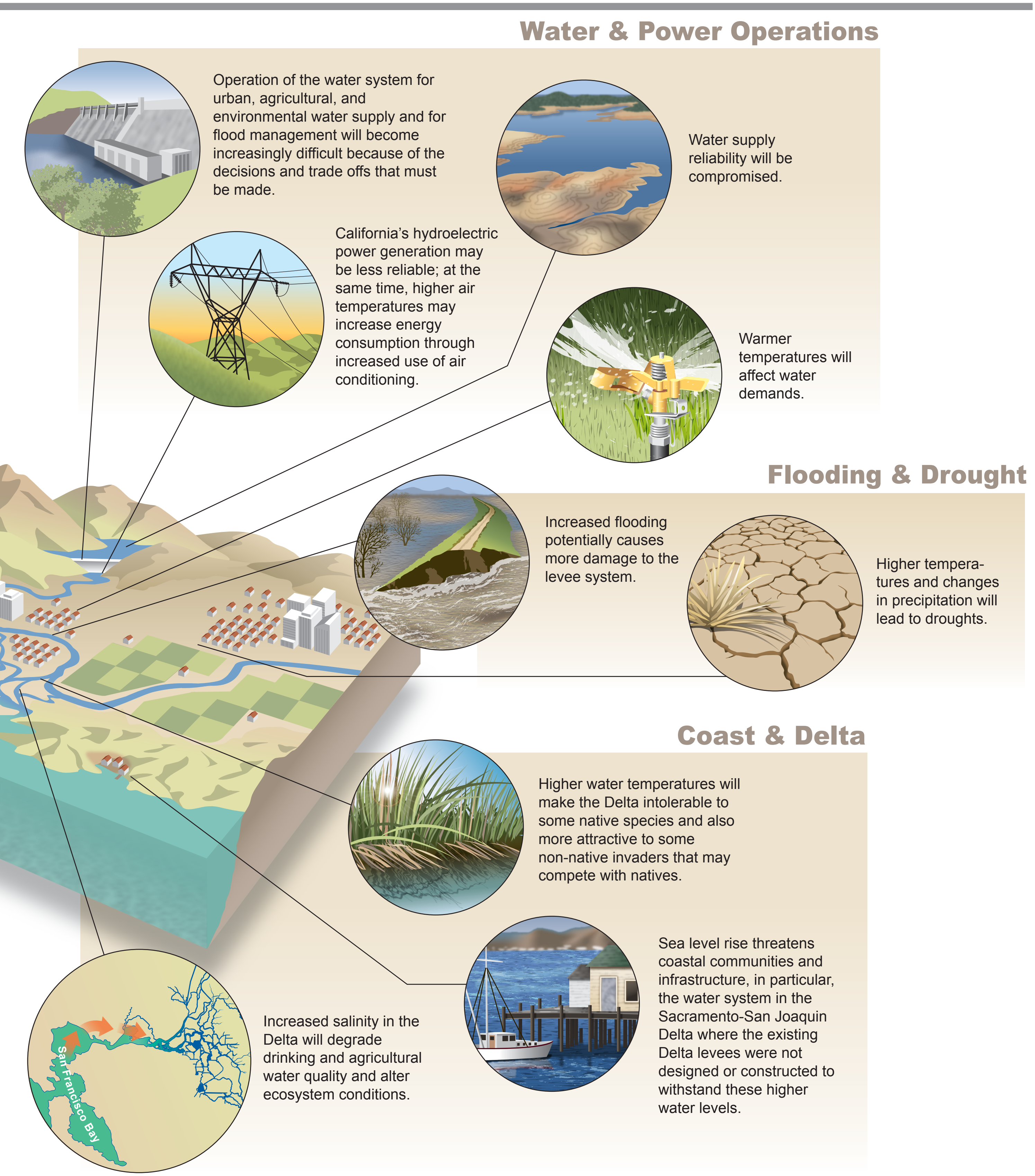
Figure 2-5 Climate Change Effects

What are the Expected Impacts from These Changes?

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

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




Water & Power Operations
Operation of the water system for urban, agricultural, and environmental water supply and for flood management will become increasingly difficult because of the decisions and trade offs that must be made.
Water supply reliability will be compromised.
California's hydroelectric power generation may be less reliable; at the same time, higher air temperatures may increase energy consumption through increased use of air conditioning.
Warmer temperatures will affect water demands.
Flooding & Drought
Increased flooding potentially causes more damage to the levee system.
Higher temperatures and changes in precipitation will lead to droughts.
Coast & Delta
Higher water temperatures will make the Delta intolerable to some native species and also more attractive to some non-native invaders that may compete with natives.
Sea level rise threatens coastal communities and infrastructure, in particular, the water system in the Sacramento-San Joaquin Delta where the existing Delta levees were not designed or constructed to withstand these higher water levels.
Increased salinity in the Delta will degrade drinking and agricultural water quality and alter ecosystem conditions.
San Francisco Bay

Box 2-1 Failure to Act

"Of all the infrastructure types, water is the most fundamental to life, and is irreplaceable. … Much of the drinking-water infrastructure is old and in need of replacement. …

"Failures in drinking-water infrastructure can result in water disruptions, impediments to emergency response, and damage to other types of essential infrastructure."

Source: American Society of Civil Engineers 2013

- Sustainable development and water use, as well as environmental stewardship, foster a strong economy, protect public health and the environment, and enhance quality of life. Managing for sustainability relies on the full consideration of social, economic, and environmental values in all phases of planning and policy- and decision-making. Sustainable water use ensures development and management of surface water and groundwater and related resources in a way that meets present needs while protecting and enhancing watersheds and the environment, and assures the ability to meet the needs of the future.
- IWM on regional and statewide scales is the basis of planning for California's water future with actions that provide multiple benefits. Reducing uncertainties and assessing risks to the surface water and groundwater supply and flood systems are essential for developing plans that also allow for sustainability of water uses, systems, and resources.
- Californians face an unacceptable risk of flooding. California must invest to help prevent flood disasters and to reduce the impacts of flooding, or billions more will be needed to recover from inevitable flooding. All levels of government should work toward implementing the recommendations identified in California's Flood Future Report.
- A diversified portfolio of resource management strategies improves system flexibility and resiliency for changing and extreme hydrologic conditions.
- Solutions to California's water and flood management challenges are best planned and carried out on a regional basis. Hydrologic, demographic, geopolitical, socioeconomic, and other differences among California's regions demand that the mix of water management strategies be suited to meet each region's needs for the long term.
- Water conservation, recycling, and greater system efficiency in California must continue to be a fundamental strategy for all regions and individual water users in California. The cumulative effect of each decision to use water more efficiently has an enormous impact on future water supplies and water quality.
- California can better prepare for future droughts and climate change, as well as improve water supply reliability and water quality, by taking advantage of the extensive water storage capacity of groundwater basins when managed in closer coordination with surface storage and other water supply sources, when available. These supplies include, but are not limited to, recycled municipal water, surface runoff and flood flows, urban runoff and stormwater, imported water, water transfers, and desalination of brackish and sea water.
- California must protect the quality of its surface water and groundwater and use available supplies with greater care because water will always be a precious resource.
- California needs additional groundwater and surface water storage capacity. Storage gives water managers tremendous flexibility to invest in a greater number of resource management strategies, meet multiple needs, and provide vital reserves in drier years. In many cases, storage is necessary for benefits from other resource management strategies to occur, such

as water-dependent recreation, conjunctive management, conveyance, and environmental stewardship.

- When technically, legally, and environmentally feasible, available aquifer space should be used for managed recharge for implementing multi-benefit projects that generate source water for groundwater storage by capturing water not used by other water users or the environment.
- California must develop and implement aquifer recharge area delineation and mapping required by Assembly Bill (AB) 359 and promote groundwater planning transparency and public education.
- Management to sustain the Delta will require that a healthy Delta ecosystem and a reliable water supply for California be coequal goals, and that we recognize the Delta as a unique and valued area.
- State government has a lead role in coordinating the water management activities of federal, tribal, regional, and local governments and agencies and developing stable strategies for financing water management actions.
- Science and technology are providing new insights into threats to our watersheds — including our waterways and groundwater basins — from climate change and other stressors. California must use this knowledge to take protective actions and manage water in ways that protect and restore the environment.
- California must strengthen and expand the California Statewide Groundwater Elevation Monitoring (CASGEM) Program for its long-term sustainability, complete groundwater management and planning assessments for all Senate Bill (SB) 1938 groundwater management plans and develop guidelines to promote best practices in groundwater management, and undertake statewide groundwater basin assessment for the CASGEM high-priority basins.

Focus of Update 2013 — Three Overarching Themes

The complete Update 2013 (all volumes) contains a large variety of information. This information serves many purposes among a wide variety of audiences, such as elected officials, planners, tribal entities, academia, the general public, and others. While Update 2013 contains many refinements from Update 2009, Update 2013 has significantly advanced the State's strategic plan in three critical areas. To address challenges and build upon past successes, the *California Water Plan Update 2013* recommends additional strategies and actions to:

- Enhance regional and statewide IWM.
- Strengthen government agency alignment.
- Invest in innovation and infrastructure.

These three themes, which emerged during the development of Update 2013, provide focus for refining and advancing the strategic plan and are applicable to every level of resource planning. These themes are interconnected and never considered separately. The strategic plan embraces the themes (described below) as the basis for developing tools, plans, actions, and achieving results portrayed in Update 2013. These three themes, in addition to the Update 2013 vision, mission, goals, guided the development of the objectives and related actions, all of which are described in Chapter 8, "Roadmap For Action."

Enhancing Regional and Statewide Integrated Water Management

The first theme for Update 2013 is to improve IWM and covers both regional and statewide scales. With Update 2013, the State is renewing its commitment to IWM. IWM is a strategic approach to planning and implementing water management programs that combines flood management, environmental stewardship, and water supply actions to deliver multiple economic, environmental, and social benefits across watershed and jurisdictional boundaries. The strategic plan included in Update 2013 builds on the foundation for IWM presented in Update 2009. (See Box 2-2.)

IWM provides a set of principles and practices that include strengthening government agency alignment through open and transparent planning process. This leads to stakeholder and decision-maker support for investment in various aspects of resource management, such as innovation and infrastructure. This support provides increased advocacy, as well as a greater number and variety of potential implementers and financiers.

IWM and integrated regional water management (IRWM) practices have made strides over the past 12 years, and Update 2013 encourages the expansion and enhancement of these practices.

The following key concepts enhance successful IWM planning:

- **Broad-based Knowledge** — The IWM approach relies on blending knowledge from a variety of disciplines, including engineering, economics, environmental sciences, public policy, and public information. It includes information gathering and other tools, policies, planning, regulations, and investments. Technical analyses simultaneously consider flood management, water supply, water quality, land use, water supply, ecosystem, and other actions to deliver multiple benefits at watershed and basin scales. This approach also promotes system flexibility and resiliency to accommodate changing conditions, such as regional preferences, ecosystem needs, climate change, flood or drought events, and financing capabilities.
- **High Value, Multiple Benefits** — IWM recognizes that localized, narrowly focused projects are not always the most cost-effective use of public and ratepayer resources and can have negative unintended consequences within regions. The IWM approach helps deliver more benefits at a faster pace, while using fewer resources, than is sometimes possible with single-benefit projects. While IWM seeks to leverage multiple benefits and partners, IWM does not promote the exclusion of single-purpose projects. In many localities, such projects can and do deliver cost-effective benefits.
- **Broad Access to Funding Sources** — One of the benefits of using an IWM approach is the potential to access funding sources that may not have been available to single-benefit projects. This is particularly important to achieving sufficient and stable funding for long-term flood management.
- **Collaboration and Alignment Are Necessary** — Efforts to effectively manage California natural resources will require unprecedented alignment and cooperation among public agencies, tribal entities, landowners, interest-based groups, and other stakeholders. Collaboration is required to prioritize actions and garner enough community support for investment to occur and be sustained. Better agency alignment of plans, policies, and regulations is needed to improve and expedite implementation.

Box 2-2 Integrated Water Management — What and Why

- Integrated Water Management (IWM) is a strategic approach to planning and implementing water management programs that combines flood management, ecosystem enhancement, and water supply actions to deliver multiple benefits *across watershed and jurisdictional boundaries*.
- The IWM approach maximizes limited resources to provide for *increased public well-being*.
- Well-implemented IWM projects *enjoy broader support* and thus are less likely to be delayed or stopped during the implementation phase.
- Fostering broader implementation of IWM is intended to improve or restore expected levels of service within flood and water management systems statewide, while also *improving system resiliency* (the ability of systems to respond to and recover from significant stressors).
- IWM program delivery will be conducted using measurable objectives that *provide for accountability of public investment* and transparency on the value that society will attain from investing in IWM initiatives.

The objectives and the related actions described in Chapter 8, "Roadmap For Action," collectively are the proposed improvements in IWM.

Update 2013 represents an important next step in advancing IWM by articulating the outcomes or types of benefits of greatest value to the broad range of stakeholders represented as part of the various Update 2013 advisory groups (see Figure 2-6). These desired outcomes define the scope of IWM. See Box 2-3 for a list of desired outcomes as expressed by stakeholders. This list also represents the scope of IWM. For example, actions that produce one or more of the desired outcomes fall within the scope of IWM.

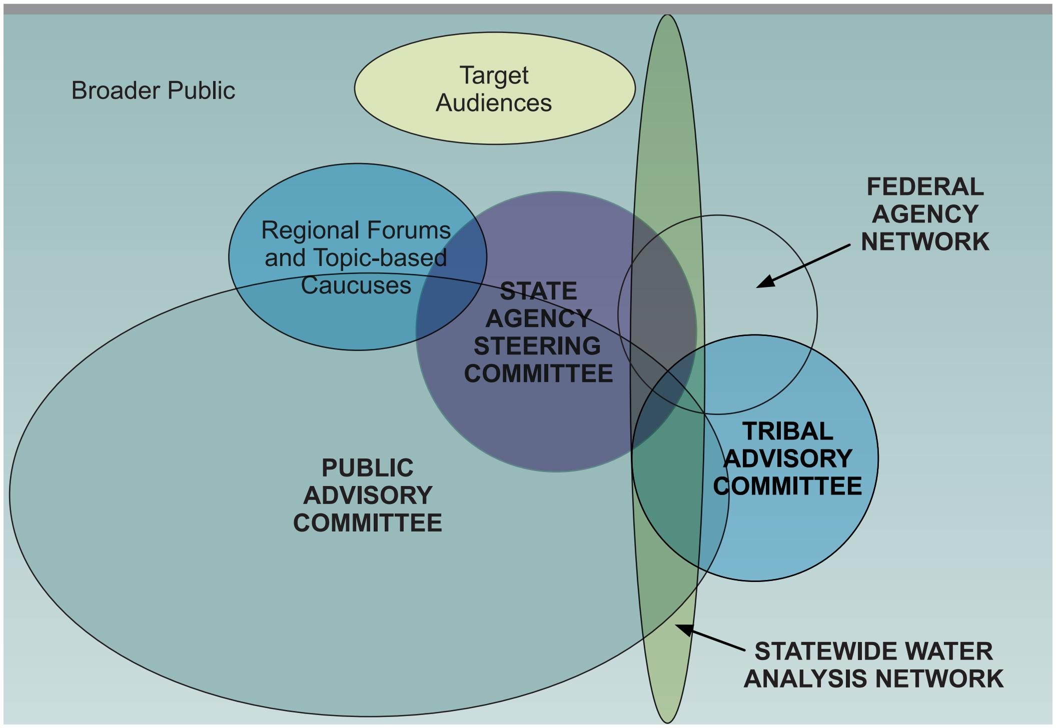
Strengthening Government Alignment

The second theme for Update 2013 is strengthening government agency alignment. Update 2013 includes actions to make significant improvements in agency alignment from that presented in Update 2009. The primary purpose for improving alignment of government agencies is to expedite implementation of resource management strategies and help assure efficient achievement of multiple objectives. This includes collaboration with regulatory agencies to reduce time and costs required to implement IWM projects while protecting and enhancing natural resources.

Labyrinth of Laws

Currently, project implementers must navigate and comply with California's labyrinth of uncoordinated and at times conflicting laws and regulations that lead to project delays and mounting planning and compliance costs. These ultimately create significant difficulties in meeting basic community safety and water supply needs, along with goals outlined in Update 2013. For example, implementation of State-government-incentivized groundwater recharge projects have been delayed or abandoned owing to a State permitting process that places risks on the implementer's water rights (i.e., regulations require surface-water-right holders to reopen

Figure 2-6 Water Plan Update 2013 Collaboration Graphic



historic water-rights agreements, subjecting water rights holders to the risk of various unrelated water rights challenges, so as to include groundwater recharge as a approved beneficial use of the original surface-water right). This is even true for small projects that are well planned, have the voluntary support of private landowners, and would provide multiple benefits. In fact, project participants (e.g., landowners and financiers) that have gone through the permitting process are often not willing to tackle the process again. Those who have heard second hand about the process tend to opt out when presented with opportunities to contribute.

Other examples of impacts from insufficient government alignment include the fact that planning and permitting costs of projects have been increasing as a portion of total planning and implementation costs. For some smaller infrastructure and ecosystem enhancement activities, permitting costs have exceeded the implementation and acquisition costs. In many other cases, program or project implementation has yet to occur despite decades of planning activities, even as the intended benefits of these programs and projects are forgone as a result of the delays. Addressing this challenge represents a critical scope of work. It is important to acknowledge that regulations can and do also provide basic community safety and water supply needs. They also help meet many CWP goals. Update 2013 promotes innovation for all IWM tools, including all regulation and administrative tools.

Social and Technical Complexities

At the same time, planning a project within the current regulatory environment is technically complex, making it difficult for a single entity to comprehend all the geophysical and social complexities and dynamics of resource management and planning. California's anthrodiversity, as previously described, as well as the state's large size, only further increases the complexity of

Box 2-3 IWM Desired Outcomes

In addition to the four key concepts that enhance successful integrated water management (IWM), which are introduced in the Enhancing Regional and Statewide Integrated Water Management section of this chapter, the scope of IWM was further defined and clarified for Update 2013. The approach for such descriptions is expressed in terms of the matters of most importance (or desired benefits/outcomes) to stakeholders. The list below summarizes the types of desired outcomes that define the scope of IWM. For example, actions that produce one or more of these desired outcomes fall within the scope of IWM. A more detailed description of these topics is provided in Chapter 3, "California Water Today."

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

management and planning tasks for any single entity. Accordingly, data management, planning, policy-making, and regulation must occur in a very collaborative, regionally based manner, with the ultimate product being a composite of input and data from a large variety of elected officials, opinion leaders, stakeholders, scientists, and subject experts. Sound outcomes rely on a blend of subject expertise and perspectives woven together (e.g., hydrology, climatology, engineering, earth sciences) into comprehensive policies and implementation decisions that are place based and regionally appropriate.

Collaborating For Alignment

The California Biodiversity Council has created an initiative to improve the alignment of relevant plans, programs, policies, and regulations (see Box 2-4). Update 2013 leverages, expands (to the full scope of IWM), and evolves this work. Chapter 4, "Strengthening Government Alignment," elaborates on existing water management governance and the move toward improved government alignment.

Strides have been made to improve alignment, such as the formation and engagement of the Water Plan State Agency Steering Committee, Water Plan Federal Agency Network (FAN), and 48 regional water management groups. However, local, State, federal, and tribal governments often do not collaborate to the degree necessary to effectively manage the challenges described above. Update 2013 used the collaborative approach shown in Figure 2-7 for structuring conversations intended to help planners understand what stakeholders value with respect to water resources (resource-dependent values), help participants work from a common understanding and assumptions about drivers that affect how and where water resources occur in California, and to ultimately guide the conversations toward development of potential actions. The Update 2013 outreach and engagement process is described in Volume 4, *Reference Guide*, in the article, "Process Guide — California Water Plan Update 2013." Figure 2-6 illustrates the breadth of participants that contributed to Update 2013.

Update 2013 has taken a first step in aligning State government by incorporating information and recommendations from IWM-related planning documents of the State Agency Steering Committee member agencies. Featured State plans and initiatives are those plans and programs by State, federal, tribal, and local government agencies that have a direct connection with the CWP. Chapter 4, "Strengthening Government Alignment," in this volume describes plans used to develop and augment the content in the Update 2013.

Investing in Innovation and Infrastructure

The third theme for Update 2013 is to improve investment in innovation and infrastructure. A stable, effective funding stream is an essential component of successful water resource implementation. Update 2013 provides strategies for future funding, a major improvement over Update 2009.

California's Flood Future Report estimated that more than $150 billion in potential projects and other expenditures will be required to address flood risk throughout the state (California Department of Water Resources and U.S. Army Corps of Engineers 2013). There are also over 10,000 projects identified within the 48 integrated regional water management plans. In total, resource management actions will require up to $500 billion of future investment over the

Box 2-4 California Biodiversity Council

The California Biodiversity Council (CBC) was formed in 1991 to improve coordination and cooperation among the various resource management and environmental protection organizations at federal, State, and local levels.

The CBC's initiative to improve the alignment of the plans, programs, policies, and regulations of its member agencies will enable the CBC to achieve its founding goals with:

- More consistent vision of desired conditions for natural resource management, conservation, and stewardship across California (less fragmented work in silos).
- More efficient and cost-effective planning and implementation of natural resource conservation projects (less duplication and waste).
- More holistic, watershed-scale policies and regulations (fewer agency conflicts).
- More outcome-based and regionally appropriate agency policies and regulations (focus on the What and less on How).
- Better sharing of information, expertise, and tools (less duplication by leveraging resources).
- Expedited conservation project implementation with more consistent and effective technical and financial assistance to project proponents (lower project cost and fewer delays).

In April 2013, the CBC renewed its commitment to agency alignment with their resolution, *Strengthening Agency Alignment for Natural Resource Conservation* (California Biodiversity Council 2013).

The resolution is formed around four goals:

1. Increased coordination with all levels of government and agencies (federal, tribal, State, local), stakeholder groups, private landowners, and others.
2. Increased effectiveness through leveraging of existing networks, relationships, and multi-agency venues.
3. Improved sharing of data, information, tools, and science among governments and agencies.
4. Better alignment of planning, policies, and regulations across governments and agencies, as well as coordinated and streamlined permitting to increase regulatory certainty.

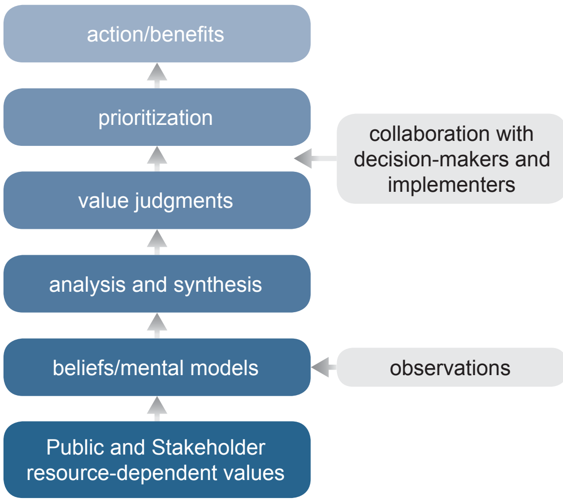
These goals are supported by guiding principles, practices, and tools, and recommended organizational improvements. See Volume 4, *Reference Guide*, for a copy of the resolution.

next few decades to reduce flood risk, provide reliable and clean water supplies, and enhance ecosystems and their services. We are beginning to integrate resource management and planning, but funding remains fragmented, unstable, and inefficient, which limits opportunities for further integration.

Other compounding challenges include the fact that debt is at near-record levels, existing bond funds will be fully allocated by 2018, willingness of the public to pay for government activities is waning, investment in infrastructure and ecosystem values and services has been deferred for decades, and future federal funding is highly uncertain. This debt level increases pressure on developing alternative financing strategies that capitalize on local, State, and federal cost sharing and IWM.

Very little of the total state IWM funding allows discretion or flexibility. Bond and legislative language designates funding purposes. General obligation bonds backed by property taxes and

Figure 2-7 Water Plan Update 2013 Collaboration Approach



The collaborative process for updating the California Water Plan has been expanded for Update 2013, as well. The project team continues to incorporate input from the Statewide Water Analysis Network, a Public Advisory Committee, and a steering committee of State agency representatives. This time,the State Agency Steering Committee has been increased to include 28 State agencies. A new Tribal Advisory Committee has been established, with representatives from 34 California tribes, bands, and rancherias who can share approaches taken and provide advice pertaining to tribal lands and cultural practices involving water. A Federal Agency Network has been added, as well.

the General Fund are required to be used for capital projects, not operation and maintenance. 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.

From 1995 to 2010, average annual State expenditures were about $2 billion per year, with a peak of just over $2.5 billion in fiscal year (FY) 2010. This is largely attributable to bond money from continued appropriations of Propositions 1E and 84. For that same time frame, federal expenditures averaged $1.2 billion per year, with a peak of $1.4 billion in FY 2001 and again in FY 2005. Local expenditures comprise the largest component, averaging $14.5 billion per year. Local expenditures peaked at about $18 billion in FY 2010. This is likely a result of increased subventions and loans from DWR related to Propositions 1E and 84. While overall IWM expenditures in California have been increasing in recent years, federal investment is shrinking relative to State and local investment.

Through intensive collaboration with the Update 2013 Finance Caucus, the investment categories presented in Box 2-5 helped support a common understanding of potential investments and an effective role for State government. This approach was useful for aligning funding and finance planning processes across over 2,300 local, State, and federal government agencies, each with its own planning processes and scales.

Update 2013 provides a more comprehensive approach to State IWM funding and finance compared with historical and current practices of prioritizing activities and projects by a combination of funding earmarks and a project's readiness for construction.

Chapter 3, "California Water Today," describes existing local, State, and federal IWM spending and debt levels. Currently, projects that tend to be most implementable, most consistent with priorities of a particular funding source, or that happen to be at the front of the queue when money becomes available, are often not linked to multi-faceted strategic objectives. The approach used for Update 2013 promotes proactive planning and prioritization of activities to drive future investment decisions and funding. See Chapter 7, "Finance Planning Framework," for a description of finance categories and strategies, including general obligation bonds, fees, taxes, and public-private partnerships.

Box 2-5 Categories of Integrated Water Management Investment

Innovation:

- Governance of State integrated water management (IWM) improvements.
- Planning and public engagement improvements.
- Information technology (data and analytical tools).
- Government agency alignment improvements.
- Water technology and science advancements.

Infrastructure (human and ecosystem), implemented at the following scales:

- Local.
- Groundwater basin.
- Watershed.
- Regional.
- Interregional.
- State.
- Interstate.
- International.
- Tribal.

Two primary categories of investment are innovation and infrastructure. Infrastructure includes structures and facilities that support human activities, but it also includes green infrastructure (e.g., wetlands, riparian habitat, watershed systems). Innovation includes development of new analytical tools and other planning process improvements. Both categories may include the capital cost of constructing a facility or restoring habitat and the long-term operation and maintenance costs, which have often been an afterthought to implementation and not adequately financed over their useful life.

Innovation and infrastructure are further broken down into investment categories (again, for State government policy-making purposes), as shown in Box 2-5. In addition to the categories of investment shown in Box 2-5, there are many resource management and administrative tools included in Update 2013.

There are 30 resource management strategies presented in Volume 3, which are grouped according to these seven categories:

- Reduce water demand.
- Improve operational efficiency and transfers.
- Increase water supply.
- Improve flood management.
- Improve water quality.

- Practice resource stewardship.
- People and water.

Similar to the resource management strategies described in Volume 3 of Update 2013, which focus on actions, there are also several administrative tools that can be used to generate IWM benefits. See Chapter 7, "Finance Planning Framework," for more information on administrative tools.

There are seven categories of administrative tools:

- Collaborative decision-making.
- Education.
- Legislation.
- Voter-approved propositions.
- Regulation.
- Permitting.
- Litigation.

The Update 2013 approach to guiding future investment improves the apportioning and better informs the use of different financial strategies. The Investment in Innovation and Infrastructure theme has a major role in advancing Update 2013 from Update 2009. In weaving the theme throughout this Update 2013 strategic plan, the following related needs played a major role in the preparation of Chapter 7, "Finance Planning Framework," and the financing actions in Chapter 8, "Roadmap For Action." Development of the finance strategy for Update 2013 considered ways to:

- Increase the reliability, predictability and level of State IWM funding for statewide and regional water programs and projects.
- Provide a consistent method for allocating, awarding, and disbursing State funding for water innovation and infrastructure programs and projects.
- Avoid funding earmarks.
- Include regional accounts to continue IRWM to increase flexibility, reflect local and regional conditions, and advance regional goals and investment priorities.
- Provide proactive planning and implement consistent rules and standards for allocating State funding.

Role of State Government in Integrated Water Management

The guidance provided by the Update 2013 vision, mission, goals, objectives, and principles (see Chapter 8) are applicable to all levels of planning and by federal, State, and local agencies and other implementing entities. As noted above, local agencies' expenditures on IWM have comprised the largest component of all agency investments — a trend that is expected to continue. Local agencies will continue to be primarily responsible for funding projects and programs that create local benefits and to participate in larger systemwide projects that benefit them.

The role of State government in IWM is to fulfill its basic obligations, commitments, and responsibilities, as well as to invest in IWM innovation and infrastructure.

Basic Obligations

The obligations of State government include:

- **Representing California in government-to-government interactions** with the federal government, other states, and other sovereign nations and tribal governments.
- **Meeting basic public health and safety needs for all Californians** by regulating minimum public health standards and by providing assistance to communities that are unable to meet regulations.
- **Protecting public trust resources** by regulation and in planning and allocation of water resources. The public trust doctrine recognizes that certain natural resources, including water, tide and submerged lands, the beds and banks of navigable rivers, and fish and wildlife resources, are owned by the public and held in trust for present and future generations of Californians.
- **Protecting unique real property interests.** The State has a fundamental responsibility to California taxpayers to protect the real property assets owned by the State and reduce State liabilities.

Commitments and Responsibilities

- **Operate and manage the State Water Project.** State government is the owner and operator of the State Water Project (SWP) and has the responsibility (and contractual commitments) to provide reliable water supplies to the water contractors, the financiers and beneficiaries of the SWP.
- **Plan, implement, and maintain the State Plan of Flood Control.** State government has responsibility for providing assurances to construction access, operations, and maintenance for portions of the State's federally authorized flood protection system.
- **Planning, policy research, and technical assistance.** State government performs many critical planning and research activities in support of resource management (executive, legislative, and local government) decisions and advancing water science and technology.
- **Integrate water rights and water quality planning.** Basin Plans are prepared for each of the 10 hydrologic regions and by statute become part of the CWP.

Investing in Innovation and Infrastructure

Investing in innovation and infrastructure is a shared responsibility across local, State, federal, tribal, and private entities. State government has traditionally delegated IWM investment decisions to local governments and regions. State government should continue to focus its investments within a framework that empowers local governments and regions, supports regional decision-making, and encourages regional self-reliance.

State government should take a lead role in investing in innovation actions for the benefit of all regions. Innovation includes a broad range of activities that comprises governance, planning and process improvements, data, tools, and water technology

The Groundwater Replenishment System (GWRS) has been operating since January 2008. Jointly developed by Orange County Water District (OCWD) and Orange County Sanitation District (OCSD), GWRS is the largest water purification project of its kind in the world.

research and development. The State's investment in innovation will provide processes and information that will aid decision-making throughout the state and support more cost-effective infrastructure investments by regional and local entities.

The State invests in its own real property infrastructure (i.e., State Water Project and State-federal flood management system). The State also has a role in creating incentives for the planning, construction, and management of natural and human infrastructure in fulfillment of the State's strategic objectives. This is implemented throughout the state at various geographical and jurisdictional scales, including local, groundwater basin, watershed, regional, interregional, State, interstate, international and tribal. Although this infrastructure may be owned and operated by other entities, the State has a role in creating incentives that help achieve the State's goals.

The State's role in investing in innovation and infrastructure should be focused in the following four areas to provide:

1. **What regions cannot accomplish on their own.** The State has a role in assisting regions if they cannot accomplish necessary water management services on their own, such as assisting regional water management groups in developing their IRWM Plans and helping to ensure that all Californians are provided with basic public health and safety. The State predominantly delegates the responsibility to provide basic public health and safety needs for local governments to achieve while the State enforces regulations to ensure that minimum standards are met. However, the State has a role in assisting regions that cannot accomplish basic public health and safety needs on their own, such as disadvantaged communities or some tribal communities. The State can provide technical and financial assistance to these communities. In some circumstances, the State can also function as a service provider of last resort and provide these basic services itself when justified.

2. **What involves interregional, interstate, or international issues.** It is common for natural streams and infrastructure to cross regional, state, and international boundaries. In its role as representing California in government-to-government relationships, the State must take the lead in addressing international, interstate, or trans-boundary issues that extend beyond the geographical reach and jurisdictional authority of local and regional agencies. This includes, for example, negotiation with other states or Mexico regarding California's rights and interests in resources provided by the Colorado River. In addition to interstate and international issues, the State also has a role in promoting collaboration within and among regions for the benefit of the entire state.

3. **What the State can do more efficiently.** The State is uniquely suited to implement some activities more efficiently than other agencies or organizations because it can leverage resources and can provide economies of scale. The State has a responsibility to leverage these advantages to address specific needs common to all agencies involved in IWM. Information from these activities benefits the entire state. Operating on a statewide scale can also reduce inconsistencies or redundancies among regions. Examples of activities that the State can perform more efficiently and that provide value statewide include:

   A. **Facilitate process improvement and government agency alignment.** The State can play a major role in working with agencies to improve planning and project development processes.

   B. **Provide regulatory oversight and alignment.** The State is uniquely suited to provide regulatory oversight to protect public health and safety and public trust values — including water quality, environmental protection, flood management, and dam safety — through several State agencies. In addition to establishing, monitoring, and enforcing regulations, the State also has a role in promoting and facilitating alignment of regulatory processes involving federal and State regulations. Better interagency regulatory alignment helps improve consistency and predictability in regulatory standards and addresses unclear, conflicting, inconsistent, or mutually exclusive regulatory objectives or requirements for projects.

C. **Provide data, information, decision support, modeling tools, and expertise in specialty areas.** The State is uniquely suited to collect, store, and disseminate water-resources-related data and information to support regional and statewide water system modeling, analytical tools, and decision support tools. State government expertise in specialty water resource areas should also be used to address the critical water-related issues of the state. (See Chapter 3, "California Water Today," for complete descriptions of water-related issues.) For example, State government expertise in climate change research should help monitor, predict, and prepare for the effects of climate change on California's water and flood protection systems and the environment.

D. **Conduct and coordinate public outreach and policy guidance on water-related issues.** The State is uniquely suited to assist water agencies, local governments, tribes, and non-governmental organizations to educate the public and legislature on water issues. Providing a unified, coordinated message on key water issues can help convey their importance to the public and the legislature.

E. **Facilitate systemwide management.** The State is uniquely suited to facilitate development and implementation of water projects that have impacts on a systemwide scale (i.e., across multiple regions of the state), such as major storage, large system flood management, and Delta improvements. Local agencies often are limited in their ability to work on a systemwide scale because of jurisdictional limitations. The State has more flexibility to assert leadership in interregional projects on a systemwide scale that spans geographic and agency boundaries. The State may therefore find it advantageous to incentivize local and regional projects that provide benefits to the state, but which may not be financially feasible at the local or regional level. For example, investing in a rural region located in an upper watershed may be the most cost-effective solution for increasing overall water supplies to the state, but local agencies within that region may lack the resources or may not find it in their interest to make that investment themselves.

F. **Conduct statewide master planning.** The State is uniquely suited to conduct statewide master planning. This includes, for example, preparing CWP updates as a public forum to integrate State, federal, tribal, regional, and local plans to meet the state's future agricultural, urban, and environmental water demands and water management objectives.

4. **What provides broad public benefits.** The State has a role in implementing activities (and incentivizing local and regional activities) that have broad public benefits and in advancing sustainability through public safety, environmental stewardship, and economic stability. Public benefits are defined as very diffuse benefits that cannot be easily associated with specific user groups or a particular set of beneficiaries. This includes reducing environmental impacts created long ago, known as legacy impacts, which no longer have responsible parties to pay for mitigation.

How California decides to prioritize and pay for necessary water resource management improvements is one of the most significant issues the state faces today. Past investments have provided a down payment and a good basis for further improvements; however, the financing methods of the past are no longer sustainable. The stakes are high as future investment decisions will significantly affect public safety, environmental stewardship, and economic stability. What is at stake includes flood risk to Californians' lives and assets; sustainability of natural resources, including the stewardship or extinction of species/habitats and the ecosystem services they can provide; and California's $2 trillion economy, which has significant value, both nationally and globally, and directly affects the fate of existing businesses, their employees, and their employees' families.

The price tag for needed water resource management improvements is daunting, but failure to address these challenges will put more and more Californians at risk. We are beginning to integrate resource management and planning, but funding remains fragmented, unstable, and inefficient, which limits opportunities for further integration. In fact, many current funding practices and constructs, developed decades ago, drive investment priorities more so than emerging plans and stakeholder priorities (which have significantly changed over the last several decades). These rigid funding constructs also do not allow for the adaptability necessarily to respond to emerging challenges.

Update 2013 calls for more strategic, disciplined, and aligned investments in innovation and infrastructure and identifies shared stakeholder values and potential mechanisms for future financing. Moving forward, the State needs to clarify funding purposes, as well as assess and articulate the value of current and future expenditures, to secure the necessary investments that will deliver sustainable and resilient water resources, both natural and human-made. It will take decades to upgrade the aging water-related infrastructure and accomplish ecosystem improvements. However, we need to continue taking steps toward financing implementation of a diverse portfolio of water management actions with an equally diverse portfolio of funding sources, including locally funded, cost-sharing, and State and federal sources.

Locally funded programs are primarily financed through revenue bond sales that are supported through users' fees. Many local major water-supply projects, including local and regional water-supply conveyance, treatment, distribution, and wastewater treatment, are included in this category. Some systemwide projects can also be included in this category. Small and isolated disadvantaged communities are one exception, as many of their water supply systems need upgrades to provide adequate water supply and/or address their water quality issues. Typically, local/regional water purveyors' and wastewater agencies' user fees, with some exceptions, provide adequate funding for operation and maintenance of their water systems. Nonetheless, operation and maintenance of the flood management system by the State and local flood assessment districts is more challenging.

Cost-sharing programs have local and regional benefits, as well as State and national benefits. Many of the proposed infrastructures fit within this category and are generally funded through a cost-shared agreement among the federal, State, and local agencies, depending on the program/project beneficiary. Examples of these types of projects include some regional water supply security projects and most flood protection projects. Many flood and community districts sell bonds secured by specific tax assessments to fund their capital improvements. Passage of Proposition 218 in 1996 put new restrictions on this type of financing by requiring approval by two-thirds of voters. The result has been delays in some capital improvements and failure to approve others.

State-funded and federally funded programs have broad statewide and public (or societal) benefits. They are generally supported by State and federal public funding. Examples of these projects are the systemwide ecosystem enhancements, systemwide flood-risk reduction projects, as well as implementation and operation of large-scale water supply infrastructure. Cities, counties, and the State generally finance their capital improvement programs through General Obligation bonds, which are secured by full faith of the credit issuer. Many local agencies and disadvantaged communities may not have adequate funding or means of financing local shares of their infrastructure improvement through bond sales (i.e., lack of credit or high interest rates). In these cases, providing low-interest State and/or federal loans to local agencies to cover their local cost share of the project will be helpful.

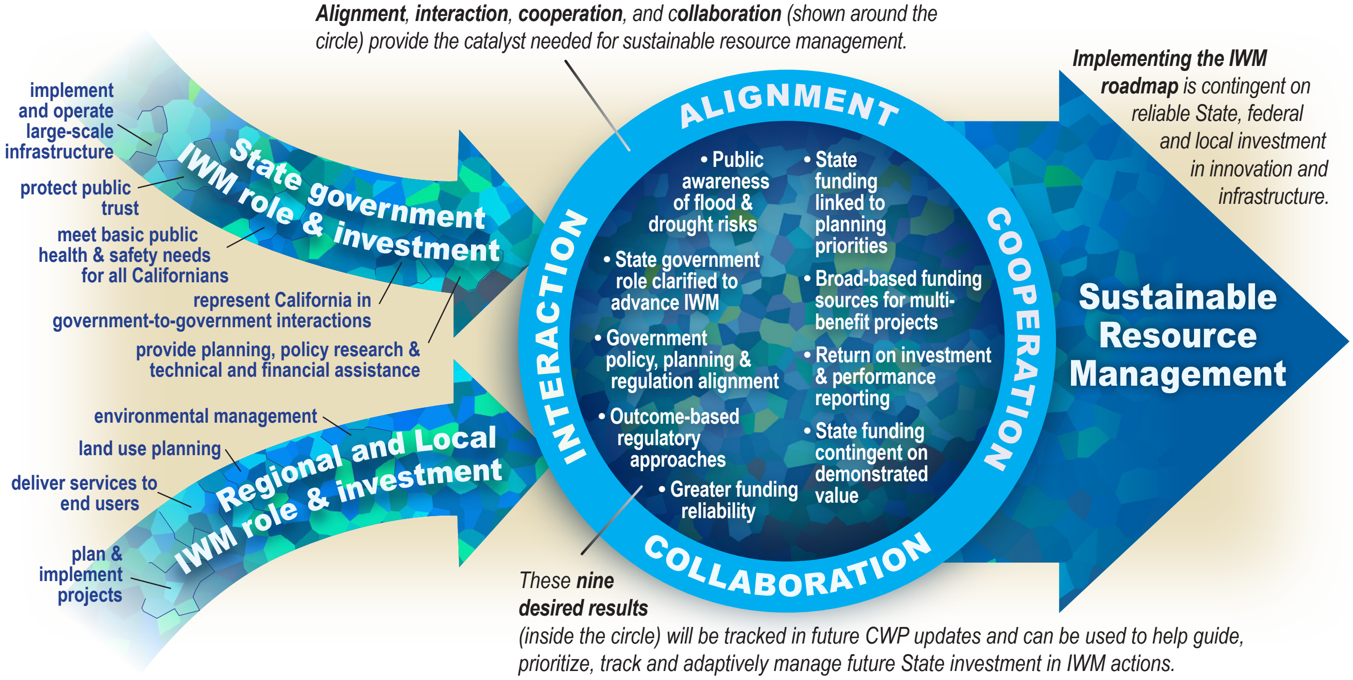
Integrated Water Management in Action

The immediate and changing conditions, priorities, and challenges described in Update 2013 require that Californians step up existing efforts to provide integrated, reliable, sustainable, and secure water resources and management systems for our health, public safety, economy, and ecosystems — today and for generations. The State needs to continue to invest in innovation and infrastructure, as detailed in Chapter 7, "Finance Planning Framework." To accomplish this requires implementing a strategic water plan with vision and goals, and an implementation plan with objectives and near-term and long-term actions. The plan must build on State and stakeholder accomplishments since Update 2009, as well as the fundamental lessons of water resource management learned in recent years. Figure 2-8 (below) emphasizes how State, regional, and local entities must come together (align) to deliver the resources needed to effectively implement (invest in) IWM actions. Several key IWM activities are summarized (in the arrows located on the left side of Figure 2-8) for State, regional, and local government roles and investment. The roles of the respective government entities cannot be accomplished without significant new collaboration and alignment, particularly regarding international, interstate, statewide, and interregional IWM activities.

In Figure 2-8, the desired results shown in the circle represent key accomplishments that must occur to achieve the Update 2013 IWM vision and objectives. Volume 1, Chapter 8, lays out 17 objectives and a menu of more than 300 actions that can move California toward accomplishing the desired outcomes. These results will be tracked in future CWP updates and can be used to help guide, prioritize, track, and adaptively manage future State investment in IWM actions. Alignment, interaction, cooperation, and collaboration (shown around the circle of Figure 2-8) provide the catalyst needed for sustainable resource management.

Figure 2-8 Integrated Water Management in Action

State, regional and local entities must come together to effectively implement IWM actions. These roles cannot be accomplished without significant new collaboration and alignment, particularly regarding international, statewide, and interregional IWM activities.



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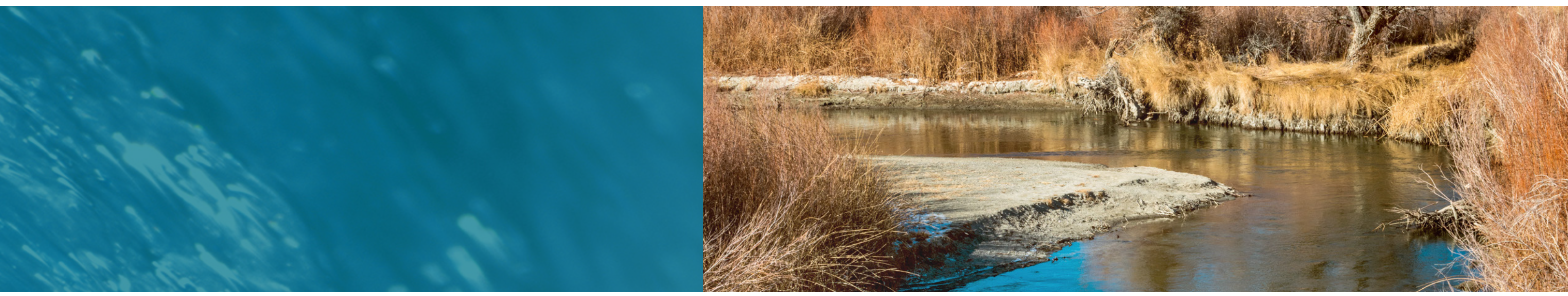
VOLUME 1 - THE STRATEGIC PLAN

CHAPTER 3

California Water Today



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

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Chapter 3. California Water Today

About This Chapter

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

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

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

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

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

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

Planning for Stability amid Extreme Diversity and Variability

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

Social Diversity

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

Resource-Dependent Values

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

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

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

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

Public's Understanding of Geophysical Systems

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

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

1. California's water systems are unimaginably complex and linked to every facet of natural resources, the State's economic activity, and public safety.
2. Scientific understanding is far from complete.
3. Water plays very different roles in people's lives, depending on their interest, location, value placed on natural resources, and many other variables.

Geophysical Variability

Precipitation is the primary source of the state's water supplies, and it varies from place to place, season to season, and year to year. Most of the snowfall and rainfall occurs in the mountains in the northern and eastern areas, and most water is used in the central and southern valleys and along the coast. In addition, the state's ecosystem, agricultural, and urban water users have variable demands for the quantity, timing, and place of use. In any year, there is often either one of two threats: the state's water systems may not have enough water to meet all water demands during droughts or an excess of water causes floods. Figure 3-1 provides an example of the magnitude and frequency of variability in California's hydrology.

Climate and Water Availability

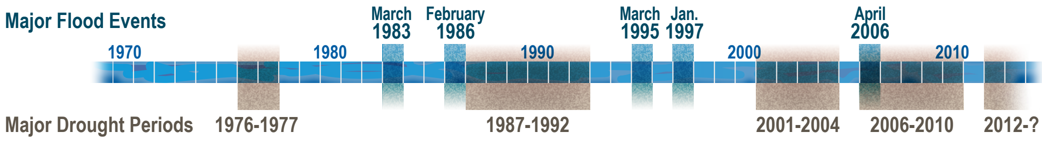
The amount and variability of precipitation, as well as temperature, differ dramatically between California's northern regions and its southeast portions. As such, statewide average information does not truly depict regional conditions and often over-generalizes California's water conditions. Wet, average,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

California's local, State, and federal projects and programs form the backbone of a statewide water system that was developed during the first part of the 20th century. These projects have worked together to make water available at the right places and times and to move floodwaters. In the past, this system has allowed California to meet most of its agricultural and urban water management objectives and flood management objectives. Figure 3-2 presents a map of California with major rivers, water conveyance, and storage facilities.

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

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

Figure 3-1 Feast or Famine



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

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

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

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

Hydrologic Regions and Areas

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

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

Figure 3-3 **Variable Flood Risk**

Figure 3-4 Types of Water Use

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

Box 3-1 About Update 2013 Regional Reports

California Water Plan Update 2009 expanded the regional reports. Each regional report in *California Water Plan Update 2013* includes a summary of surface water quality issues and needs, regional flood and flood management issues, a table of strategies proposed by recent integrated regional water management efforts, climate change challenges, and projected water demands to 2050 for three alternative scenarios. These regional reports have also added information about tribal populations and tribal lands in each region.

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

Hydrologic Regions

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

Delta Region and Mountain Counties Areas

- **Sacramento-San Joaquin Delta and Suisun Marsh.** An overlay area because of its common characteristics, environmental significance, and important role in the state's water systems. The region was the focus of the Governor's Blue Ribbon Delta Vision Task Force, 2006 through 2008. In December 2008, the Delta Vision Committee issued a final implementation report to the governor and Legislature that includes near-term actions necessary to achieve Delta sustainability and to avoid catastrophe (see Chapter 4, "Strengthening Government Alignment," in this volume).
- **Mountain Counties.** Includes the foothills and mountains of the western slope of the Sierra Nevada and a portion of the Cascade Range. The area includes the eastern portions of the Sacramento River and San Joaquin River hydrologic regions and watersheds, and stretches from Plumas County in the north and into Fresno County in the south. This area shares a common water supply and other resource issues that are compounded by urban growth. It also is the area of origin for much of the state's developed surface water supply.

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

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

IRWM Planning Regions

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

Land Use and Development Patterns

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

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

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

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

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

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

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

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

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

State Land Use Policy

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

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

Managing Urban and Agricultural/Rural Land Use

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

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

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

Box 3-2 Land Use Jurisdiction

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

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

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

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

California has more than 37 million acres of forest located primarily in the major mountain ranges of the state. Forests in California are owned and managed by a wide array of federal, State, tribal, and local agencies; private companies; families and individuals; and nongovernmental organizations (NGOs). Each entity has a different forest management strategy with different goals and constraints. These forest and rural lands are watersheds for many of the urban water supply sources, and are key components of flood management strategies (see Chapter 23, "Forest Management," in Volume 3, *Resource Management Strategies*).

Tribal Lands

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

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

Comparing Changes in Applied Water Use and the Real Gross Value of Output for California Agriculture: 1967 to 2010

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

Executive Summary

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

The rising real value of our agricultural output, coupled with falling crop water use, has more than doubled the “economic efficiency” of agricultural water use in California during the past 43 years. In 1967, there was $666 (in 2010 dollars) of gross agricultural revenue produced in California for each acre-foot of applied water. By 2010, this measure had risen to $1,494 per acre-foot. That represents a 124.2 percent real increase in 43 years. Much of this increase has occurred since 2000.

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

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

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

San Francisco Chronicle Nov. 30, 2008

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

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

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

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

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

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

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

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

Public Land Management

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

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

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

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

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

Military Activities

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

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

Water Conditions

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

Environmental Water

In addition to managing California's water resources for domestic, industrial, and agricultural use, water purveyors must also manage for the needs of the environment and its ecosystems. Although a considerable amount of water is dedicated to maintenance and restoration of aquatic and riparian ecosystems, environmental needs are not always met. Recent studies of the streamflow requirements of aquatic life, mainly represented by salmon, reveal that flows in many California rivers and streams sometimes fall below minimum desirable levels. These minimum flow levels are called objectives in the scenarios of Chapter 5, "Managing an Uncertain Future," in this volume. Objectives for the major rivers, estuaries, and wetlands of northern and

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

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

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

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

Flood Management

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

For the purposes of mapping areas that warrant flood insurance, the Federal Emergency Management Agency (FEMA) has traditionally used the 100-year flood event, which refers to the level of flood flows expected at least once in a 100-year period (a 1-percent annual chance). As California's hydrology changes, what is currently considered a 100-year flood may occur more often, leaving many communities at greater risk for flood damage. Planners need to factor a new level of safety into the design, operation, and regulation of flood control facilities, such as dams, floodways, bypasses, and levees, as well as the design of local sanitary sewers and storm drains.

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

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

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

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

Water Supplies and Uses

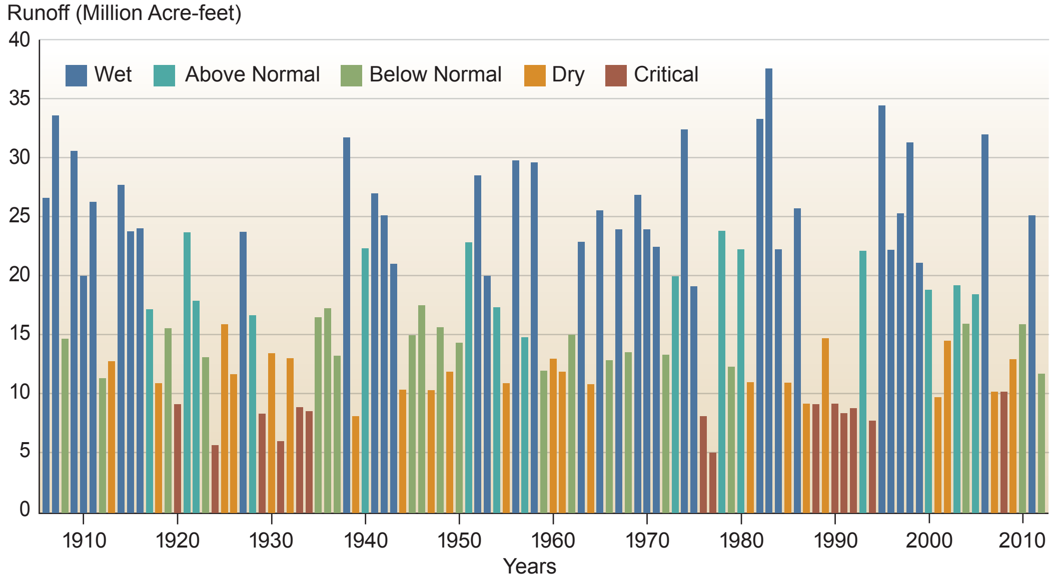
During the 20th century, Californians were able to meet water demands primarily through an extensive network of water storage and conveyance facilities, groundwater development, and more recently by improving water efficiency.

Significant water supply and water quality challenges persist on the local and regional scale. Although some regions have made great strides in water conservation and efficiency, the state's water consumption has grown along with its population. Many communities are reaching the limits of their supply with current water systems management practices and regulations.

The state's water resources are variable and agricultural, urban, and environmental water uses all vary according to the wetness or dryness of a given year. In very wet water years, agricultural and urban landscape (outdoor) water demands are lower because the high amount of rainfall directly meets these needs. Water demands are usually highest during average to below-average water years in which agricultural and outdoor water uses are at full deployment. During very dry water years, demands for water are reduced as a result of urban and agriculture water conservation practices and because the available surface water supplies are at less-than-average levels for use. However, increasing trends toward permanent cropping reduces California's ability to respond to changing supplies and increases reliance on groundwater supplies to meet demand.

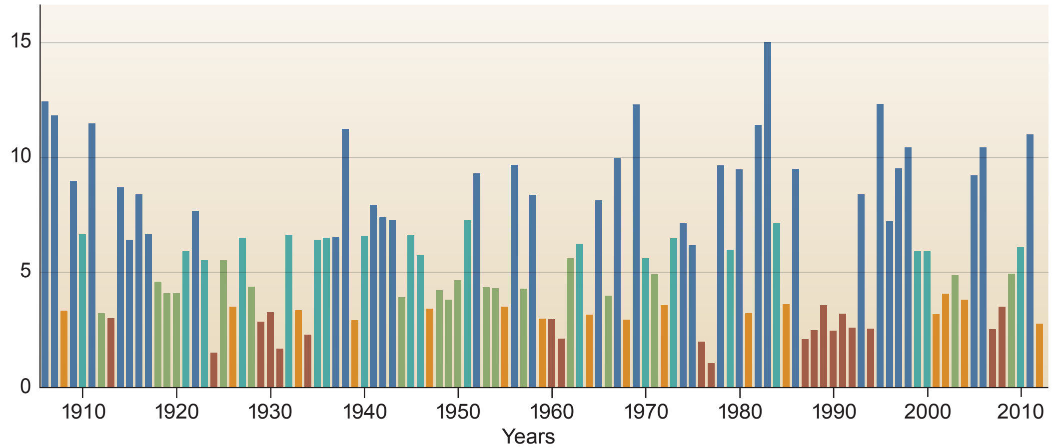
An indicator of California's hydrology and the annual surface water supplies is the amount of water that flows into the state's major rivers. For the central portions of California, the Sacramento River basin and San Joaquin River basin indices have been used for many years to evaluate the amount of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

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



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

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



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

indices describe unimpaired natural runoff from 1906 to the present, with five-year classifications identified from wet to critical. Many decisions about annual water requirements for the Delta are based on these indices, as are the amounts of surface water supplies available to many agricultural and urban regions of the state.

Surface and Groundwater Connections

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

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

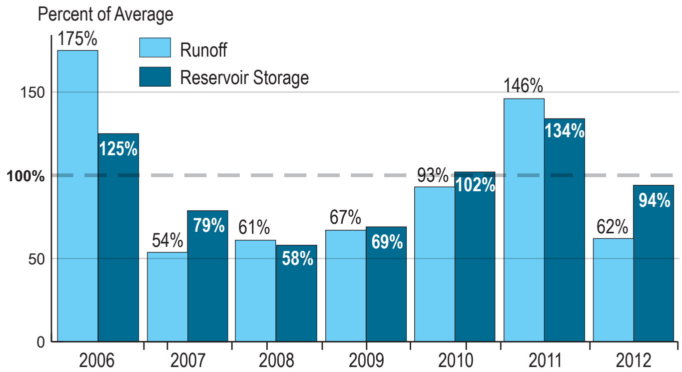
Other factors also affect the availability of surface water. In December 2007, U.S. District Court Judge Oliver Wanger imposed restrictions on water deliveries from the Delta to protect the threatened delta smelt. This can significantly decrease deliveries to homes, farms, cities, and industry by both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

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

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

Incidentally, small water systems and private well owners have historically experienced most of the water shortage emergencies during droughts. The majority of these problems result from depending on unreliable water sources, such as groundwater from fractured rock aquifers or small and shallow coastal-terrace groundwater basins. Historically, at-risk geographic areas include the foothills of the Sierra Nevada and the Coast Range, inland Southern California, and the North Coast and Central Coast regions. Most small systems and private wells are located in lightly populated rural areas where opportunities for interconnections with another system, water transfers, or emergency relief can be scarce. These findings do not necessarily reflect the quality of water delivered to the public, since many communities treat their water prior to delivery. Also, these findings do not reflect private domestic well users or other small water systems that are not regulated, because no comprehensive database exists for these systems.

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



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

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

State Water Project Deliveries

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

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

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

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

Box 3-4 Groundwater Overdraft

Overdraft is the condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions. Overdraft can be characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years. The calculation of overdraft requires an evaluation of change in groundwater storage over multiple years that, as a whole, represent average hydrology and water supply. To calculate overdraft, the average annual change in groundwater storage must be calculated over an extended period that includes a varied hydrologic regime to accurately approximate average conditions. Overdraft can lead to increased extraction costs, land subsidence, water quality degradation, and environmental impacts. A comprehensive assessment of overdraft in California's groundwater basins has not been conducted since 1980 (California Department of Water Resources 1980). The California Department of Water Resources estimated that overdraft is between 1 and 2 million acre-feet annually (California Department of Water Resources 2003), but the estimate is tentative with no current corroborating data.

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

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

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

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

Central Valley Project Deliveries

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

Colorado River Supplies

Before 2003, California's annual use of Colorado River water ranged between 4.5 and 5.2 maf. In recent years, Arizona has begun to exercise full use of its basic apportionment, and Nevada has approached full use of its entitlement and surplus allocation. Therefore, California has had to reduce its dependence on Colorado River water to 4.4 maf in average years. A record eight-year drought in the Colorado River basin has reduced current reservoir storage throughout the river system to just over 50 percent of total storage capacity.

Local Water Supplies

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

Water Portfolio and Water Balances

Statewide information has been compiled to present the current levels of California's developed water uses and the water supplies available for water years 1998 through 2010. Data for years 1998, 2000, and 2001 were presented in *California Water Plan Update 2005*; Update 2009 presented water years 1998-2005. For Update 2013, the same data structure and water portfolio concepts have been used to assemble and present statewide information for the additional years (see Box 3-5, "Water Portfolio Concept and Key Definitions"). Statewide summaries of the detailed water supplies and applied water uses, 1998 through 2005, are presented in Volume 5, *Technical Guide*. For consistency, the same portfolio format and data tables are used for regional reports.

Statewide balances are presented here for 10 years, 2001-2010 (Table 3-2, "California Hydrologic Water Balance Summary, 2001-2010," and Figure 3-10, "California Water Balance by Water Year, 2001-2010"). Regional balances are available in Volume 2, *Regional Reports*. The 10-year sequence did not include any major floods and does not encompass the possible range of far wetter and far drier years in the record.

The statewide water balance, Figure 3-10, demonstrates the state's variability for water use and water supply. *Water use* shows how applied water was used by urban and agricultural sectors and dedicated to the environment; *water supply* shows where the water came from each year to meet those uses.

California, in an average water year similar to 2010, receives about 200 maf of water from precipitation and imports from Colorado, Oregon, and Mexico. Approximately 50-60 percent of this total supply is used by native vegetation; evaporates to the atmosphere; provides some of the water for agricultural crops and managed wetlands (referred to as effective precipitation); or flows to Oregon, Nevada, the Pacific Ocean, or salt sinks, such as saline groundwater aquifers and the Salton Sea. The remaining 40-50 percent, identified as dedicated or developed water supplies and as shown in Figure 3-10, is distributed among urban and agricultural uses for protecting and restoring the environment, or as storage in surface water and groundwater reservoirs for later use. In any year, some of the dedicated supply includes water used multiple times (reused water) and water that is held in storage from previous years. Ultimately, about

Box 3-5 Water Portfolio Concept and Key Definitions

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

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

The water summary table provides more detailed information about total statewide water supply sources and provides estimates for the primary uses of the state's supplies for these years. As indicated, a large component of the statewide water supply is used by natural processes, such as evaporation, evapotranspiration from native vegetation and forests, and percolation to groundwater. This water is generally not counted as part of the dedicated water supplies. Each of the regional reports presents this information at the regional level.

A more detailed statewide summary of dedicated water supplies and uses for water years 1998-2010 is presented in Volume 5, *Technical Guide*, which provides a breakdown of the components of developed supplies and uses for agricultural, urban, and environmental purposes. For each of the water years, information is presented as applied water and net water usage, as well as the calculated total water depletion. Much of the environmental water in this table is dedicated to meeting instream flow requirements and flows in Wild and Scenic rivers, which in some cases can later be reused for other downstream purposes.

Key Water Supply and Use Definitions

For consistency with the 1998, 2005, and 2009 California Water Plan updates, *California Water Plan Update 2013* computes dedicated water supplies and uses based on applied water data.

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

one-third of the dedicated supply flows to the Pacific Ocean or to other salt sinks, in part to meet environmental water requirements for designated Wild and Scenic rivers and other environmental requirements and objectives.

In each of the regional reports, bar charts similar to the statewide water balance by water year provide regional data. Comparing them with the statewide figure helps to illustrate how individual regions compare with the statewide distribution. Figure 3-11 depicts water balances

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

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

Notes:

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

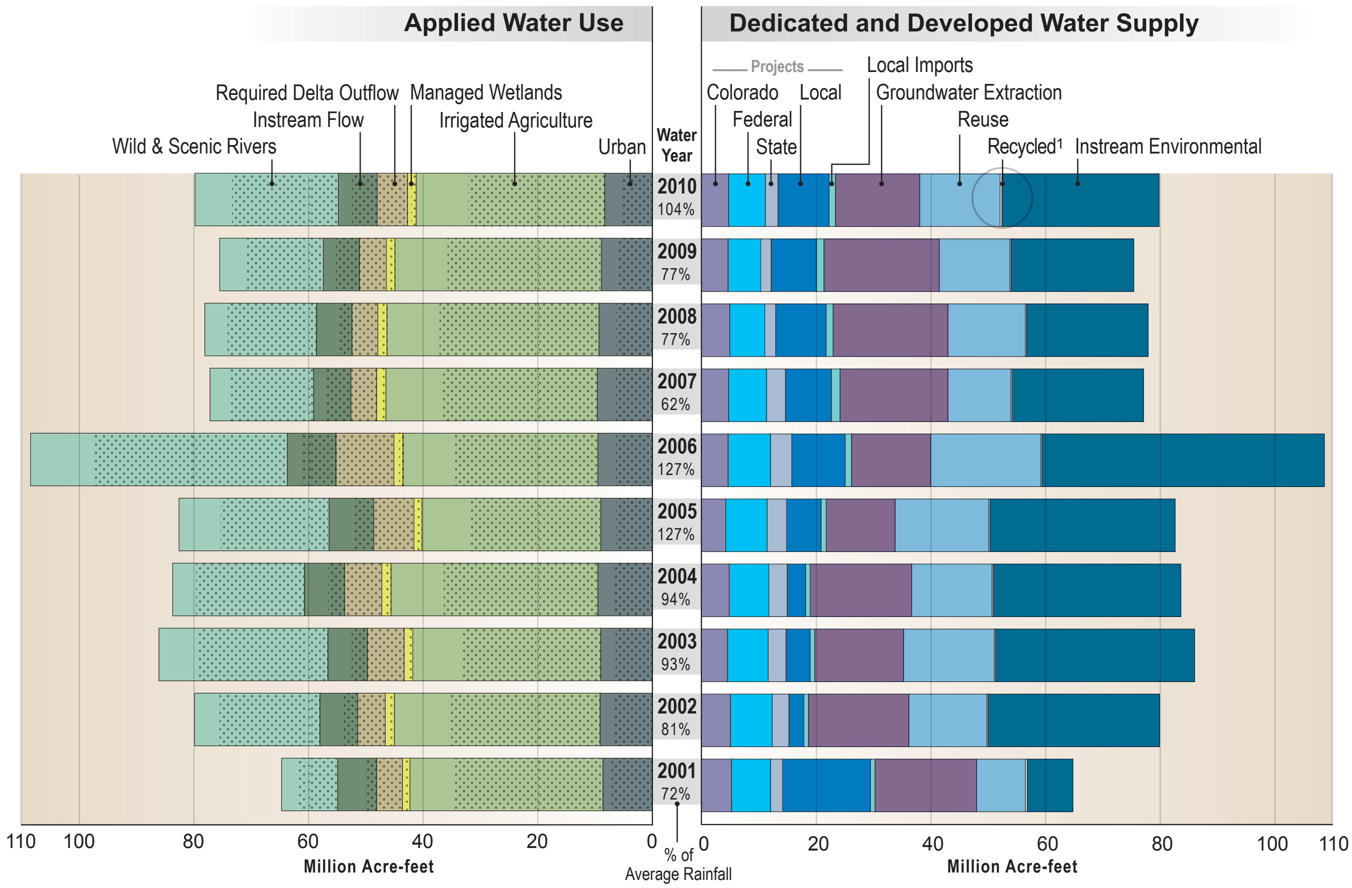
[a] Definition: Consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is greater than consumptive use because it includes consumptive use, reuse, and outflows.

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

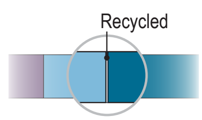
This equation does not include unknown factors such as natural recharge and subsurface inflow and outflow. For further details, refer to Volume 4, *Reference Guide*, the article "California's Groundwater Update 2013" and Volume 5, *Technical Guide*.

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

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



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



[1] **Detail of bar graph:** *For water years 2001-2010, recycled municipal water varied from 0.2 to 0.5 MAF of the water supply .*

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

Key Water Supply and Water Use Definitions

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

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

Instream environmental. Instream flows used only for environmental purposes.

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

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

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

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

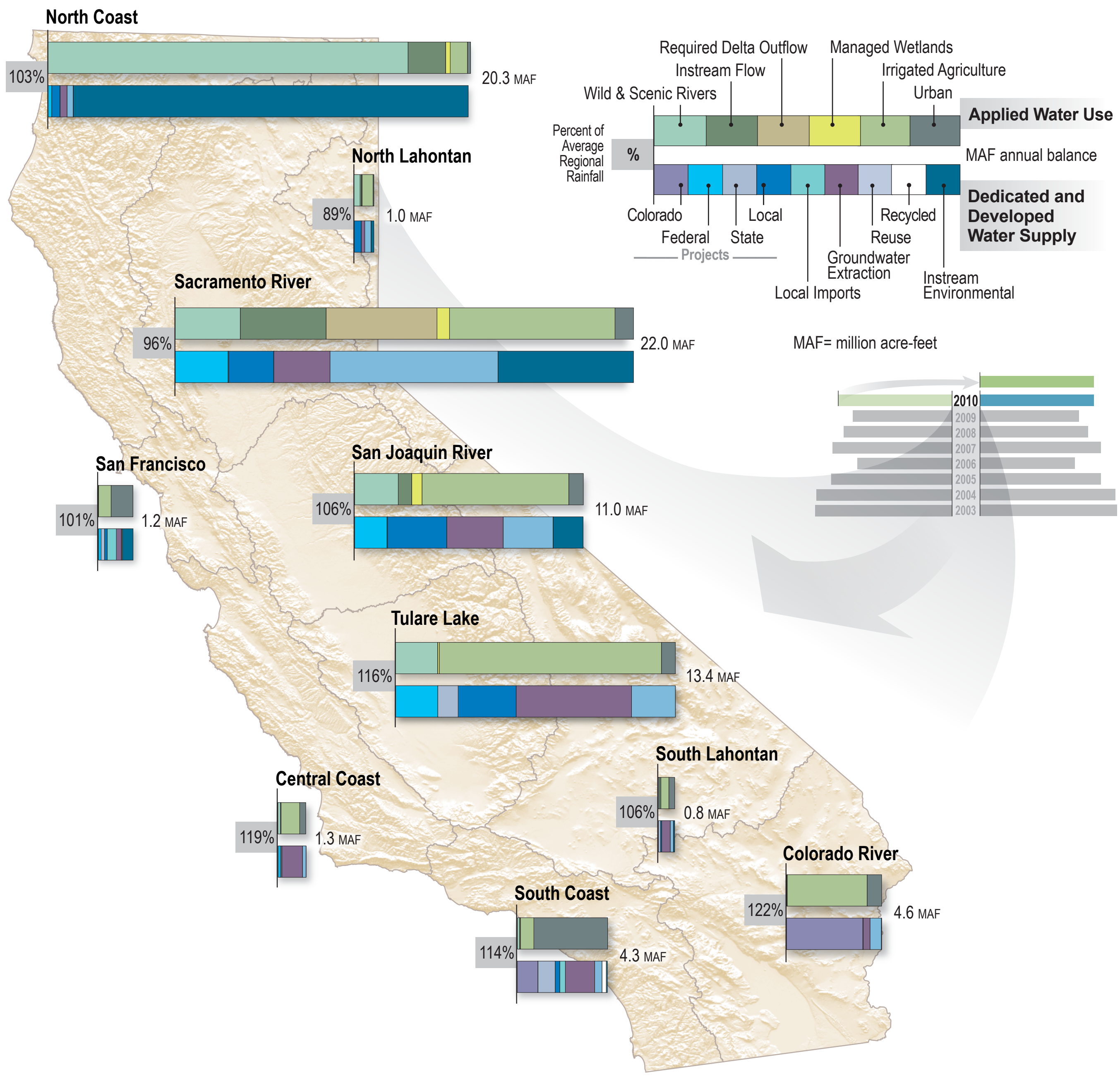
Urban water use. The use of water for urban purposes, including residential, commercial, industrial, recreation, energy production, military, and institutional classes. The term is applied in the sense that it is a kind of use rather than a place of use.

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

California Water Balance by Water Year Data Table (MAF)

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

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



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

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

When water supply and water use information from the regional reports is accumulated for the statewide totals, some categories are not applicable, such as interregional water transfers between one hydrologic region and an adjoining region. This type of information is not shown in the statewide tables. Figure 3-12 shows inflows and outflows between California's hydrologic regions by using data from current base year 2010, a near average water year.

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

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

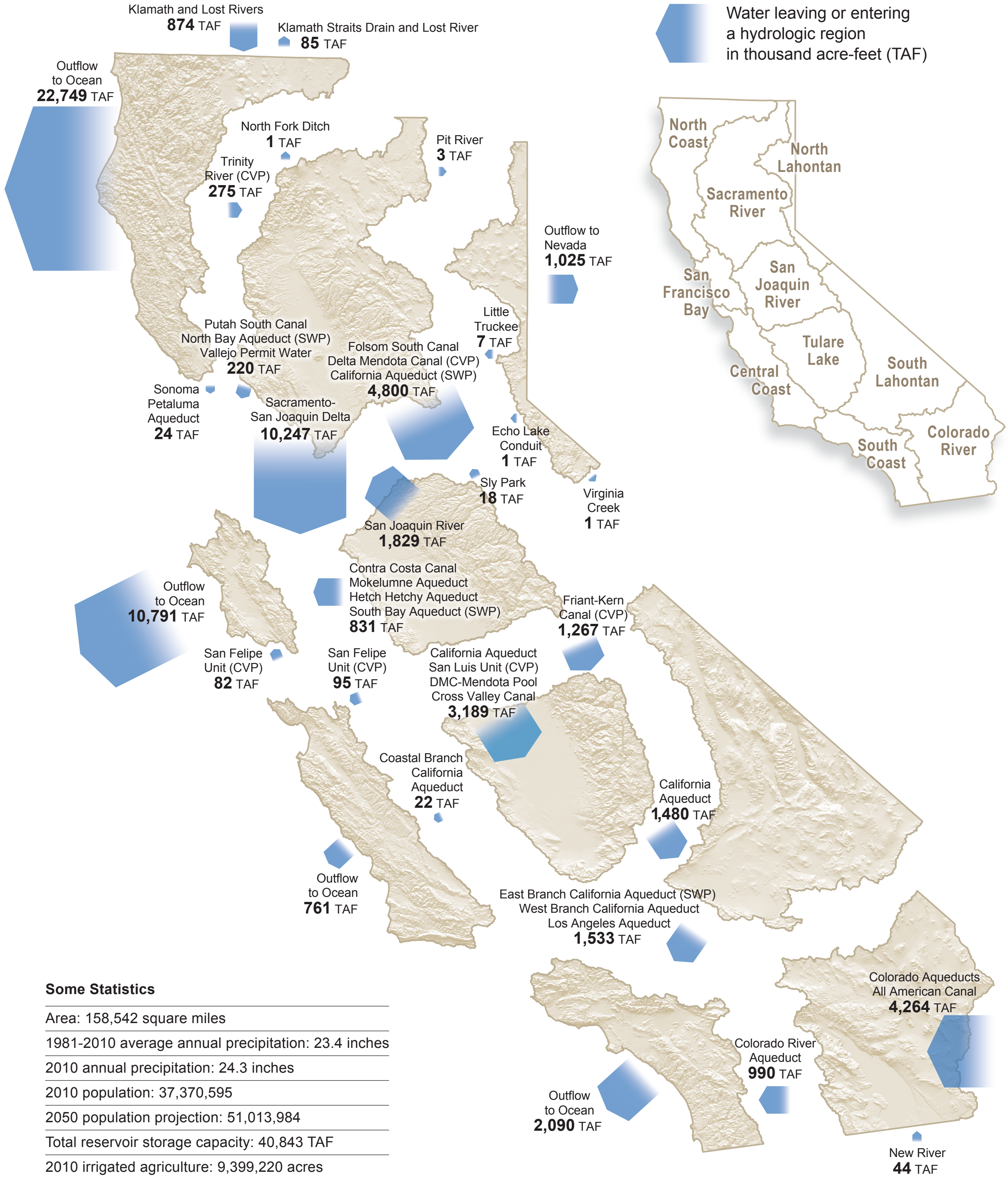
Annual groundwater extractions in California averaged about 16,500 taf and contributed to about 39 percent of the state's total water supply. Evaluation of the statewide groundwater supply by type of use indicates that California's groundwater supplies account for 39 percent of the total annual agricultural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

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

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

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

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



Some Statistics

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

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

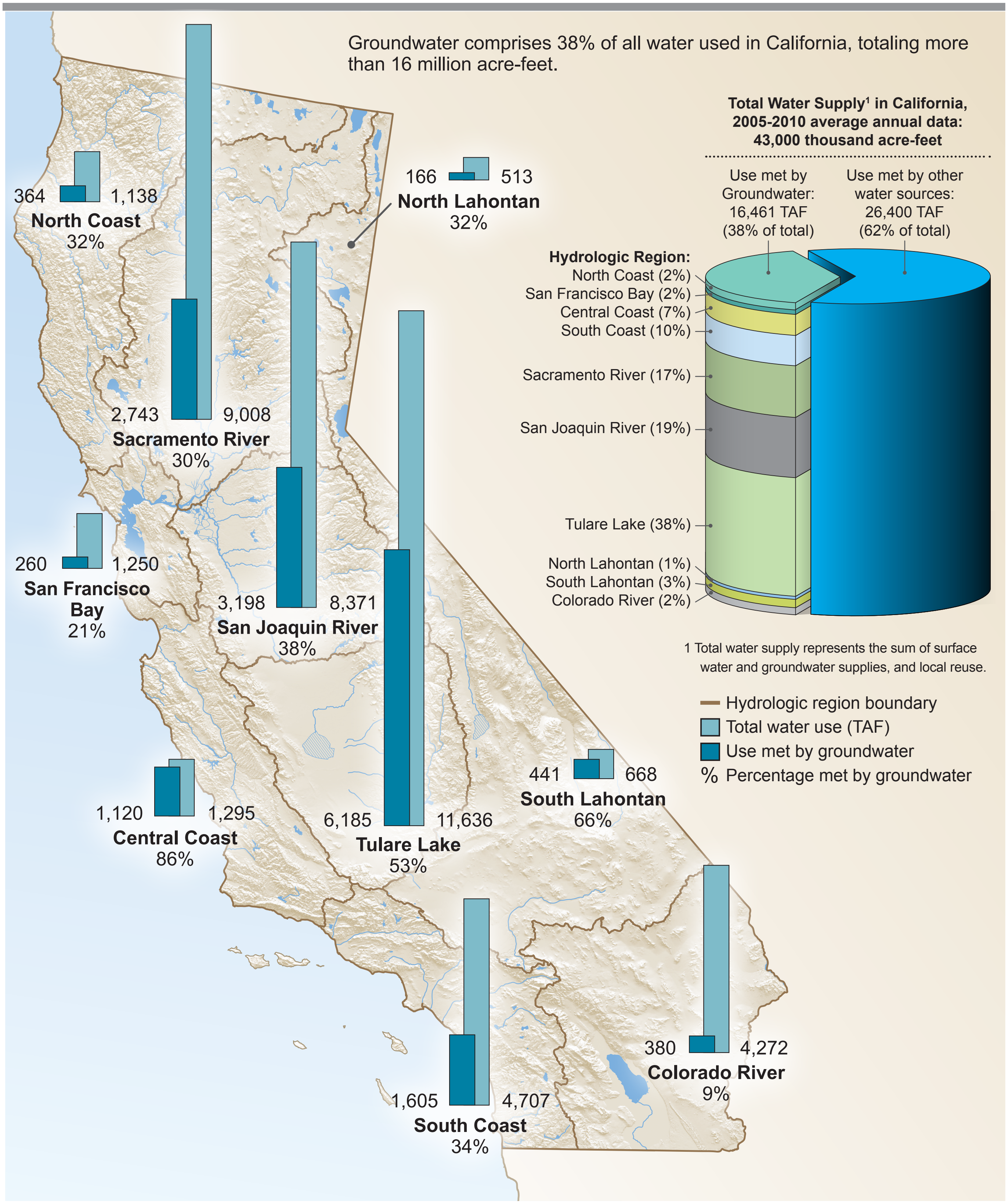


Figure 3-14 **Annual Groundwater and Surface Water Supply Trends**

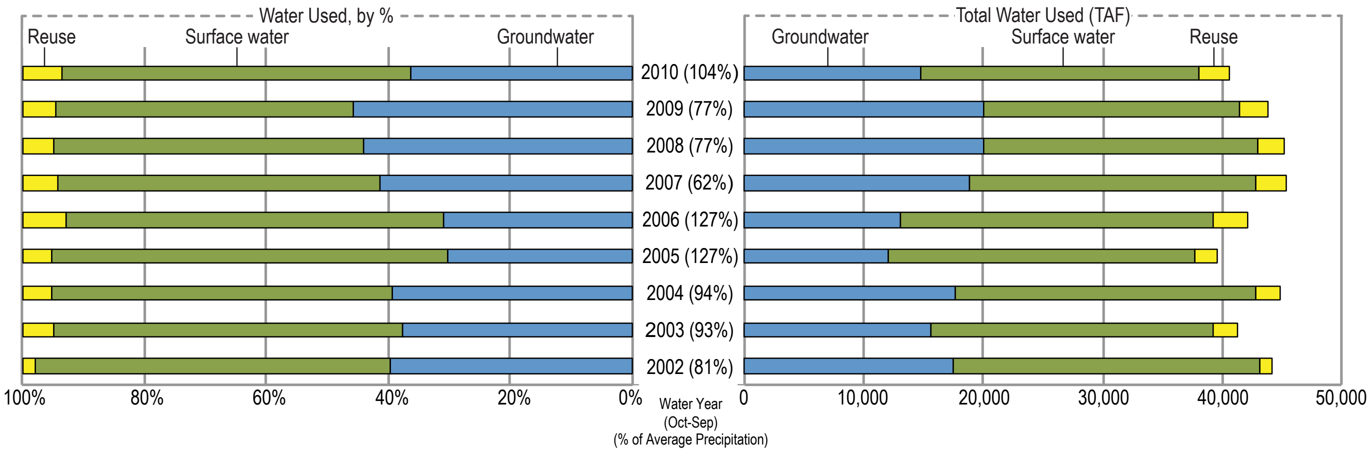
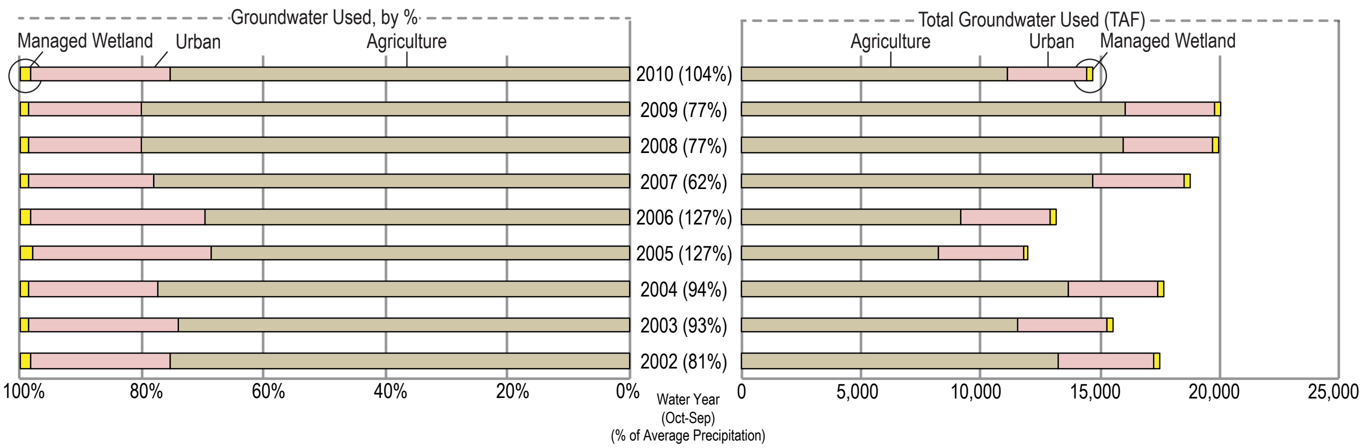


Figure 3-15 **Annual Groundwater Supply Trend by Type of Use**



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

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

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

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

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

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

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

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

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

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

Figure 3-16 California Groundwater Level Trends

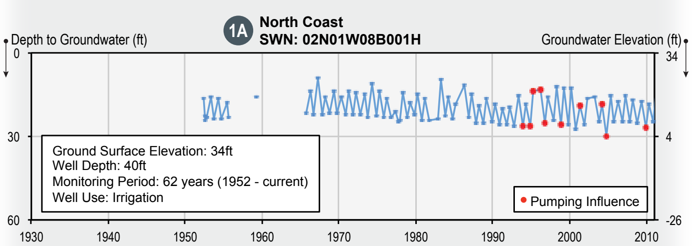
Aquifer response to changing demand and management practices

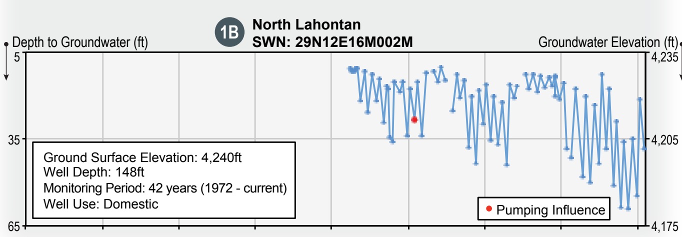
Hydrographs were selected to help tell a story of how local aquifer systems respond to changing groundwater demand and resource management practices. Additional details are provided in the Volume 2 Regional Reports and Volume 4 Reference Guide article, "California's Groundwater Update 2013."

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

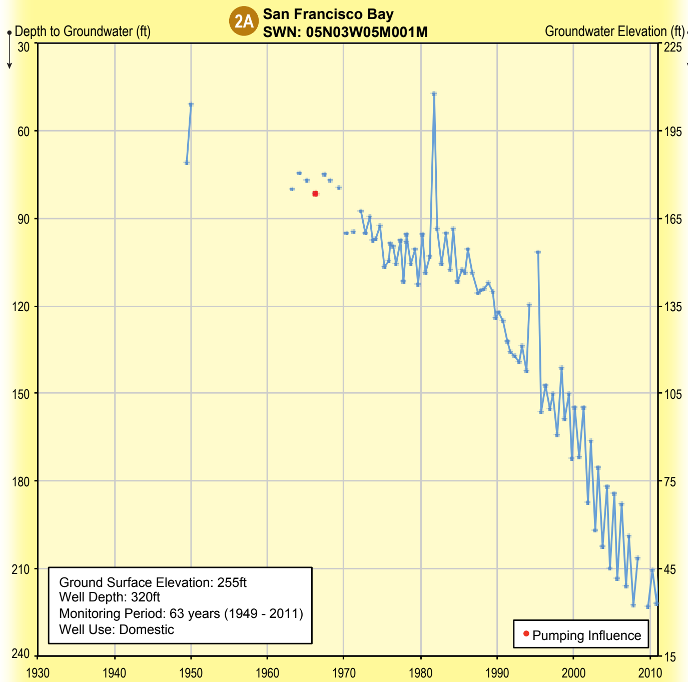
Well Location Map

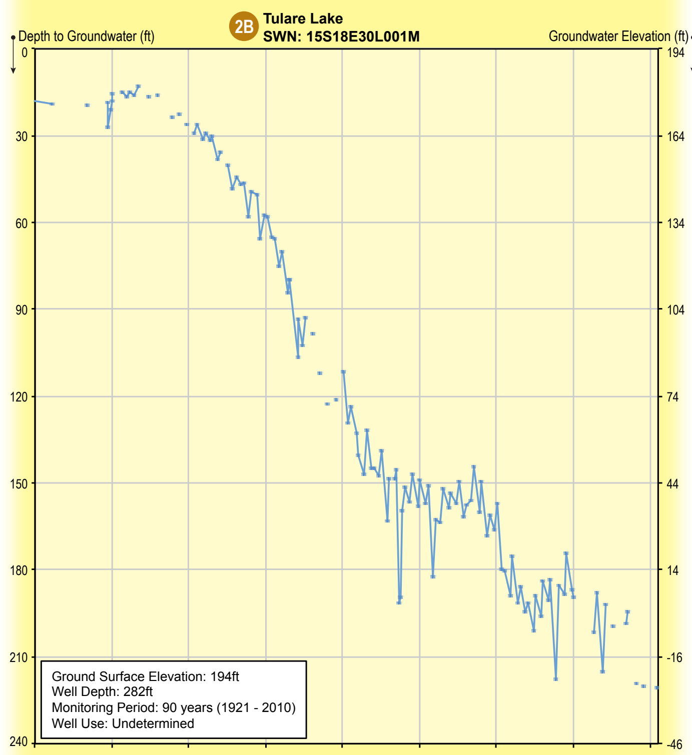
Theme 1: Long term groundwater levels remain reasonably stable due to limited demand and adequate recharge.



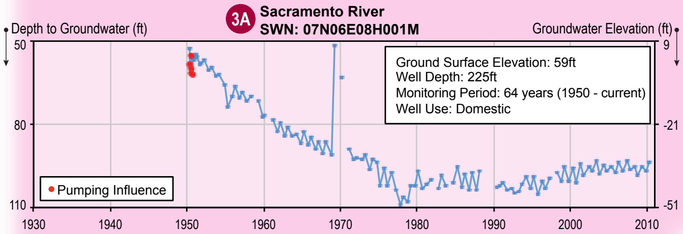


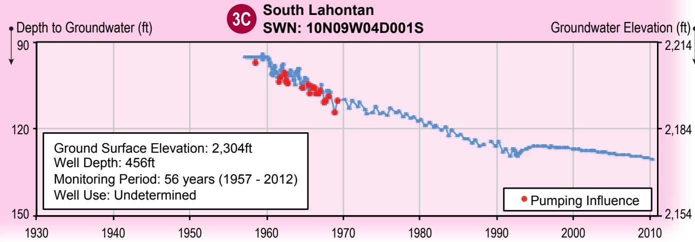
Theme 2: Long-term decline in groundwater levels due to annual demand being consistently greater than annual recharge.

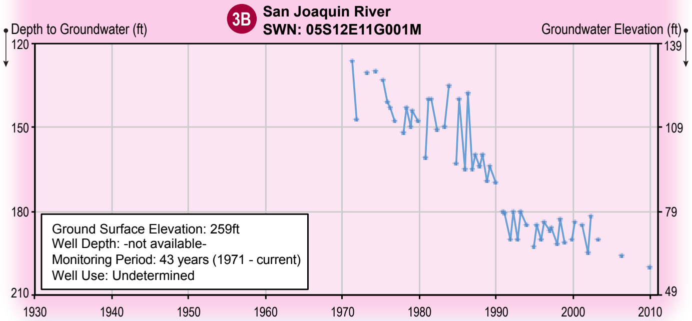




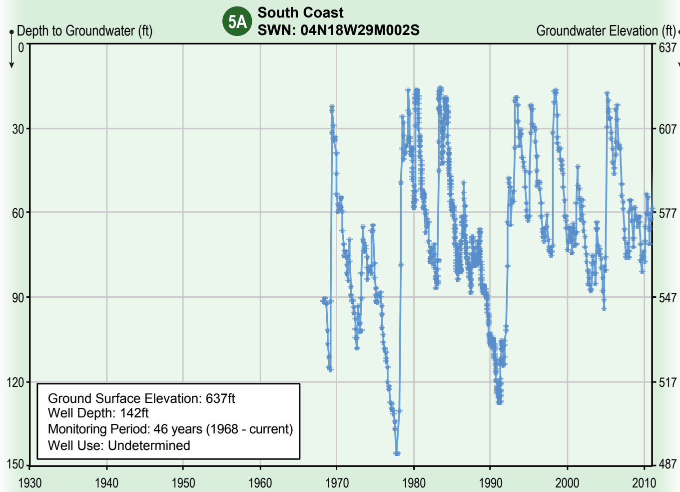
Theme 3: Long-term decline in groundwater levels that have stabilized but not recovered, due to reduced demand.



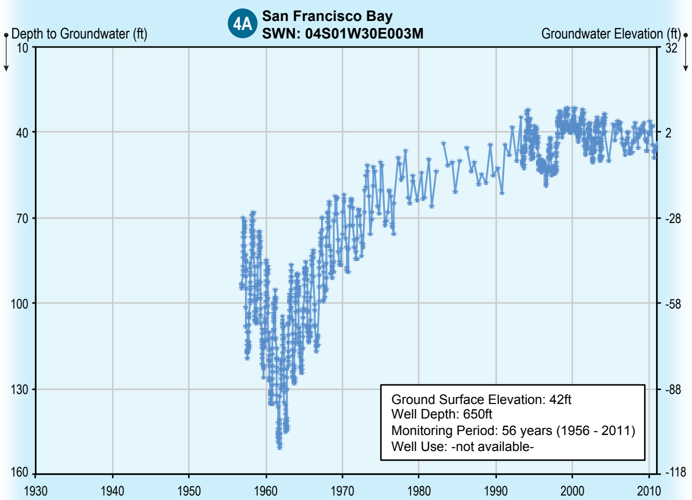


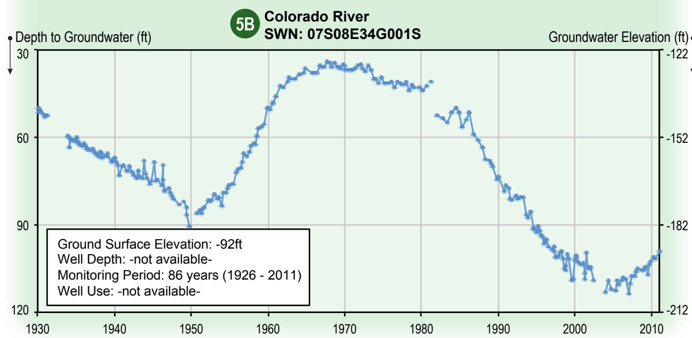


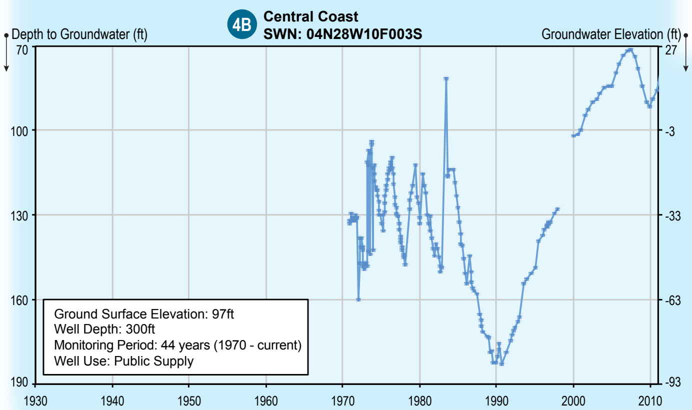
Theme 5: Long-term groundwater levels remain reasonably stable due to proactive recharge, prior to long-term declines.

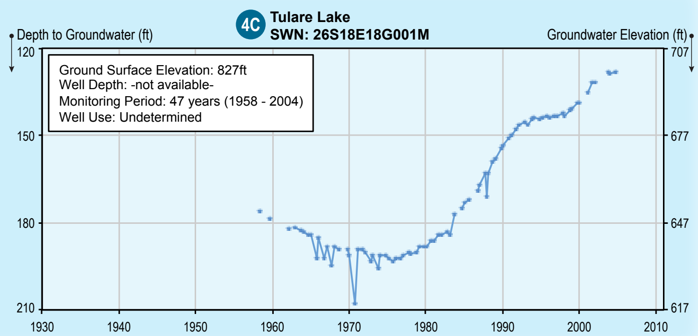


Theme 4: Long-term decline in groundwater levels that have stabilized and improved, due to reduced demand and increased recharge.









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

Water Quality

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

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

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

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

Table 3-3 State Water Quality Database Web Sites

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

Project Operation and Reoperation

California depends on vast statewide water management systems to provide clean and reliable water supplies, protect lives and property from floods, withstand drought, and sustain environmental values. Those water management systems include physical facilities and their operational policies and regulations. The facilities include more than 1,200 State, federal, and local reservoirs, as well as canals, treatment plants, and levees. These systems are often interconnected. The proper operation of one system sometimes depends on the smooth operation of another. The successful operation of the complete system becomes vulnerable if any parts fail. See Chapter 7, "System Reoperation," in Volume 3, *Resource Management Strategies*, for further details.

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

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

Institutional Setting and Governance

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

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

This system that governs the distribution of water and the related scheduling was created more than a century ago, primarily to meet the needs of agriculture and urban dwellers, and it ignored environmental impacts. The California Constitution was amended in 1928 to require that all water uses be reasonable and beneficial and to prohibit the waste and unreasonable use or unreasonable method of use of all water resources (Article X, Section 2). As the years passed, new laws and court decisions addressing water's effect on the environment constrained that same water allocation (Little Hoover Commission 2010).

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

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

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

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

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

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

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

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

Tribal Water Management

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

IWM Funding and Expenditures

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

Resource Management from 1850-Present

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

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

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

Box 3-6 Current Conflicts over California's Water

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

Source: Hanak et al. 2011.

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

Historical IWM Funding

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

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

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

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

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

State Bonds

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

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

2000	Current	Forward

Environmental/ Public Trust Period

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

Bond Period

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

Integration Period

Innovation actions

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

Infrastructure improvements:

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

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

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

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

Local, State, and Federal Expenditures, 1995 to 2010

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

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

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

Important Observations about Current IWM Funding

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

Critical Challenges

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

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

Protect and Restore Surface Water Quality

The quality of California water is a particular and growing concern. Water bodies may be impaired from various sources. Discharges from municipal and industrial facilities can affect water bodies, but compared with other sources, pollution from these point-source discharges has been largely controlled. Discharges from agricultural lands — including irrigation return flow, flows from tile drains, and stormwater runoff — can affect water quality by transporting pollutants, including pesticides, sediment, nutrients, salts, pathogens, and heavy metals from cultivated fields into surface waters. Stormwater flows over urban landscapes, as well as dry-weather flows from urban areas, also constitute a significant source of pollutants that contribute to water quality degradation. These flows carry pollutants downstream, which often end up on beaches and in coastal waters.

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

Changes in the timing of river flows may affect water quality and beneficial uses in many different ways. At one extreme, flood peaks may cause more erosion, resulting in higher turbidity and concentrated pulses of pathogens, nutrients, and other pollutants. This will challenge water treatment plant operations to produce safe drinking water. Increased sediment loads associated with higher intensity flooding can also threaten the integrity of water works infrastructure, including more rapid buildup of sediments in reservoirs, and deposition of debris and sediments in canals and intakes. At the other extreme, lower summer and fall flows may provide less dilution of contaminants. These changes in streamflow timing may require new approaches to manage discharge permitting and non-point-source pollution. To make informed decisions on streamflow timing and improve water quality and the health of streams, California needs to

Box 3-7 The Diamond-Water Paradox

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

Source: American Society of Civil Engineers 2013.

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

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

Protect and Restore Groundwater Quality

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

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

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

Multi-Year Dry Periods (Drought)

Impacts of drought are typically felt first by those most reliant on annual rainfall — ranchers engaged in dry land grazing, rural residents relying on wells in low-yield rock formations, or small water systems lacking a reliable source. Drought impacts increase with the length of a drought as carry-over supplies in reservoirs are depleted and water levels in groundwater basins decline (see Figure 3-18, “Potential Impacts of Continuing Drought”).

Climate change could extend California’s drought periods and make them worse. Warming temperatures and changes in rainfall and runoff patterns may exacerbate the frequency and intensity of droughts. Regions that rely heavily on surface water (i.e., rivers, streams, and lakes) could be particularly affected as runoff becomes more variable and more demand is placed on groundwater. Combined with urbanization expanding into wildlands, climate change could further stress the state’s forests and make them more vulnerable to pests, disease, and changes in species composition. Along with drier soils, forests may experience more frequent and intense fires that result in changes in vegetation and eventually a reduction in the water supply and storage capacity of a healthy forest.

During droughts, California has historically depended on its groundwater to supplement other depleted supplies. Increased reliance on groundwater to supplement drought and regulatory cutbacks in surface water supplies is already having impacts on some groundwater basins; moreover, groundwater-related impacts from climate change have the potential to affect future groundwater sustainability. In addition, climate change has the potential to significantly alter historical patterns of groundwater recharge and exacerbate drought conditions. More effective groundwater basin management will be necessary to mitigate existing groundwater overdraft and avoid additional overdraft driven by the changing climate. In regions with contaminated groundwater basins, some additional steps may be required to remediate the aquifer before implementing active recharge and conjunctive use.

Floods and Flooding

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

Figure 3-18 Potential Impacts of Continuing Drought

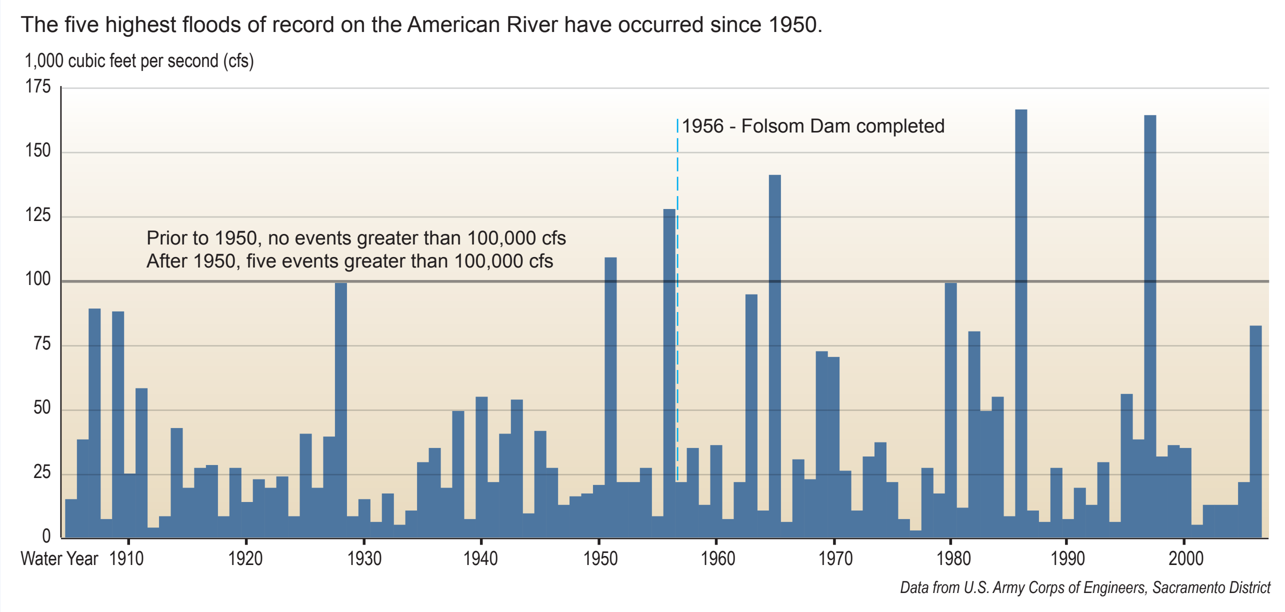
obstacles. Escalating development in floodplains has increased the potential for loss of life and flood damage to homes, businesses, and communities.

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

Box 3-8 Understanding Hydrologic Changes over Time

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

Figure A American River at Folsom Dam



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

Catastrophic flooding in multiple locations throughout the state could equal or exceed the economic, social, and environmental damage caused by Hurricane Katrina in 2005. More than 7 million people live in California's floodplains, and this population continues to increase. Moreover, State government's potential liability in the aftermath of *Paterno v. State of California*, which held the State liable for flood-related damages caused by a levee failure, exacerbates the financial consequences of flooding to all Californians.

As a consequence of lack of funding and environmental concerns, both the State and local agencies in all regions of California have found it increasingly difficult to carry out adequate maintenance programs by using established methods. Habitat can be negatively affected by some levee maintenance practices, such as vegetation removal or filling burrow holes. Environmental regulations require that local and State agencies develop new approaches to deal with the backlog of maintenance activities. While there is value in the environmental permitting process, the time and resources needed to complete the process can delay maintenance of critical public safety infrastructure.

Climate change may increase the state's flood risk by producing higher peak flows and a shift toward more intense winter precipitation. Rising snowlines caused by climate change will allow more Sierra Nevada watersheds to contribute to peak storm runoff. Flood events, such as the 10-year and larger floods, may increase with the changing climate. Along with changes in the amount of the snowpack and accelerated snowmelt, scientists project greater storm intensity, resulting in more direct runoff and flooding, which will be exacerbated in urban areas by impervious land surfaces, such as asphalt and traditional impervious concrete. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As streamflows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildland fires resulting from climate change, there is, in turn, a potential for more floods following fire, which will increase sediment loads and degrade water quality.

Environment/Ecosystem

California has lost more than 90 percent of the wetlands and riparian forests that existed before the Gold Rush. Successful restoration of aquatic, riparian, and floodplain species and communities ordinarily depends on at least partial restoration of physical processes that are driven by water. In riverine habitats, these processes include floodplain inundation, natural patterns of erosion and deposition of sediment, a balance between infiltration and runoff, and substantial variation in seasonal streamflow. In a balanced system, groundwater systems also contribute to ecosystem services through streamflow augmentation, discharge to wetland areas, and provision of a critical source of water to valley oaks and other groundwater-dependent vegetation. The diminution of these physical processes often leads to impacts on native species, thus presenting another huge barrier to ecosystem restoration.

As an example, nearly all California waterways are controlled to reduce the impacts associated with large fluctuations in seasonal flow. Larger rivers are impounded to capture winter runoff and spring snowmelt, reduce the downstream effects of peak-flow events, and provide a measured release of high-quality water during the dry season. Many naturally intermittent streams have become perennial, often from receipt of urban wastewater discharges or from use as supply and drainage conveyances for irrigation water. Other streams that were once perennial have become seasonally dewatered owing to nearby groundwater pumping, resulting in streamflow depletion. Groves of valley oaks in the San Joaquin and Tulare Lake regions have diminished to a fraction of their original number as a result of significant lowering of groundwater levels. The Delta has become more like a year-round freshwater lake than the seasonally brackish estuary it once was. In each case, native species have declined or disappeared. Exotic species have become prevalent, often because they are better able to use the greater or more stable summer moisture and flow levels than the drought-adapted natives (see Chapter 22, "Ecosystem Restoration," in Volume 3, *Resource Management Strategies*).

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

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

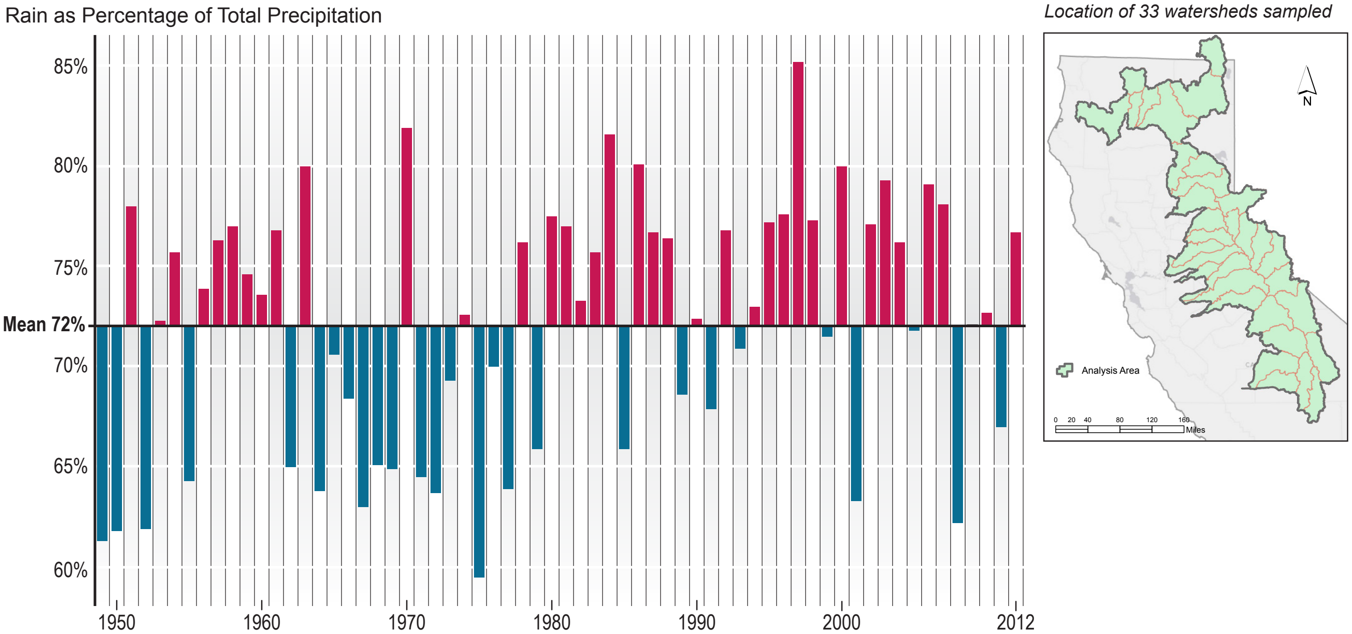
A second example concerns forest management in the mountain watersheds that supply the bulk of California's water. One hundred years of fire suppression has produced unusually dense stands of small trees, which are much more susceptible to combustion during wildfires than larger, old-growth trees. They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

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

Climate Change

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

Figure 3-19 **Rain/Snow Historical Trends**



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

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

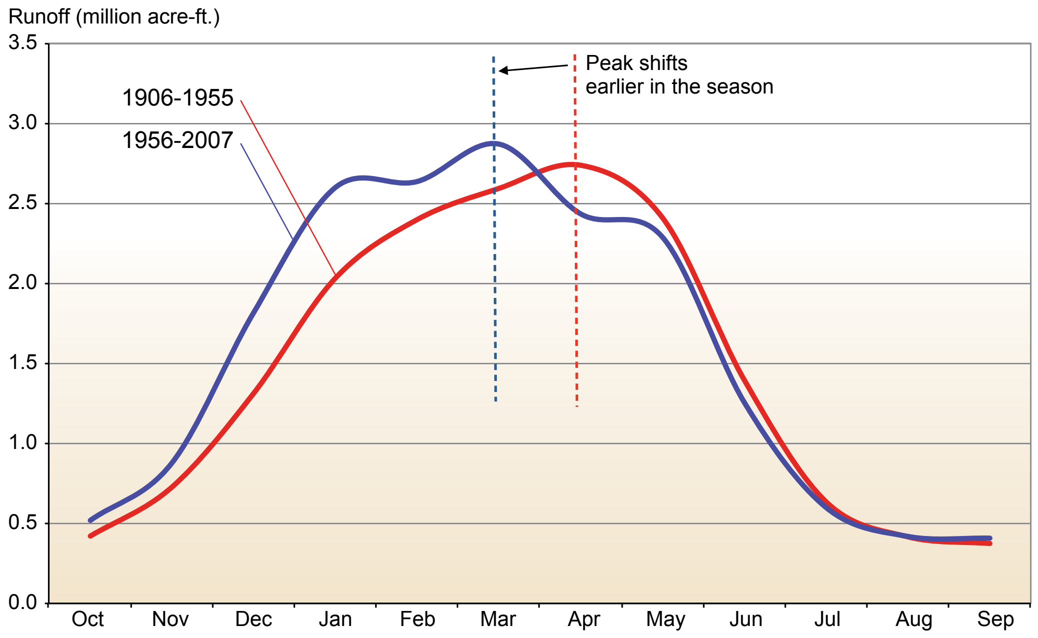
For data and analysis methodology, see the article "Estimating California Snowfall Trends Using Available Gridded Precipitation and Freezing Level Data" (Volume 4, *Reference Guide*).

Temperature Trends, Hydrologic Impacts, and Projections

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

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

Figure 3-20 Monthly Average Runoff of Sacramento River System



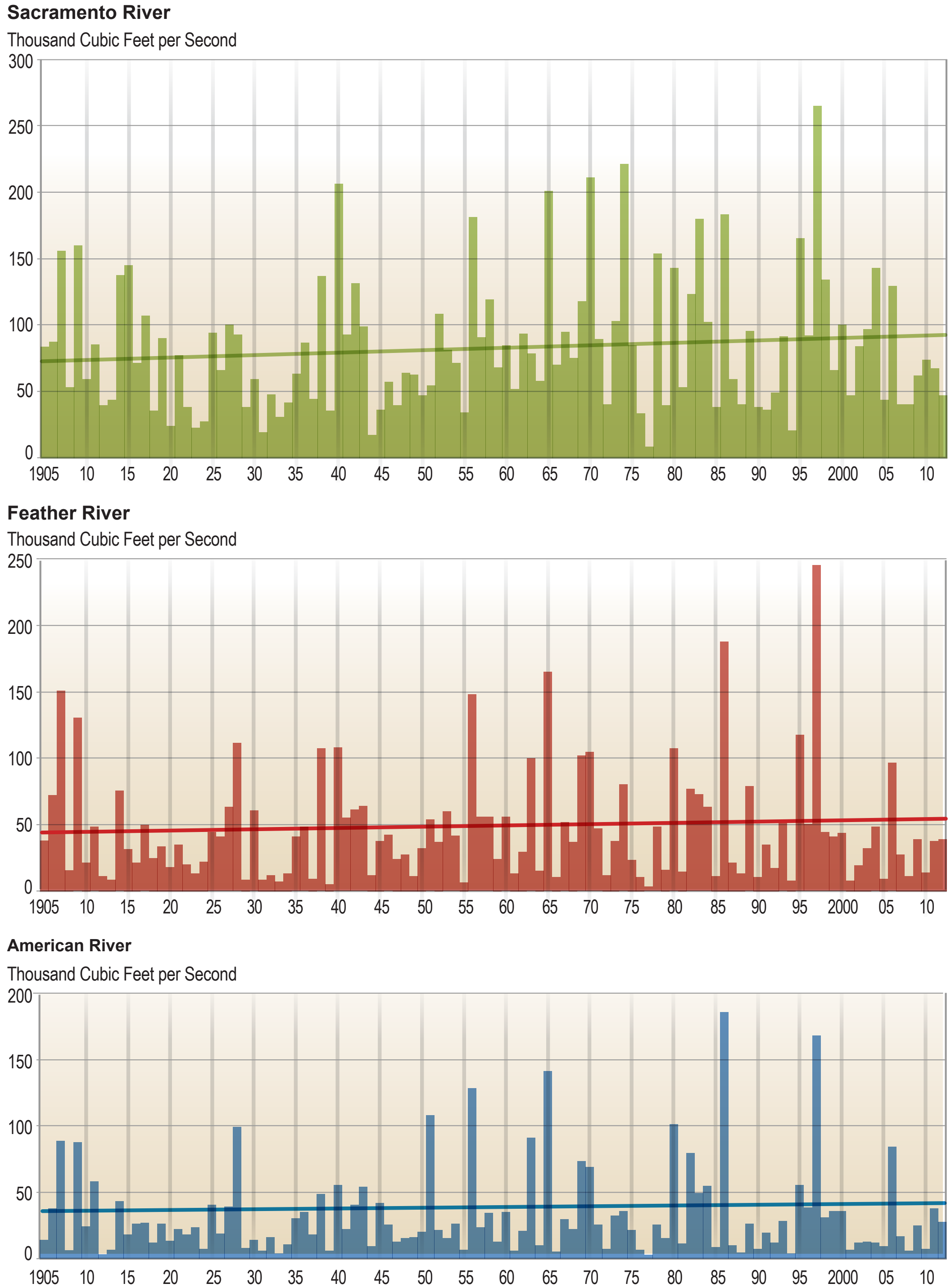
Note: Average monthly runoff in the Sacramento River System is a critical component of California's water supply. Flood protection and water supply infrastructure have been designed and optimized for historical conditions. However, the timing of peak monthly runoff between 1906-1955 (redline) and 1956-2007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

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

Additional changes can be seen in the hydrologic record. Snowmelt provides an annual average of 15 maf of water, slowly released by melting from about April to July each year. Much of the state's water infrastructure was designed to capture the slow spring runoff and deliver it during the drier summer and fall months. The water management community has invested in, and depends on, a system based on historical hydrology, but managing to historical trends will no longer work. Historical hydrology may no longer provide an accurate picture of future conditions. Figure 3-20 shows the timing of runoff has changed during the last 100 years in California's largest water supply watershed, the Sacramento River System.

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

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



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

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

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

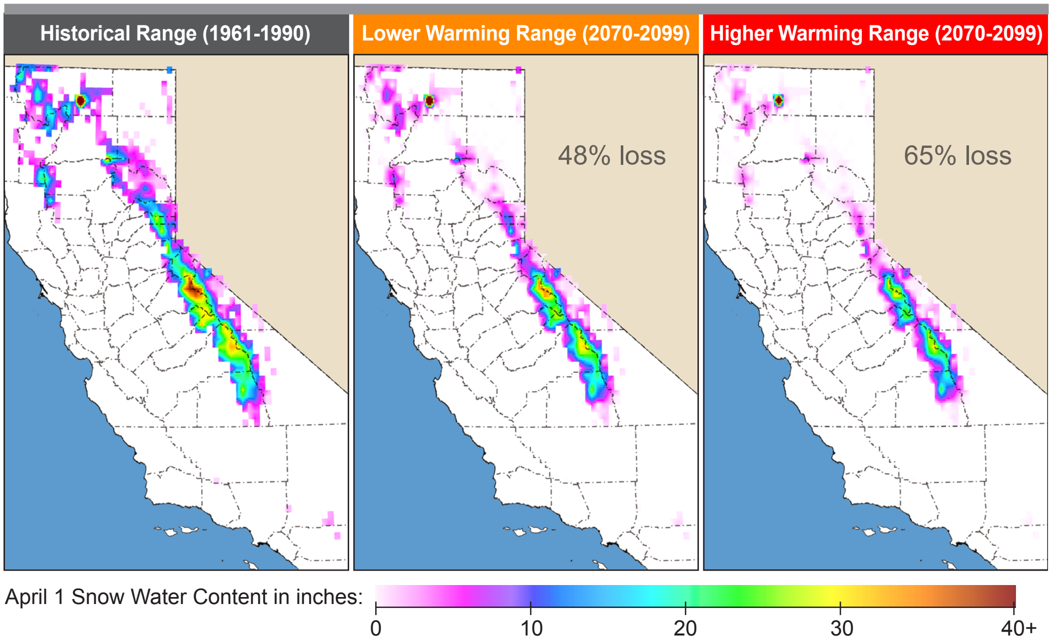
If the atmosphere undergoes additional warming, runoff could continue to shift earlier in the year. One study that has bearing on all major water export systems is a simulation of the SWP. Increasing temperatures were simulated in the Feather River basin to gauge the sensitivity of the SWP to increasing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

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

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

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

Figure 3-22 Snowpack Projections



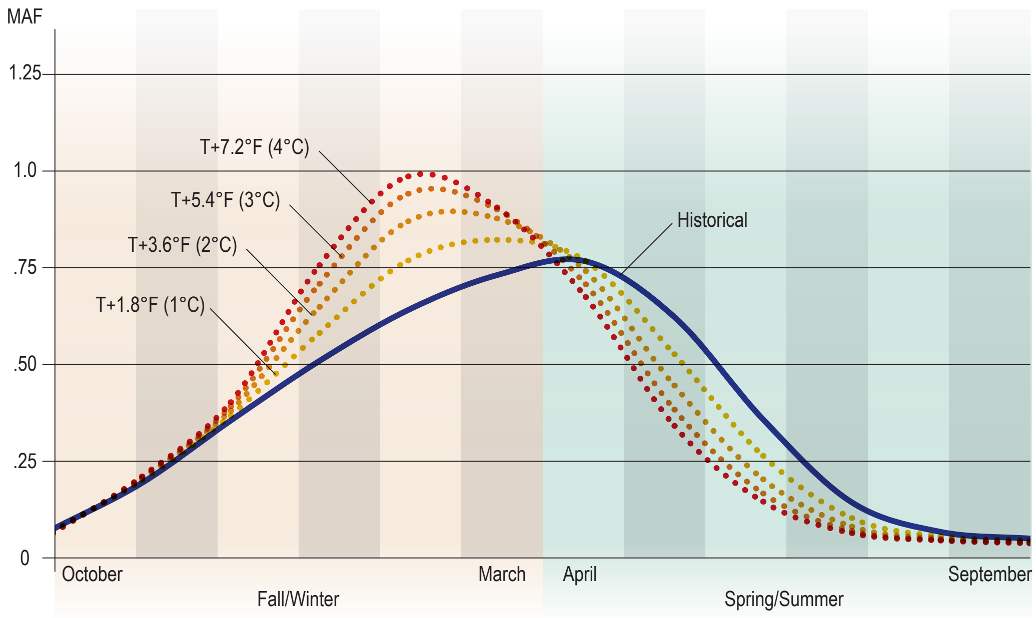
Note: Historical and projected April 1st snow-water content for the Sierra for lower and higher warming scenarios depicting the effect of human-generated GHGs and aerosols on climate. By the end of this century, the Sierra snowpack is projected to experience a 48-65 percent loss from its average at the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

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

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

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

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



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

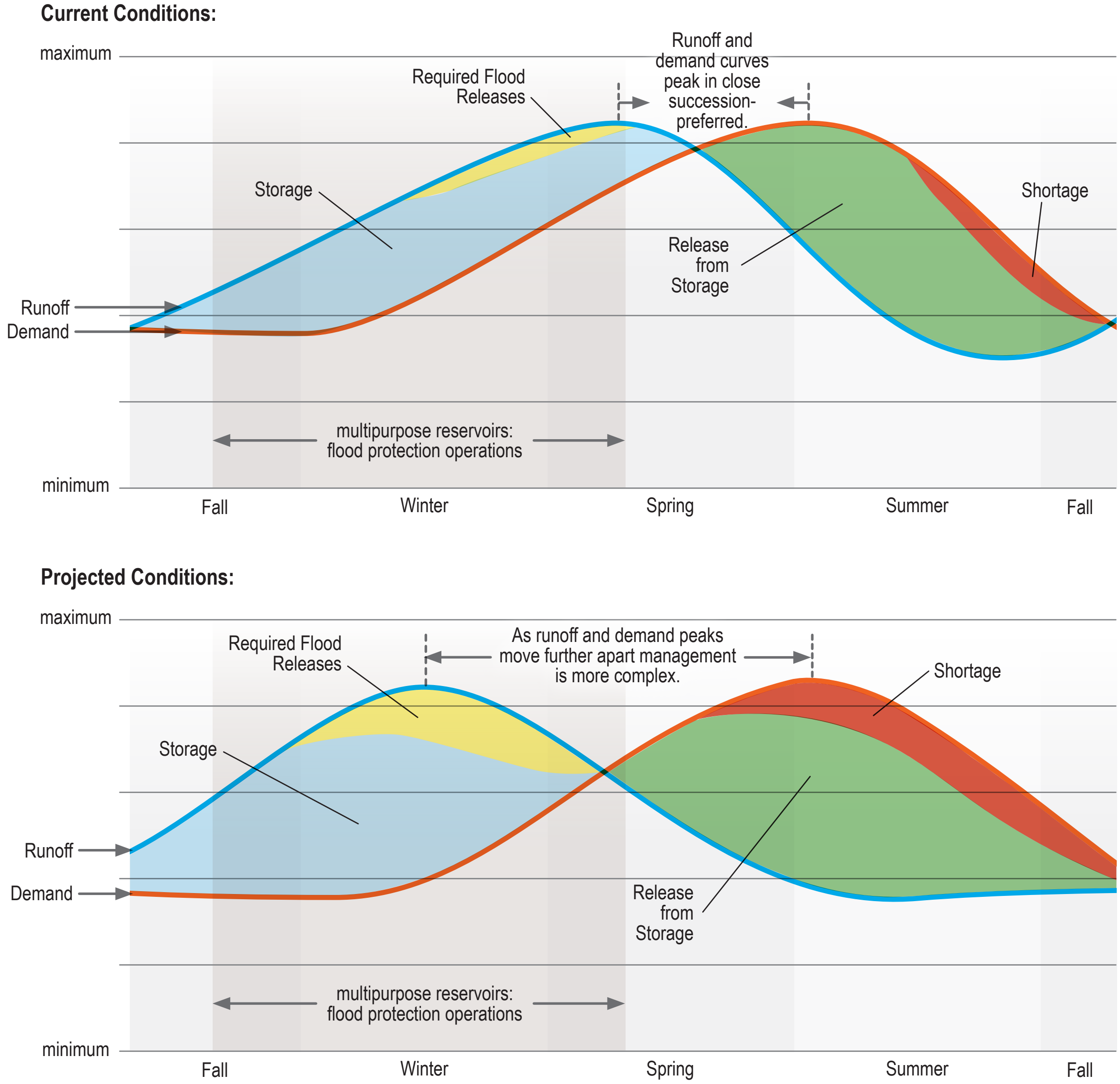
Warmer temperatures would also increase evaporation from reservoirs, lakes, and rivers. With increasing temperatures, net evaporation from reservoirs is projected to increase by 15-37 percent (Medellin-Azuara et al. 2009; California Natural Resources Agency 2010).

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

Sea Level Rise

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

Figure 3-24 How Earlier Runoff Affects Water Availability



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

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

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

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

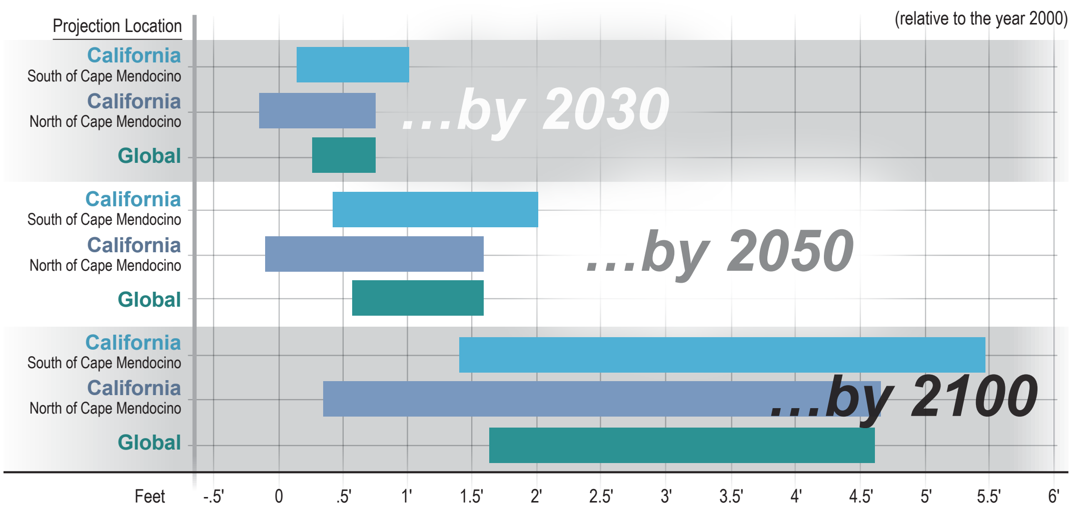
The sea-level-rise implications for California include increased risk of storm surge and flooding for coastal residents and infrastructure, including many of the state's low-lying coastal wastewater and recycled water treatment plants. Most coastal damage from sea level rise is caused by the confluence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

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

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

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

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



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

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

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

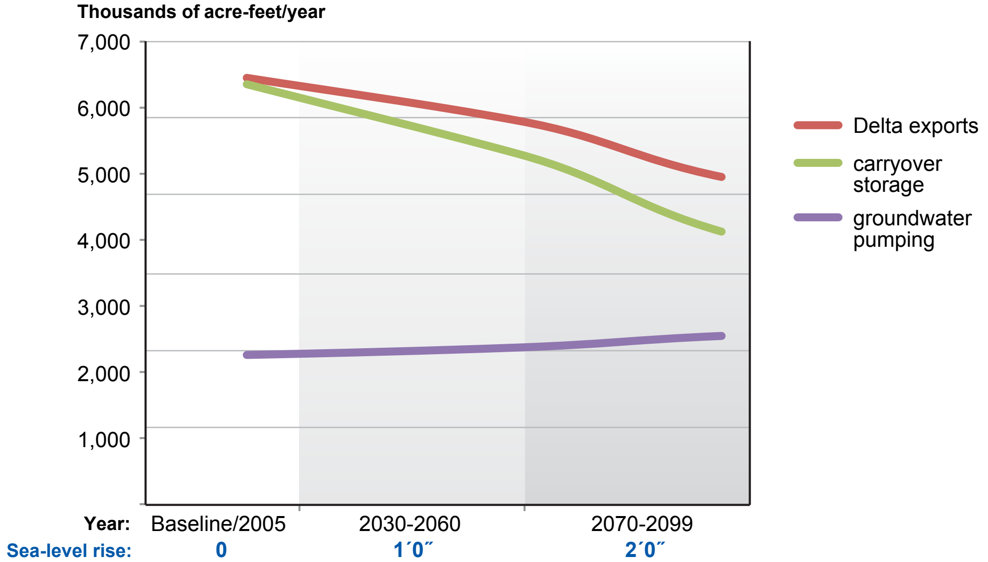
Sea level rise may also affect drinking water supplies for coastal communities owing to the intrusion of seawater into coastal aquifers. As sea levels rise, the lens of salty groundwater penetrates further inland and displaces additional fresh groundwater, as shown in Figure 3-27. This effect can be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

Climate Change and the Water-Energy Nexus

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

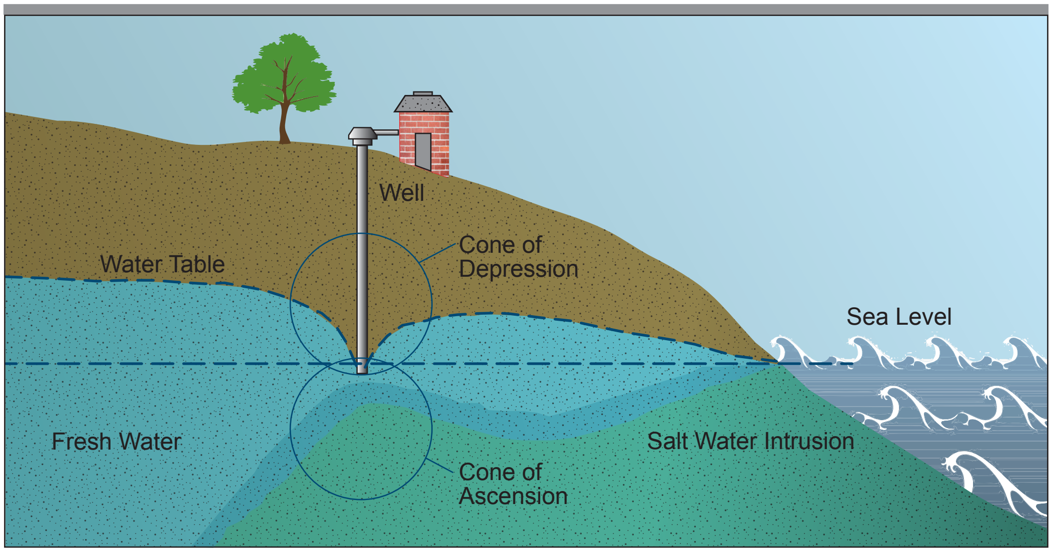
Water-related energy use in California is largely based on the information in a California Energy Commission study. Figure 3-28 depicts water-related energy use in California, including

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



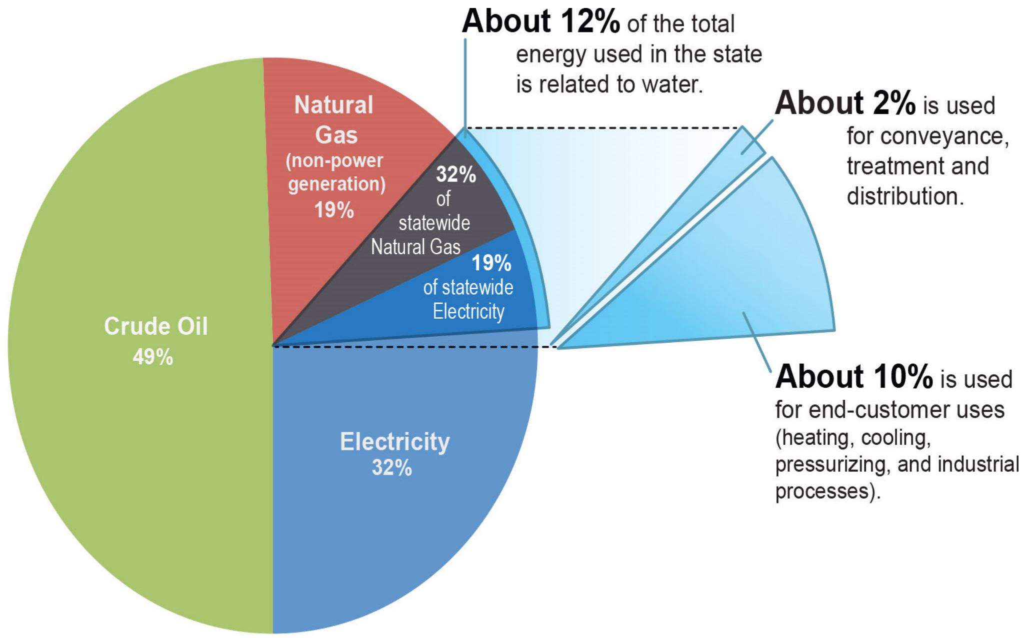
Note: The effects of sea level rise and changes in hydrology driven by climate change were modeled while holding salinity levels in the Sacramento-San Joaquin Delta (Delta) at levels currently required by regulation. The analysis shows that if salinity in the Delta continues to be managed as it currently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

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



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

Figure 3-28 Energy Use Related to Water



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

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

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

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

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

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

Delta Vulnerabilities

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

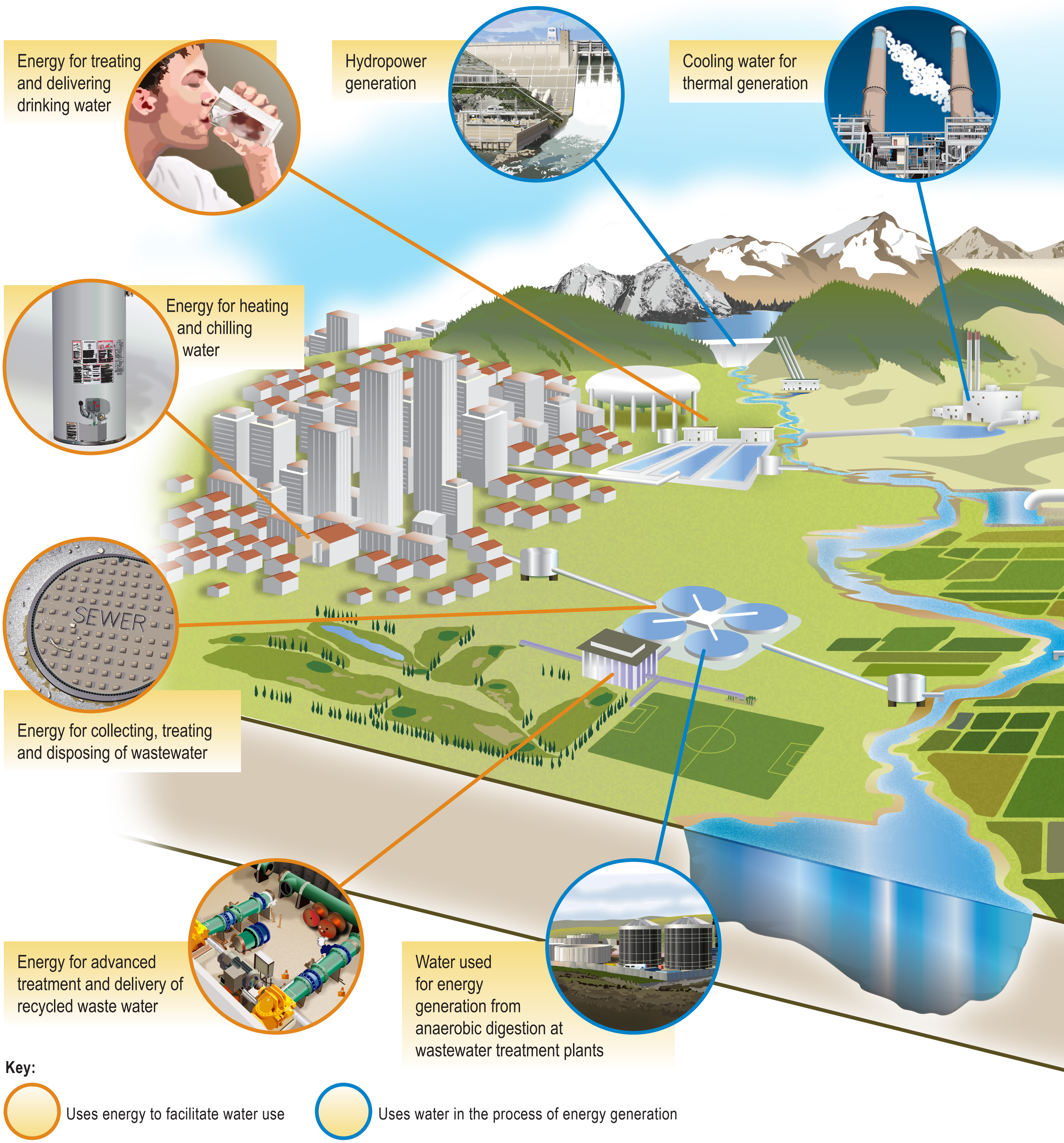
Much of the land in the Delta region is below sea level and is protected by an extensive system of levees. Since many of the Delta's 1,330 miles of levees were built in the late 1800s and early 1900s, they were not designed or constructed using modern engineering practices. The Delta levees are critical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

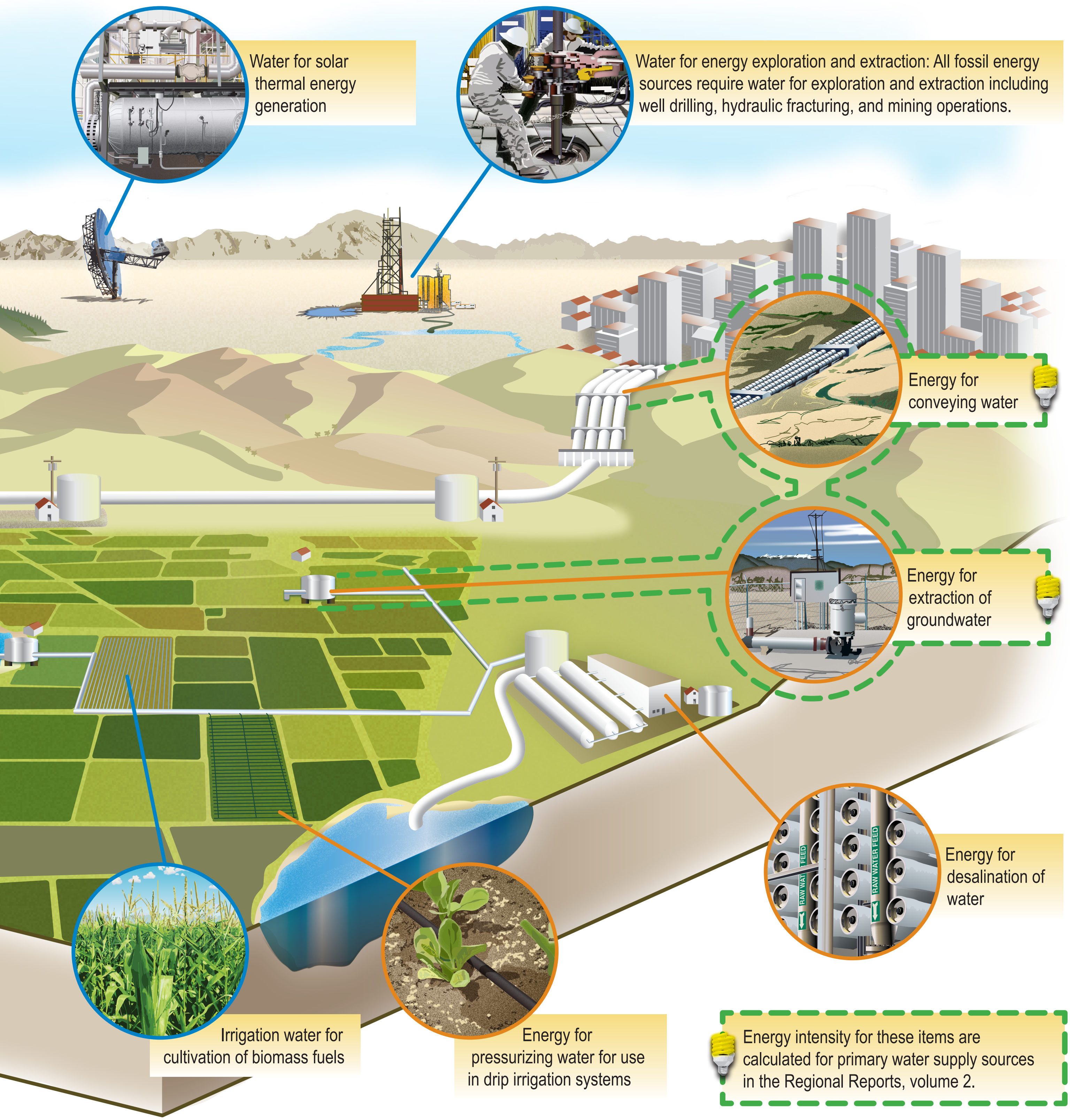
Since completion of the initial facilities of the SWP in 1975, levee failures during high water and dry weather have caused Delta islands to be flooded 37 times. Some islands have been flooded and recovered multiple times. A few islands, such as Franks Tract that flooded in the 1930s, have never been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

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

- A major earthquake with a magnitude of 6.7 or greater in the vicinity of the Delta region has a 62 percent probability of occurring sometime between 2003 and 2032. This event could cause multiple levee failures, fatalities, and extensive property destruction. If the earthquake occurred in a dry year, the loss of exports would contribute to adverse economic impacts of $15 billion or more.

Figure 3-29 The Water Energy Connection




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

- Winter storms and related high-water conditions are the most common cause of levee failures in the region. The State typically spends at least $6 million per year in moderately successful attempts to prevent levee failures resulting from winter storms. High-water conditions could cause about 140 levee failures in the Delta during the next 100 years.
- Dry-weather levee failures (also called "sunny-day" events) unrelated to earthquakes, such as from slumping or seepage, will continue to occur in the Delta about once every seven years.

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

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

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

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

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

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

Catastrophic Events and Emergency Response

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

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

Data Gathering and Exchange

An increasing population, stressed ecosystems, and California's economic future and its reliance on agriculture, industry, and technology all rely on the state's limited water resources. At the same time, uncertainty in climate change, energy sectors, and other drivers of future change require California to develop effective management strategies based on better science and technology. Data analysis, modeling, and other scientific tools are required to create and improve strategies that can maximize water supply reliability and water quality. They also improve understanding and ability to communicate flood risks.

Government reports have concluded that a key role for science and technology is to expand options for management and use of water resources. Scientists and water managers must employ IWM and a systems approach that considers physical, chemical, biological, social, behavioral, and cultural aspects. These require data and analytical tools that are more sophisticated than currently available to water and flood managers. See the further discussion in Chapter 6, "Integrated Data and Analysis: Informed and Transparent Decision-Making," in this volume.

Disadvantaged Communities

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

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

Funding

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

Responses and Opportunities

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

Stewardship and Sustaining Natural Resources

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

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

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

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

Watershed and Resource Restoration Programs

The California Department of Conservation administers its Watershed Program to advance sustainable watershed-based management of California's natural resources through community-based strategies. The new statewide watershed program is an extension of the previous CALFED Bay-Delta Watershed Program and will include grants for watershed coordinators. (For more specific information, see http://www.conservation.ca.gov/dlrp/wp/Pages/Index.aspx.) In the same vein, the California Watershed Indicators Council was formed to begin developing a framework for assessing the health of watersheds throughout the state.

Conservation: 20 Percent Reduction by 2020

On February 28, 2008, Governor Schwarzenegger wrote to the leadership of the California State Senate, outlining key elements of a comprehensive solution to problems in the Delta. The first element on the governor's list was "a plan to achieve a 20 percent reduction in per capita water use statewide by 2020." In March 2008, the 20x2020 Agency Team convened and has developed a plan to meet the goal set by the governor. (See http://www.waterboards.ca.gov/water_issues/hot_topics/20x2020/index.shtml. See also Senate Bill No. 7 [SB X7-7], Statewide

Box 3-9 DWR Environmental Stewardship Principles

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

Water Conservation, as part of the 2009 Comprehensive Water Package discussed later under the "Recent Legislation" section of this chapter.) Figure 3-30 shows statewide urban water use baseline and 2020 targets.

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

Some of DWR's conservation efforts include:

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

Regional/Local Planning and Management

Water managers have learned that even though imported supplies will continue to be important, they cannot be relied on to satisfy future water demands. Additional imported water supplies will likely not be available to meet increasing future water demands. Starting in the 1970s, concerns about protecting the environment were manifested in strong new laws and regulations. These regulations affected the ability of interregional water projects to deliver water. The resulting uncertainty also contributed to the hesitancy to invest in additional facilities for these interbasin systems and forced water agencies to make difficult decisions about how to provide a reliable water supply.

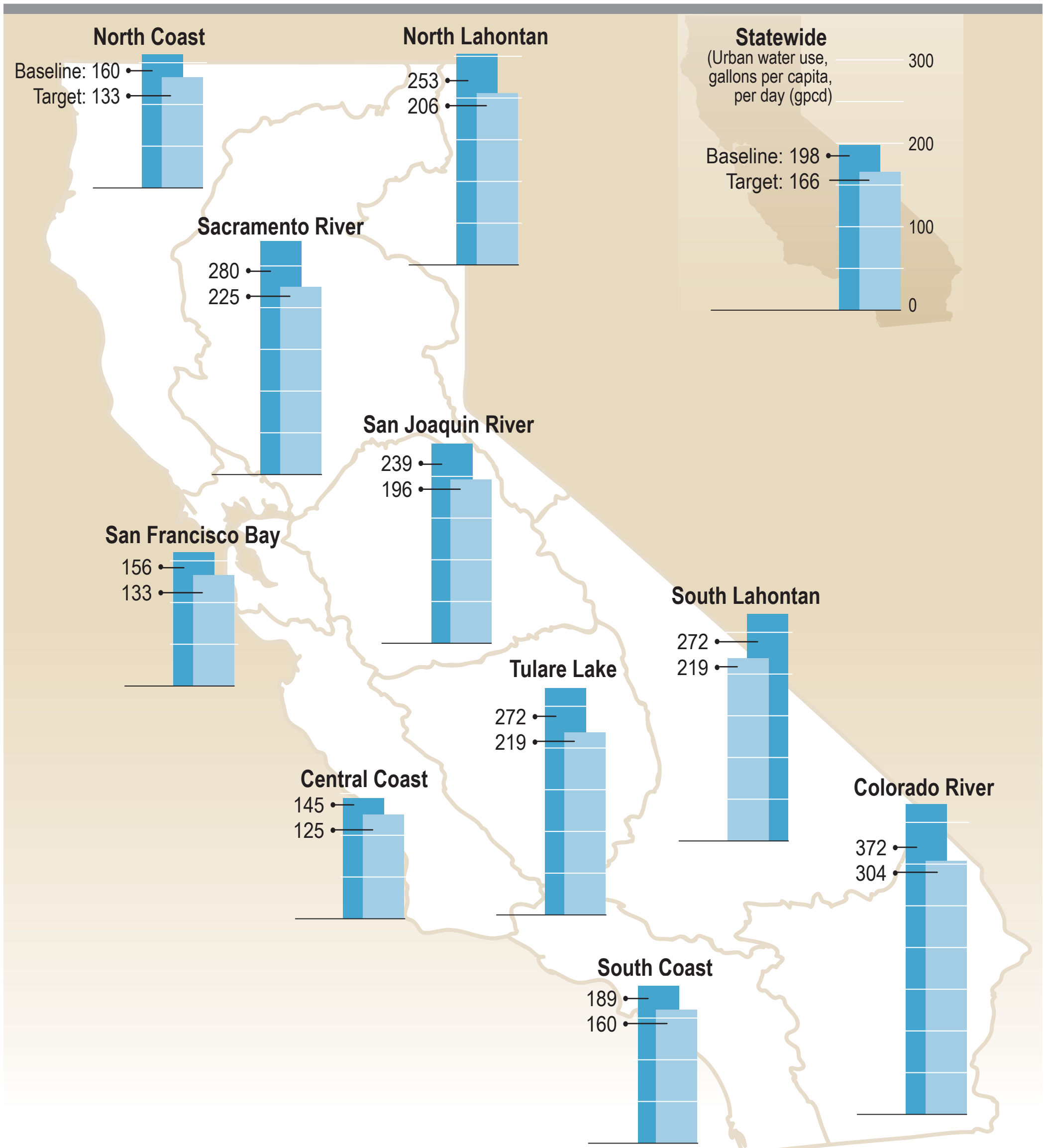
Local and regional agencies have been developing local water management programs and projects, such as water conservation, recycling measures, and groundwater storage, to increase regional self-reliance. Water managers increasingly plan for more sustainable water management by implementing actions that address multiple resource objectives (e.g., flood protection, water use efficiency, water quality protection, and environmental stewardship). Water managers must also consider broad needs, such as public safety, economic growth, environmental quality, and social equity.

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

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

Integration of the goals and objectives associated with local urban, agricultural, groundwater, and watershed management plans needs to be incorporated into the local IRWM planning to

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



Source: California Department of Finance 2006.

achieve the maximize efficiencies and implement sustainable water management. The extent to which regions have carried these out has been driven by such considerations as economics, environment, engineering, and institutional capacity.

Stakeholders are working together throughout California to develop regional and watershed programs that cover multiple jurisdictions and provide multiple resource benefits. In several regions, agencies have formed partnerships to combine capabilities and share costs. IRWM has become established and continues to increase.

On September 30, 2008, Governor Schwarzenegger signed SB 1 (Statutes of 2008) (http://www.leginfo.ca.gov/pub/07-08/bill/sen/sb_0001-0050/sbx2_1_bill_20080930_chaptered.pdf). SB 1 contains replacement language for the Integrated Regional Water Planning Act of 2002 (CWC

Section 10530 et seq.) as well as the first appropriations for the IRWM grant program from Propositions 84 and 1E (see the "Propositions and Bonds" section below).

Water agencies in many regions are successfully employing a mix of resource management strategies, many having State and federal incentives. Experience is showing that these regional efforts can resolve regional needs better, especially when paired with statewide water management systems. Regional water management options can reduce physical and economic risks and provide regional control over water supplies. More is being done to meet water demands with water conservation; reoperation of facilities; water recycling; groundwater storage and management; transfer programs; stormwater capture projects; and, in limited cases, regional or local surface storage reservoirs (see Volume 3, *Resource Management Strategies*, for further discussion of regional management options). Overall, this increased focus on IRWM solves water management problems more efficiently, considers other resource issues, and enjoys broader public support.

Water Use Efficiency

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

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

Another benefit of increased water-use efficiency is reduced energy use. According to the CEC, end-use of water is the most energy-intensive portion of the water-use cycle in California. Measures to increase water-use efficiency and reuse will reduce electricity demand from the water sector, which, in turn, can reduce GHG emissions. DWR has funded many water-use efficiency projects. Implementation of 124 agricultural and urban water-use efficiency projects is expected to achieve 190,000 acre-feet per year (af/yr.) of water savings. If this savings are achieved, it will be equivalent to 190,000 million watt-hours per acre-foot (MWh/af) per year and 90,000 metric tons of GHG emissions reduction. This calculation assumes an average energy intensity of 1 MWh/af, or 0.475 metric ton of CO_2 equivalent per 1 MWh.

Coordination of Water and Land Use Planning

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

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

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

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

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

Delta and Suisun Marsh Planning

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

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

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

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

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

Bay Delta Conservation Plan

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

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

- Provide for a more reliable water supply for California by modifying conveyance facilities to create a more natural flow pattern.
- Provide a comprehensive restoration program for the Delta.
- Provide the basis for permits under federal and State endangered species laws for activities covered by the plan based on the best available science.
- Identify sources of funding and new methods of decision-making for ecosystem improvements.
- Provide for an adaptive management and monitoring program to enable the plan to adapt as conditions change and new information emerges.
- Streamline permitting for projects covered by the plan.

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

Delta Stewardship Council

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

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

Delta Risk Management Strategy

The DRMS evaluates the risks from Delta levee failures and ways to reduce those risks. Preliminary evaluations show that there are substantial levee-failure risks from earthquakes and floods, and these are expected to increase in the future. In Phase 1, DRMS evaluated the risk and consequences to the Delta and the state associated with the failure of Delta levees and other assets, considering their exposure to a number of hazards today and in the future. In Phase 2, DRMS evaluated strategies and actions that can reduce these risks and potential consequences. Additional information is available at http://www.water.ca.gov/floodsafe/fessro/levees/drms/.

Delta Regional Ecosystem Restoration Implementation Plan

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

The Suisun Marsh Plan

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

Statewide and Interregional Planning and Response

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

California FloodSAFE Program

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

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

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

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

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

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

Success of the FloodSAFE program depends on active participation from many key partners, such as Cal EMA, Central Valley Flood Protection Board, DFW, USACE, FEMA, U.S. Fish and Wildlife Service, NOAA, tribal entities, and many local sponsors and other stakeholders. DWR will continue to work closely with key partners and stakeholders to accomplish the FloodSAFE vision.

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

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

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

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

California Statewide Groundwater Elevation Monitoring Program

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

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

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

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

As required by the CWC, DWR submitted the *2012 CASGEM Status Report* to the Legislature and governor, which provided the background of the CASGEM program and described the first two years of its implementation. The report is available on the CASGEM Web site. Subsequent reports are required to be submitted every five years, beginning in 2015. Table 3-4 summarizes the progress of the CASGEM program since it began.

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

1. The population overlying the basin.

2. The rate of current and projected growth of the population overlying the basin.

Table 3-4 CASGEM Program Progress 2009-2012

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

Notes:

AB = Assembly Bill, CASGEM = California Statewide Groundwater Elevation Monitoring, DWR = California Department of Water Resources, FAQs = frequently asked questions, SB = Senate Bill

3. The number of public supply wells that draw from the basin.

4. The total number of wells that draw from the basin.

5. The irrigated acreage overlying the basin.

6. The degree to which persons overlying the basin rely on groundwater as their primary source of water.

7. Any documented impacts on groundwater within the basin, including overdraft, subsidence, saline intrusion, and other water quality degradation.

8. Any other information that DWR determines is relevant.

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

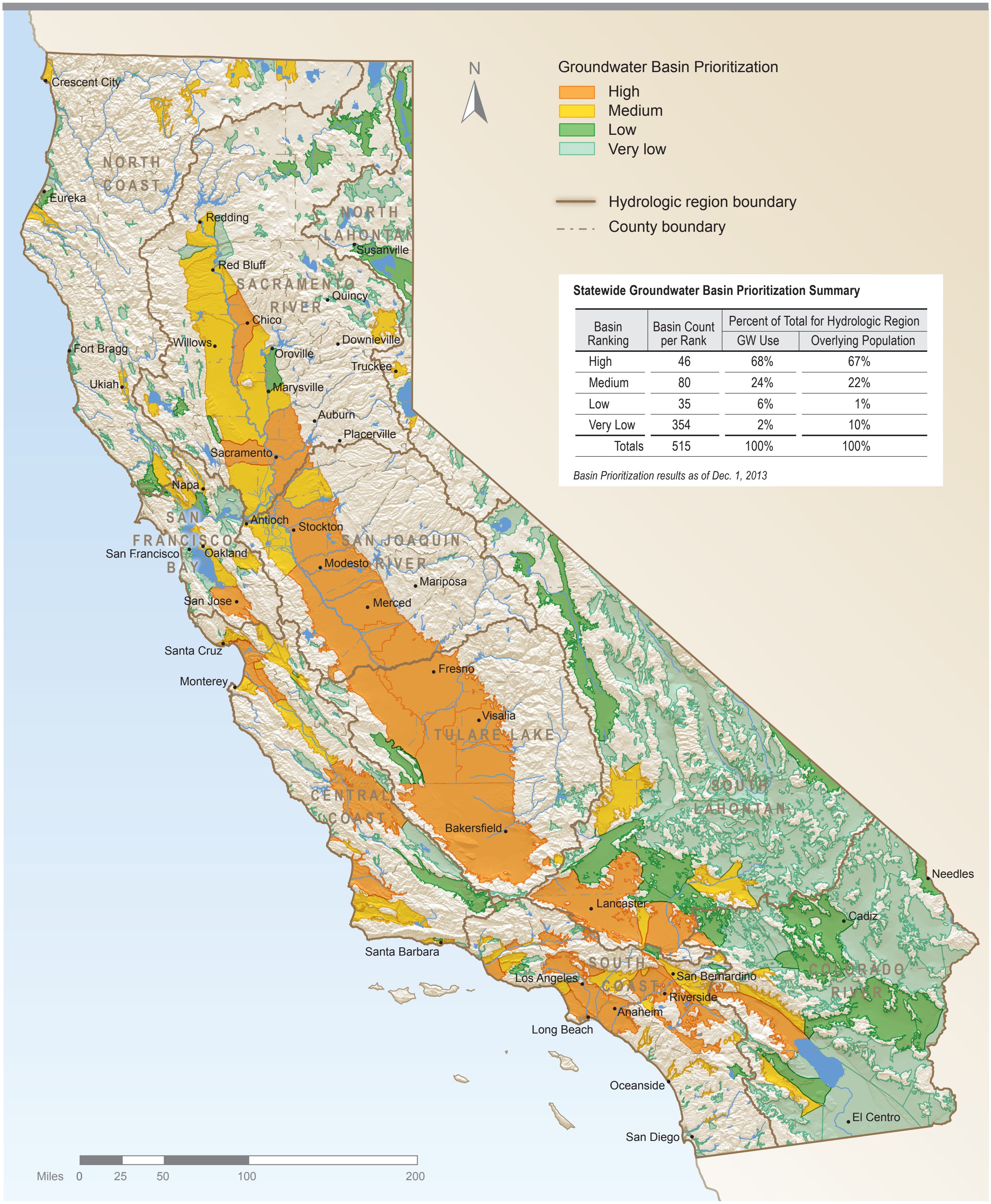
As described above, the primary intent of basin prioritization is to assist DWR in implementing the CASGEM Program. Additionally, the comprehensive set of data included in the analysis allows basin prioritization to serve as a valuable statewide tool to help evaluate, focus, and align limited resources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

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

Short-Term Activities

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

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



Statewide Groundwater Basin Prioritization Summary

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

Basin Prioritization results as of Dec. 1, 2013

Long-Term Activities

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

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

Drought Response

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

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

Governor Brown directed State officials to take all necessary actions to prepare for water shortages. CAL FIRE recently announced it hired additional firefighters to help address the increased fire threat, the DPH identified and offered assistance to communities at risk of severe drinking water shortages, and DFW restricted fishing on some waterways owing to low water flows that have become much worse during the drought. Also in January, the California Natural Resources Agency (CNRA), Cal/EPA, and the California Department of Food and Agriculture released the *California Water Action Plan*, which will guide State efforts to enhance water supply reliability, restore damaged and destroyed ecosystems, and improve the resilience of our infrastructure.

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

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

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

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

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

2009 Drought Water Bank

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

California Water Commission

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

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

Strategic Growth Council

In September 2008, SB 732 became law, creating the Strategic Growth Council (SCG). The council is a cabinet-level committee tasked with coordinating the activities of State agencies to:

- Improve air and water quality.
- Protect natural resource and agriculture lands.
- Increase the availability of affordable housing.
- Improve infrastructure systems.
- Promote public health.
- Assist State and local entities in the planning of sustainable communities and meeting AB 32 (Global Warming Solutions Act of 2006) goals.

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

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

Western States Water Council

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

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

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

Adapting to Climate Change

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

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

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

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

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

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

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

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

Mitigation of Greenhouse Gas

Emissions

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

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

State Legislation, Policies and Related Actions

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

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

Department of Water Resources Actions

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

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

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

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

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

DWR convened a task force consisting of academic experts, urban retail water suppliers, environmental organizations, and commercial, industrial, and institutional water users to develop BMPs for the commercial, institutional and industrial (CII) water sectors. DWR's forthcoming "CII Task Force Report to the Legislature" (2014) includes recommended BMPs and their technical and financial feasibility to support water use efficiency and water supply sustainability in CII sectors.

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

Actions from other Agencies and Organizations

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

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

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

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

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

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

Energy Intensity of Water

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

Water Footprint of the Energy Sector

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

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

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

State Water Resources Control Board

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

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

- Comprehensively addressing water-quality protection and restoration.

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

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

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

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

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

Recent Litigation

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

Recent State Legislation

Hydraulic Fracturing

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

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

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

2009 Water Legislation Package

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

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

- **SB 1 Delta Governance/Delta Plan.** Established a framework to achieve the coequal goals of providing a more reliable water supply to California and restoring and enhancing the Delta ecosystem. The coequal goals will be achieved in a manner that protects the unique cultural, recreational, natural resource, and agricultural values of the Delta.
- **SB 6 Groundwater Monitoring.** For the first time in California's history, this act required local agencies to monitor the elevation of their groundwater basins to help manage the resource better during both average water years and drought conditions.
- **SB 7 Statewide Water Conservation.** Created a framework for future planning and actions by urban and agricultural water suppliers to reduce California's water use. For the first time in California's history, this act required agricultural water suppliers to prepare and submit agricultural water management plans to DWR and implement efficient water management practices. The bill also established a statewide goal for urban water agencies to reduce statewide per-capita water consumption 20 percent by 2020 (see the "Water Use Efficiency" section of this chapter).
- **SB 8 Water Diversion and Use/Funding.** Improved accounting of the location and amounts of water being diverted by recasting and revising exemptions from the water diversion

reporting requirements under current law. Additionally, this bill appropriated existing bond funds for various activities to benefit the Delta ecosystem, secured the reliability of the state's water supply, and increased SWRCB staff to manage the duties of this statute.

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

- **AB 685 State Water Policy.** Declares it is State policy that everyone has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes. It directs State agencies to consider this policy when revising, adopting, or establishing policies, regulations, and grant criteria when those policies, regulations, and grant criteria are pertinent to the uses of water described in this bill.
- **AB 1750 Rainwater Capture Act of 2012.** Defines key terms relating to rainwater capture and authorizes the installation of rainwater capture systems.
- **AB 1965 Land Use: Flood Protection.** Revises previous provisions included in SB 1278 (see below) related to planning and zoning for flood protection in the Sacramento-San Joaquin Valley.
- **AB 2230 Recycled Water: Car Washes.** Requires specific new car-wash facilities constructed after January 1, 2014, to reuse at least 60 percent of the water or to use recycled water provided by a water supplier for at least 60 percent of its wash and rinse water.
- **SB 71 State Agencies: Reports.** Specific to DWR activities, this bill eliminates various outdated reports relating to the now-defunct CALFED program and the Bay-Delta Authority, quarterly reporting of expenditures from the Electric Power Fund, and an antiquated reporting requirement from DWR and the California Water Commission.
- **SB 200 Delta Levee Maintenance.** Extends until July 1, 2018, the current State cost-share rate for the Delta Levee Maintenance Subventions Program, which is set at up to 75 percent of the costs in excess of $1,000 per levee mile. After that date, the cost-share will revert to 50 percent.
- **SB 1278 Planning and Zoning: Flood Protection: Sacramento-San Joaquin Valley.** Changes existing local flood-protection requirements, extending by one year the time frame under which cities and counties must incorporate flood risk information into their general plans and zoning ordinances. Also requires DWR, before July 2, 2013, to issue specific floodplain maps and data that will assist local agencies in updating their general plans.
- **SB 1495 Sacramento-San Joaquin Delta Reform Act of 2009.** Exempts two types of actions (certain leases as well as routine dredging operations) from review by the Delta Stewardship Council as "covered actions" under the Delta Plan, as originally provided for by SB X7-1 in 2009.
- **AB 359 Groundwater Management Plans.** The groundwater legislation requires (1) local agencies to expand notification regarding GWMP preparation and development, and to provide a map identifying recharge areas to local agencies, DWR, and other interested persons; (2) DWR to post GWMPs and information regarding local agencies having jurisdiction to develop GWMPs; and (3) a map identifying the recharge areas for the groundwater basin be included in a GWMP for purposes of the State funding requirements.

Strengthening Flood Protection

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

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

Propositions and Bonds

In recent years, California voters have approved a series of bonds to preserve and improve the state's natural resources. Propositions 12, 13, 40, and 50 made $12.3 billion available that have been used by local governments and State agencies for a wide variety of activities, such as water conservation, acquisition of land to protect wildlife habitats, and restoration of damaged ecosystems.

The infrastructure package approved by the voters in November 2006 included water and flood measures in Propositions 1E and 84. These measures provided $4.9 billion for flood management and approximately $1 billion for IRWM, including wastewater recycling, groundwater storage, conservation, and other water management actions.

Proposition 1E — Disaster Preparedness and Flood Protection Bond Act

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

Some examples of specific projects include the following:

- Sacramento Area Flood Control Agency, Natomas Levee Improvement Program (Sacramento County) — $49 million.
- Levee District No. 1 of Sutter County, Lower Feather River Setback Levee at Star Bend (Sutter County) — $16.3 million.

- Reclamation District 2103 (Wheatland), Bear River North Levee Rehabilitation Project (Yuba County) — $7.4 million.
- Three Rivers Levee Improvement Authority, Feather River Setback Levee (Yuba County) — $138.5 million.

Proposition 84

In November 2006, voters approved the Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006 (Proposition 84) authorizing $5.4 billion in GO bonds for natural resources purposes. The bond funds continue to enable the State to invest in important projects and programs that improve water quality and drinking water availability, water supply availability, flood risk reduction, habitat conservation, and resource projects for State and local parks and coastal and ocean protection.

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

- **Tahoe Conservancy Environmental Improvement Program** — to help preserve the world-renowned clarity of North America's largest alpine lake.
- **CAL FIRE** — to preserve urban forestry and biomass projects to reduce the State's emissions of GHGs.
- **DFW** — to restore the Bay Delta and coastal fisheries.
- **Wildlife Conservation Board** — to preserve and protect forests, wildlife habitat, rangeland, grazing land and grasslands, and oak woodlands.
- **Coastal Conservancy and the San Francisco Bay Area Conservancy Program** — to help protect the scenic beauty, recreational opportunities, and economic vitality of California's 1,100 miles of magnificent coastline.
- **Ocean Protection Trust Fund** — to expand efforts to preserve and protect California's unique ocean resources and diverse marine life.
- **DWR** — for IRWM projects that will improve California's use of its water resources and for a wide array of expenditures to improve water resources management around the state.
- **SWRCB** — to leverage federal funds for infrastructure investments to prevent pollution of drinking water supplies and for matching grants to local agencies to reduce stormwater contamination of rivers, lakes, and streams.

Proposed Water Bond

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

Federal Government

American Recovery and Reinvestment Act of 2009

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

California received $336.6 million for the following projects:

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

SECURE Water Act

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

Natural Resources Conservation Service's Water Quality Improvement Initiative

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

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

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

Proposed Legislation to Regulate Hydraulic Fracturing

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

National Water Quality Portal

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

Clean Water Act Framework

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

The program includes:

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

Executive Orders to Improve Collaboration on Planning and Permitting

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

The initiative has two overarching goals.

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

Delta Islands and Levees Feasibility Study

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

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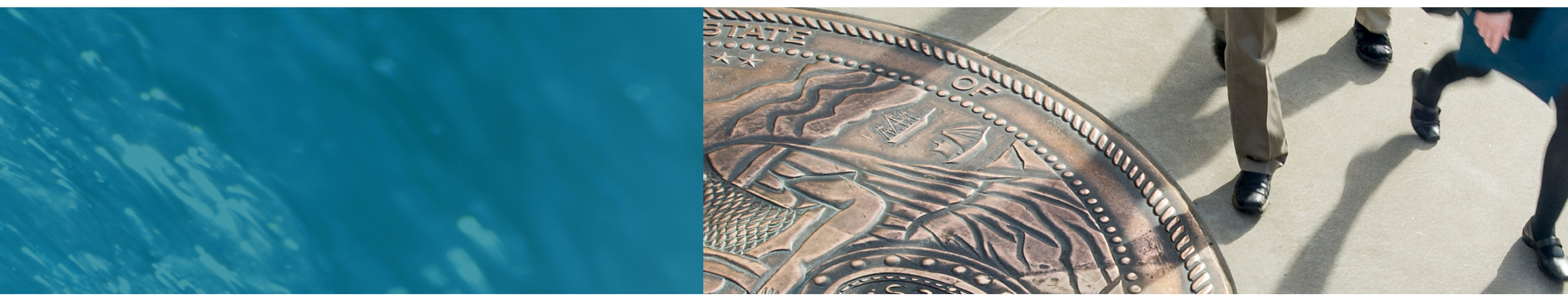
VOLUME 1 - THE STRATEGIC PLAN

CHAPTER 4

Strengthening Government Alignment



State agencies are working to align policies, planning, regulations, funding, and implementation of Update 2013 objectives and related actions. At the regional level, local governments and districts also are collaborating in the same way. At both levels of government, the common goal is to expedite and reduce the cost of projects that deliver multiple, diverse benefits.

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Chapter 4. Strengthening Government Alignment

About This Chapter

California's water management system is large, complex, and fragmented. Achieving successful implementation of integrated water management (IWM) requires communication, cooperation, collaboration, and alignment among decision-makers at all levels of federal, tribal, State, regional, and local entities. The *California Water Plan Update 2013* (Update 2013) is the State's water plan, and it is not an isolated effort of one agency. This chapter explores the many parts of California water management and the mechanisms leading to alignment of government policies and practices. To achieve this, the chapter cross-references and demonstrates coordination and collaboration with other State government programs to provide consistent strategic direction, goals, objectives, and actions.

This chapter describes the Water Plan State Agency Steering Committee as a key feature of Update 2013 and its efforts to create a plan that embraces all relevant State government plans, programs, policies, and regulations (see Box 4-1). The collaboration of the committee has expanded since *California Water Plan Update 2009* (Update 2009), growing to 28 State government agencies and departments with jurisdictions over diverse aspects of water resources.

The chapter also:

- Outlines key principles and goals for agency alignment.
- Provides a general overview of water management institutions and governance in California.
- Explains the roles of multiple agencies in regards to water.
- Explains the process for identifying and integrating recommendations from 36 featured State plans.
- Describes how featured State plans were used to develop and augment content in Update 2013.
- Concludes with a recap of the implications of the existing policy framework of featured State plans to shape, guide, and constrain water governance in California.

Strengthening Government Alignment

One of the three themes for Update 2013 (as outlined in Chapters 1 and 3 of this volume) is strengthening government alignment. The theme emphasizes the importance of aligning strategies and actions introduced in Update 2009. Agency alignment will expedite and reduce the cost of the implementation of resource management strategies (RMSs) and help ensure efficient achievement of multiple IWM objectives. Alignment does not alter agencies' authority or responsibility, but instead yields a result of agencies working together better.

Update 2013 promotes strategies and practices for significant improvements in government agency alignment. This includes better communication and collaboration to implement IWM activities while protecting and enhancing natural resources.

Box 4-1 Water Plan State Agency Steering Committee Member Agencies

Air Resources Board

Business, Transportation, and Housing Agency

California Coastal Commission

California Emergency Management Agency (Cal EMA)

California Energy Commission

California Environmental Protection Agency (Cal/EPA)

California Public Utilities Commission

California State Board of Food and Agriculture

California Water Commission

Delta Stewardship Council

Department of Boating and Waterways

Department of Conservation

Department of Fish and Wildlife

Department of Food and Agriculture

Department of Forestry and Fire Protection (CAL FIRE)

Department of Housing and Community Development

Department of Parks and Recreation

Department of Public Health

Department of Toxic Substances Control

Department of Water Resources

Governor's Office of Planning and Research

Native American Heritage Commission

Natural Resources Agency

Ocean Protection Council

Sierra Nevada Conservancy

State Lands Commission

State Water Resources Control Board

Strategic Growth Council

Laws and regulations provide the framework for basic community safety and water supply needs and ensure a healthy environment, vibrant economy, and social equity. They also help meet many California Water Plan (CWP) goals. At the same time, within the context of IWM, many requirements designed for single objectives can appear to work at cross purposes as multi-benefit projects often have more complex considerations that require trade-offs and balancing needs.

Often those who implement multi-benefit and IWM project must navigate California's labyrinth of laws and regulations. This sometimes leads to delaying projects and mounting planning and compliance costs. These impediments can ultimately create significant difficulties in meeting community safety, environmental, or economic goals along with achieving goals outlined in Update 2013. This may even be true for small projects that are well planned, have the voluntary support of the community and private landowners, and would provide multiple benefits.

Some project participants, such as landowners and investors, which have gone through the permitting process, are unwilling to tackle the process again. Those who have heard about the difficulties second-hand may opt out when presented with opportunities to contribute.

The solution is not to remove the safeguards of agency oversight. Project planning in California is technically complex and location-appropriate. These complexities exist because there are wide varieties of climates, landforms, and institutions as well as a very diverse, place-based range of cultures that can be described as anthrodiversity (e.g., the human aspect of biodiversity that denotes the value of sustaining varied human habitats, such as rural, suburban, and urban communities). This means achieving IWM requires that data management, planning, policy-making, and regulation occur in a very collaborative and regionally appropriate manner. The ultimate product of the collaboration is a composite of diverse input and data from a large variety of elected officials, opinion leaders, stakeholders, scientists, and subject experts. Sustainable outcomes will rely on a blend of subject expertise and perspectives woven together into comprehensive place-based and regionally appropriate policies and implementation.

The Update 2013 goals for agency alignment are based on several key principles:

- Agencies will remain autonomous.
- Action will be voluntary.
- No new infrastructure or planning effort will be created to manage alignment.
- Action will occur at multiple organizational levels.
- No single agency can solve some of the presenting issues by itself.

Instead of creating new institutions or organizational structures to manage alignment, agencies are encouraged to utilize simple self-organizing principles to collaborate and coordinate their activities in a manner that supersedes traditional silos and hierarchical management approaches. This is done with an understanding that alignment emerges from frequent interactions with three basic ingredients:

- Participants need to engage in strong, dynamic non-linear action and work across multiple organizational boundaries, not just up and down a chain of command. These interactions often result in immediate positive and negative feedback about what works, could work, or will need to be reconsidered so that only the best options are pursued.
- Participants need to take advantage of opportunities to interact and align as they become available while continuing to explore future potential interaction.
- The process of alignment consists of multiple interactions, similar to balancing while riding a bicycle, with continuous adjustments as requirements evolve.

Strides have been made to improve alignment with the formation and engagement of Water Plan State Agency Steering Committee, the Water Plan Federal Agency Network (FAN), and dozens regional water management groups. However, federal, State, tribal, and local governments do not yet collaborate to the degree necessary to effectively manage the challenges described above. Examples of impacts from insufficient government alignment include planning and permitting costs of projects have been increasing as a portion of total planning and implementation costs. For some smaller infrastructure and ecosystem enhancement activities, permitting costs have exceeded the implementation and acquisition costs. In many other cases, program or project implementation has yet to occur despite decades of planning and permitting activities, even as the intended benefits of these programs and projects are forgone as a result of the delays.

At the same time, funding and stakeholder support must occur prior to the effective delivery of desired IWM benefits. Enough certainty or confidence in the planned IWM activity is required to receive stakeholder support through the public administration process and, ultimately, receive funding from investors. None of these things can occur without extensive collaboration throughout the entire planning process.

If all partners have the same understanding of the project regardless of their individual needs, the project can be implemented more easily. Collaboration necessary to achieve stronger government agency alignment begins with establishing a common understanding at every stage of project or program development. Different partners have different perspectives on what they hope a project or program should achieve. For example, those implementing a project may think very differently about a project than a regulatory agency or those who are responsible for operating and maintaining a facility would think about it. State agencies may have different perspectives on a project. Each partner is influenced by public and stakeholder advocacy for system improvements and operations. In turn, this advocacy influences government policy-makers and financiers at the State, federal, tribal, local, and regional government levels.

The purpose for emphasizing collaboration and strengthening alignment throughout the Update 2013 process goes well beyond sharing of information and project updates to stakeholders. Collaboration is required to help ensure that resource management recommendations achieve the desired outcome by vetting, integrating suggestions, and ultimately creating IWM recommendations that are implementable and supported by stakeholders and communities. It also helps create a CWP update process and a document that is accurate, complete, and clear.

Following are some examples of crosscutting practices that agencies can take to improve alignment. Many of these and others are represented in Chapter 8, "Roadmap For Action," in this volume.

1. Identify all other agencies with overlapping or related responsibilities and engage them early and often during planning.

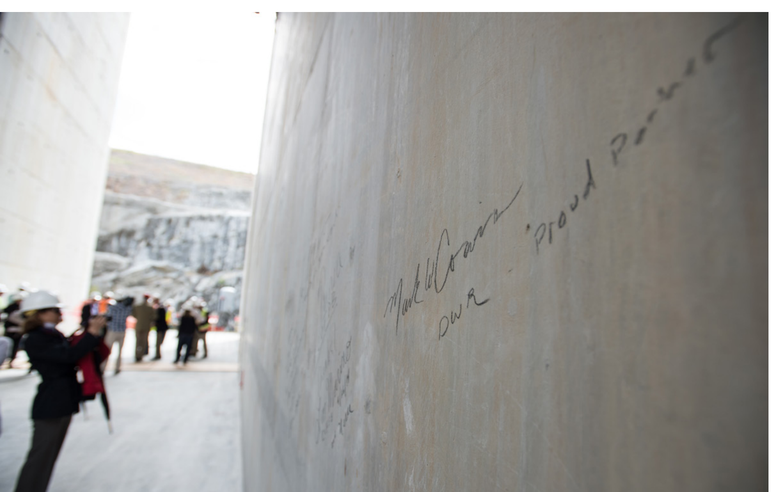
2. Respect and value the roles and responsibilities of other agencies (e.g., not seeking to affect other agencies' budgets, responsibilities, or positions negatively).

3. Work together to identify common goals for IWM.

4. Strive to align goals and recommendations across all agencies' plans.

5. Use an inclusive, transparent, and collaborative process to increase trust and improve relationships among agencies.

6. Coordinate monitoring and research on the highest priority innovations.



Folsom Dam Joint Federal Project — U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, DWR, Central Valley Flood Protection Board, and Sacramento Area Flood Control Agency working together to achieve a 200-year level of flood protection for Sacramento. (April 2014)

7. Use adaptive management to provide a framework for developing an accurate and common understating of natural and human-made systems and potential solutions.
8. Engage all levels of relevant participants (those doing the on-the-ground work up to those having a high level of oversight), starting at the early stages of planning.
9. Create a planning clearinghouse, which would manage data and a master calendar.
10. Develop fundamental principles that would guide alignment, which would be adopted jointly by State agencies.
11. Create a matrix showing where regulatory processes align, clash, or leave gaps.

Water Management and Governance in California

As noted above, California has a large and complex water system with highly decentralized governance that involves State and federal agencies, tribal governments, thousands of local agencies, districts, private firms, millions of households, and thousands of farms. Decentralization is important for autonomy and daily management, planning, and policy-making. Even so, competing and conflicting roles and responsibilities can make it difficult to integrate regional water management. Following is an overview of California's water management system. Creating a common understanding of its parts will, in itself, lead to better alignment.

Legal Framework

California's water governance structure has ancient roots in the oldest surviving common law in history, the public trust doctrine. Additional guidance for California is provided through the following:

- Terms and conditions of statehood granted by the federal government.
- California State Constitution.
- Code and statute including propositions.
- Regulations.
- Court mandates.

The concept of the public trust was developed in America as many independent states joined the original 13 colonies. The states were granted sovereign rights to the commons (water, air, and land) and sovereign responsibility for its care. Since then, the public trust doctrine has been used extensively to protect the public's interest in water. The courts have ruled water is owned by everyone and not by any one entity. Thus, protection must be provided by its steward, state government. This interpretation has been upheld by the U.S. Supreme Court. Some, but not all, states include a water code in their state constitution.

Surface Water Rights

Water rights laws in California and in the rest of the West are markedly different from the laws governing water in the East. Historic uses and patterns of settlement, seasonal, geographic, and quantitative differences in precipitation caused California's system to develop into a unique blend of primarily two different kinds of water rights — riparian and appropriative. Other types of water rights exist in California as well, among them are reserved rights (water set aside by the federal government when it reserves land for the public domain and tribes) and pueblo rights (a municipal right based on Spanish and Mexican law).

Riparian Rights

Riparian rights usually come with owning a parcel of land that is adjacent to a source of water. When it became a state, California adopted the English common law familiar to the Eastern seaboard; such law also included the riparian doctrine.

A riparian right entitles the landowner to use a correlative share of the water flowing past his or her property for use on that property. Riparian rights do not require permits, licenses, or government approval, but they apply only to the water, which would naturally flow in the stream. Riparian rights do not entitle a water user to divert water to storage in a reservoir for use in the dry season or to use water on a separate parcel of land that is non-riparian. Also, the water user cannot use riparian water on land outside of the watershed. With rare exception, riparian rights remain with the property when it changes hands, although parcels severed from the adjacent water source generally lose their right to the water.

Riparian rights still have a higher priority than appropriative rights (discussed below). The priorities of riparian rights holders generally carry equal weight. All share the shortage among themselves during a drought.

Appropriative Rights

Appropriative water rights generally pertain to non-riparian uses and storage of water from a time of plenty to one of scarcity. Appropriative water rights, as they exist today, came about as a result of a series of historical events.

Water rights laws in California were set on a different course in 1849, when fortune seekers flocked to the state after the discovery of gold. Water development proceeded on a scale never before witnessed in the United States as these “49ers” built extensive networks of flumes and waterways to work their claims. The water carried in these systems often had to be transported far from the original river or stream. These self-governing, maverick miners applied the same “finders-keepers” rule to water that they did to their mining claims. Water belonged to the first miner to assert ownership.

To stake their water claims, the miners developed a system of “posting notice,” which signaled the birth of today’s appropriative rights system. It allowed others to divert available water from the same river or stream, but their rights existed within a hierarchy of priorities. This “first in time, first in right” principle became an important feature of modern California water rights laws.

In 1850, California entered the Union as the 31st state. One of the first actions taken by its lawmakers was to adopt the common law of riparian rights. One year later, the Legislature recognized the appropriative right system as having the force of law. The appropriative right system continued to increase in use as agriculture and population centers blossomed and ownership of land was transferred from the State and federal governments to private ownership.

Up to the early 1900s, appropriators, most of them miners and non-riparian farmers, had simply taken control of water and used what they wanted. Sometimes notice was filed with the county recorder, but no formal permission was required from any administrative or judicial body.

The Water Commission Act of 1914 established today's permit process. This legislation created the agency that evolved into the State Water Resources Control Board (SWRCB) and granted it the authority to administer permits and licenses for California's surface water. The act was the predecessor to today's California Water Code (CWC) provisions governing appropriation.

These post-1914 appropriative rights are governed by the hierarchy of priorities developed by the 49ers. In times of shortage, the most recent (junior) right holder must be the first to discontinue the use of the natural flow of the water body. Each right's priority dates to the time the permit application was filed with the SWRCB. Although pre- and post-1914 appropriative rights are similar, post-1914 rights are subject to a much greater degree of scrutiny and regulation by the SWRCB.

The CWC establishes a procedure for the SWRCB to designate stream systems as fully appropriated. Designating a stream as such precludes the SWRCB from accepting any application to appropriate water from a specified stream system, except where the proposed application is consistent with the designation.

Beneficial Use

The conflicting nature of California's dual water rights system prompted numerous legal disputes. Unlike appropriative users, riparian rights holders were not required to put water to a reasonable and beneficial use. This clash of rights eventually resulted in a constitutional amendment (Article X, Section 2 of the California Constitution) that requires all use of water to be "reasonable and beneficial." These "beneficial uses" have currently include municipal and industrial uses, agricultural irrigation, hydroelectric generation, livestock watering, fish and wildlife protection, recreational use, and aesthetic enjoyment.

Per CWC Section 1707, individuals or groups of individuals can change an existing beneficial use to dedicate some or all of the water under their water right(s) to instream beneficial uses by submitting a petition for instream flow dedication. For example, some have pursued the concept of leasing surface water as a means of improving instream flows for salmon and steelhead by paying fair compensation to water right holders for the temporary instream use of all or part of their water use. Using CWC Section 1707 ensures that water right holders who participate in this process will not lose ownership of their water rights.

Fully Appropriated Streams

CWC Sections 1205 through 1207 establish a procedure for the SWRCB to adopt a declaration designating stream systems that are determined to be fully appropriated either year-round or during specified months. Placing a stream on the declaration precludes the SWRCB from accepting any application to appropriate water from a specified stream system, except where the proposed application is consistent with the declaration. California Code of Regulations, title 23, section 871 provides that the SWRCB may revoke or revise the declaration upon its own motion or upon petition of any interested person.

Groundwater Rights

In most areas of California, overlying landowners may extract percolating groundwater and put it to beneficial use. California does not have a permit process for regulating groundwater use. In several basins, however, groundwater use is subject to regulation in accordance with court decrees that adjudicated the groundwater rights within the basins.

The California Supreme Court decided in the 1903 case, *Katz v. Walkinshaw*, that the doctrine of reasonable use (as defined in CWC Section 100), which governs other types of water rights, also applies to groundwater. Previously, the English system of unregulated groundwater pumping was dominant, but this proved to be inappropriate to California's semiarid climate. This California Supreme Court case established the concept of overlying (or "correlative") rights, in which the rights of others with land overlying the aquifer must take reasonable use into account. Later court decisions established that groundwater may be appropriated for use outside the basin, although appropriator's rights are subordinate to those with overlying rights.

Conjunctive management of surface and groundwater supplies has opened up a new set of challenges, with regard to the State's somewhat fragmented surface and groundwater laws. Recharge and storage of surface water in a groundwater basin is legally viewed as though the storage were above ground. Any appropriation of water to be stored underground must be for a beneficial purpose and place of use, as is the case for surface storage. This means that groundwater storage applicants must declare the place and purpose of a beneficial use of the water to be stored. Concerns have been raised that it is difficult for groundwater recharge project applicants to specify future purpose and place of use. Nonetheless, without this specification, State regulators cannot corroborate the stated beneficial use. Further, if a surface water rights holder petitions to change their water rights to include the recharge of groundwater, their existing water rights could be put in jeopardy as a result of the petitioning process. This tends to discourage water rights holders from seeking the addition of groundwater recharge to their existing water rights. Some interests have proposed as a solution that groundwater recharge be declared a beneficial use, in which case the applicant would not have to specify place of use.

Tribal and Federal Reserved Water Rights

The federal-tribal relationship is complex. It is built around the doctrine of trust responsibility and a composite of factors. Water rights for federally recognized tribes are similarly complex and flow from the federal-tribal relationship, treaties, statutes, agreements, and are interpreted in case law.

In some cases, rights may include access to water for dependent uses such as fishing. In *United States v. Winans* (1905), the Yakima Nation went to court to preserve the "right of taking fish at all usual and accustomed places, in common with citizens of the Territory, and of erecting temporary buildings for curing them."

The U.S. Supreme Court upheld the Yakima Nation's right, even when the usual and accustomed places were owned by non-Native Americans. The court noted that the right to fish and to access traditional fishing grounds was not a special right granted by the government through treaty. Rather, the treaty simply acknowledged a right the Native Americans already possessed and that was reserved for their current and future use.

Another key area of federal water law involves the idea of water for reserved federal lands. In *Winters v. United States* (1908), the federal government went to court to prevent diversion of water that precluded water flowing to a tribal reservation. The result, called the Winters Doctrine, holds that land without water is valueless if water is essential for the purpose of the land. In this case, the purpose was tribal agriculture and ranching. The courts have also used the Winters Doctrine — reserving sufficient water to fulfill the purpose of reserved land — in deciding water rights for other kinds of reserved federal lands such as national forests and wilderness areas.

Pueblo Water Rights

Pueblo water rights are those exercised by a municipal successor to a Spanish/Mexican pueblo. The municipal successor must have taken possession of the right as of March 3, 1854. Only two pueblo water rights have been adjudicated in California — Los Angeles and San Diego. A pueblo water right is the highest priority (first in line) water right in California. It attaches to surface flow, including tributaries, and tributary groundwater of streams within the historic boundaries of the pueblo.

The quantity is determined by present municipal needs and grows over time. It cannot be lost by non-use or prescription and it is not subject to public trust claims although prohibition against waste and unreasonable use applies (Katz 2007).

Human Right to Water

On September 25, 2012, California Governor Edmund G. Brown, Jr. signed Assembly Bill (AB) 685 into law to ensure universal access to clean water. AB 685 places the human right to water at the center of State policy and underscores the role of State agencies in addressing the impact of unsafe water on humans. It requires State agencies to consider the human right to water when "revising, adopting, or establishing policies, regulations, and grant criteria" that impact water used for domestic purposes.

The bill, which added Section 106.3 to the CWC, reads:

- It is hereby declared to be the established policy of the state that every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes.
- All relevant state agencies, including the department, the state board, and the State Department of Public Health, shall consider this state policy when revising, adopting, or establishing policies, regulations, and grant criteria when those policies, regulations, and criteria are pertinent to the uses of water described in this section.
- This section does not expand any obligation of the state to provide water or to require the expenditure of additional resources to develop water infrastructure beyond the obligations that may exist pursuant to subdivision (b).
- This section shall not apply to water supplies for new development.
- The implementation of this section shall not infringe on the rights or responsibilities of any public water system.

In the report *The Human Right to Water Bill in California, An Implementation Framework for State Agencies* (Salceda et al. 2013), the International Human Rights Law Clinic at University of California, Berkeley, School of Law provides an explanation of the key terms of the new law. The report explains the human right to water is more than just a declaration in statute. It creates an ongoing obligation for State agencies to consider the human right to water in every relevant agency decision and activity.

The law includes a list of specific values — safety, affordability, and accessibility — that agencies must consider when revising, adopting, or establishing policies, regulations, and grant criteria related to domestic water use. The courts have found in similar situations that this type of duty cannot be fulfilled through a single administrative action by a State agency. The bill's legislative intent was "to create a State policy priority and direct State agencies to explicitly consider the human right to water within their relevant administrative processes, measures, and actions."

By considering these values, State agencies can engage in responsive government decision-making and targeted programming that addresses the problems faced by disadvantaged and marginalized communities. The report concludes, "Human rights principles also foster a comprehensive approach to policy-making by focusing on underlying causes and systemic solutions in addition to individual remedies."

Water Law and Policy — Land and Agriculture

More than 43 percent of the land in California is used for food production. In contrast, California's urban use is 5 percent of California's land. Federal and State laws and policies tie water and agriculture together. When Congress passed the original Reclamation Act of 1902, the goals for water subsidies were to make the desert bloom.

Agricultural land has also been recognized in the California Constitution as meriting special status. This special status is implemented, in part, through the California Land Conservation Act (CLCA) of 1965, which is also called the Williamson Act. In the Legislative Declaration of the CLCA, the Legislature finds "That the preservation of a maximum amount of the limited supply of agricultural land is necessary to the conservation of the state's economic resources, and is necessary not only to the maintenance of the agricultural economy of the state, but also for the assurance of adequate, healthful and nutritious food for future residents of this state and nation."

A variety of codes and policies such as the California Agricultural Vision, aka AgVision (California Department of Food and Agriculture 2012), articulate the preeminence of agriculture as critical to the CWP emphasis on a healthy environment, vibrant economy, and social equity. A recent report highlights a growing concern with food security, which is access to healthy food by a large number of Californians (Chaparro et al. 2012). Previous CWP updates have also reported on concerns regarding the adequacy of food as a national security issue and the Obama administration has identified food security as an element of foreign policy.

San Luis Obispo County. While in recent years strawberries and wine grapes have been the county's most valuable crops, artichokes grow well in the cool humid climate near the coast.

State and Federal Agencies/Departments with Water-Related Roles and Responsibilities

The State and federal governments are responsible for representing and protecting the public trust. In general, the featured agencies fill, often simultaneously, five general water-related stewardship roles:

- Regulator.
- Landowner.
- Service provider.
- Funder.
- Planner, technical advisor.

Those agencies that are landowners and service providers may also be regulated. Together, in addition to roles as landowners, the State and federal governments provide assistance, guidance, scientific review, monitoring, and oversight to local governments (city- and county-owned municipal water systems), Native American tribes, and special districts.

California Government Executive Branch, Boards, and Commissions

Many State agencies and departments oversee California's water resources. DWR operates the State Water Project and is responsible for overall water supply planning. The SWRCB integrates water rights and water quality decision-making authority and is responsible for overall water quality planning. The SWRCB and the nine regional water quality control boards (RWQCBs) are responsible for protecting California's water resources. According to the Porter-Cologne Water Quality Control Act, water quality control plans (also known as basin plans) are prepared for each of the 10 hydrologic regions and by statute become part of the CWP. Below are other State agencies and departments and their roles in water management.

- **California Air Resources Board (ARB).** Promotes and protects public health, welfare, and ecological resources through the effective and efficient reduction of air pollutants. Through its effort to reduce greenhouse gas emissions, ARB plays a role in ensuring that water is managed and used in ways that minimize greenhouse gas emissions.
- **California Business Transportation and Housing Agency (BTH).** Oversees the activities of 13 departments and several economic development programs and commissions. Its operations address financial services, transportation, affordable housing, real estate, managed health care plans, and public safety.
- **California Coastal Commission.** Plans and regulates land and water uses in the coastal zone consistent with the policies of the California Coastal Act.
- **California Department of Parks and Recreation (California State Parks).** Manages more than 270 State park units, which protect and preserve culturally and environmentally sensitive structures and habitats, threatened plant and animal species, as well as ancient Native American sites, historic structures, and artifacts. California State Parks is responsible for almost one-third of the state's scenic coastline and manages many of the coastal wetlands, estuaries, beaches, and dune systems.

- **California Division of Boating and Waterways (DBW).** Became a division within the Department of Parks and Recreation in 2013. DBW develops public access to the waterways and promotes on-the-water safety with programs that include aquatic pest control in the Sacramento-San Joaquin Delta, coastal beach erosion control, and grants for vessel sewage pumpout stations.
- **California Department of Conservation (DOC).** Provides services and information that promote environmental health, economic vitality, informed land-use decisions, and sound management of California's natural resources. This department also manages a State watershed program.
- **California Department of Fish and Wildlife (DFW).** Regulates and conserves the State's wildlife and is a trustee for fish and wildlife resources. It is the State's primary department for managing native fish, wildlife, plant species, and natural communities for their intrinsic and ecological value. It serves a regulatory role by enforcing the California Endangered Species Act and Fish and Game Code Section 1600, Streambed Alteration Agreements.
- **California Department of Food and Agriculture (CDFA).** Promotes food safety, protects public and animal health, and protects California from exotic and invasive plant pests and diseases.
- **California Department of Forestry and Fire Protection (CAL FIRE).** Manages and protects California's natural resources. Provides fire protection and stewardship for more than 31 million acres of California's privately owned wildlands and offers varied emergency services in 36 of the state's 58 counties via contracts with local governments.
- **California Department of Pesticide Regulation (DPR).** Protects human health and the environment by regulating pesticide sales and use, and by fostering reduced-risk pest management. Plays a significant role in monitoring the presence of pesticides and in preventing further contamination of the water resource.
- **California Department of Public Health (CDPH).** Regulates public drinking water systems, oversees water recycling projects, grants permits for water treatment devices, certifies drinking water treatment and distribution operators, supports and promotes water system security, provides support for small water systems and for improving technical, managerial, and financial capacity, oversees the Drinking Water Treatment and Research Fund for methyl tertiary-butyl ether (MTBE) and other oxygenates in drinking water, and provides funding opportunities for water system improvements, including funding under Proposition 84, Proposition 50, and the Safe Drinking Water State Revolving Fund.
- **California Department of Toxic Substances Control (DTSC).** Provides technical oversight for the characterization and remediation of hazardous waste in soil and water.
- **California Emergency Management Agency (Cal EMA).** As part of the governor's efforts to streamline the State's emergency response capabilities, AB 38 combined the Office of Emergency Services and the Governor's Office of Homeland Security into this cabinet-level State agency in 2009. Cal EMA is responsible for overseeing and coordinating emergency preparedness, response, recovery, and homeland security activities in the state.
- **California Energy Commission.** Responsible for the forecast, regulation, and development and promotion of technology as the State's primary energy policy and planning agency.
- **California Environmental Protection Agency (Cal/EPA).** Restores, protects, and enhances the environment to ensure public health, environmental quality, and economic vitality.
- **California Department of Resources Recycling and Recovery (CalRecycle).** Protects the environment and preserves resources by empowering Californians to reduce, reuse, and recycle.

- **California Public Utilities Commission (CPUC).** Regulates privately owned water and other utility companies.
- **California Water Commission (CWC).** 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.
- **Central Valley Flood Protection Board (CVFPB).** Plans flood control along the Sacramento and San Joaquin rivers and their tributaries in cooperation with the U.S. Army Corps of Engineers.
- **Colorado River Board of California (CRB).** Protects California's rights and interests in the water resources provided by the Colorado River.
- **Delta Protection Commission (DPC).** Responsible to adaptively protect, maintain, and where possible, enhance, and restore the overall quality of the Delta environment consistent with the Delta Protection Act.
- **Delta Stewardship Council (DSC).** Responsible for achieving the coequal goals of providing a more reliable water supply for California and to protect, restore, and enhance the Delta ecosystem. The DSC has developed the Delta Plan, California's resource management plan for resolving the Delta's long-standing conflicts, and has regulatory authority over covered actions. The Delta Plan will also guide protection and enhancement of the unique resources, culture, and values of the Delta as an evolving place.
- **Governor's Office of Planning and Research (OPR).** Provides legislative and policy research support for the Governor's Office. The State Clearinghouse, a department within OPR, coordinates the State-level review of environmental documents pursuant to the California Environmental Quality Act (CEQA), provides technical assistance on land use planning and CEQA matters, and coordinates State review of certain federal grant programs.
- **Native American Heritage Commission (NAHC).** Protects Native American burials from vandalism and inadvertent destruction, provides a procedure for the notification of most likely descendants regarding the discovery of Native American human remains and associated grave goods, brings legal action to prevent severe and irreparable damage to sacred shrines, ceremonial sites, sanctified cemeteries, and place of worship on public property, and maintains an inventory of sacred places.
- **California Natural Resources Agency (CNRA).** Restores, protects, and manages the state's natural, historical and cultural resources for current and future generations using creative approaches and solutions based on science, collaboration, and respect for all the communities and interests involved.
- **Ocean Protection Council (OPC).** Ensures that California maintains healthy, resilient, and productive ocean and coastal ecosystems for the benefit of current and future generations.
- **Sierra Nevada Conservancy (SNC).** Initiates, encourages, and supports efforts that improve the environmental, economic, and social well-being of the Sierra Nevada region, its communities, and the citizens of California. The region, which comprises all or part of 22 counties and more than 25 million acres, is California's principal watershed that supplies 65 percent of the developed water supply.
- **California State Lands Commission (CSLC).** Manages public trust lands of the state, which includes the beds of all naturally navigable rivers, lakes, and streams, as well as the

state's tide and submerged lands along more than 1,100 miles of California's coastline. The public trust doctrine is applied to ensure that the public trust lands are used for water-related purposes, including the protection of the environment, public recreation, and economic benefit to the citizens of California.

- **Strategic Growth Council (SGC).** Coordinates the activities of State agencies and partners with stakeholders to promote sustainability, economic prosperity, and quality of life for all Californians.

Federal Government

The federal government is a significant landowner in California. Approximately 48 million, or 48 percent, of the 100,206,720 total state acres are in federal ownership (Gorte et al. 2012). Most of this land is California's forest and Sierra Nevada regions, and the southeastern rural areas. For example, Inyo and Mono counties respectively have 92 and 84 percent federal ownership. Some counties with large urban centers have significant federal presence. San Bernardino County has more than 80 percent federal land ownership.

Management of federal lands in the state is particularly important to water mangers as these properties often contain significant watersheds and headwaters.

The largest federal landowners in California are the Bureau of Land Management and the U.S. Forest Service, followed by the National Park Service. The Department of Defense and the U.S. Fish and Wildlife Service also maintain large tracts of property. Beyond land ownership, many federal agencies play important roles in the planning, regulation, and management of California's water resources and water dependent uses. Some key federal agencies involved with water in California are:

- **U.S. Department of Agriculture (USDA).** Provides services and leadership on food, agriculture, natural resources, rural development, nutrition, and related issues.
- **Department of Defense (DOD).** Manages an inventory of installations and facilities to keep Americans safe from outside aggression. DOD maintains a significant land base in multiple California locations with water, environmental, and ecosystem management requirements. DOD manages more than 30 million acres of land nationally.
- **U.S. Army Corps of Engineers (USACE).** Part of DOD that plans, designs, builds, and operates water resources projects such as navigation, flood control, environmental protection, disaster response, and recreation.
- **U.S. Environmental Protection Agency (EPA).** Protects human health by safeguarding the natural environment.
- **Federal Energy Regulatory Commission (FERC).** An independent agency that regulates the interstate transmission of natural gas, oil, and electricity. FERC also reviews and regulates proposals to license hydropower projects.
- **Federal Emergency Management Agency (FEMA).** As a part of the Department of Homeland Security, provides disaster response and recovery support including extreme weather events such as storms and drought. FEMA oversees the National Flood Insurance Program and the Flood Hazard Mapping Program.
- **U.S. Fish and Wildlife Service (USFWS).** Conserves, protects, and enhances fish, wildlife, plants, and their habitats.

- **U.S. Forest Service (USFS).** As part of the USDA, manages forests, watersheds, and other natural resources. The USFS maintains multiple areas in California containing major headwaters.
- **U.S. Geological Survey (USGS).** Provides water measurement and water quality research.
- **U.S. Department of the Interior (DOI).** Protects America's natural resources and heritage, honors cultures and tribal communities, and supplies energy resources.
- **Bureau of Land Management (BLM).** Part of Department of the Interior, manages federal lands for multiple purposes including energy development, grazing, and recreation. The BLM provides land management in many watersheds.
- **Bureau of Indian Affairs (BIA).** As part of the U.S. Department of the Interior, promotes economic opportunity and carries out the responsibility to protect and improve the trust assets of Native Americans, Native American tribes, and Alaska Native tribes.
- **Indian Health Services (IHS).** Provides comprehensive primary health care and disease prevention services for Native Americans. IHS maintains programs that provide technical and financial assistance to Native American tribes and Alaska Native Communities (tribes) for the cooperative development and continuing operation of safe water, wastewater, solid waste systems, and related support facilities.
- **National Oceanic and Atmospheric Administration (NOAA).** As part of the Department of Commerce, a scientific agency focused on the conditions of the oceans and the atmosphere. NOAA warns of dangerous weather, charts seas and skies, guides the use and protection of ocean and coastal resources, and conducts research to improve understanding and stewardship of the environment.
- **National Marine Fisheries Service (NMFS).** Part of the National Oceanic and Atmospheric Administration. NMFS protects and preserves living marine resources, including anadromous fish.
- **National Park Service (NPS).** As part of the Department of the Interior, manages national parks, including their watersheds.
- **Natural Resource Conservation Service (NRCS).** As part of the U.S. Department of Agriculture, provides technical and financial assistance to conserve, maintain, and improve natural resources on private lands.
- **U.S. Bureau of Reclamation (USBR).** As part of the Department of the Interior, operates the Central Valley Project (CVP), which is the largest water project in California, and regulates diversions from the Colorado River.
- **Rural Development (USDA RD).** As part of the U.S. Department of Agriculture, manages financial programs for essential public facilities and services such as water and sewer systems, emergency service facilities, and electric and telephone service. USDA RD promotes economic development by supporting loans. Provides technical assistance and information to help agricultural producers and cooperatives get started and improve the effectiveness of their operations.
- **Secretary's Indian Water Rights Office (SIWRO).** As part of DOI, manages, negotiates, and oversees implementation of settlements of Indian water rights claims, with the strong participation of Native American tribes, states, and local parties.
- **Western Area Power Administration.** Manages power generated by the Central Valley Project.

During the Update 2013 process, many federal agencies actively supported development of CWP content. USBR and USACE both engaged with DWR in joint planning and modeling efforts used for development of CWP data and tools and scenario development. The EPA entered into a joint planning effort for development of Update 2013 sustainability indicators and development of concepts like the water footprint. USGS has been engaged in multiple planning cycles to provide analytical support. The U.S. Forest Service has provided direct support to the CWP, starting with Update 2009, in the development and update of the resource management strategies and has been a key partner in Update 2013 in building multi-agency policies that support agency alignment. NRCS also became more actively engaged during Update 2013 and provided early support for the development of the sediment management resource management strategy, with direct involvement from the State Soil Scientist.

Tribal Governments, Organizations, and Communities

Just as historic uses, patterns of settlement, and seasonal, geographic, and quantitative differences in precipitation caused California's water system to develop differently than what is found in other states, the CWP definition of California Native American Tribe is also unique. It signifies all indigenous communities of California, including those that are not federally recognized, those that are federally recognized, and those with allotment lands, regardless of whether or not they own those lands. Additionally, because some water bodies and tribal boundaries cross state borders, this term includes indigenous communities in Oregon, Nevada, and Arizona that are impacted by water in California.

As described in the above section on water rights, the United States has a unique legal and political relationship with Native American tribes and entities as provided by the Constitution of the United States, treaties, court decisions, and federal statutes. As a result, tribal governments are one of many governmental entities that may be responsible for ensuring that the water is safe and available in sufficient quantities for its intended purpose. Tribes may also be involved in a wide range of water management activities within their borders from protecting and managing surface waters, including reservoirs, watershed protection of wetlands, which are home to a wide diversity of plants and animals, and flood management.

Tribal governments work in collaboration with such federal agencies as the EPA, Bureau of Indian Affairs, Indian Health Service, USBR, and the DOI, among others to meet their water resources needs. Tribal governments and communities may also participate in local, regional, and statewide water planning and management activities at their discretion.

Some federal laws also allow for tribes to be treated as having the same legal and regulatory status as States. This is important for tribes that may want to exercise their jurisdiction over a subject matter that federal law puts them on par with States. In particular, the Clean Water Act, the Safe Drinking Water Act, and the Clean Air Act all have varying provisions that treat tribes as states.

Even with a strong governance structure, many tribal communities are served by substandard water systems. Contaminated watersheds and

PG&E Main Canal near the community of Twain Harte, which supplies 95 percent of the drinking water to Tuolumne Utilities District customers, including both the Tuolumne Band and Chicken Ranch Rancheria of Me-Wuk Indians.

groundwater sources in many areas need major improvements. Multiple barriers often exist and extend beyond adequate funding to acquire updated infrastructure. Other issues include the affordability of ongoing operations and maintenance, and the ability to recruit and retain skilled personnel to manage these systems.

Water rights are also frequently mentioned by tribes as a source of contention. It is federal policy for tribal water right disputes to be resolved by negotiation rather than litigation. The DOI Secretary's Indian Water Rights Office (SIWRO) manages, negotiates, and oversees implementation of settlements of Native American water rights claims, with the strong participation of tribes, States, and local parties. SIWRO coordinates and supports federal settlement activities through 36 federal negotiation, assessment, and implementation teams working throughout the western United States. Staff on the federal teams comes from the DOI programs such as USBR and BIA.

While the federal government finds a settlement process is superior and less expensive than litigation, resolution of tribal water rights can be a lengthy and expensive process. Once settled, the right must then be implemented, which in many cases may take 5-15 years.

Tribes and California State Government

California has recognized the importance of creating a mutually respectful relationship with the tribes within its boundaries. To further this goal, Governor Brown issued Executive Order B-10-11 in 2011. The order:

- Established the position of Governor's Tribal Advisor within the Office of the Governor.
- Directed the Governor's Tribal Advisor to oversee and implement effective government-to-government consultation between the administration and tribes on policies that affect California tribal communities.
- Confirmed the Office of the Governor shall meet regularly with the elected officials of California Native American tribes to discuss State policies that may affect tribal communities.
- Directed every Executive Branch State agency to encourage communication and consultation with California Native American tribes.
- Directed agencies and departments to permit elected officials and other representatives of tribal governments to provide meaningful input into the development of legislation, regulations, rules, and policies on matters that may affect tribal communities.

Since 2011, the Resources Agency and other Executive Branch organizations have developed policies to implement the order.

Tribes and the California Water Plan

The California Water Plan Tribal Advisory Committee assists in ensuring tribal input is reflected in all aspects of the Update 2013 planning process. This input assists the State in addressing the complex water issues facing California Native American Tribes.

A document prepared for the 2013 Tribal Water Summit, hosted in part by the California Water Plan Tribal Advisory Committee, called the *Guiding Principles and Statement of Goals* *for Implementation*, outlines three specific recommended actions to better integrate tribal considerations in the State's planning for water:

1. Tribes and State agencies should work together to develop strategies and approaches that incorporate traditional/tribal ecological knowledge better into water and water-related resource planning and management activities.

2. Tribes and State agencies should work together to develop strategies, educational materials, and recommendations that further the understanding of tribal uses of water and the broader role of water and access to water in tribal lifeways including subsistence and cultural practices.

3. Tribes and State agencies should work together to develop strategies and options for ensuring early and greater collaboration regarding water resource projects, as well as watershed and land use planning and management activities, especially where decisions impact tribal trust lands and/or traditional territories/homelands.

Public Agencies, Districts, Local Governments, and Investor-Owned Utilities

Local city and county governments and special districts have ultimate responsibility for providing safe and reliable water to their customers. More than 600 California water and irrigation districts are listed in the joint University of California, Riverside and the California State University, San Bernardino Water Resources Collections and Archives database.

In general, California has two methods for forming publicly managed special districts that develop, control, or distribute water: 1) enact a General Act under which the districts may be formed as set forth in the Act, and 2) enact a Special Act creating the district and prescribing its powers.

A 2010 list produced by the Senate Local Government Committee illustrates the complexity and magnitude of special districts that may be involved in some form of IWM activity is in Table 4-1.

There are more than 2,000 special districts, which is then combined with 58 counties and 482 incorporated cities that may be involved in some type of IWM activity. This does not include any of the agencies marked with an asterisk in the table, park districts, or fire districts that may have IWM responsibilities. Not all water suppliers and distributors are publicly managed. Mutual water companies, for example, are private corporations that perform water supply and distribution functions similar to public water districts. Many of the mutual water companies are small water systems. A small water system is defined as a water system for human consumption that has 15 or more service connections or regularly serves at least 25 individuals at least 60 days of the year. This includes any collection, treatment, storage, and distribution facilities. The California Department of Public Health (CDPH) is responsible for regulating these systems. In 31 of the 58 counties, CDPH has delegated local oversight to local primacy agencies (LPAs) for the regulation of public water systems serving fewer than 200 service connections. LPAs are county environmental health jurisdictions. LPAs regulate approximately 1,600 community water systems and 3,900 non-community water systems. Non-community systems are typically associated with a smaller number of users that may not be present year round, or transient locations like rest stops.

Investor-owned utilities in water activities are regulated by the California Public Utilities Commission (CPUC). CPUC regulates 152 water and sewer companies serving more than 23 percent of all Californians.

Table 4-1 **Special Districts Involved in Some Type of IWM Activity**

District Type	Number of Agencies	District Type	Number of Agencies
County Water Districts	166	Reclamation Districts	156
Resource Conservation Districts	96	California Water Districts	136
Irrigation Districts	94	County Sanitation Districts	73
Sanitary Districts	72	Public Utility Districts	54
Storm Water Drainage and Maintenance Districts	49	Water Agency or Authority	30
Flood Control and Water Conservation Districts	48	County Waterworks Districts	28
Municipal Water Districts	37	Drainage Districts	23
Water Conservation Districts	13	Levee Districts	14
Harbor and Port Districts	13	Water Storage Districts	8
Community Services Districts	325[a]	Municipal Utility Districts	5
Municipal Improvement Districts	5	Sewer District	1
Sanitation & Flood Control Districts	2	Water Replenishment Districts	2
Mosquito Abatement and Vector Control Districts	46[b]	Metropolitan Water District	1
County Service Areas	895[c]		

Source: California Senate Local Government Committee 2010

Notes:

[a] This number is likely smaller, as these districts often provide water, sewer and storm drain services but not always.

[b] These districts are sometimes involved in flood management and water storage issues due to concerns with standing water.

[c] Only a portion of the service areas provide services.

Integrated Regional Water Management Groups

Integrated regional water management (IRWM) is a voluntary, collaborative effort to manage all aspects of water resources in a region. IRWM crosses jurisdictional, watershed, and political boundaries. It involves multiple agencies, stakeholders, individuals, and groups, and it addresses issues and differing perspectives of all the entities involved through crafting mutually beneficial solutions.

California has 48 IRWMs that are recognized by DWR. Most of these regions have an IRWM plan following principles established by the Legislature and guidelines developed by DWR. Some regions are developing their IRWM plans for the first time, while others are updating theirs. Individual IRWM plans deal with widely varying water resources conditions and establish regional goals and objectives. Table 4-2 shows key IRWM events.

At a minimum, a region is defined as a contiguous geographic area encompassing the service areas of multiple local agencies. Regions are defined to maximize integrated water management activities opportunities and effectively integrate water management programs and projects within a hydrologic region.

The Region Acceptance Process (RAP) is a component of the IRWM Program Guidelines. It is used to evaluate and accept an IRWM region into the IRWM grant program. The RAP is not a grant funding application; however, acceptance of the composition of an IRWM region into the IRWM grant program is required for DWR IRWM grant funding eligibility. (See Figure 4-1.)

IRWM is a prime example of integrated resource planning, which began in the late 1980s in the electric power industry, as a comprehensive approach to resource management and planning. When applied to water management, integrated resource planning is a systems approach that explores the cause-and-effect relationships between different aspects of water resource management, with an understanding that changes in the management of one aspect of water resources can affect others. Because water resources are often not tied to the boundaries of a single water management agency, a consensus-based, cross-jurisdictional, regional approach allows formulation of comprehensive solutions to regional water resource issues. The methods used in IRWM include a range of water resource management strategies, which relate to water supply, water quality, water use efficiency, operational flexibility, and stewardship of land and natural resources.

Resource Conservation Districts

Resource Conservation Districts (RCDs) are special districts and are a good example of strong local government. The 99 districts statewide are the center of locally led conservation in their communities and accomplish thousands of practical, hands-on conservation projects every year. Projects often involve agriculture and private land. Typical projects include:

- Water conservation.
- Watershed protection.
- Creek restoration.
- Streambank restoration.
- Habitat improvement.
- Fish passage.
- Hedgerow plantings.
- Community education.
- Grower workshops.
- Native plantings.
- Creek cleanups.

Table 4-2 Key IRWM Events

Year	Event
2002	Integrated Regional Water Management Act encourages local agencies to work cooperatively to manage local and imported water supplies to improve the quality, quantity, and reliability of those supplies.
2002	Proposition 50, the Water Security, Clean Drinking Water, Coastal and Beach Protection Act provides $500,000,000 to fund competitive grants for projects consistent with an adopted IRWM plan.
2005	*California Water Plan Update 2005* names IRWM as a key initiative to ensure reliable water supplies.
2006	Proposition 84, the Safe Drinking Water, Water Quality, and Supply, Flood Control, River and Coastal Protection Bond Act of 2006 provides $1,000,000,000 for IRWM planning and implementation.
2006	Proposition 1E, the Disaster Preparedness and Flood Prevention Bond Act which provides, among other actions, $300,000,000 for stormwater projects that reduce flood damage and are consistent with an IRWM plan.
2008	Integrated Regional Water Management Planning Act provides a general definition of an IRWM plan as well as guidance to the Department of Water Resources about what IRWM program guidelines must contain. Guidelines include standards for identifying a region for the purposes of developing or modifying an IRWM plan.

- Educating agriculturists on better and new environmental practices, particularly around water conservation.
- Classroom visits.
- Fire prevention projects.
- Fire prevention education.
- Technical assistance to agriculturists.
- Watershed management.

Most RCDs do not receive taxpayer funding, and bring millions of dollars to local communities through conservation projects funded mainly through grants and private contributions. Those RCDs that receive tax dollars return every dollar at a 10 to 1 ratio.

Academic Institutions

California's public and private academic institutions play a vital role in California water management by providing research and other expertise to inform decision-making. Academics and policy experts from multiple universities are members of advisory councils, including those for the CWP, and prepare policy briefs to frame issues for public dialog. A small sample of CWP participation from California universities follows:

The **International Center for Water Technology** (ICWT) is part of California State University, Fresno State University, and was established in 2001 to educate, promote, and assist in developing and adopting innovative technologies that improve water utilization,

Figure 4-1 **Integrated Regional Water Management Planning Regions Accepted or Conditionally Accepted by DWR as of Publication**

reduce energy demand, and impact air quality positively. ICWT is provides direct expertise for the Water Plan Technology Caucus.

Faculty from the **University of California, Davis** (UC Davis) supports many aspects of data and information development for the CWP, ranging from development of sustainability indicators to providing peer reviews for technical tools.

California State University, Sonoma assisted with development of easy-to-use land use planning tools that illustrate water-land decision options. This effort has been a center piece of work by the Water Plan Land Use caucus.

The **Water Resources Institute** (WRI) is part of California State University, San Bernardino. WRI partners with DWR to coordinate the Alluvial Fan Task Force composed of county supervisors, local flood managers, developers, land use/environmental interests and representatives of State and federal agencies. The members were charged with developing a Model Ordinance (see http://aftf.csusb.edu/documents/DRAFT_MODEL_ORDINANCE.pdf) and local planning tools that would provide a model for future land use decisions on alluvial fans.

The **Center for Collaborative Policy** (CCP), a unit of the College of Social Sciences and Interdisciplinary Studies at California State University, Sacramento, has provided neutral third party facilitation and technical advice on collaboration for the CWP since 2000.

State Agency Coordination through the Water Plan Steering Committee

To achieve comprehensive and integrated management of California's water resources, the Water Plan Steering Committee guided the development of Update 2009 (see Box 4-1). In the past, DWR had performed this role with little formal input from other State agencies. The Steering Committee collaborates to develop a more comprehensive CWP that strategically integrates California's water supply, water use efficiency, water quality, flood management planning, and environmental stewardship, as well as respective agency missions and goals.

Working together, the State agencies sought to improve water governance by taking action on the following:

- Review and revise the vision, mission, and goals of the CWP, and update its implementation plan. Develop multiple scenarios of future California water conditions and use these scenarios to evaluate different combinations of resource management strategies, called response packages, for a range of water demand and supply assumptions.
- Develop climate change scenarios to evaluate impacts on California's water resources and water systems and identify and recommend statewide and regional adaptation strategies.
- Update the regional reports for the 10 hydrologic regions and for Delta and Mountain counties as areas of special concern. Use information gained from the IRWM and local water and flooding efforts to describe critical issues, key initiatives, effectiveness of regional planning efforts, and region-specific response strategies.
- Update the 27 resource management strategies with current research and information and add three new strategies. Expand strategy narratives to describe their suitability for integrated flood management, new challenges, and their current and future implementation in various regions.

- Estimate and present actual water uses, supplies, and quality (water portfolios) for water years 2006 through 2010. Improve methods for representing consumptive and non-consumptive environmental water and where water reuse is occurring.
- Improve information exchange and data integration, data, and analytical tools to inform all CWP activities and decisions and to assist California water planners and managers.
- Incorporate findings and recommendations from featured State government plans and initiatives into Update 2013.

Agency Coordination through the Biodiversity Council

The California Biodiversity Council (CBC) was formed in 1991 to improve coordination and cooperation between the various resource management and environmental protection organizations at federal, State, and local levels. Strengthening ties between local communities and governments has been a focus of the council by way of promoting strong local leadership and encouraging comprehensive solutions to regional issues.

The council was not created to independently establish new projects, or to become another bureaucracy. Rather, its purpose is to discuss, coordinate, and assist in developing strategies and complementary policies for conserving biodiversity. Members exchange information, resolve conflicts, and promote development of regional conservation practices.

The council has 42 members, including 20 State agencies, 12 federal agencies, and 10 local governments. It is chaired by the Secretary of the California Natural Resources Agency and the California State Director of the Bureau of Land Management. The council meets 2-3 times a year on issues relating to natural resource conservation in California.

In 2012, collaboration between the council and the CWP update process was established to align planning processes better and to interact more efficiently with federal agencies. One result was a joint convening of a Workshop to Align Agency Conservation Plans, Policies, and Programs held in October 2012. The results of this workshop led to the February 6, 2013 California Biodiversity Council Meeting in Davis where the co-chairs committed to a new resolution for the council entitled Strengthening Agency Alignment for Natural Resource Conservation. The resolution includes:

- Increasing coordination with all levels of governments and agencies (federal, tribal, State, local), stakeholder groups, private landowners, and others.
- Increasing effectiveness through leveraging of existing networks, relationships, and multi-agency venues.
- Improving sharing of data, information, tools, and science among governments and agencies.
- Aligning planning, policies, and regulations better across governments and agencies and coordinate and streamline permitting to increase regulatory certainty.

The resolution also includes 11 principles, 11 practices and tools, and several organizational actions. The full text

Hope Valley Meadow, Sierra Nevada (May 2014). Restoration of the meadow is anticipated to begin in the fall of 2015. American Rivers has developed technical restoration designs, and the USFS is currently completing NEPA analysis for the project.

of Strengthening Agency Alignment for Natural Resource Conservation is at http://biodiversity.ca.gov/2013resolution.html.

Companion State Plans and the California Water Plan

A major effort of the State Agency Steering Committee was to identify State planning processes, policies, plans, and procedures that had a direct connection with the CWP. The goal was to create awareness among agencies and the public of related planning documents. This assessment allows agencies to work collaboratively to leverage each other's resources and objectives and overcome barriers.

There are three tiers of State agency plans — companion, nexus, and featured. A review gathered 191 companion State agency plans with some nexus to the issues considered in the CWP. At least 68 of those plans, referred to as nexus plans, had direct relevance to Volume 3, *Resource Management Strategies*; 36 plans, referred to as featured plans, informed the objectives and related actions in Chapter 8, "Roadmap For Action," of Volume 1, *The Strategic Plan*. The plans focus on different resources and programs respective to their agencies, but each provides part of the overall framework of California's water governance.

Featured State Plans

The 36 featured plans in Update 2013 (a subset of the nexus plans) substantially inform the water planning process (Table 4-3). In some cases, such as plans of the SWRCB, the relationship is legally required. In others, the relationship draws from a mutual governance responsibility. In collaboration with the State Agency Steering Committee, the CWP recognizes and intentionally reflects and incorporates key objectives and actions of the featured plans. This intentional conciliation builds alignment across multiple planning processes and agencies. Below are short descriptions of the 36 plans.

2010 Strategic Fire Plan for California (Department of Forestry and Fire Protection)

The California Fire Plan is the State's road map for reducing the risk of wildfire. The Fire Plan is a cooperative effort between the State Board of Forestry and Fire Protection and the California Department of Forestry and Fire Protection (CAL FIRE). By placing the emphasis on what needs to be done long before a fire starts, the Fire Plan looks to reduce firefighting costs and property losses, increase firefighter safety, and to contribute to ecosystem health.

2012 Central Valley Flood Protection Plan (DWR)

The Central Valley Flood Protection Plan (CVFPP) guides the State's investment in flood management in the Sacramento and San Joaquin River basins and provides a basis for coordinating with federal and local agencies in implementation. Prepared with significant public input, the CVFPP identifies a systemwide investment approach for sustainable, integrated flood management, focusing on areas currently protected by facilities of the State Plan of Flood Control (SPFC). Utilizing the most comprehensive evaluations to date for flood damage reduction, potential life loss, and environmental restoration opportunities, it guides flood management investments in the range of $14 to $17 billion during the next 20 to 25 years.

Table 4-3 Featured State Plans Featured in Update 2013

Featured State Plans	Agency
2010 Strategic Fire Plan for California	CAL FIRE 2010
2012 Central Valley Flood Protection Plan	Department of Water Resources 2012
2013 Integrated Energy Policy Report	California Energy Commission 2012
Alluvial Fan Task Force, Findings and Recommendations Report	Alluvial Fan Task Force 2010
Bay Delta Conservation Plan – Public Draft	Bay Delta Conservation Plan Steering Committee, currently being developed
California Agriculture Vision: Strategies for Sustainability	California Department of Food and AgricultureA 2010
California Drought Contingency Plan	Department of Water Resources 2010
California Native American Tribal Engagement in the California Water Plan Update 2013 - Tribal Engagement Plan	Calfiornia Water Plan, Tribal Advisory Committee, Draft Nov. 2010
California Ocean Protection Council Five-Year Strategic Plan 2012-2017	Ocean Protection Council
California Outdoor Recreation Plan 2008: An Element of the California Outdoor Recreation Planning Program	State Parks 2009
California's Forest and Rangelands: 2010 Assessment and 2010 Strategy Report	CAL FIRE 2010
California Strategic Growth Council Strategic Plan 2012-2014	California Strategic Growth Council 2012
California's Flood Future: Recommendations for Managing the State's Flood Risk	Department of Water Resources 2013 Draft
California's Water Commission Strategic Plan 2012	California Water Commission 2012
California Transportation Plan 2025 (April 2006) and 2030	Caltrans Oct. 2007
California Wildlife Action Plan	California Department of Fish and Wildlife 2007
Climate Change Scoping Plan: A Framework for Change	California Air Resources Board, currently being updated
Delta Plan	Delta Stewardship Council 2013
Department of Toxic Substances Control 2011-2016 Strategic Plan	Department of Toxic Substances Control
Environmental Goals and Policy Report	Governor's Office of Planning and Research, currently being developed
General Plan Guidelines	Governor's Office of Planning and Research, currently being updated
Recycled Water Policy	State Water Resources Control Board 2009

Featured State Plans	Agency
Regional Water Quality Control Plans (Basin Plans)	Regional Water Quality Control Boards
Safeguarding California Plan – Public Draft	California Natural Resources Agency, currently being updated
San Francisco Bay/Sacramento – San Joaquin Delta Estuary Water Quality Control Plan	State Water Resources Control Board, currently being updated
Sierra Nevada Conservancy Strategic Plan	Sierra Nevada Conservancy 2011
Sierra Nevada Conservancy 2013-14 Action Plan	Sierra Nevada Conservancy 2012
Small Water System Program Plan	California Department of Public Health 2012
State Coastal Conservancy Strategic Plan 2013-2018	California Coastal Conservancy 2012
State of California Emergency Plan	Cal EMA 2009
State of California Multi-Hazard Mitigation Plan	Cal EMA 2010
Strategic Plan for the Future of Integrated Regional Water Management	Department of Water Resources, currently being developed
The Climate Action Plan of the Sierra Nevada: A regional Approach to Address Climate Change	Sierra Nevada Conservancy 2009
Threat and Hazard Identification and Risk Assessment	Cal EMA, currently being developed
Water Action Plan	California Public Utilities Commission 2010
Water Boards Strategic Plan 2008-2012	State Water Resources Control Board 2008

The primary goal of the CVFPP is to improve flood risk management by reducing the chance and consequences of flooding and improve public safety, preparedness, and emergency response. The CVFPP also includes the following supporting goals:

- Improve operations and maintenance.
- Promote ecosystem functions.
- Improve institutional support.
- Promote multi-benefit projects.

Prepared by DWR and adopted by the Central Valley Flood Protection Board, the CVFPP is updated every five years, with each update providing support for subsequent policy, program, and project implementation. Implementation of the plan will require preparation of regional- and State-level financing plans.

2013 Integrated Energy Policy Report (California Energy Commission)

Senate Bill 1389 (Chapter 568, Statutes of 2002) requires the California Energy Commission to prepare a biennial integrated energy policy report that contains an assessment of major energy trends and issues facing the state's electricity, natural gas, and transportation fuel sectors and provides policy recommendations to conserve resources, protect the environment, ensure reliable, secure, and diverse energy supplies, enhance the state's economy, and protect public health and safety. The Energy Commission prepares these assessments and associated policy recommendations every two years as part of the *Integrated Energy Policy Report*. Preparation of this report involves close collaboration with federal, State, and local agencies and a wide variety of stakeholders in an extensive public process to identify critical energy issues and develop strategies to address those issues.

Alluvial Fan Task Force, Findings, and Recommendations Report (Alluvial Fan Task Force)

The Alluvial Fan Task Force (AFTF) was established by legislation and charged DWR with appointing a diverse stakeholder group that would examine the unique flood risks and environmental issues associated with development on alluvial fans and also provide recommendations to the Legislature to reduce flood risks and unintended environmental consequences in future development on alluvial fans. Throughout the AFTF process, the members collaborated to identify general findings that local governments should consider when planning for or considering future development on alluvial fans. Based on these findings, fourteen recommendations emerged that the State and other public agencies should consider when planning for or considering future development on alluvial fans. (See *Alluvial Fans Task Force Findings and Recommendations Report* at http://aftf.csusb.edu/documents/FINDINGS_Final_Oct2010_10-29-10_web.pdf.)

Bay Delta Conservation Plan

The proposed Bay Delta Conservation Plan (BDCP) is a comprehensive conservation strategy designed to address critical environmental and water delivery issues in the Sacramento-San Joaquin Delta with an ecosystem-based approach. The BDCP supports the coequal goals of habitat restoration and reliable water supply set forth in the Sacramento-San Joaquin Delta Reform Act of 2009.

The BDCP is a Habitat Conservation Plan and Natural Community Conservation Plan developed in compliance with the federal Endangered Species Act and the California Natural Community Conservation Planning Act. The plan would be implemented over a 50-year period and seeks long-term take permits. As a planning document, the BDCP describes the proposed actions to improve the condition of habitat and species in the Delta, reduce adverse effects of water diversions on the covered species, and provide a reliable water supply.

While the BDCP is meant to be beneficial to the environment, specific actions in the plan can have an impact on natural and human environments. These impacts must be evaluated and actions identified to mitigate them. State and federal environmental laws require a review of potential impacts of the BDCP before it can be approved and implemented. As a result, the BDCP Environmental Impact Report/Environmental Impact Statement (EIR/EIS) was prepared in compliance with the California Environmental Quality Act and the National Environmental Policy Act.

The BDCP, the EIR/EIS, and supporting documentation will provide the basis for informed decision-making, including applications for issuance of endangered species incidental take permits for facility and operational changes to the State Water Project.

California Agriculture Vision: Strategies for Sustainability (Department of Food and Agriculture)

Agriculture Vision, aka AgVision, is more than a set of policy recommendations. It is a platform for thoughtful engagement of diverse stakeholder views about California's food and agriculture system, and it is a call for leadership by all those concerned about the future of California agriculture and its continued critical role.

California Drought Contingency Plan (DWR)

The California Drought Contingency Plan is a statewide plan for minimizing drought impacts by improving agency coordination, enhancing monitoring and early warning capabilities, water shortage impact assessments, and preparedness, response, and recovery programs. The plan identifies an integrated, regional approach to addressing drought, drought action levels, and appropriate agency responses as drought conditions change.

California Native American Tribal Engagement in the California Water Plan Update 2013 — Tribal Engagement Plan (CWP Tribal Advisory Committee)

The California Water Plan Update 2013 Tribal Engagement Plan continues the relationships built between State agencies and California Native American Tribes during Update 2009. The Tribal Engagement Plan is not a consultation process, but a document for how Update 2013 intends to build on the work from Update 2009 in approaching its goal of increasing tribal involvement. The objectives for engaging California Native American Tribes in Update 2013 include:

1. Begin addressing the complex tribal water issues identified during Update 2009, including at the 2009 Tribal Water Summit and in Objective 12 of the Update 2009 Strategic Plan (see Volume 1, Chapter 7 of Update 2009).
2. Integrate tribal information and tribal perspectives in the CWP, including but not limited to *The Strategic Plan, Regional Reports, and Resource Management Strategies*.
3. Improve the overall quality and comprehensiveness of the CWP, making it a more relevant and useful document.
4. Educate many water professionals about tribal water issues and water management strategies.
5. Increase tribal inclusion and engagement in water planning throughout California.

California Ocean Protection Council Five-Year Strategic Plan 2012-2017 (Ocean Protection Council)

In 2012, the Ocean Protection Council (OPC) released a 5-year update to their original strategic plan. The OPC was created through the California Ocean Protection Act (COPA) in 2004 to help protect, conserve, and maintain healthy coastal and ocean ecosystems and the economies they support. The OPC works with diverse interests and provides the leadership needed to meet the accelerating and complex contemporary challenges as set forth in COPA. The new strategic plan for fiscal year 2012-2013 through fiscal year 2016-2017 proposes OPC action in areas of critical need where the council's involvement can yield tangible progress and have the greatest impact. The OPC will focus on five areas over the next five years:

1. Science-based decision-making.
2. Climate change.
3. Sustainable fisheries and marine ecosystems.
4. Coastal and ocean impacts from land-based sources.
5. Existing and emerging ocean uses.

California Outdoor Recreation Plan (Department of Parks and Recreation)

The California Outdoor Recreation Plan (CORP) is the State's strategy for identifying the wide range of ways in which recreation providers can deal with obstacles and create the outdoor recreation opportunities to meet current and future public demand. The CORP and associated research provide strategies for all public agencies (federal, State, local, and special districts engaged in providing outdoor recreation lands, facilities and services throughout the state) for meeting the outdoor recreation needs of Californians. The CORP presents valuable information about participation, and demand for water-dependent outdoor recreation activities including fishing, motor boating, paddle sports, and swimming. The plan inventories protected lands throughout the state, compiles public opinions about outdoor recreation and the management of public waters and lands, describes why wetlands are important recreation resources, and addresses the California Recreation Policy.

California Forest and Rangelands: 2010 Assessment and 2010 Strategy Report (Department of Forestry and Fire Protection)

The report, *California's Forests and Rangelands: 2010 Assessment*, has been completed by CAL FIRE's Fire and Resource Assessment Program (FRAP). It highlights key policy issues and options for the subsequent strategy document, which provides the framework for State and federal programs that support good forest and rangeland stewardship in California.

California Strategic Growth Council Strategic Plan 2012-2014 (California Strategic Growth Council)

This strategic plan lays out a comprehensive three-year work plan for the California Strategic Growth Council. It also defines the council's vision, mission, and various roles and responsibilities. The work plan is based on four strategies that follow the legislative mandates of the Strategic

Growth Council. The strategies are supported by 12 actions identified to accomplish the strategic objectives. To enhance common understanding, a high-level description is provided of the purpose and proposed methods for accomplishing each action.

California's Flood Future: Recommendations for Managing the State's Flood Risk (DWR)

DWR and the USACE developed *California's Flood Future: Recommendations for Managing the State's Flood Risk*, a comprehensive look at statewide exposure to flood risk. The report identifies and addresses the barriers to improved flood management and provides information intended to inform decisions about policies and financial investments to improve public safety, foster environmental stewardship, and support economic stability. Information used to develop *California's Flood Future* was provided by more than 140 public agencies.

California's Water Commission Strategic Plan 2012 (California Water Commission)

The California Water Commission's Strategic Plan 2012 outlines California's water challenges and the California Water Commission's goals and strategies to address those challenges. The plan discusses critical issues in California's water management, the history of the commission, and defines its roles and duties. It also highlights the commission's newly adopted mission statement, major goals, and strategies for achieving those goals.

California Transportation Plan 2025 (Department of Transportation)

The California Transportation Plan (CTP) is a statewide, long-range transportation plan for meeting the state's future mobility needs. The CTP defines goals, policies, and strategies to achieve a collective vision for California's future transportation system. This plan, with a minimum 20-year planning horizon, is prepared in response to federal and State requirements and is updated every five years. The current CTP 2025 was approved in 2006 and updated by an addendum in October, 2007, to comply with new federal planning requirements governing development of the plan.

California Wildlife Action Plan (Department of Fish and Wildlife and Wildlife Health Center at University of California, Davis)

The California Department of Fish and Wildlife, working in partnership with the Wildlife Health Center at University of California, Davis, directed the development of *California Wildlife: Conservation Challenges*. This report identifies species of habitats of greatest conservation need, the major stressors affecting native wildlife and habitats, and statewide and region-specific actions needed to restore and conserve California's wildlife.

Climate Change Scoping Plan: A Framework for Change (California Air Resources Board)

The Global Warming Solutions Act of 2006 (AB 32) required the ARB to prepare a scoping plan to achieve reductions in greenhouse gas (GHG) emissions in California. The AB 32 Scoping Plan, approved by the ARB in December 2008, provides the outline for actions to reduce California's GHG emissions. ARB is in the process of updating the Scoping Plan and its discussion draft for public review and comment was released in October 2013. The update to the Scoping Plan builds upon the initial Scoping Plan with new strategies and recommendations including: 1) define ARB climate change priorities for the next five years and lay the groundwork to reach post-2020 goals, 2) identify opportunities to leverage existing and new funds to further drive GHG emission reductions through strategic planning and targeted low-carbon investments, and 3) evaluate how to align the State's "longer-term" GHG reduction strategies with other State policy priorities for water, waste, natural resources, clean energy, transportation, and land use. The water sector aspect of the Scoping Plan Update assesses progress toward the 2020 goal and provides the current status of each water measure, including water use efficiency, water recycling, water system energy efficiency, reuse urban runoff, renewable energy production, and water public goods charge. It also provides recommendations to the transition beyond 2020 with balanced multiple policy objectives across a wide spectrum of State water- and climate-planning documents, such as the AB 32 Scoping Plan, the Safeguarding California Plan for preparing for climate risks, the California Water Plan, the Delta Plan, the Bay Delta Conservation Plan, and the Integrated Regional Water Management Strategic Plan.

Department of Toxic Substances Control Strategic Plan 2011-2016 (Department of Toxic Substances Control)

The Department of Toxic Substances Control's (DTSC's) strategic plan is a living document. It is aligned with their operations and is designed to focus on safeguarding communities, protecting the health of all residents, restoring land and water to safe levels, and maximizing effectiveness and efficiency to better serve Californians. Immediate threats are mitigated by protecting the public and/or implementing enforcement action. Long-term threats are mitigated by removing exposure or are avoided by substituting safer consumer products. Threats may be in the air, soil, or water on tribal, federal, State or private lands. Mitigating these threats requires DTSC to work across organizational boundaries with local, State, federal and national organizations. DTSC also administers the federal Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Superfund programs for the EPA, and manages orphan funds designated for use to clean up abandoned and/or neglected properties that can be usefully re-developed.

Environmental Goals and Policy Report (Governor's Office of Planning and Research)

The discussion draft of the 2013 Environmental Goals and Policy Report (EGPR) provides an overview of the State's environmental goals, keys steps to achieving these goals, and a framework of metrics and indicators to help inform decision-making at all levels to help the State to reach these goals.

Delta Plan (Delta Stewardship Council)

The 2009 Delta Reform Act created the Delta Stewardship Council and required that it develop a legally enforceable, long-term management plan for the Delta to achieve the coequal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the

Delta ecosystem. These coequal goals must be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place. The Delta Plan focuses on a number of key strategies to achieve these coequal goals. State and local agencies undertaking covered actions are required to make such covered actions be consistent with the Delta Plan.

General Plan Guidelines (Governor's Office of Planning and Research)

Governor's Office of Planning and Research (OPR) has begun its update of the *2003 General Plan Guidelines*. This document provides assistance to local governments for developing their long-range general plans. The update will include pertinent new statutory and legal requirements along with advice for planners, elected officials, and the general public on how a general plan can be used to achieve a sustainable, livable community.

Recycled Water Policy (State Water Resources Control Board)

The Recycled Water Policy was adopted by SWRCB in 2009 and is intended to increase the use of recycled water from municipal wastewater sources in support of the SWRCB's Strategic Plan priority to promote sustainable local water supplies. Increasing the acceptance and promoting the use of recycled water is a means towards achieving sustainable local water supplies and can result in reduction in greenhouse gases, a significant driver of climate change. The policy is also intended to encourage beneficial use of recycled water.

Regional Water Quality Control Plans (Ten Basin Plans — State Water Resources Control Board)

The water quality control plans, or basin plans, for the 10 hydrologic regions are the State's water quality control planning documents. They designate the beneficial uses and water quality objectives for all surface water and groundwater. They also include implementation programs to achieve water quality objectives. Basin plans are developed and adopted by the regional water quality control boards and then approved by the SWRCB, the EPA, and the Office of Administrative Law, where required.

Safeguarding California Plan (Natural Resources Agency)

The Safeguarding California Plan will be an update to the 2009 California Climate Adaptation Strategy. This plan will build upon efforts to reduce and prepare for climate risks by providing a multi-sector framework to reduce climate risk. It is designed to work in conjunction with more in-depth, sector-specific climate planning and risk reduction activities and also fits into a broader suite of coordinated State actions on climate change. This plan is designed to provide policy guidance for State decision-makers, highlighting climate risks in nine sectors in California: 1) Agriculture, 2) Biodiversity and Habitat, 3) Emergency Management, 4) Energy, 5) Forestry, 6) Ocean and Coastal Ecosystems and Resources, 7) Public Health, 8) Transportation, and 9) Water. Progress to date, as well as sector-specific and cross-sector recommendations, are all discussed in the plan. The draft plan was released in December 2013.

San Francisco Bay/Sacramento — San Joaquin Delta Estuary Water Quality Control Plan (State Water Resources Control Board)

In December 2007 and January 2008, resolutions adopted by the SWRCB directed staff to develop a strategic work plan that describes the coordinated activities of the SWRCB to address Bay-Delta issues, prioritizes the scope of individual activities, and specifies timelines and resource needs. It describes high-priority Bay-Delta activities that the SWRCB will continue through 2013.

The SWRCB recognizes that it has neither the capacity nor the responsibility to conduct all the planning and implementation activities needed to protect and restore fisheries, aquatic habitats, and other beneficial uses in the Bay-Delta. Accordingly, the work plan identifies activities that will need to be coordinated with other efforts. Overall, the work plan identifies a range of actions that constitute a reasonable sharing of responsibility to protect the Bay-Delta and the public trust, while still protecting diverse public interests.

Sierra Nevada Conservancy Strategic Plan (Sierra Nevada Conservancy)

The Sierra Nevada Conservancy Strategic Plan 2013 sets priorities for the conservancy within the context of its broad mission and statutorily established program areas, and focuses efforts on measurable and attainable actions over the next three years. This plan, to be implemented in ongoing collaboration with multiple partners, will be carried out through specific actions identified in a series of annual work plans, beginning with the Sierra Nevada Conservancy's 2013-14 Action Plan that establish realistic actions by fiscal year in support of the established priorities.

Sierra Nevada Conservancy 2013-14 Action Plan (Sierra Nevada Conservancy)

The Action Plan contains the major initiatives and activities to be undertaken by the Sierra Nevada Conservancy between July 2013 and June 2014, consistent with the Sierra Nevada Conservancy Strategic Plan.

Small Water System Program Plan (California Department of Public Health)

California Department of Public Health (CDPH) has developed a Small Water System Goal that brings small community water systems into sustainable compliance with primary drinking water standards. CDPH has developed an implementation plan that defines specific tasks to achieve the goal as well as measureable results of progress. CDPH will focus on third-party provider services and internal efforts toward these systems in order to bring them into compliance. The intent is to direct attention and resources toward these systems to help them find a solution and develop their technical, managerial, and financial capacity that will ensure sustainability into the future.

State Coastal Conservancy Strategic Plan 2013-2018 (California Coastal Conservancy)

The California Coastal Conservancy's 2013-2018 Strategic Plan identifies key issues for the California coast over the next five years including the steps needed to respond to climate change. The plan includes an overview of agency priorities in the context of California's coastal management program, a delineation of coastal issues by region, and a summary of the agency's financial status and needs. The plan describes the conservancy's overall vision and identifies specific metrics to measure the effectiveness of the Coastal Conservancy's work. In addition, it includes a summary of the Coastal Conservancy's past accomplishments.

State of California Emergency Plan (California Emergency Management Agency)

The State of California Emergency Plan outlines a State-level strategy in support of local government efforts to protect the public during a large-scale emergency. In accordance with the California Emergency Services Act, the State Emergency Plan describes:

1. Methods for carrying out emergency operations.
2. The process for rendering mutual aid.
3. Emergency services of governmental agencies.
4. How resources are mobilized.
5. Public information.
6. Continuity of government.

The plan is intended to establish statewide emergency management policy and provide guidance and standardization for use by all stakeholders.

State Multi-Hazard Mitigation Plan (California Emergency Management Agency)

Cal EMA led the effort to complete the 2013 Enhanced State of California Multi-Hazard Mitigation Plan (SHMP), which includes a flood component. The SHMP is the official statement of the State's hazard identification, vulnerability analysis, and hazard mitigation strategy. The SHMP is the result of a collaborative multi-agency planning process that included DWR.

Strategic Plan for the Future of Integrated Regional Water Management (DWR)

The purpose of this new plan is to advance IRWM, further enable, empower, and support regional water management groups, and better align State and federal programs to support IRWM. There has been ten years of progress implementing IRWM. Developing this plan further will involve significant engagement of stakeholders to review the progress made and plan for the future, especially considering possible future funding challenges.

The Climate Action Plan of the Sierra Nevada: A Regional Approach to Address Climate Change (Sierra Nevada Conservancy)

This is a regional climate plan developed by the Sierra Nevada Conservancy with direction from the Sierra Nevada Conservancy Governing Board, the secretary of the California Natural Resources Agency, and the governor. It provides a Sierra Nevada perspective and further defines region-specific needs and roles in assessing, mitigating, and adapting to the current and anticipated effects of climate change on the region's ecosystems, habitats, species, and natural and human-made resources and communities. The plan synthesizes information and provides strategies and actions for integrating, supporting, and enhancing existing programs and projects in key areas including water, forest/fire, habitat/biodiversity, biomass, and energy efficiency. The conservancy's Climate Action Plan will integrate and coordinate efforts to create economies of scale, share resources and expertise, and maximize the benefits for the region.

Threat and Hazard Identification and Risk Assessment (California Emergency Management Agency)

The Threat and Hazard Identification and Risk Assessment is an annual report that began in 2012. It is a process for identifying community-specific threats and hazards and setting capability targets for each core capability identified in the National Preparedness Goal as required in Presidential Policy Directive 8. One of the core capabilities is response and recovery of key infrastructure systems during an emergency which include water and wastewater systems.

Water Action Plan (Public Utilities Commission)

The Water Action Plan sets forth the California Public Utilities Commission's (CPUC) policy objectives for the regulation of investor-owned water utilities and highlights the actions the CPUC will take to implement these objectives. The Water Action Plan has four key principles:

1. Safe, high quality water.
2. Highly reliable water supplies.
3. Efficient use of water.
4. Reasonable rates and viable utilities.

Water Boards Strategic Plan 2008-2012 (State Water Resources Control Board)

In 2008, the SWRCB and the nine regional water quality control boards released an update of their strategic plan. Reflecting the many changes to the environmental regulatory landscape that occurred since publication of the Water Boards 2001 Strategic Plan, the new plan highlights key actions to reduce fragmentation and leverage resource. The plan institutionalizes processes to evaluate consistency and effectiveness continuously of program implementation across the State and regional water quality control boards. Most of the actions of the plan to manage and protect the State's water resources will be implemented within watersheds to eliminate fragmented management approaches. Considering trends and challenges, the Water Boards Strategic Plan Update is designed to support functioning, sustainable watersheds where progress can be measured through environmental goals of healthy surface water and groundwater, and increasing reliance on sustainable water supplies.

CWP Objectives and Related Actions

The objectives and related actions presented in Chapter 8, "Roadmap For Action," are taken, in part, from the featured State agency plans and the various topic

El Dorado Hills Branch LIbrary uses recycled water in their water features and to irrigate the surrounding landscaping.
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caucuses. Many objectives and related actions derived from featured State agency plans were developed to meet various resource management and communication goals.

Table 4-4 (below) shows the featured plans that have content related to the CWP objectives and related actions found in Chapter 8, “Roadmap For Action.”

Resource Management Strategies

The featured State plans have multiple connections with the Update 2013 Volume 3, *Resource Management Strategies*. Table 4-5 (below) shows how each featured plan relates to the resource management strategy categories. Several featured plans have crosscutting recommendations, such as the need to both improve water quality and practice resource stewardship.

Implications and Considerations

The new complexities of managing water resources require rigorous, collaborative, and multidisciplinary approaches. The formation of the Tribal Advisory Committee, outreach to federal agencies through joint planning efforts, collaboration with the California Biodiversity Council, and continued expansion of the State Agency Steering Committee furthers better alignment of California’s water management. The continued inclusion of featured plans has already paid dividends, as many State agencies are now cross-referencing and engaging the CWP process in creating these plans. Federal agencies are also participating in joint outreach and planning efforts on items of mutual concern. The statewide, broad adoption of IRWM planning has improved collaboration and achieved new insights on ways regions can work together to achieve their goals. Much work remains, but the efforts of the Update 2013 process offers new ways of working together to enhance many existing processes.

Table 4-4 Matrix of Featured Plans and Related Objectives

Title	Agency	Water Plan Objectives
2010 Strategic Fire Plan for California	CAL FIRE	8
2012 Central Valley Flood Protection Plan	DWR	6, 8, 13, 14, 15
2013 Integrated Energy Policy Report	CEC	2, 9
Alluvial Fan Task Force, Findings and Recommendations Report	AFTF	1, 6, 10, 14, 15, 16
Bay Delta Conservation Plan — Public Draft	BDCP-SC	7
California Agriculture Vision: Strategies for Sustainability	CDFA	2, 5, 9, 15, 16
California Drought Contingency Plan	DWR	2, 8, 10
California Native American Tribal Engagement in the California Water Plan Update 2013 - Tribal Engagement Plan[a]	TAC	12
California Ocean Protection Council Five-Year Strategic Plan 2012-2017	OPC	5, 10, 15, 16
California Outdoor Recreation Plan 2008	State Parks	14
California Forests and Rangelands: 2010 Assessment and 2010 Strategy Report	Cal Fire	5, 11, 16
California Strategic Growth Council Strategic Plan 2012-2014	SGC	10, 14, 15, 16
California's Flood Future: Recommendations for Managing the State's Flood Risk	DWR	6, 8, 14, 15, 16
California's Water Commission Strategic Plan 2012	CWC	7, 12, 16
California Transportation Plan 2025 and 2030	Caltrans	1, 4
California Wildlife Action Plan	CDFW	5, 15
Climate Change Scoping Plan: A Framework for Change	CARB	9
Delta Plan	DSC	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 14, 16
Department of Toxic Substances Control Strategic Plan 2011-2016	DTSC	16
Environmental Goals and Policy Report	OPR	5
General Plan Guidelines	OPR	15
Recycled Water Policy	SWRCB	2, 4, 14
Regional Water Quality Control Plans (10 Basin Plans)	SWRCB	4
Safeguarding California Plan	CNRA	9, 15
San Francisco Bay/Sacramento – San Joaquin Delta Estuary Water Quality Control Plan	SWRCB	7
Sierra Nevada Conservancy Strategic Plan	SNC	5, 14

Title	Agency	Water Plan Objectives
Sierra Nevada Conservancy 2013-14 Action Plan	SNC	5
Small Water System Program Plan	CDPH	13
State Coastal Conservancy Strategic Plan 2013-2018	CCC	5, 14, 16
State of California Emergency Plan	Cal EMA	8, 16
State Multi-Hazard Mitigation Plan	Cal EMA	8, 15
Strategic Plan for the Future of Integrated Regional Water Management	DWR	1
The Climate Action Plan of the Sierra Nevada: A Regional Approach to Address Climate Change	SNC	3, 15
Threat and Hazard Identification and Risk Assessment	Cal EMA	8
Water Action Plan	CPUC	2, 4, 13, 14, 16
Water Boards Strategic Plan 2008-2012	SWRCB	4

Notes:

CAL FIRE = California Department of Forestry and Fire Protection, DWR = California Department of Water Resources, CEC = California Energy Commission, AFTF = Alluvial Fan Task Force, BDCP-SC = Bay Delta Conservation Plan - Delta Stewardship Council, CDFA = California Department of Food and Agriculture,TAC = Tribal Advisory Committee, OPC = California Ocean Protection Council, State Parks = California Department of Parks and Recreation, SGC = California Strategic Growth Council, CWC = California's Water Commission, Caltrans = California Department of Transportation, CARB = California Air Resources Board, DTSC = Department of Toxic Substances Control, OPR = Governor's Office of Planning and Research, DSC = Delta Stewardship Council, SWRCB = State Water Resource Control Board, CNRA = California Natural Resources Agency, SNC = Sierra Nevada Conservancy, DPH = California Department of Public Health, CCC = California Coastal Conservancy, Cal EMA = California Emergency Management Agency, CPUC = California Public Utilities Commission

[a] This is a stakeholder generated plan rather than a State agency plan.

Table 4-5 Matrix of Featured Plans and Resource Management Strategy Categories

Title	Agency	Reduce Water Demand	Improve Operational Efficiency and Transfers	Increase Water Supply	Improve Water Quality	Practice Resource Stewardship	Improve Flood Mgmt.	People and Water
2010 Strategic Fire Plan for California	CAL FIRE					X		
2012 Central Valley Flood Protection Plan	DWR					X	X	
2013 Integrated Energy Policy Report	CEC	X	X					
Alluvial Fan Task Force, Findings and Recommendations Report	AFTF					X	X	X
Bay Delta Conservation Plan — Public Draft	BDCP-SC		X		X	X		
California Agriculture Vision: Strategies for Sustainability	CDFA	X	X	X	X	X		X
California Drought Contingency Plan	DWR	X	X					
California Native American Tribal Engagement in the CWP Update 2013 – Tribal Engagement Plan	TAC							X
California Ocean Protection Council Five-Year Strategic Plan 2012-2017	OPC	X	X	X	X	X	X	X
California Outdoor Recreation Plan 2008	State Parks					X		X
California Forests and Rangelands: 2010 Assessment and 2010 Strategy Report	CAL FIRE				X	X		X
California Strategic Growth Council Strategic Plan 2012-2014	SGC					X		X

Title	Agency	Reduce Water Demand	Improve Operational Efficiency and Transfers	Increase Water Supply	Improve Water Quality	Practice Resource Stewardship	Improve Flood Mgmt.	People and Water
California's Flood Future: Recommendations for Managing the State's Flood Risk	DWR				X	X	X	X
California's Water Commission Strategic Plan 2012	CWC		X					X
California Transportation Plan 2025 and 2030	Caltrans				X	X		
California Wildlife Action Plan	CDFW				X	X		X
Climate Change Scoping Plan: A Framework for Change	CARB					X		
Department of Toxic Substances Control Strategic Plan 2011-2016	DTSC				X			
Environmental Goals and Policy Report	OPR	X			X	X		
Delta Plan	DSC	X	X	X	X	X	X	X
General Plan Guidelines	OPR				X	X	X	
Recycled Water Policy	SWRCB	X		X	X			
Regional Water Quality Control Plans (10 Basin Plans)	SWRCB				X	X	X	
Safeguarding California Plan	CNRA				X	X		X
San Francisco Bay/Sacramento — San Joaquin Delta Estuary Water Quality Control	SWRCB		X	X	X	X		
Sierra Nevada Conservancy Strategic Plan	SNC					X		X

Title	Agency	Reduce Water Demand	Improve Operational Efficiency and Transfers	Increase Water Supply	Improve Water Quality	Practice Resource Stewardship	Improve Flood Mgmt.	People and Water
Sierra Nevada Conservancy 2013-14 Action Plan	SNC					X		X
Small Water System Program Plan	DPH				X			
State Coastal Conservancy Strategic Plan 2013-2018	CCC				X	X	X	X
State of California Emergency Plan	Cal EMA						X	
State Multi-Hazard Mitigation Plan	Cal EMA				X	X	X	X
Strategic Plan for the Future of Integrated Regional Water Management	DWR	X	X	X	X	X	X	X
The Climate Action Plan of the Sierra Nevada: A regional Approach to Address Climate Change	SNC			X	X	X		X
Threat and Hazard Identification and Risk Assessment	Cal EMA						X	
Water Action Plan	CPUC	X		X	X			X
Water Boards Strategic Plan 2008-2012	SWRCB	X		X	X	X	X	

Notes:

CAL FIRE = California Department of Forestry and Fire Protection, DWR = California Department of Water Resources, CEC = California Energy Commission, AFTF = Alluvial Fan Task Force, BDCP-SC = Bay Delta Conservation Plan Delta Stewardship Council, CDFA = California Department of Food and Agriculture, TAC = Tribal Advisory Committee, OPC = California Ocean Protection Council, State Parks = California Department of Parks and Recreation, SGC = California Strategic Growth Council, CWC = California's Water Commission, Caltrans = California Department of Transportation, CARB = California Air Resources Board, DTSC = Department of Toxic Substances Control, OPR = Governor's Office of Planning and Research, DSC = Delta Stewardship Council, SWRCB = State Water Resource Control Board, CNRA = California Natural Resources Agency, SNC = Sierra Nevada Conservancy, DPH = California Department of Public Health, CCC = California Coastal Conservancy, Cal EMA = California Emergency Management Agency, CPUC = California Public Utilities Commission

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VOLUME 1 - THE STRATEGIC PLAN

CHAPTER 5

Managing an Uncertain Future

Sea level stake at Crissy Field, San Francisco. Over the last 100 years, sea level has risen by 8 inches at Crissy Field and continues to rise. Climate change is expected to raise the sea level, reduce snowpack, and bring fiercer droughts and floods. DWR is modeling potential future climates, potential future populations, and land use patterns to prepare for risks and plan for water needs out to a year 2050 horizon.

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Chapter 5. Managing an Uncertain Future

About This Chapter

Chapter 5, "Managing an Uncertain Future," emphasizes the need for decision-makers, water and resource managers, and land use planners to use a range of considerations in planning for California's water future in the face of many uncertainties and risks. It provides examples of uncertainties and discusses the need to assess risks in planning for actions with more sustainable outcomes. An approach is presented for evaluating resource management strategies for robustness by using multiple future scenarios. Water management vulnerabilities identified during preparation of *California Water Plan Update 2013* (Update 2013) are presented. A framework is provided to measure the sustainability of water management policies and projects. This chapter describes the following topics:

- Recognizing and Planning for Risk and Uncertainty.
- Water Scenarios 2050: Possible Futures.
- Managing for Sustainability.
- Summary.

Recognizing and Planning for Risk and Uncertainty

Overview

On January 27, 2014, the California Natural Resources Agency, the California Environmental Protection Agency, and the California Department of Food and Agriculture released a detailed California Water Action Plan to help guide state efforts and resources with regard to improving the reliability of water supply, providing the ecosystem restoration needed to bring the water system back into balance, and strengthening the resilience of the state's infrastructure. The Water Action Plan recognizes that the challenges facing California are many: uncertain water supplies, water scarcity and drought, declining groundwater basins, poor water quality, declining native fish species and loss of wildlife habitat, flood risks, and supply disruptions. Similarly, the California Water Plan (CWP) acknowledges that planning for the future is uncertain and that change will continue to occur (see Box 5-1). Update 2013 builds on three key considerations in the planning approach for future management of regional and statewide water resources. The planning approach should (1) recognize and reduce uncertainties inherent in the system, (2) define and assess the risks that can hamper successful system management and select management practices that reduce the risks to acceptable levels, and (3) keep an eye toward approaches that help implement and maintain water and flood management systems that have more sustainable outcomes.

Box 5-1 Uncertainty, Risk, and Sustainability

Uncertainty. Uncertainty is what we do not know about the system. For example, engineers do not know the foundation conditions under all California levees. Uncertainty can be decreased by reducing data gaps to increase knowledge.

Risk. Most risks originate from such hazards as floods, earthquakes, and droughts that would occur even if all uncertainty could be eliminated. Reducing uncertainty provides a clearer view of what the risks to the system are.

Risk is the probability of the occurrence (multiplied by) consequences of the occurrence over a range of potential events.

Sustainability. A sustainable system or process has longevity and resilience. A sustainable system manages risk but cannot eliminate it. A sustainable system generally provides for the economy, the ecosystem, and social equity. Water sustainability is the dynamic state of water use and supply that meets today's needs without compromising the long-term capacity of the natural and human aspects of the water system to meet the needs of future generations. For example, planning ways to eventually eliminate drafting more groundwater than can be recharged over the long term is one approach for improving sustainability.

Traditional Planning Approach — The Past Is a Model for the Future

Water managers recognize the variable nature of water flow in California's streams and rivers during wet and dry periods spanning from seasons to multiple years. Having too little water or too much water — droughts or floods — were often primary reasons that Californians built early water projects. Early in California's water development history, personal observations and experience were often used to help size water facilities because of the limited availability of recorded data.

A system to record water flow conditions over time gradually improved information available to water managers. However, the main assumption governing water planning and management for much of California's history has been that past records were a good indication of the frequency, duration, and severity of future floods and droughts, and these records were used as predictors of potential future conditions. In addition, historical records were generally used to establish trends, such as population growth, which were assumed to continue into the future.

This static view of the range of possible future conditions based on past records worked fairly well when the demands on the resources were considerably lower than now. Early designers of water facilities may have understood the variability of storm events and the range of streamflows that could occur, as well as the likelihood that a reservoir would refill in a given year, but generally they did not fully understand or consider the interrelationships among ecosystem functions, flood management, water availability, water use, and water quality.

The past approach to flood planning focused on flood damage reduction and public safety. Projects were designed to control and capture flood flows by using such facilities as dams, levee systems, bypasses, and channel enlargements. Although these projects provided significant flood protection benefits, some of these early structural projects caused unintended or redirected consequences of higher peak flows, conflicts with environmental resources, and increased flood risks. These experiences have prompted flood planners to look more comprehensively at flood systems to gain a better understanding of floodplains, related water supply, and environmental systems to provide multiple benefits.

In addition, risks posed by earthquakes, extreme floods, and extreme droughts were generally underestimated. Without a complete acknowledgment of the uncertainties inherent in the system and the risks that the system actually faced, management was relatively simple compared with today's standards. Conditions appeared more certain and less risky than they actually were, and water managers were more focused on meeting shorter term objectives. Although understanding the past is still an important part of managing for the future, it is becoming increasingly apparent that continued management under this traditional approach will not provide for sustainable water resources into the future.

New Planning Approach — Anticipate Change

Today, as part of integrated water management (IWM), California's water and resource managers must recognize that conditions are changing and will continue to change. Traditional approaches for predicting the future based solely on projecting past trends will no longer work. Today, there is better recognition that strategies for future water management must be dynamic, adaptive, and durable. In addition, the strategies must be comprehensive and integrate physical, biological, and social sciences, as well as consider risk and uncertainty.

California's water management system is large and complex, with decentralized water governance that requires a great deal of cooperation and collaboration among decision-makers at the State, federal, tribal, regional, and local level. California lacks a common analytical framework and approach to understand and manage the system, especially when management actions may compete for the same resources. Given today's uncertainties and those that may occur in the future, water managers must make sound investments that balance risk with reward. Update 2013 works to strengthen alignment between water managers while considering investment in innovation and infrastructure with multiple benefits.

As described in more detail in Chapter 6, "Integrated Data and Analysis: Informed and Transparent Decision Making," the CWP promotes ways to develop a common approach for data standards and understanding, evaluating, and improving regional and statewide water-management systems, and for common ways to evaluate and select from alternative management strategies and projects. To these ends, the California Department of Water Resources (DWR) has initiated work on the Water Planning Information Exchange (Water PIE). This system for accessing and sharing data across existing networked databases will use Web services and geographic information system (GIS) software to improve analytical capabilities, develop timely surveys of statewide land use and water use, and estimate future implementation of resource management strategies. Ultimately, Water PIE will build on, complement, and connect several existing data-sharing sites managed by DWR, including the Water Data Library, California Data Exchange Center, and the California Irrigation Management Information System.

Update 2013 acknowledges that planning for the future is uncertain and that change will continue to occur. It is not possible to know for certain how population growth, land use decisions, water demand patterns, environmental conditions, climate, and many other factors that affect water use, supply, and flood management may change by 2050. To anticipate change, water management and planning for the future need to consider and quantify uncertainty, risk, and sustainability.

- **Uncertainty.** How water demands will change in the future, how ecosystem health will respond to human use of water resources, what disasters may disrupt the water system, and how climate change may affect water availability, water use, water quality, flooding, and the ecosystem are just a few uncertainties that must be considered. The goal is to anticipate and reduce future uncertainties, and to develop water management strategies that will perform well despite uncertainty about the future.

  Uncertainties will never be eliminated, but better data and improved analytical tools will allow water and resource managers to better understand risks within the system. Many water agencies in California have begun incorporating climate change information into their operation and planning processes to reduce uncertainty of how climate may affect California's water resources in the future. Additional efforts are needed to develop the accurate climate data needed to reduce uncertainty and risk in California water management in the future. To read more about the development of DWR's Climate Science program, see in Volume 4, *Reference Guide*, the article "The State of Climate Change Science for Water Resources Operation, Planning, and Management," and visit http://www.water.ca.gov/climatechange.

- **Risk.** Uncertainties about future conditions contribute to water-related risks. Each future event has a certain, but unknown, chance of occurring and a set of consequences should it occur. Combining the likelihoods with consequences yields estimates of risk. For example, a chance of a levee failure with a certain-size flood event can be estimated with associated economic and human consequences. Likewise, one can estimate the likelihood of a drought of a specific severity and combine this with estimates of the consequences.

  By reducing the uncertainties described above, the "true" risks can be reduced. Many water managers are performing risk assessments that can be used in future planning to balance risk with reward when implementing new management actions. Risk assessments are also a way to quantitatively consider the uncertainties that relate to events of interest, such as the performance of levees, the consequences of flooding, and the impact of events on the environment.

- **Sustainability.** Given the uncertainties and risks in the water system, one set of resource management strategies may provide for more sustainable water supply, flood management, and ecosystems than another set of resource management strategies. IWM must be dynamic, adaptive, and durable. As described later in this chapter, DWR has developed a draft framework for quantifying indicators of water sustainability and has begun testing the indicators in regional pilot studies.

Recognizing and Reducing Uncertainty

It is important to consider two broad types of uncertainty while striving to improve data collection and analytical tools.

1. The first type of uncertainty comes from the inherent randomness of events in nature, such as the occurrence of an earthquake or a flood. However, additional data may allow better quantification of this uncertainty.

2. The second type of uncertainty can be attributed to lack of knowledge or scientific understanding. In principle, this uncertainty can be reduced with improved knowledge that comes from collection of additional information.

California's water and resource managers must deal with a broad range of uncertainty. Uncertainty is inherent in the existing system and in all changes that may occur in the future. For example, although water managers can be certain that the flows in California's rivers will be different next year compared with this year, they do not know the exact magnitude or timing of those changes. The threat of a chemical spill that may disrupt water diversion presents uncertainty. Future protections for endangered species may require modifications in water operation procedures that are unknown today. Scientists are trying to understand the reasons for the pelagic fish decline in the Sacramento-San Joaquin Delta (Delta), the condition of levees throughout the state, and the extent of groundwater recharge and overdraft, to name just a few of the uncertainties that need to be addressed in planning for the future.

For the purposes of considering potential changes and their inherent uncertainties, it is useful to consider and estimate how change may occur. Gradual changes can include such factors as variation in population by region, shifts in the types and amount of crops grown in an area, or changes in precipitation patterns or sea level rise. Sudden changes can include episodic events, such as earthquakes, floods, droughts, equipment failures, chemical spills, or intentional acts of destruction. The nature of these changes, the uncertainties about their occurrence, and their potential impacts on water management systems can greatly influence the response to the changes. Box 5-2 shows some sources of future change and uncertainty.

With improved understanding of uncertainties, risks facing future operation of the system can be better assessed. Most risks originate from such hazards as floods, earthquakes, and droughts. But risks can also result from other issues, such as water demands growing faster than anticipated, salt water intrusion, or land subsidence caused by groundwater overdraft. *Risk* can be defined as the probability that a range of undesirable events will occur, which is usually linked with a description of the corresponding consequences of those events. Box 5-3 describes how risk management is an integral part of flood management. A range of tools is available for assessing and accounting for risk (see in Volume 4, *Reference Guide*, the article "Accounting for Risk").

There is no way of predicting the future with absolute certainty, but scenarios of possible future conditions can be constructed. Update 2013 considers many alternative, plausible, yet very different future scenarios as a way of considering uncertainty and risk and improving resource sustainability. For example, three alternative population growth rates and three alternative assumptions about future land-use development density are considered, thus yielding nine alternative growth scenarios. Many alternative scenarios of future climate are considered in order to represent extended droughts and climate change. The concept is not to plan for any one given future, but to identify strategies that are robust across many scenarios. Certain combinations of management strategies may prove to be robust regardless of future conditions. This is especially true if the strategies have a degree of adaptability to differing conditions that may develop. A general description of the scenarios can be found in the next section.

Water Scenarios 2050: Possible Futures

Since *California Water Plan Update 2005* (Update 2005), the CWP has used the concept of multiple future scenarios to capture a broad range of uncertain factors that affect water management, but over which water managers have little control. Scenarios are used to test the robustness of strategies by evaluating how well strategies perform across a wide range of possible future conditions. The CWP organizes scenarios around themes of population growth, land use patterns, and climate change. Growth scenarios characterize a range of uncertainty surrounding

Box 5-2 Sources of Future Change and Uncertainty

Sources of Gradual or Long-term Change and Uncertainty

Urban Land Use (population). Projecting future changes in population, development patterns, changes in runoff and infiltration with increased impervious area, and changes in water quality impacts becomes more uncertain with the time frame of the projection.

Agricultural Land Use. Agricultural water use is influenced by land conversions to urban or ecosystem uses, but also depends on cropping patterns driven by water availability and the world economy.

Other Land Use. Conversions of land to ecosystem or other uses can change water use, water quality, ecosystem health, and many other factors. Some ecosystem uses consume more water per acre than agricultural and urban uses.

Climate Change. The changing climate presents many uncertainties in the magnitude, pattern, and the rate of potential change:

- **Snowpack.** California's snowpack, a major part of annual water storage, is decreasing with increasing winter temperatures.
- **Hydrologic Pattern.** Warmer temperatures and decreasing snowpack cause more winter runoff and less spring/summer runoff.
- **Rainfall Intensity.** Regional precipitation changes remain difficult to determine, but larger precipitation events could be expected with warmer temperatures in some regions.
- **Sea Level Rise.** Sea level rise is increasing the threat of coastal flooding, salt water intrusion, and even disruption of water exports from the Sacramento-San Joaquin Delta (Delta) should levees fail on key islands and tracts.
- **Water Demand.** Plant evapotranspiration increases with increased temperature.
- **Aquatic Life.** Higher water temperatures are expected to have a negative effect on some species and may benefit species that compete with native species.
- **Greenhouse Gas Emissions — Carbon Intensity or Carbon Footprint.** Storage, transport, and treatment of water involves substantial amounts of energy, which in most cases result in the release of greenhouse gas emissions that contribute to climate change. Each water management strategy should be evaluated for its contribution to the accumulation of greenhouse gasses in our atmosphere.

Sources of Sudden or Short-term Change and Uncertainty

Delta Vulnerabilities. The Delta is highly susceptible to flooding and to disruption of significant water supply to many areas of the state.

Droughts. The severity, timing, and frequency of future droughts are uncertain.

Floods. The severity, timing, and frequency of future floods are uncertain.

Earthquakes. Though more is known about earthquakes, their location, timing, and magnitudes can have various effects on water systems.

Facility Malfunction. Deferred maintenance and aging infrastructure can cause unexpected outages in portions of the system.

Chemical Spills. Chemical spills are unpredictable, but can disrupt surface water and groundwater supplies.

Intentional Disruption. Vandalism, terrorist acts, and even cyber threats can have serious potential impacts on the operational capability of water delivery and treatment systems.

Fire. Wildfire in local watersheds can change runoff characteristics and affect water quality for decades.

Economic disruption. Sudden changes in the economy influence the ability to pay for improvements to the water management system.

Changing Policies/Regulations/Laws/Social Attitudes. Some changes in policies, regulations, laws, and social attitudes may be gradual, but some may be sudden:

- **Endangered species.** New endangered species listings can require significant changes to water system operations and water supply distribution for agricultural, urban, and environmental uses.
- **Plumbing Codes.** Future changes in plumbing codes, such as installing ultralow-flow toilets, could allow use of innovative water fixtures to conserve water.
- **Emerging Contaminants.** The nature and impact of contaminants may change in the future, especially with new health and ecological risk information.

Box 5-3 Managing Floods versus Managing Flood Risk

Managing floods means building and operating facilities, such as dams, weirs, levees, and pump stations, to safely store and convey flood flows within designated channels to reduce the chance of flooding. Although such improvements can greatly reduce flood risk, they cannot entirely eliminate it. Subsequently, floodplains are often developed because of the perception that the chance of flooding has been eliminated. As a result, the overall flood risk (paradoxically) can increase following construction of flood control facilities. Flood risk is the combined effect of the chance of flooding and the property that would be damaged if flooded. Managing flood risk means either reducing the chance of flooding or the population and property exposed to flooding, or a combination of both. Thus, managing flood risk can include flood control facilities, as well as limiting floodplain development; elevating structures above flood elevations; creating natural flood storage and groundwater recharge areas; and using flood risk notification, flood insurance, and flood preparedness.

Source: California Department of Water Resources 2012

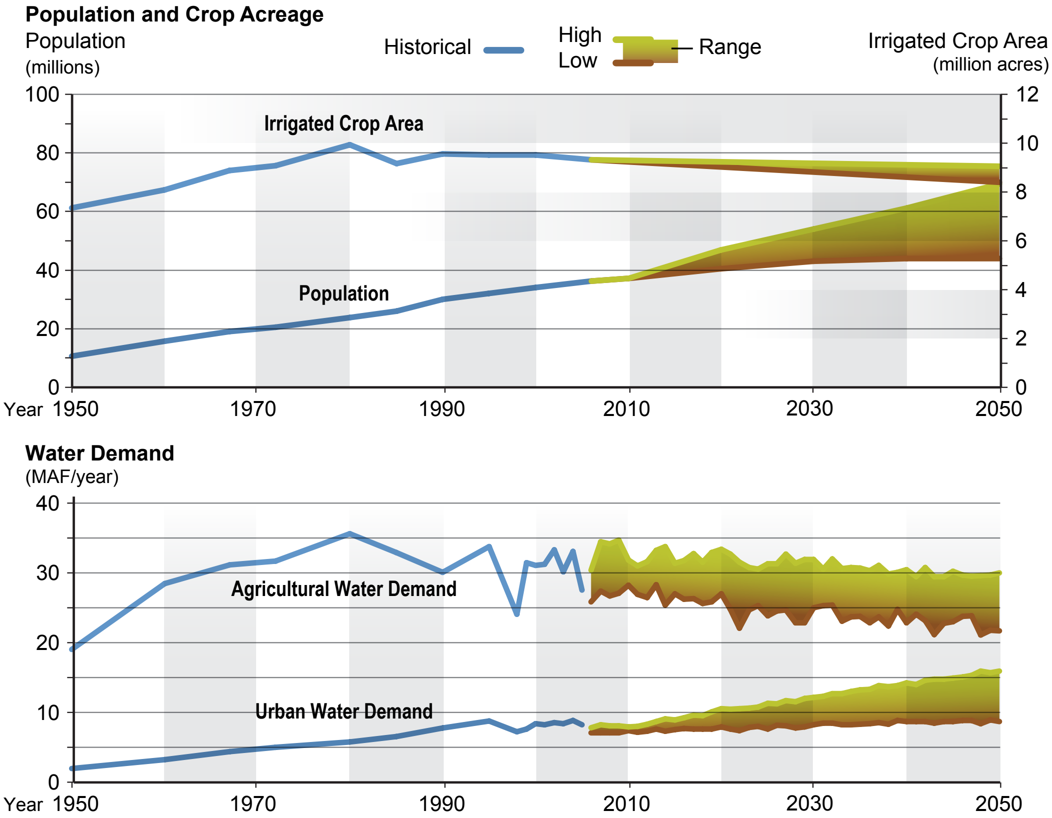
how cities and other land managers will accommodate future population growth through infill development or expansion into areas of existing open space and agriculture. Climate scenarios explore how future climate change might influence timing; distribution; and amount of precipitation, storm runoff, and water supply. Figure 5-1 shows how population growth, irrigated crop area, and water demand have changed historically and how the CWP scenarios suggest these factors may change in the future.

Growth Scenarios

Future water demand is affected by a number of growth and land use factors, such as population growth, planting decisions by farmers, and size and type of urban landscapes. The CWP quantifies several factors that together provide a description of future growth and how growth could affect water demand for the urban, agricultural, and environmental sectors. Growth factors are varied among the scenarios to describe some of the uncertainty faced by water managers. For example, it is impossible to predict future population growth accurately, so the CWP uses three different but plausible population-growth estimates when determining future urban water demands. In addition, the CWP considers up to three alternative views of future development density. Population growth and development density will reflect how large the urban landscape will have become by 2050 and are used by the CWP to quantify encroachment into agricultural lands by 2050. Table 5-1 identifies the growth scenarios relative to current trends by using information from the California Department of Finance and the Public Policy Institute of California.

For Update 2013, DWR worked with researchers at the University of California, Davis, to quantify how California might grow through 2050. The UPlan model was used to estimate a year 2050 urban footprint under the scenarios of alternative population growth and development density listed in Table 5-1 (see http://ice.ucdavis.edu/project/uplan for information on the UPlan model). UPlan is a simple, rule-based urban growth model intended for regional or county-level modeling. The needed space for each land use type is calculated from simple demographics and is assigned based on the net attractiveness of locations to that land use (based on user input), locations unsuitable for any development, and a general plan that determines where specific types of development are permitted. Table 5-2 describes the amount of land devoted to urban use for 2006 and 2050, and the change in the urban footprint for California under each scenario. Table 5-3 describes how future urban growth could affect the land devoted to agriculture in 2050.

Figure 5-1 Scenario Drivers and Water Demand



Irrigated land area is the total agricultural footprint. Irrigated crop area is the cumulative area of agriculture, including multi-crop area, where more than one crop is planted and harvested each year. Each of the growth scenarios shows a decline in irrigated acreage over existing conditions, but to varying degrees.

Climate Scenarios

A significant improvement to the CWP scenarios in Update 2013 is a quantitative look at the uncertainty surrounding future climate change when evaluating the performance of new resource management strategies. After consultation with its Climate Change Technical Advisory Group, DWR chose to include 22 alternative climate scenarios in the evaluation of future strategies. These include 12 climate scenarios identified by the Governor's Climate Action Team (CAT) for future climate change, five scenarios repeating historical climate with a severe 3-year drought, and five scenarios repeating historical climate with a warming temperature trend. Each of the climate scenarios has separate estimates of future precipitation and temperature. Collectively these estimates provide planners with a range of precipitation and temperature that might be experienced in the future, and they are used with other factors to estimate future water demands. Refer to Volume 4, *Reference Guide,* the article "Overview of Climate-Change Scenarios Being Analyzed," for additional information on the CAT climate scenarios.

Table 5-1 Conceptual Growth Scenarios

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

Table 5-2 Growth Scenarios (Urban) — Statewide Values

Scenario	2050 Population (millions)	Population Change (millions) 2006[a] to 2050	Development Density	2050 Urban Footprint (million acres)	Urban Footprint Increase (million acres) 2006[b] to 2050
LOP-HID	43.9[c]	7.8	High	5.6	0.3
LOP-CTD	43.9	7.8	Current Trends	6.2	1.0
LOP-LOD	43.9	7.8	Low	6.5	1.2
CTP-HID	51.0[d]	14.9	High	6.3	1.1
CTP-CTD	51.0	14.9	Current Trends	6.7	1.5
CTP-LOD	51.0	14.9	Low	7.1	1.9
HIP-HID	69.4[e]	33.3	High	6.8	1.6
HIP-CTD	69.4	33.3	Current Trends	7.6	2.4
HIP-LOD	69.4	33.3	Low	8.3	3.1

Notes:

[a] 2006 population was 36.1 million.

[b] 2006 urban footprint was 5.2 million acres.

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

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

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

Table 5-3 Growth Scenarios (Agriculture) — Statewide Values

Scenario	2050 Irrigated Land Area[a] (million acres)	2050 Irrigated Crop Area[b] (million acres)	2050 Multiple Crop Area[c] (million acres)	Reduction in Irrigated Crop Area (million acres) 2006 to 2050
LOP-HID	8.6	9.2	0.65	0.1
LOP-CTD	8.4	9.0	0.63	0.3
LOP-LOD	8.3	8.9	0.63	0.4
CTP-HID	8.4	9.0	0.63	0.3
CTP-CTD	8.2	8.9	0.62	0.4
CTP-LOD	8.1	8.7	0.61	0.6
HIP-HID	8.2	8.9	0.62	0.4
HIP-CTD	8.0	8.6	0.60	0.7
HIP-LOD	7.8	8.4	0.58	0.9

Notes:

[a] 2006 Irrigated land area was estimated by the California Department of Water Resources (DWR) to be 8.7 million acres.

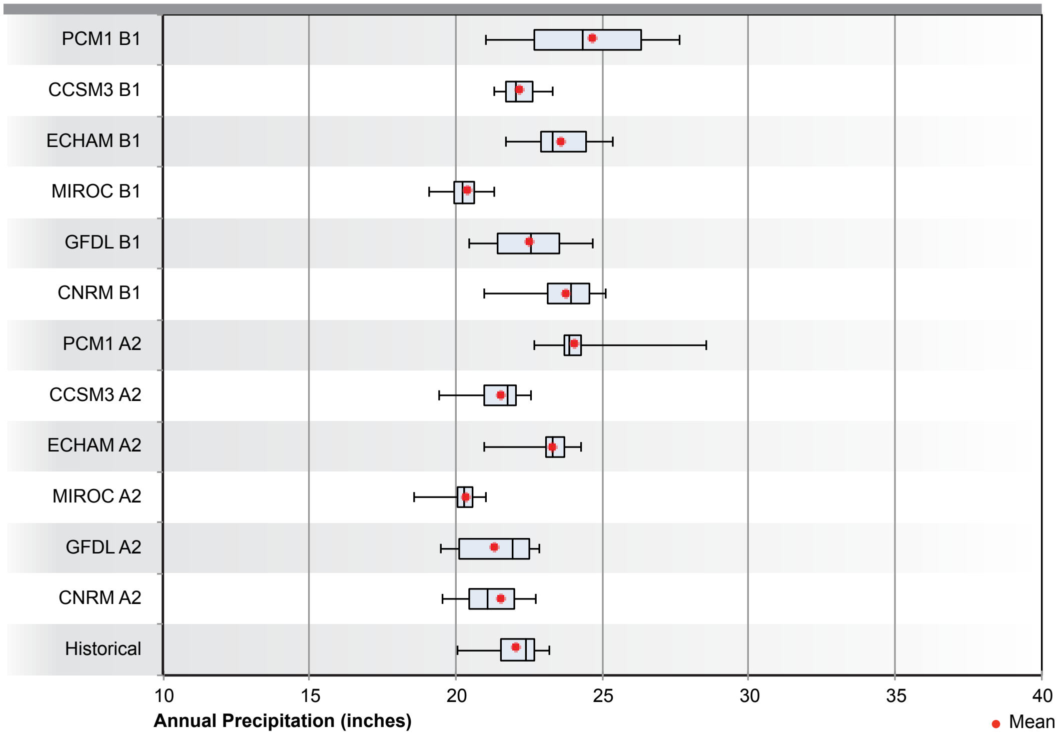
[b] 2006 Irrigated crop area was estimated by DWR to be 9.3 million acres.

[c] 2006 multiple crop area was estimated by DWR to be 0.65 million acres.

Figures 5-2, 5-3, 5-4, and 5-5 show the variation in 30-year running average annual precipitation for locations in the Central Valley and Sierra Nevada foothill regions for the 1915-2003 historical period, as well as 2011-2099 for the 12 CAT scenarios of future climate. The variation in the 30-year running average precipitation is represented as a box plot (also known as a box-and-whisker diagram or plot), which is a convenient way of graphically summarizing groups of numerical data by using five numbers (the smallest observation, lower quartile [Q1], median [Q2], upper quartile [Q3], and largest observation). For example, for the historical period, the box plot for Red Bluff shows a minimum value of about 20 inches in the driest 30-year period and a maximum value of slightly over 23 inches in the wettest 30-year period. The precipitation values used to generate the box plots are from a specific location (i.e., Red Bluff, Oroville, Fresno, and Millerton).

Figure 5-6 shows the trend in the change in average annual temperature for the Sacramento Valley floor for each climate sequence compared with the 1951-2005 historical average. A distinct upward trend in temperature change is shown in each climate scenario. Nonetheless, there is considerable year-to-year fluctuation and different expectations for the long-term magnitude of temperature change. While the absolute change in temperature varies from region to region, the relative change in average annual temperature follows a pattern similar in all regions to that shown for the Sacramento River Hydrologic Region in Figure 5-6.

Figure 5-2 Variation in 30-Year Running Average Precipitation for Historical Record (1915-2003) and Alternative Scenarios of Future Simulated Climate (2011-2099) for Red Bluff



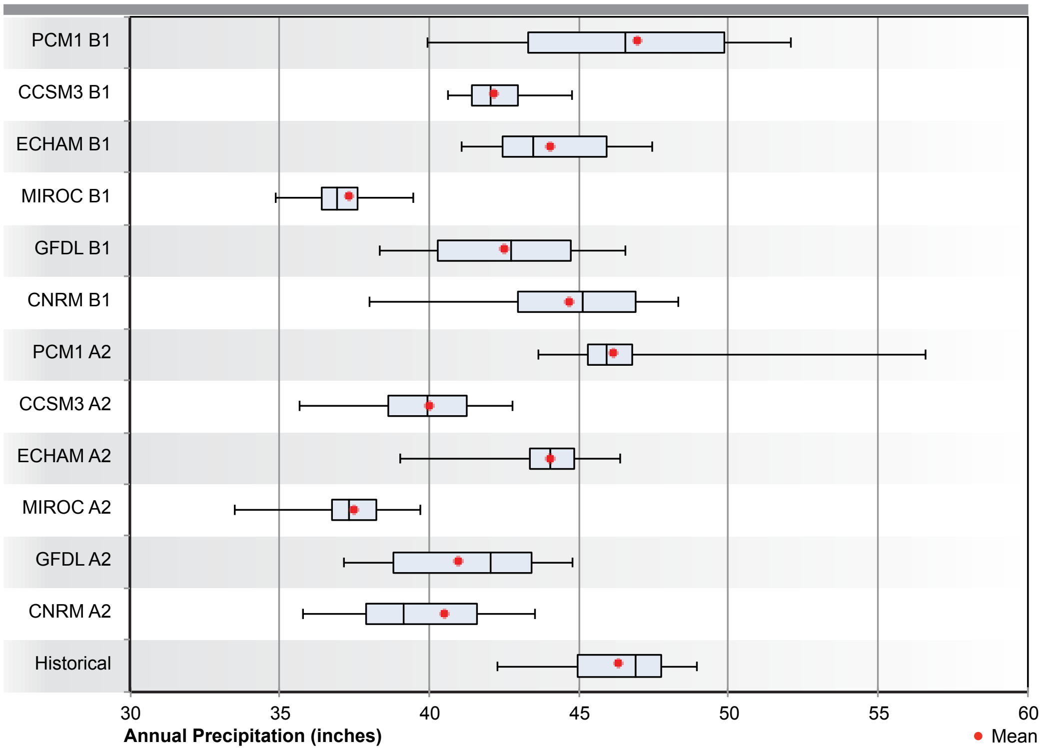
Future Environmental Requirements

The CWP uses currently unmet environmental objectives as a surrogate to estimate new requirements that may be enacted in the future to protect the environment or new ecosystem restoration actions implemented, for example, under an integrated regional water management (IRWM) plan. These unmet objectives are instream flow needs or additional deliveries to managed wetlands that have been identified by regulatory agencies or by pending court decisions, but which are not yet required by law. For Update 2013, the CWP has identified the following unmet objectives:

- American (Nimbus) Department of Fish and Wildlife Values.
- Stanislaus (Goodwin).
- Ecosystem Restoration Program #1, Delta Flow Objective.
- Ecosystem Restoration Program #2, Delta Flow Objective.
- Ecosystem Restoration Program #4, Freeport.
- Trinity below Lewiston.
- Ecosystem Restoration Program #3 San Joaquin River at Vernalis.
- San Joaquin River below Friant.
- Level 4 Water Deliveries to Wildlife Refuges.

The analysis of Response Packages, described below, includes assessments of these additional objectives. These are only some of the unmet objectives in the state. In particular, they do not

Figure 5-3 Variation in 30-Year Running Average precipitation for Historical Record (1915-2003) and Alternative Scenarios of Future Simulated Climate (2011-2099) for Oroville



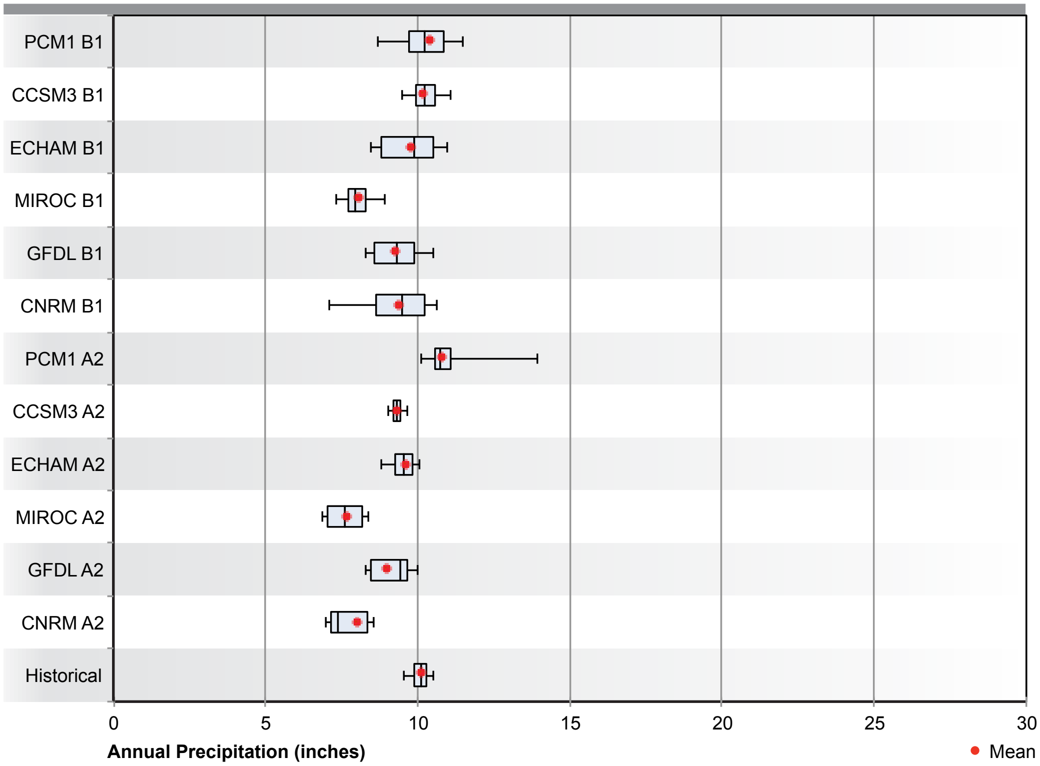
include additional water to protect species in the Delta, as recommended in the December 2008 Delta Smelt Biological Opinion issued by the U.S. Fish and Wildlife Service, or to protect salmon and several other species, as recommended in the June 2009 Biological Opinion on the Central Valley Water Project by the National Marine Fisheries Service.

Evaluating Vulnerabilities and Resource Management Strategies for Three Hydrologic Regions

Throughout development of Update 2013, DWR has worked with the Statewide Water Analysis Network (SWAN) to develop methods to regionally evaluate and quantify the costs, benefits, and tradeoffs of different resource management strategies through the application of the Water Evaluation and Planning (WEAP) modeling platform. SWAN serves as the technical advisory committee for the CWP. The CWP is testing the evaluation methods by focusing on the three hydrologic regions in the Central Valley: the Sacramento River, San Joaquin River, and Tulare Lake hydrologic regions (see Figure 5-7). (For more information, refer to Volume 4, *Reference Guide*, the article “Evaluating Response Packages for the California Water Plan Update 2013, Plan of Study.”)

This analysis of vulnerabilities and response packages uses Robust Decision Making (RDM), a quantitative decision-support methodology designed to facilitate decisions under conditions of deep uncertainty (Lempert et al. 2003; Groves and Lempert 2007). Deep uncertainty occurs when the parties to a decision do not know — or agree on — the best model for relating actions to

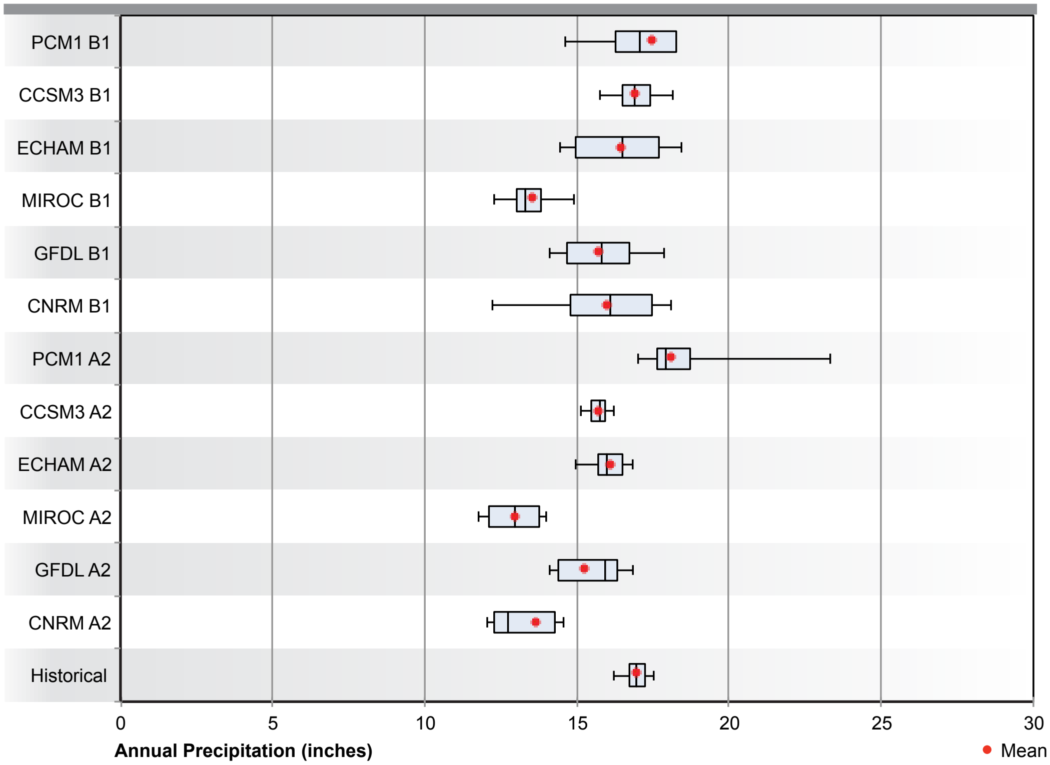
Figure 5-4 Variation in 30-Year Running Average Precipitation for Historical Record (1915-2003) and Alternative Scenarios of Future Simulated Climate (2011-2099) for Fresno



consequences or the likelihood of future events. RDM rests on a simple concept: Rather than use models and data to predict the future and then plan for that prediction, RDM runs models over hundreds to thousands of different sets of assumptions to describe how plans perform in many plausible futures. This information is used as part of a vulnerability analysis to identify which future conditions could result in the management decisions not achieving their objectives. RDM then informs a tradeoff analysis, in which different decisions are compared based on their ability to reduce vulnerabilities, their costs, and other outcomes. (For more information about RDM and case studies, visit http://www.rand.org/methods/rdmlab.html.) Figure 5-8 shows the key steps of an RDM analysis.

The CWP is using this RDM framework to first evaluate the vulnerability of current water management in the Central Valley (Steps 1-3 in Figure 5-8) and then compare how various water management response packages could improve the resilience of the water management system (Steps 1-4 in Figure 5-8). Specifically, the vulnerability analysis explores how well the Central Valley water management system would perform under a wide range of futures defined by scenarios of urban growth and climate conditions. Urban growth scenarios reflect future population growth, density of housing, water use rates, and changes to irrigated land and cropping patterns. Climate scenarios describe different but plausible sequences of monthly temperatures and precipitation. Some scenarios reflect historical conditions, modified by an extended drought and climate warming. Others are derived from global climate model simulations. System performance is evaluated with respect to urban and agricultural supply reliability, reliability of meeting instream flow requirements and objectives, and changes in groundwater levels.

Figure 5-5 Variation in 30-Year Running Average Precipitation for Historical Record (1915-2003) and Alternative Scenarios of Future Simulated Climate (2011-2099) for Millerton

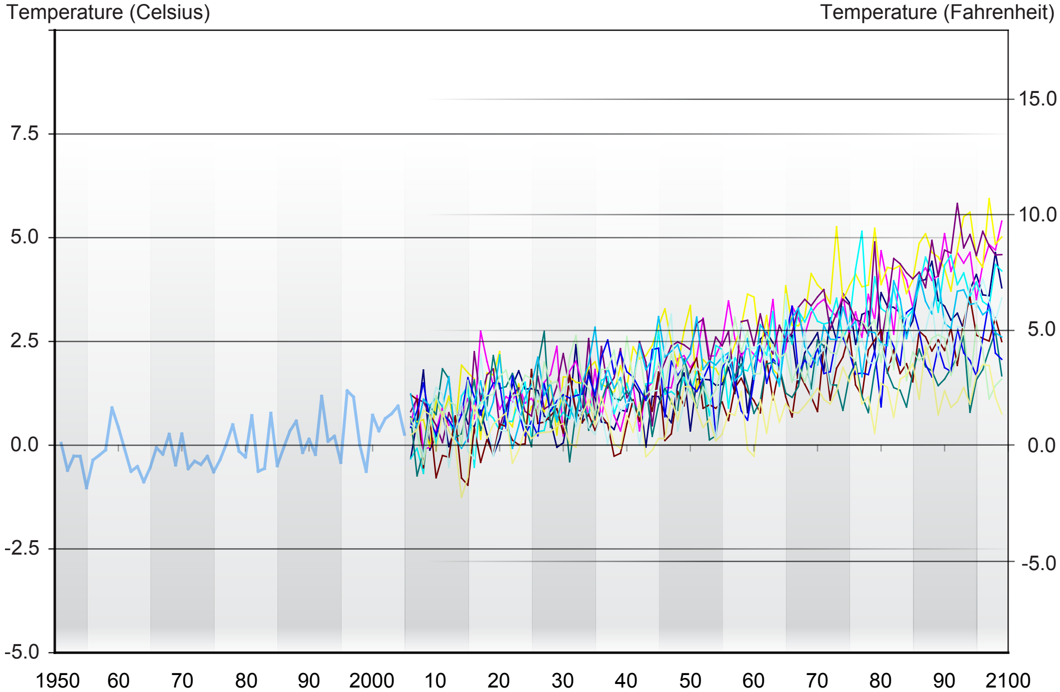


The CWP applied a model of the Central Valley water management system developed in the WEAP modeling platform to regionally quantify water management outcomes across a large number of growth and climate scenarios (see Box 5-4). For each scenario, an assessment was made of water supply, demand, and unmet demand in the urban and agricultural sectors; changes in groundwater; and how frequently instream flow requirements and objectives were met.

Figures 5-9 and 5-10 provide an example of information obtained from the Central Valley WEAP model and show urban and agricultural water supply, as well as demand and unmet demand results, for a single simulation (out of many) performed for the San Joaquin River Hydrologic Region. These simulations are based on historical supply conditions and Current Trends population and urban-density scenarios, and currently planned management. For the urban sector, demand gradually increases after the first 20 years of the simulation, and demand is completely met in all but one year (Figure 5-9). In the agricultural sector, water demand is more variable and declines slightly over time as urbanization reduces irrigated land area (Figure 5-10). Supply largely meets demand, except for simulated years 2023 and 2024, which corresponds to a repeat of 1976-1977 drought conditions. The model projects small but persistent unmet demands under a repeat of historical hydrologic conditions. Shortages are more acute under the dry conditions of 1977 and the early 1990s. These results are consistent with the greater water supply constraints present in these regions today.

The CWP evaluated numerous simulations under various future conditions to understand broadly how demand could change over time and to what extent supplies would be available to meet the demand. When reviewing results from numerous future simulations, the annual results for unmet

Figure 5-6 Change in Average Annual Temperature from Historical 1951-2005 Average and 12 Scenarios of Future Climate Years 2006-2100 for Sacramento Valley Floor



Note: In this figure, historical period shows actual demand (blue line). Each colored line represents 1 of 12 climate scenarios.

demand were summarized using a reliability metric. Reliability for this analysis is reported as the percentage of years in which water supply meets most of the water demand (e.g., 95 percent). Different reliability thresholds were defined for the urban and agricultural sectors in the Central Valley to reflect different historical levels of delivery (see Table 5-4).

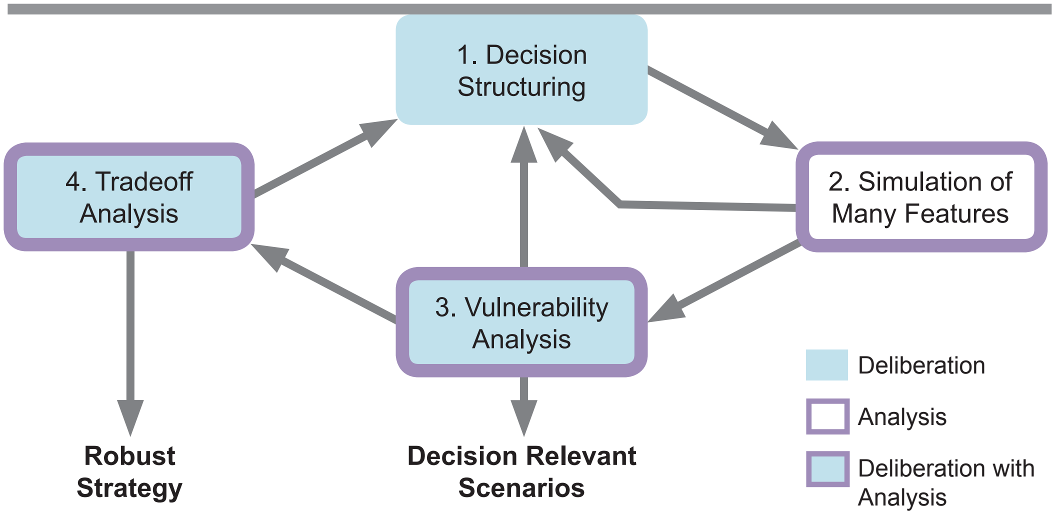
The CWP evaluated outcomes under currently planned management conditions for 198 futures representing combinations of climate and growth scenarios. Specifically, 22 climate scenarios — 10 different variations of historical climate with and without warming and 12 derived from global climate models — were evaluated for each of nine different growth scenarios. Reliability, defined as the percentage of years in which demand is sufficiently met by supply, is one of several different ways the CWP summarizes the projections of future urban and agricultural conditions. Groundwater conditions are summarized by the changes over the 45-year simulation period, and environmental flows are summarized by the reliability in which flow objectives are met. The analysis characterizes environmental flows as instream flow requirements (IFRs), which are flow objectives that are active in the baseline conditions and all response packages, and environmental flow targets (EFTs), which are flow objectives that are active in only some of the response packages, as described below.

Figure 5-11 shows the range of urban and agricultural reliability in the Sacramento River, San Joaquin River, and Tulare Lake hydrologic regions. In the figure, each symbol indicates the reliability for one of 198 simulations. The vertical lines indicate the median of each distribution, and

Figure 5-7 **California's Hydrologic Regions Highlighting Three Central Valley Regions Used in Test Case**

Original map and data points courtesy of University of California, Davis

Figure 5-8 Robust Decision Making Steps Used in Water Plan Analysis



Source: Groves and Bloom 2013

the shaded areas indicate the results that fall within the middle half of the distribution (between the 25th and 75th percentiles). The figure shows that both the urban and agricultural sectors in the Sacramento River Hydrologic Region, as well as the urban sector for the San Joaquin River Hydrologic Region, are projected to remain highly reliable across the futures evaluated. Reliability for the agricultural sector in the San Joaquin River Hydrologic Region and the urban sector in the Tulare Lake Hydrologic Region is lower, with about half the futures leading to reliability of less than 95 percent. For the agricultural sector in the Tulare Lake Hydrologic Region, reliability is broadly lower, with a median result of about 71 percent reliability. In some futures, reliability falls below 50 percent.

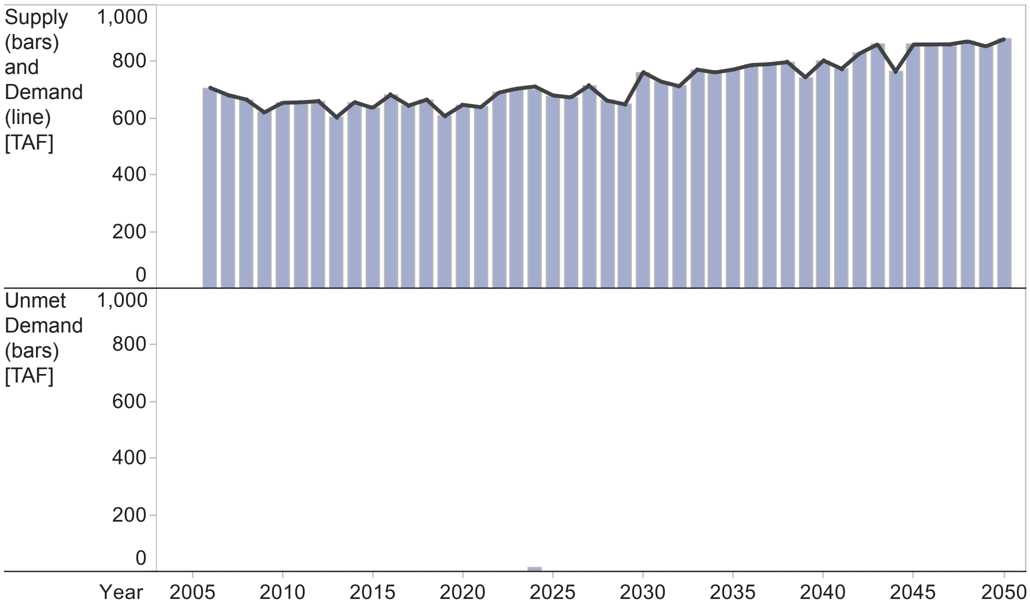
Figure 5-12 shows how groundwater storage would change in the Sacramento River, San Joaquin River, and Tulare Lake hydrologic regions for each of the 198 futures evaluated. In the Sacramento River Hydrologic Region, more than half the futures lead to increases in groundwater levels. This is caused by climate scenarios that are wetter than historical averages, combined with reduced agricultural water use resulting from projected urbanization of some agricultural lands. Groundwater in the San Joaquin River Hydrologic Region shows slight increases over the 45-year simulation period for most of the futures. Conversely, in the Tulare Lake Hydrologic Region, most futures lead to groundwater declines, with about half being greater than 10 percent.

The analysis focuses on five IFRs, three in the Sacramento River Hydrologic Region and two in the San Joaquin River Hydrologic Region, and four EFTs, three in the Sacramento River Hydrologic Region and one in the San Joaquin River Hydrologic Region. Figure 5-13 shows how the reliability for six IFRs varies across the futures. For the Sacramento River Hydrologic Region (blue symbols), performance for the IFRs is high, exceeding a reliability of more than 90 percent for all futures for Trinity below Lewiston and American (Nimbus). Flows relative to additional targets for Ecosystem Restoration Programs (ERPs) #1, #2, and #4 are high as well. Flows relative to additional targets at American (Nimbus) are significantly lower. For flows in the San Joaquin River Hydrologic Region (green symbols), reliability is high for each of the three IFRs — San Joaquin River at Vernalis, Stanislaus (Goodwin), and San Joaquin River below

Box 5-4 Central Valley WEAP Model

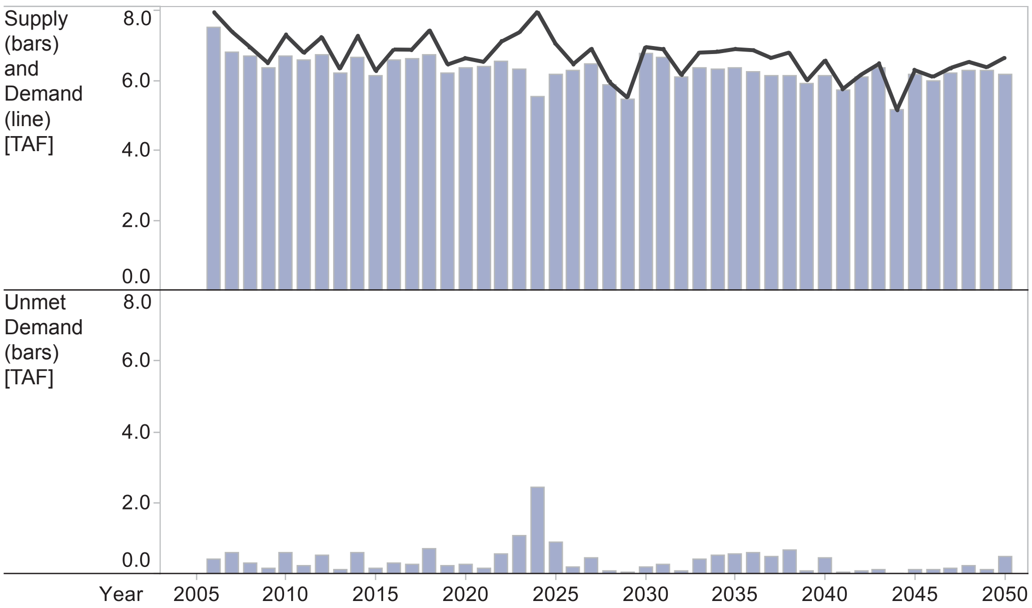
The California Water Plan supported the development of a model of the Central Valley by using the Water Evaluation and Planning (WEAP) system (see www.weap21.org). The WEAP system is a comprehensive, fully integrated river basin analysis tool. It is a simulation model that includes a robust and flexible representation of water demands from different sectors and the ability to program operating rules for infrastructure elements, such as reservoirs, canals, and hydropower projects (Purkey and Huber-Lee 2006; Purkey et al. 2007; Yates, Purkey et al. 2005; Yates, Sieber et al. 2005; Yates et al. 2008; and Yates et al. 2009). Additionally, it has watershed rainfall-runoff modeling capabilities that allow all portions of the water infrastructure and demand to be dynamically nested within the underlying hydrological processes. This functionality allows the analyses of how specific configurations of infrastructure, operating rules, and operational priorities will affect water uses as diverse as instream flows, irrigated agriculture, and municipal water supply under the umbrella of input weather data and physical watershed conditions. This integration of watershed hydrology with a water systems planning model makes WEAP ideally suited to study the potential impacts of climate change and other uncertainties internal to watersheds. The physical water-management system represented in WEAP is represented conceptually below.

Figure 5-9 Single Simulation of Urban Supply, Demand, and Unmet Demand for the San Joaquin River Hydrologic Region



Note: TAF = thousand acre-feet. In the upper part of the figure, the black line indicates demand, and vertical bars indicate annual supply (top) and annual unmet demand (bottom). This simulation is for the historical climate and CTP-CTD land use scenario.

Figure 5-10 Single Simulation of Agricultural Supply, Demand, and Unmet Demand for the San Joaquin River Hydrologic Region



Note: TAF = thousand acre-feet. In the upper part of the figure, the black line indicates demand, and vertical bars indicate annual supply (top) and unmet demand (bottom). This simulation is for the historical climate and CTP-CTD land use scenario.

Friant. The additional targeted flows are met in less than half of all months at Stanislaus (Goodwin) across all futures.

The CWP examined the urban and agricultural sectors that were the most vulnerable across the future scenarios by evaluating which future conditions would lead to low agricultural reliability in the San Joaquin Hydrologic Region and low urban and agricultural reliability in the Tulare Lake Hydrologic Region. This analysis considered less than 95-percent reliability as representative of a management vulnerability. For San Joaquin River agriculture, reliability is less than 95 percent in about 36 percent of the futures. Tulare Lake's urban and agricultural sectors are less than 95 percent reliable in 30 percent and 95 percent of futures evaluated, respectively. Using statistical analysis, the CWP identified that the two most important factors driving low-reliability outcomes are futures with high temperature and low precipitation in future decades. The specific growth scenarios (variations in population and land use density) are of secondary importance. Figures 5-14, 5-15, and 5-16 show reliability results graphed against the temperature trend (vertical axis) and change from historical precipitation levels (horizontal axis) of each simulation. In these graphs, X's are those results that are less than 95 percent reliable and O's are those that are more than 95 percent reliable. For the agricultural sector in the San Joaquin Hydrologic Region, low-reliability results correspond to the climate scenarios in which temperature is greater than 62.9 degrees and precipitation declines more than 5 percent from historical levels (Figure 5-14).

For the urban sector in the Tulare Lake Hydrologic Region, population growth partially explains the conditions that lead to low reliability. In Figure 5-15, the X's and O's show reliability results for the high-population/low-density growth scenario — one that leads to higher urban demand. For this growth scenario, 8 of 10 low-reliability outcomes correspond to conditions that are equal

Table 5-4 Reliability Thresholds

Hydrologic Region	Urban Sector	Agricultural Sector
Sacramento River	98%	90%
San Joaquin River	98%	85%
Tulare Lake	98%	80%

to or warmer than historical conditions and are more than 4 percent drier (colored region of the figure). Under a growth scenario in which urban demands are lower — the low-population/high-density growth scenario — there are only five low-reliability outcomes, and four of the five occur when conditions are much warmer and drier (up and to the left of the dashed lines in figure).

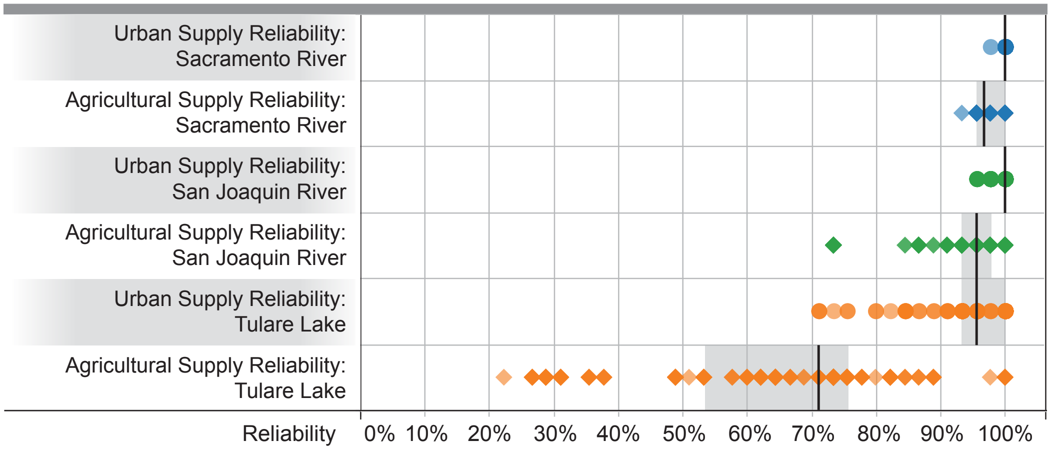
In the agricultural sector for the Tulare Lake Hydrologic Region, almost all futures are low reliability (less than 95 percent). Figure 5-16 shows results for the current trends in population and density land-use scenarios. In this graphic, each symbol averages the reliability results for each climate scenario across the nine growth scenarios. All but one climate scenario leads to low reliability, and reliability generally declines for warmer and dryer climate conditions (upper left). The warmest and driest climate conditions lead to reliability below 50 percent. These results clearly indicate that the agricultural sector within the Tulare Lake Hydrologic Region will likely continue to experience low-supply reliability, and perhaps extreme reliability problems, without additional water management strategies.

In summary, the Sacramento River Hydrologic Region is projected to remain highly reliable, with stable groundwater storage levels in most futures evaluated — even under alternative climate change projections. For the San Joaquin River Hydrologic Region, however, significant shortages would occur in the agricultural sector under climate conditions that are modestly warmer and slightly drier than experienced historically. For the Tulare Lake Hydrologic Region, urban supply reliability is below 95 percent in many futures, particularly those with warmer and drier conditions, and where high population growth is combined with low land-use density. For the agricultural sector, reliability is consistently below 95 percent and dips lower than 50 percent in the hottest and driest climate scenarios.

Evaluation of Management Response Packages

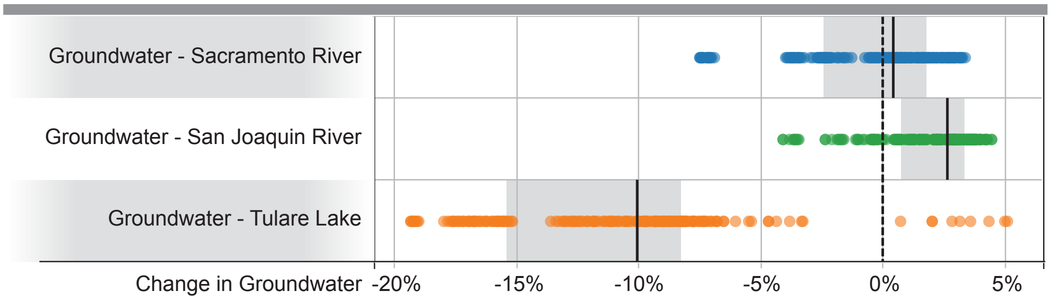
The CWP evaluated how implementing alternative mixes of resource management strategies could reduce the Central Valley vulnerabilities described above. The focus of this analysis was on the Sacramento River, San Joaquin River, and Tulare Lake hydrologic regions. Management response packages are each comprised of a mix of resource management strategies selected from Volume 3 and implemented at different investment levels and locations. These response packages do not represent a definitive set of alternatives; instead, they illustrate different levels of strategy diversification that could be taken to address water management challenges. Table 5-5 describes the currently planned management baseline and five response packages that were evaluated. They are designed to incrementally increase in diversification in each subsequent diversification level. The first two add strategies that can be implemented locally, such as water use efficiency, and that require some regional coordination and infrastructure investment, such as conjunctive management and recycled municipal water. Diversification Levels 3-5 all include additional

Figure 5-11 **Range of Urban and Agricultural Reliability Results Across Futures**



Note: Circles indicate urban reliability results, and diamonds indicate agricultural reliability results. Blue, green, and orange symbols correspond to results for the Sacramento River, San Joaquin River, and Tulare Lake hydrologic regions, respectively.

Figure 5-12 **Range of Groundwater Storage Changes Across Futures**



Note: Blue, green, and orange symbols correspond to results for the Sacramento River, San Joaquin River, and Tulare Lake hydrologic regions, respectively.

strategies designed to meet new environmental flow targets, increase water use efficiency and lead to the recovery of the region's groundwater basins. Box 5-5 provides a discussion on including new surface storage as part of the response packages.

Figure 5-17 summarizes changes in urban and agricultural reliability among diversification levels as additional management response packages are implemented. These additional response packages are shown from one diversification level to the next:

- Currently Planned Management to Diversification Level 2 — increasing urban and agricultural efficiency, water reuse, and conjunctive management.
- Diversification Level 2 to Diversification Level 3 — adding additional environmental flow and groundwater recovery targets.
- Diversification Level 3 to Diversification Level 5 — adding even more efficiency and conjunctive management.

In the graphics contained in Figure 5-17, each symbol represents a pair of results for one of 66 futures, those for three growth scenarios and 22 climate scenarios. The narrower, lighter end

Figure 5-13 Range of Reliability for Environmental Flow Objectives Across Futures

Note: Circles correspond to IRFs and diamonds correspond to EFTs. The color of the symbols indicates the hydrologic region — Sacramento River (blue) and San Joaquin River (green). The Trinity River (brown) below Lewiston is located in the North Coast Hydrologic Region and is included in the Central Valley WEAP model in relation to imports to the Sacramento River Hydrologic Region.

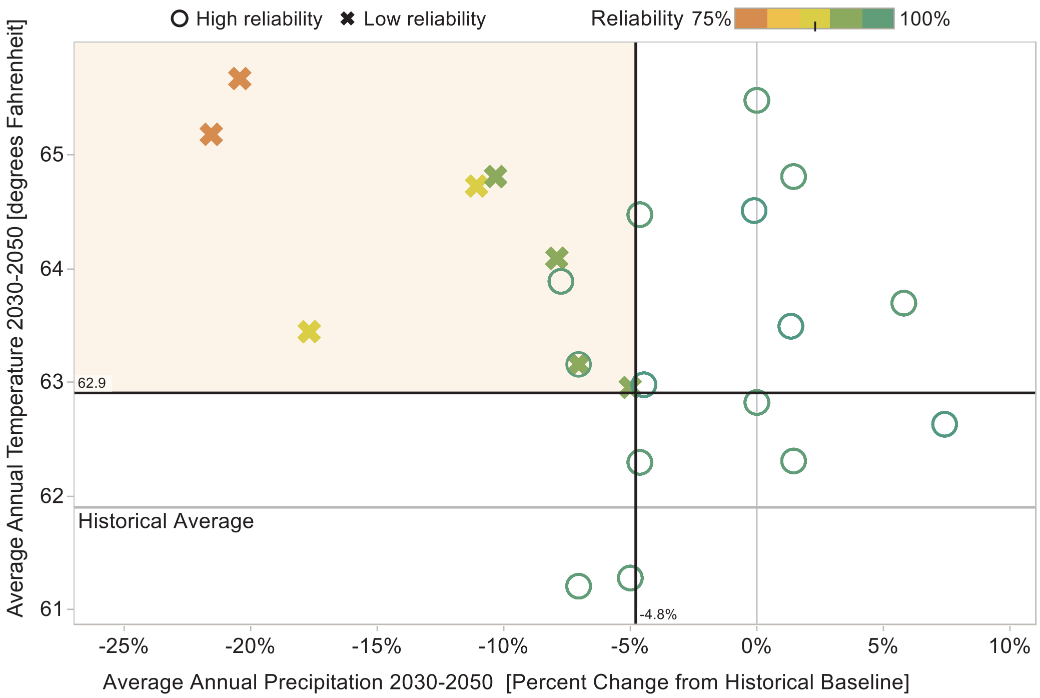
marks the result for the first response package and the thicker, darker end marks the result for the second response package. The horizontal position indicates urban supply reliability and the vertical position indicates agricultural supply reliability. The dashed lines mark the 95-percent reliability threshold, below which any percentage of reliability is considered low.

Across all response package comparisons, bigger changes are observed in the Tulare Lake Hydrologic Region than in the San Joaquin River Hydrologic Region, reflecting lower baseline reliability in the Tulare Lake Hydrologic Region. The efficiency increases in Diversification Level 2 significantly improve reliability in both the urban and agricultural sectors in the Tulare Lake Hydrologic Region. The additional environmental and groundwater flow targets in Diversification Level 3, however, reverse some of these improvements and lead to lower reliability for many futures. As described below, concurrent improvements are seen in groundwater storage and environmental flows with Diversification Level 3. Lastly, the additional efficiency and conjunctive management in Diversification Level 5 once again improve reliability across both sectors, close to the levels achieved with Diversification Level 3.

To summarize results across the 66 futures evaluated (three bounding growth scenarios multiplied by 22 climate scenarios), the following summary metrics are used:

- Percentage of futures in which urban supply reliability exceeds 95 percent.
- Percentage of futures in which agricultural supply reliability exceeds 95 percent.

Figure 5-14 **Climate Conditions Leading to Low Agricultural Supply Reliability in the San Joaquin River Hydrologic Region**

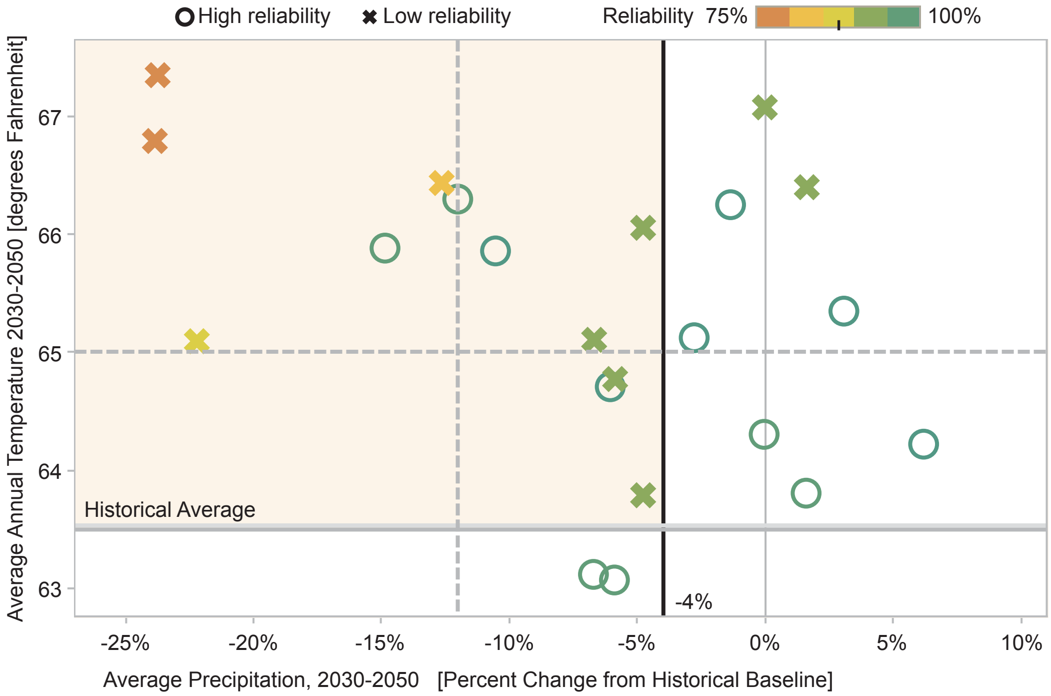


Note: Each point represents one future under the current management baseline strategy. The X's represent futures in which policy objectives are not met, and O's represent futures in which policy objectives are met. The color of the symbols indicates their reliability. The shaded area indicates the climate conditions that generally lead to low reliability. Because there are only 12 unique climate sequences used to generate 36 futures, each combination of temperature trend and change in precipitation represents three results.

- Percentage of futures in which groundwater storage in the last decade of simulation (2041-2050) is less than the starting year.
- Percentage of futures in which flow objective reliability exceeds 95 percent.

Figures 5-18, 5-19, and 5-20 summarize results for each of the diversification levels for these five metrics for the Sacramento River, San Joaquin River, and Tulare Lake hydrologic regions, respectively. The number and color within each square indicates the percentage of futures in which performance is low. For the Sacramento River Hydrologic Region (Figure 5-18), urban supply reliability is high for all futures across all diversification levels. Agricultural reliability declines below the 95-percent vulnerability threshold in about a third of all futures, when additional environmental flow and groundwater recovery targets are implemented (Diversification Level 3). Reliability in about half of these futures recovers with the implementation of strategies in Diversification Level 5. The number of futures with reductions in groundwater storage is reduced from 43 percent to 36 percent with Diversification Level 3. The additional flow targets improve ERPs #1 and #2 — completely eliminating any vulnerability — but the targets do not improve the number of futures in which the additional American (Nimbus) target is reliably met. Implementation costs increase with the significant conservation and recycling implemented in Diversification Level 2 and higher. Note that the cost of adding environmental flow requirements and groundwater reduction targets in Diversification Level 3 are not accounted for in the figure.

Figure 5-15 Climate Conditions Leading to Low Urban Supply Reliability in the Tulare Lake Hydrologic Region for the High-Population and Low-Density Land Use Scenario



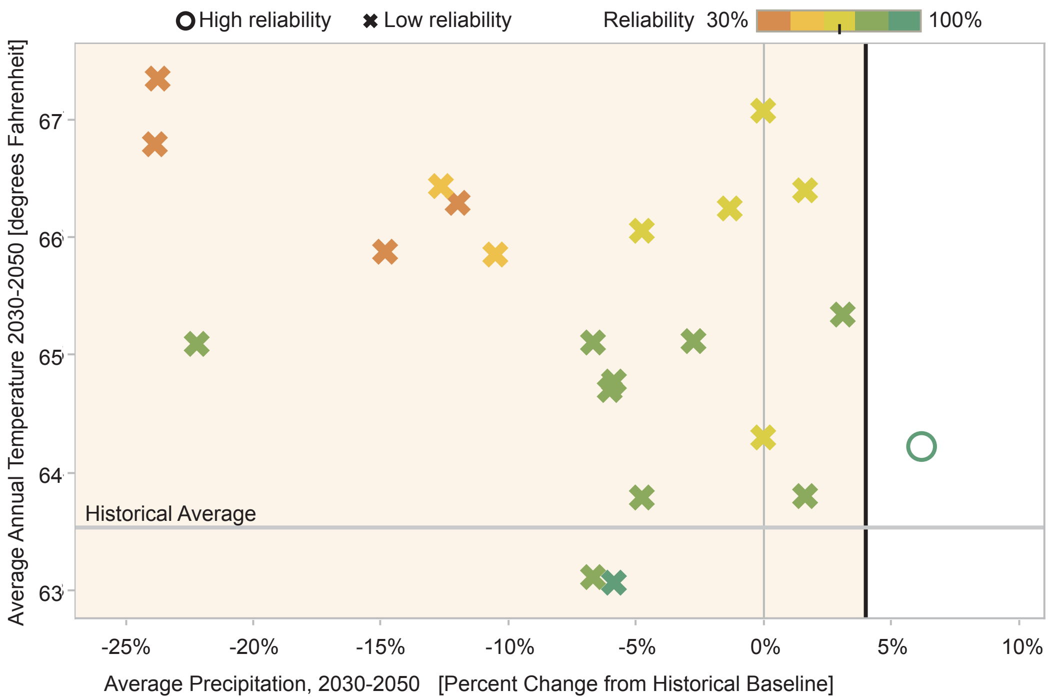
Note: Each point represents one future under the current management baseline strategy. The X's represent futures in which policy objectives are not met, and O's represent futures in which policy objectives are met. The color of the symbols indicates their reliability. The shaded area indicates the climate conditions that generally lead to low reliability. The dotted lines indicate the vulnerable region for the subset of futures based on the low-population/high-density growth scenario.

For the San Joaquin River Hydrologic Region (Figure 5-19), similar patterns are seen across the performance metrics. The management strategies included in the first two diversification levels — efficiency, conjunctive use, and recycling — lead to marked improvements in the percentage of futures in which agricultural supply is reliable and groundwater storage does not decline. The addition of environmental flow and groundwater recovery targets in Diversification Level 3 leads to improvement in groundwater storage and achieves targeted flows at Stanislaus (Goodwin) for all futures. These improvements in groundwater and environmental flows come at the expense of agricultural supply reliability and, to a lesser extent, urban supply reliability. The additional conservation and conjunctive use in Diversification Levels 4 and 5 partially mitigate these effects.

While the inclusion of environmental flow targets in Diversification Levels 3-5 does not reduce the number of futures in which reliability is low for the American (Nimbus) EFT, it does significantly increase the reliability — just not to the 95-percent reliability threshold (see Figure 5-20). By comparison, Diversification Level 3 leads to high reliability for all futures for ERPs #1 and #2 and Stanislaus (Goodwin) targets.

For the Tulare Lake Hydrologic Region (Figure 5-21), the tradeoffs between urban and agricultural reliability and groundwater levels are also clearly evident. Improvements in urban and agricultural supply reliability are realized through Diversification Level 2. While groundwater storage

Figure 5-16 **Climate Conditions Leading to Low Agricultural Supply Reliability Results in the Tulare Lake Hydrologic Region**



Note: Each point represents the average reliability result for the nine growth scenarios for one climate scenario under the current management baseline strategy. The X's represent futures in which policy objectives are not met, and O's represent futures in which policy objectives are met. The color of the symbols indicates their reliability. The shaded area indicates the climate conditions that generally lead to low reliability.

improves considerably with the implementation of groundwater recovery targets and more efficiency in Diversification Levels 3-5, vulnerability in the agricultural sector remains high.

This first-of-its-kind CWP analysis of future vulnerabilities and responses provides several important insights relevant to California water management. First, there are many plausible futures in which the currently planned management strategy would lead to low-reliability outcomes, declining groundwater conditions, and lower-than-desired environmental flows. For the San Joaquin River agricultural sector, favorable climate conditions (i.e., cooler and wetter) would lead to improvements, but many plausible future climate conditions would further degrade conditions. In Tulare Lake, even more plausible future conditions lead to vulnerabilities, particularly for the agricultural sector.

Implementation of additional water management diversification through increased water-use efficiency, conjunctive use, and recycling can clearly hedge against future climate and demographic uncertainties. Balancing the additional goals of improvements in groundwater storage and environmental flows, however, requires additional investment in resource management strategies. Specifically, implementing groundwater and environmental flow targets improve some (but not all) groundwater and flow objectives, but requires even more additional conservation and conjunctive management to maintain urban and agricultural reliability. Lastly, the analysis shows that agricultural supply reliability in Tulare Lake will be unreliable in all but

Table 5-5 Resource Management Strategies Used in Plan of Study

Management Baseline or Response Package	Resource Management Strategy						
	URBAN WATER-USE EFFICIENCY	AG WATER-USE EFFICIENCY	RECYCLED MUNICIPAL WATER	CONJUNCTIVE MANAGEMENT AND GROUNDWATER		ECOSYSTEM RESTORATION	SURFACE STORAGE
				Groundwater Banking	Groundwater Recovery Targets	Environmental Flow Targets	
Currently Planned Management	20% by 2020	Current	Current	Current	Limit: Historical low	Flow requirements	**This strategy could not be evaluated as part of the Central Valley Vulnerability Assessment (See Box 5-5).**
Diversification Level 1	20% by 2020; 30% by 2030	10%, by 2020	Current	Current	Limit: Historical low	Flow requirements	
Diversification Level 2	20% by 2020; 30% by 2030	10%, by 2020	50% recycled water use, by 2030	Up to 20 taf/month/ planning area, beginning in 2020	Limit: Historical low	Flow requirements	
Diversification Level 3	20% by 2020; 30%, by 2030	10%, by 2020	50% recycled water use, by 2030	Up to 20 taf/month/ planning area in SOD, beginning in 2020	Limit: Average of historical low and initial levels in WMM, beginning in 2015	Flow requirements plus additional targets, beginning in 2015	
Diversification Level 4	30% by 2030 30% by 2030; 35% by 2040	10%, by 2020; 15%, by 2030	50% recycled water use, by 2030	Up to 40 taf/month/ planning area in SOD, beginning in 2020	Limit: Average of historical low and initial levels in WMM, beginning in 2015	Flow requirements plus additional targets, beginning in 2015	

Management Baseline or Response Package	Resource Management Strategy						
	URBAN WATER-USE EFFICIENCY	AG WATER-USE EFFICIENCY	RECYCLED MUNICIPAL WATER	CONJUNCTIVE MANAGEMENT AND GROUNDWATER		ECOSYSTEM RESTORATION	SURFACE STORAGE
				Groundwater Banking	Groundwater Recovery Targets	Environmental Flow Targets	
Diversification Level 5	30% by 2030; 30% by 2030; 40% by 2040	10% by 2020; 20% by 2030	50% recycled water use, by 2030	Up to 40 taf/month/ planning area in SOD, beginning in 2020	Limit: Average of historical low and initial levels in WMM, beginning in 2015	Flow requirements plus additional targets, beginning in 2015	

Notes:

taf = thousand acre-feet, SOD = South of Delta, WMM = water management model

Shading denotes relative levels of effort for each strategy.

Box 5-5 Analyzing Surface Storage and Delta Conveyance as Management Responses

There is a high level of interest by many stakeholders in evaluating new surface storage and conveyance improvements in the Sacramento-San Joaquin Delta (Delta) to help address California's water management problems. The limitations of the Central Valley Application of the Water Evaluation and Planning (WEAP) model precluded the evaluation of new surface storage or Delta conveyance options as part of the vulnerability and response package analysis performed for the California Water Plan (CWP). Additional improvements to the Central Valley WEAP application are needed to fully reflect operations of the Delta, reflect demands occurring in Delta export areas located outside the Central Valley, and accurately represent ecosystem performance metrics. New storage and conveyance may be highly complementary to the resource management strategies that were ready for the analysis performed for CWP Update 2013. The potential benefits, costs, and issues for new surface storage are described in Chapters 13 and 14 of Volume 3, *Resource Management Strategies*, and for new conveyance in Chapters 5 and 6 of that volume.

the most optimistic climate conditions, even with full implementation of the strategies included here. The addition of strategies not included in this analysis, such as surface storage, may be required to reduce these vulnerabilities.

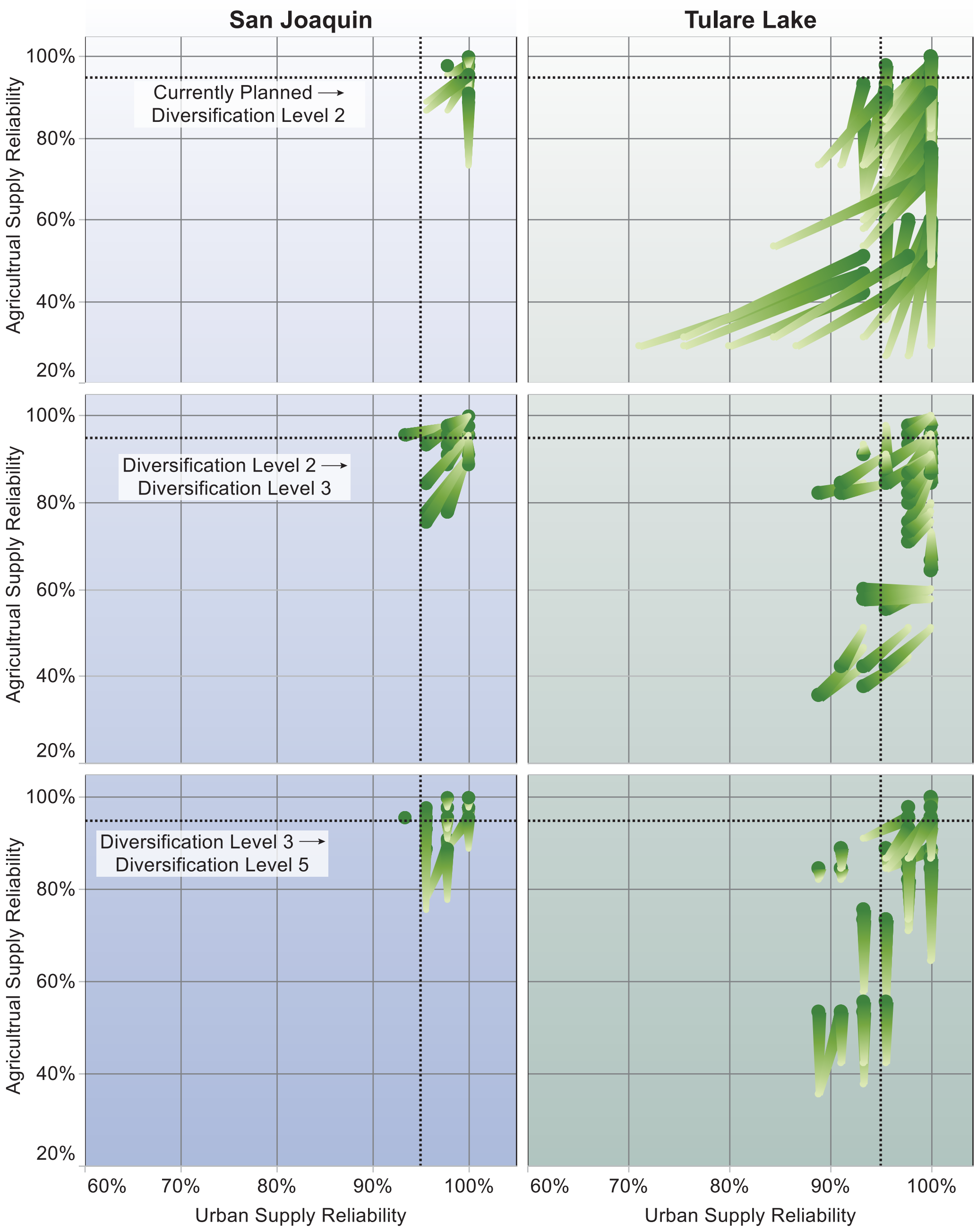
Statewide 2050 Water Demands

The section above describes a vulnerability assessment for the Sacramento River, San Joaquin River, and Tulare Lake hydrologic regions, which was conducted to demonstrate application of RDM techniques. In this section, a description is provided for how future statewide water demands might change under scenarios organized around themes of growth and climate change described earlier in this chapter. The change in water demand from 2006 to 2050 is estimated for each hydrologic region for agriculture and urban sectors under nine growth scenarios and 13 scenarios of future climate change. The climate change scenarios included the 12 CAT scenarios described earlier in this chapter and a thirteenth scenario representing a repeat of the historical climate (1962-2006) to evaluate a "without climate change" condition.

Figure 5-22 shows the change in statewide water demands for the urban and agricultural sectors under nine growth scenarios, with variation shown across 13 climate scenarios. The nine growth scenarios include three alternative population growth projections and three alternative urban-land development densities, as shown in Table 5-1. The change in water demand is the difference between the historical average for 1998 to 2005 and future average for 2043 to 2050. Urban demand is the sum of indoor and outdoor water demand, where indoor demand is assumed not to be affected by climate. Outdoor demand, however, depends on such climate factors as the amount of precipitation falling and the average air temperature. Figure 5-22 shows the change in water demand under a repeat of historical climate and a range representing 12 scenarios of future climate change. The net change in water demand for the sum of the urban and agricultural sectors is shown at the top of the figure.

Urban demand increased under all nine growth scenarios, consistent with population growth. On average, urban demand increased by about 1.3 million acre-feet (maf) under the three low-population scenarios, 2.9 maf under the three current-trend population scenarios, and about 6.1 maf under the three high-population scenarios, when compared with the historical average of 8.2

Figure 5-17 Change in Urban and Agricultural Supply Reliability as Additional Response Packages Are Implemented for the San Joaquin River Hydrologic Region (left panel) and Tulare Lake Hydrologic Region (right panel)



Note: Each line shows results corresponding to two different response packages, with the darker end corresponding to the second response package. The dotted lines indicate the vulnerability thresholds used to summarize results across the ensemble of futures.

Figure 5-18 Percentage of Scenarios Showing Unacceptable Outcomes for Selected Performance Metrics Across Different Response Packages for the Sacramento River Hydrologic Region

	Urban Supply Reliability	Agricultural Supply Reliability	Groundwater Change	Trinity below Lewston [IFR]	American (Nimbus) [IFR]	American (Nimbus) [EFT]	ERP #1 and #2 [EFT]	ERP #4, Freeport [EFT]	Average Annual Cost Above Current Plan
Currently Planned	0%	0%	42%	0%	0%	100%	14%	0%	$0.0M
Diversification Level 1	0%	0%	36%	0%	0%	100%	9%	0%	$106.6M
Diversification Level 2	0%	0%	36%	0%	0%	100%	9%	0%	$108.1M
Diversification Level 3	0%	36%	30%	0%	0%	100%	0%	0%	$108.1M
Diversification Level 4	0%	19%	27%	0%	0%	100%	0%	0%	$204.0M
Diversification Level 5	0%	15%	25%	0%	0%	100%	0%	0%	$304.0M

[IFR] = instream flow requirement [EFT] = environmental flow target

Note: Numbers and color indicate the percentage of 88 futures in which the currently planned management is vulnerable. The urban and agricultural sectors are vulnerable if they are less than 95 percent reliable. Groundwater change is vulnerable if it is negative. IFR and EFT metrics are vulnerable if they are less than 95 percent reliable.

maf. The results show that change in future urban water demands is less sensitive to housing density assumptions or climate change than to assumptions about future population growth.

Agricultural water demand decreases under all future scenarios owing to reduction in irrigated lands as a result of urbanization and background water conservation, when compared with historical average water demand of 30.2 maf. Under the three low-population scenarios, the average reduction in water demand was about 3.0 maf, while it was about 4.3 maf for the three high-population scenarios. For the three current trend population scenarios, this change was about 3.6 maf. The results show that low-density housing would result in more reduction in agricultural water demand because more agricultural lands are lost under low-density housing than high-density housing.

Figure 5-23 depicts the change in water demand for the agricultural and urban sectors for each of the 10 hydrologic regions. For each of the nine growth scenarios shown in Table 5-1, change in water demand was determined based on a repeat of a historical climate pattern and for 12 alternative scenarios of future climate change. It is evident from Figure 5-23 that future climate change presents a significant uncertainty with respect to future water demands. All regions show an increase in urban water demands and decrease in agricultural water demands. The South Coast is expected to have the greatest increase in urban water demands in response to population growth. Additional details about the regional water demands can be found in the Volume 2, *Regional Reports*.

Figure 5-19 Percentage of Scenarios Showing Unacceptable Outcomes for Selected Performance Metrics Across Different Response Packages for the San Joaquin River Hydrologic Region

	Urban Supply Reliability	Agricultural Supply Reliability	Groundwater Change	San Joaquin River at Vernalis [IFR]	San Joaquin River below Friant [IFR]	Stanislaus (Goodwin) [IFR]	Stanislaus (Goodwin) [EFT]	Average Annual Cost Above Current Plan
Currently Planned	0%	36%	19%	0%	0%	0%	100%	$0.0M
Diversification Level 1	0%	14%	11%	0%	0%	0%	100%	$103.3M
Diversification Level 2	0%	9%	9%	0%	0%	0%	100%	$146.8M
Diversification Level 3	5%	34%	6%	0%	0%	0%	0%	$147.0M
Diversification Level 4	5%	27%	6%	0%	0%	0%	0%	$227.7M
Diversification Level 5	5%	14%	1%	0%	0%	0%	0%	$396.6M

[IFR] = instream flow requirement [EFT] = environmental flow target

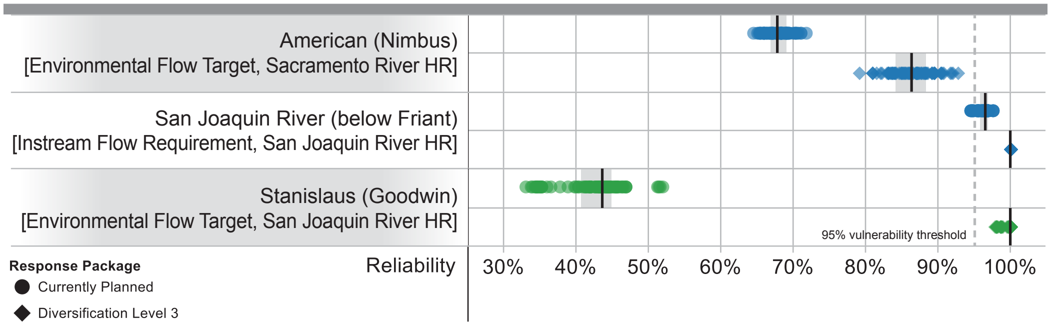
Note: Numbers and color indicate the percentage of 88 futures in which the currently planned management is vulnerable. The urban and agricultural sectors are vulnerable if they are less than 95 percent reliable. Groundwater change is vulnerable if it is negative. IFR and EFT metrics are vulnerable if they are less than 95 percent reliable.

Limitations of Future Water Management Analysis for Update 2013

The analysis of resource management strategies developed for Update 2013 can allow comprehensive analysis of strategy performance when conducted at a sufficient level of detail. However, all technical endeavors are subject to the limits of the particular technology being used and the financial resources available. The following are some of the important limitations the CWP team has identified for the analysis used for Update 2013.

- For Update 2013, DWR tested a vulnerability assessment for the Sacramento River, San Joaquin River, and Tulare Lake hydrologic regions, which included an assessment of water supply, demand, and unmet demand in the urban and agricultural sectors. The analysis for the remaining seven hydrologic regions in California was coarser and focused on quantifying future water demands under alternative future scenarios.
- Many of the resource management strategies identified in Volume 3 can be represented in the Update 2013 application of WEAP, particularly those related to the water management objectives to reduce water demand, improve operational efficiency and transfers, and increase water supply. However, the analysis for Update 2013 had limited ability to none at all with regard to quantifying strategies that improve flood management, improve water quality, and

Figure 5-20 Range of Reliability for Three Environmental Flow Objectives Across Futures for Currently Planned Management and Diversification Level 3



practice resource stewardship. These will be considered as part of future enhancements to the CWP.

- The analysis for Update 2013 quantified some of the resource-management-strategy benefits for providing a supply benefit, improving drought preparedness, providing environmental benefits, improving operational flexibility and efficiency, and reducing groundwater overdraft. There was limited to no ability to quantify benefits for improving water quality, reducing flood impacts, energy benefits, and recreational opportunities. Quantifying these other benefits will be considered as part of future enhancements to the analytical framework.
- The analysis to support the CWP is designed to represent the water management system at a sufficient level of detail to reflect important planning conditions, but not for detailed water project operations or to capture all detailed flows through the system. As a result, many system features, such as groundwater basins, are simplified to capture the broad regional behavior of groundwater recharge, groundwater storage, and hydrologic connection to rivers and lakes. Significant refinement in the analysis will be needed to support decisions by individual water districts.

Managing for Sustainability

With a growing recognition that California's water systems are over allocated — and faced with climate change, growing population, and more stringent environmental requirements — decision-makers, water managers, and planners are becoming increasingly aware of the need to sustainably manage water and respond to changing availability and constraints on water. In Updates 2005 and 2009, the State refocused attention on the sustainability of California's water systems and ecosystems in light of current water management practices and expected future changes. A number of concurrent efforts are underway at the regional, State, and federal levels to manage natural resources more sustainably (see in Volume 4, *Reference Guide*, the article "Managing for Sustainability," for more information). As an illustration, a significant, multi-agency collaborative effort — U.S. EPA California Footprint Sustainability Indicators Suite — is summarized in Box 5-6.

The California Water Sustainability Indicators Framework (CWSIF), developed as part of Update 2013, brings together water sustainability indicators that will provide information regarding water system conditions and their relationships to ecosystems, social systems, and economic systems. Figure 5-24 shows a conceptual representation of the CWSIF, as well as how communities interact to develop sustainability indicators, by using analytical information that ultimately is used to drive our water policy and to inform other end uses.

Figure 5-21 Percentage of Scenarios Showing Unacceptable Outcomes for Selected Performance Metrics Across Different Response Packages for the Tulare Lake Hydrologic Region

	Urban Supply Reliability	Agricultural Supply Reliability	Groundwater Change	Average Annual Cost Above Current Plan
Currently Planned	32%	95%	95%	$0.0M
Diversification Level 1	18%	89%	94%	$171.1M
Diversification Level 2	7%	68%	69%	$212.3M
Diversification Level 3	23%	89%	32%	$212.1M
Diversification Level 4	23%	86%	31%	$350.7M
Diversification Level 5	22%	78%	19%	$546.5M

Note: Numbers and color indicate the percentage of 88 futures in which the currently planned management is vulnerable. The urban and agricultural sectors are vulnerable if they are less than 95 percent reliable. Groundwater change is vulnerable if it is negative.

Sustainability indicators are qualitative or quantitative parameters from monitoring programs (e.g., streamflow) selected to represent parts of ecological, social, or economic systems. (See in Volume 4, *Reference Guide*, the article "California Water Sustainability Indicators Framework.") The evaluation of the sustainability indicators reveals how our actions or inaction can degrade or improve conditions that lead to water sustainability. The CWSIF is built around statements of intent (e.g., objectives) and domains (e.g., water quality). Reporting indicator condition is based on the principle of measuring how far a current condition is from a desired condition. The CWSIF is intended to support reporting of conditions to a wide array of water and environmental stakeholders, the public, and decision-makers to build knowledge and to enhance adaptive decision-making and policy change. A detailed representation of the CWSIF is depicted in Figure 5-25, showing several steps involved with linking sustainability goals and objectives into public policy by using reliable data and scientific information. Both the conceptual and detailed descriptions of the CWSIF (Figures 5-24 and 5-25) highlight the adaptive and collaborative nature of efforts to develop sustainable policies.

Goals and objectives are just one way to organize our thinking about an evaluation of sustainability. Another common approach is to evaluate progress within areas of concern or domains (e.g., ecosystem health). Five domains of natural and human systems are defined for the CWSIF (Table 5-6), which capture most of the environmental, social, and economic concerns about water sustainability: water supply reliability, water quality, ecosystem health, adaptive and sustainable management, and social benefits and equity.

Explicit criteria must be used to select indicators to ensure that the resulting evaluation is robust and usable in decision-making. For Update 2013, about 80 candidate indicators were selected on the basis of the indicator selection criteria, from an extensive review of sustainability and water system indicators around the world and in California. This exercise resulted in a set of candidate indicators that efficiently covered the sustainability objectives, while also covering the five

Figure 5-22 Change in Statewide Agricultural and Urban Water Demands for 117 Scenarios from 2006-2050 (million acre-feet per year)

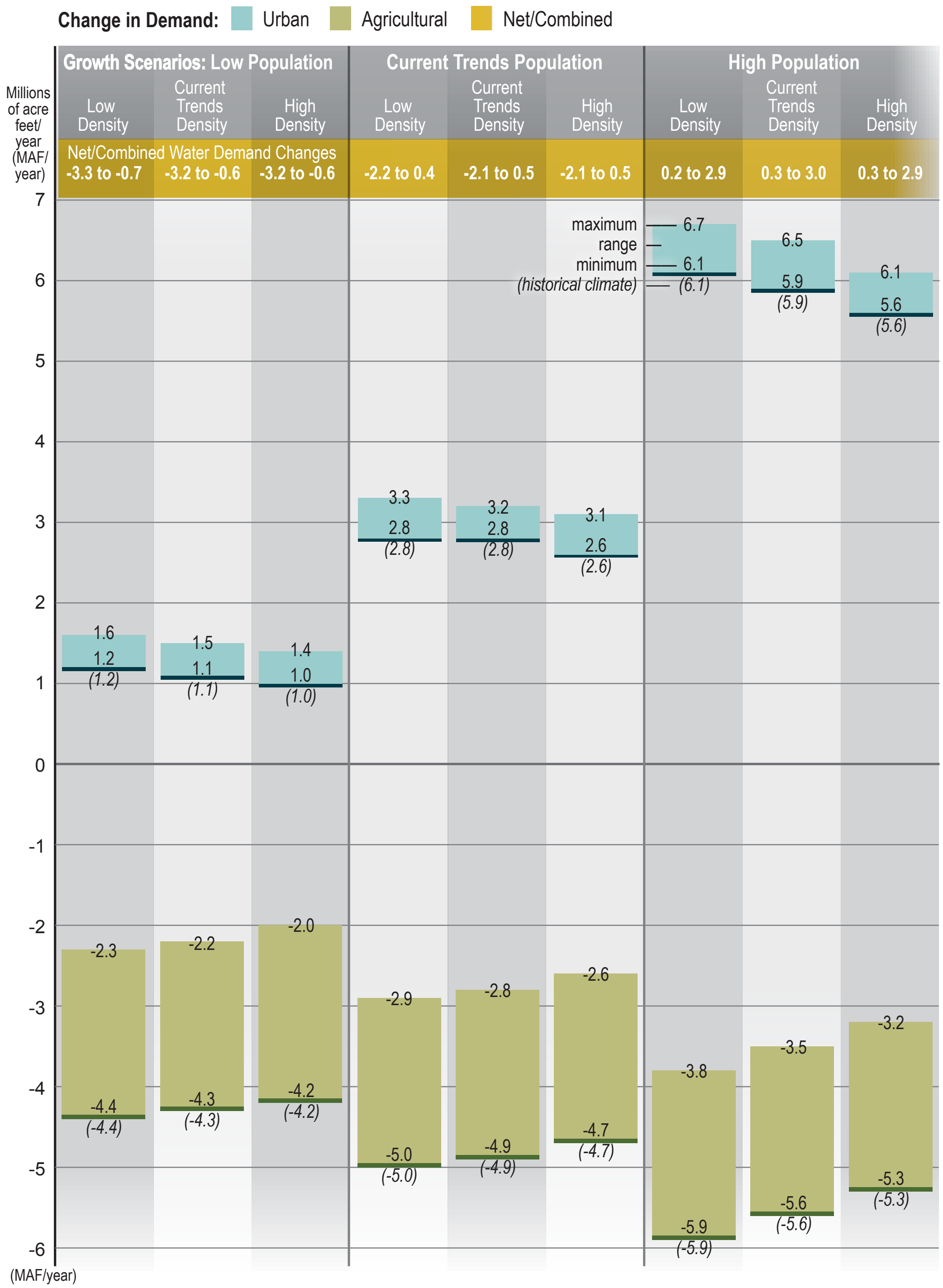
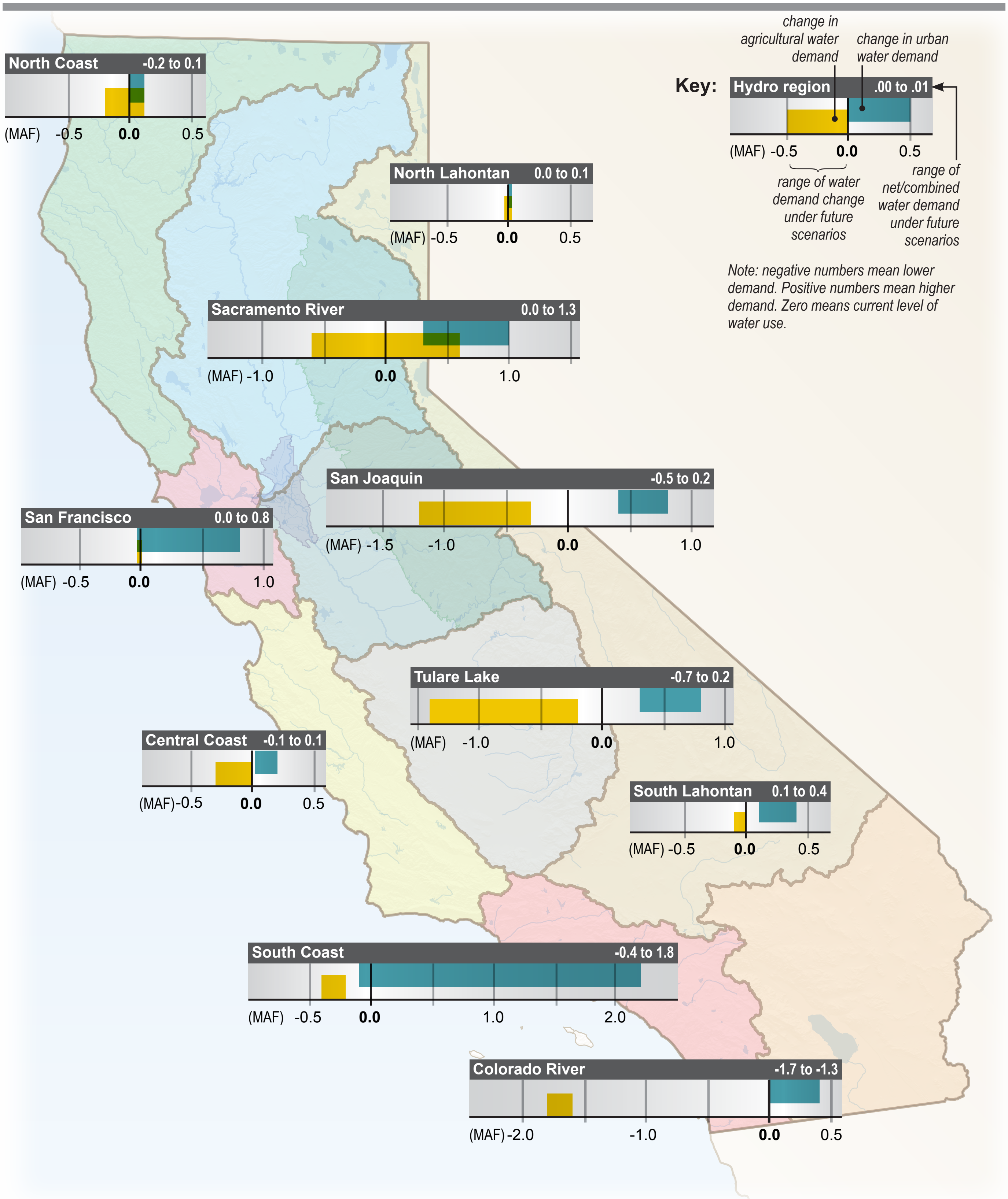


Figure 5-23 Change in Regional Agricultural and Urban Water Demands for 117 Scenarios from 2006-2050 (million acre-feet per year)



Box 5-6 U.S. EPA California Footprint Sustainability Indicators Suite

U.S. Environmental Protection Agency (EPA) Region 9 undertook the California Footprint Sustainability Indicators Suite to document such challenges as increasing population, aging infrastructure, depleting groundwater, degraded ecosystems, and a changing climate. The product includes the California Water Sustainability Indicators Framework, which involves the development of water sustainability indicators, water footprint, and a decision-support tool. A water footprint and an ecological footprint at a state scale have been developed for the first time to pilot the Decision Support Tool as a Global Earth Observation System of Systems project. The indicators suite also includes statewide indicators derived from satellite remote-sensing data -— a plant growth index and a total water and groundwater flux indicator with supporting data from the National Aeronautics and Space Administration's (NASA's) Gravity Recovery and Climate Experiment (GRACE). The project was funded by the EPA's Advance Monitoring Initiative and the California Department of Water Resources (DWR). Collaborators include the EPA's Office of Research and Development, DWR, University of California, Davis, the Pacific Institute, NASA's Jet Propulsion Laboratory, California State University, Monterey Bay, and the U.S. Geological Survey.

domains (e.g., water quality). The selected indicators are listed in Volume 4, *Reference Guide*, in Appendix D of the article "California Water Sustainability Indicators Framework."

Testing Sustainability Indicators with Pilot Studies

To assess the usefulness of the CWSIF for measuring water sustainability, it was tested at the state and regional scales. Draft sustainability goals and objectives were developed, based on Update 2009 objectives and resource management strategies. Indicators corresponding to the goals and objectives were chosen from the global literature and previous guidance in the CWP and other State planning documents. In the case of the State pilot, the sustainability goals and objectives, as well as the candidate indicators, were presented to various Update 2013 stakeholder forums, including the sustainability indicators interagency workgroup, State Agency Steering Committee, Public Advisory Committee, and Tribal Advisory Committee. The background, methods, results, and data downloads for the state and regional scale analyses are available at http://indicators.ucdavis.edu.

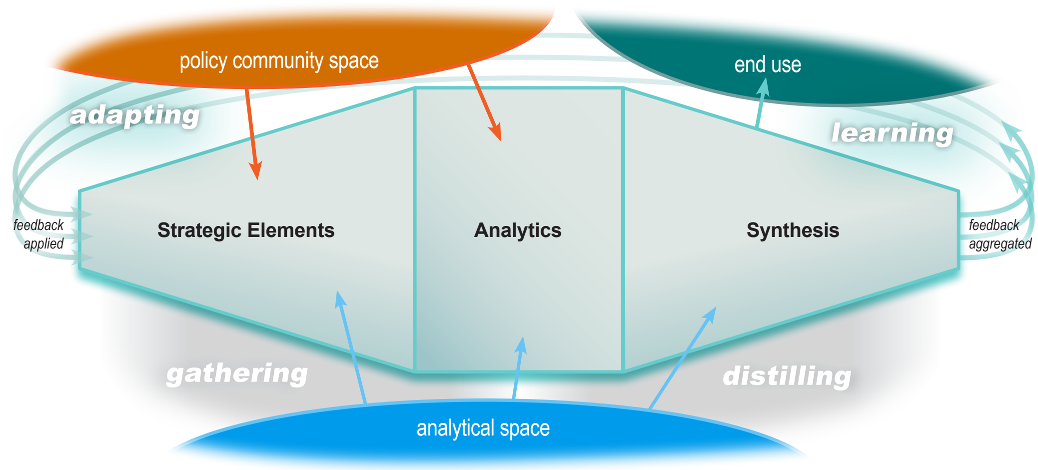
Statewide Pilot

Water sustainability indicators were evaluated at varying levels of specificity across the state, with the unit area of analysis depending on the specific indicator and data availability. For example, the water footprint and public perceptions of water management are measured at the state scale, whereas groundwater quality is measured at the well scale. Indicator evaluation included a conversion of the data to an equivalent sustainability score. The scores were calculated at the unit area of analysis, as well as being aggregated to each of the 10 hydrologic regions. The sections that follow include discussion of this analysis organized around the five water sustainability domains (see Table 5-6).

Water Footprint

A preliminary assessment has been conducted for California's Water Footprint. The Water Footprint can help identify water-related risks associated with California's consumption patterns.

Figure 5-24 Conceptual California Water Sustainability Indicators Framework

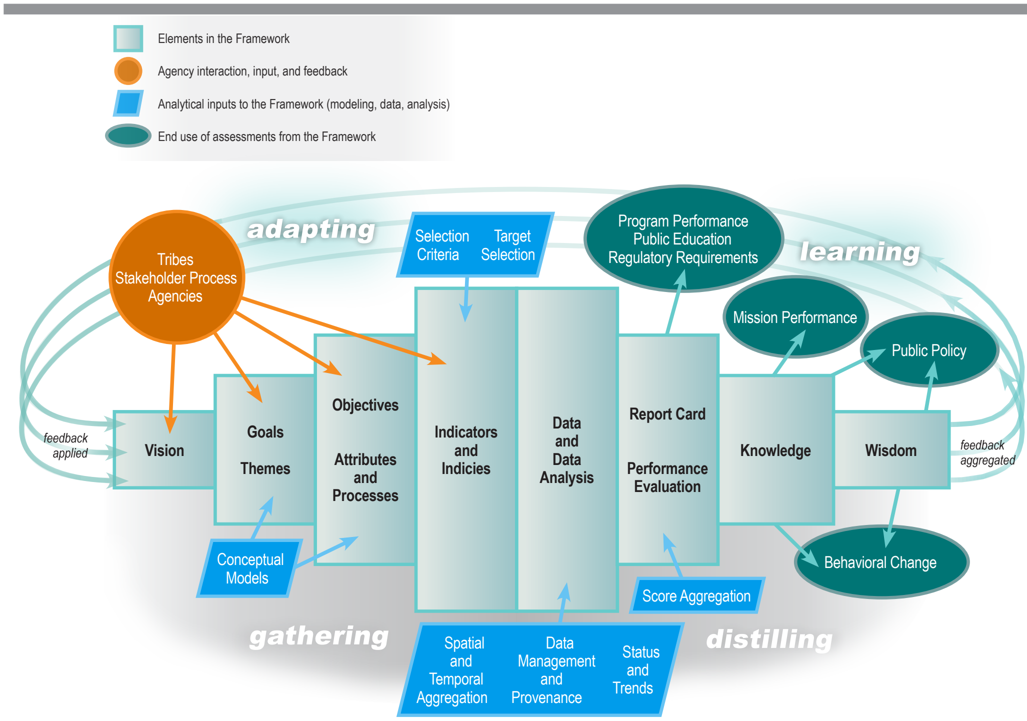


This risk results in part from the energy and hydraulic systems that distribute water, but also from changing hydrologic and ecologic conditions in California and in places that produce goods and services consumed in the state. By demonstrating the degree to which our state has externalized its Water Footprint by importing water-intensive goods, the Water Footprint analysis may encourage State and regional water strategic plans to consider the vulnerability associated with water-import dependency. The Water Footprint comprises three functions of water, each labeled by color: green water, blue water, and grey water. Green water is the amount of precipitation and soil moisture that is directly consumed in an activity, such as in growing crops. Blue water is the amount of surface or groundwater that is applied and consumed in an activity, such as in growing crops or manufacturing an industrial good. Finally, grey water is the amount of water needed to assimilate pollutants from a production process back into water bodies at levels that meet governing standards, regardless of whether those standards are actually met.

The current assessment estimates that California's overall Water Footprint — a measure of the total volume of freshwater that is used to produce the goods and services consumed by Californians — is 100 maf per year (Figure 5-26). This estimate represents the total amount of water used to support California's population and includes water for producing agricultural and industrial goods and energy products, as well as for residential, commercial, and institutional purposes. Nearly 20 percent of the total Water Footprint, or 20 maf, is associated with goods produced and consumed in California, which is referred to as California's Internal Water Footprint. About 80 percent of California's Water Footprint (80 maf) is associated with goods that are consumed in California but are produced outside of the state, and this is referred to as California's External Water Footprint. The majority of California's External Water Footprint relates to goods imported from other states and to a lesser degree from California's major foreign trading partners (e.g., Mexico, Canada, China). (See Box 5-7 for additional information about the Water Footprint as an index of sustainability.)

California's Water Footprint pertaining to the consumption of energy products within the state (herein "Energy Water Footprint") was also assessed. Figure 5-27 shows the amount of water required to produce the energy consumed in California between 1990 and 2008. As shown in Figure 5-27, before 2003, California's Energy Water Footprint was about 1.5 maf. During this

Figure 5-25 Details of the California Water Sustainability Indicators Framework



period, methyl tertiary butyl ether (MTBE) was added as an oxygenate to automotive gasoline to reduce air pollution, especially ground-level ozone and smog. By the end of 2002, however, MTBE was banned in California because it was detected in groundwater aquifers around the state. MTBE was replaced with ethanol in 2003. This change, as shown in Figure 5-27, led to a four-fold increase in California's Energy Water Footprint.

In 2008, the most recent year of analysis, the total Energy Water Footprint was 5.6 maf. More than two-thirds of this amount (4.0 maf) was green water, and the remainder (1.6 maf) was blue water. The green water portion of California's Energy Water Footprint is entirely attributable to bioethanol, most of which is blended with gasoline. The blue water portion of bioethanol adds a smaller, yet still significant, amount to California's Energy Water Footprint (0.4 maf). The process of increased blending of bioethanol in California's gasoline has also accelerated an externalization of the state's Energy Water Footprint. Figure 5-28 shows that, from 1990 to 2002, about half of California's Energy Water Footprint was external. In 2008, nearly 90 percent was external. The import of bioethanol from the U.S. Midwest is the primary driver of this phenomenon, though increased imports of other fuels, such as oil and natural gas, have also played a minor role.

Water Quality

Water Quality Index. There are many ways to measure water quality, including physical (e.g., temperature), chemical (e.g., pesticides), and biological (e.g., healthy algal communities) attributes. Water quality is affected by land and water development, as well as by natural processes. Land development leads to runoff of pollutants into local waterways and contributes to the degradation of water quality. One indicator of potential water quality is "impervious cover," which is the proportion of a watershed that has been covered by structures and related

Table 5-6 Water Sustainability Domains

Domain Name	Description
Water Supply Reliability	The availability or provision of water of sufficient quantity and quality to meet water needs for health and economic well-being and functioning
Water Quality	The chemical and physical quality of water to meet ecosystem and drinking water standards and requirements
Ecosystem Health	The condition of a natural system, including terrestrial systems interacting with aquatic systems through runoff pathways
Adaptive and Sustainable Management	A management system that can nimbly and appropriately respond to changing conditions and is equitable and representative of the various needs for water in California
Social Benefits and Equity	The health, economic, and equity benefits realized from a well-managed water system, including management of water withdrawal and water renewal

development. Our assessment shows that streams in most hydrologic regions appear to have good water quality (Figure 5-29). Streams in more urbanized regions are more likely to have moderate water quality scores. Averages at the hydrologic regions scale do not reflect local conditions, which may vary from exceptionally good to very degraded. In addition, specific point sources of impacts on water quality from agricultural drainage, for example, are not captured in this approach.

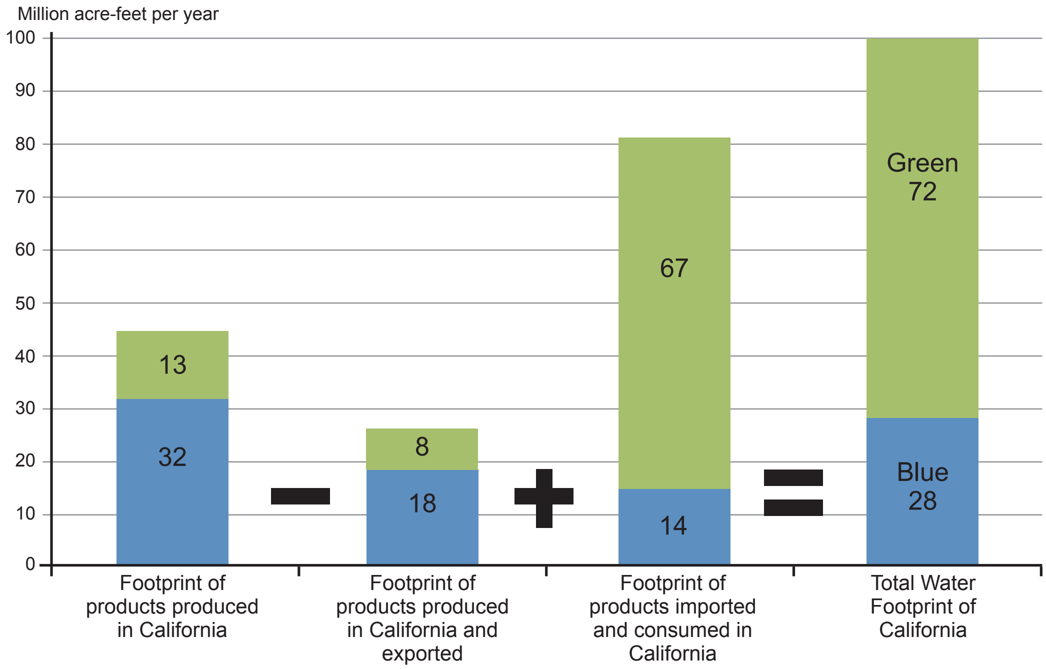
Ecosystem Health

Geomorphic Process. When land is developed, it changes stormwater runoff patterns and timing, constrains and modifies stream channels, and can exacerbate local and regional flooding. As is the case with the water quality index, impervious land cover is an indicator of land development that is useful for understanding modification of geomorphic processes. Streams in the urbanized San Francisco Bay and South Coast hydrologic regions are more likely to experience modified geomorphic processes than are rural and undeveloped areas (Figure 5-30).

California Stream Condition Index. Aquatic ecosystems have many varying attributes and processes that can be used to indicate the condition of the water body relative to standards of ecosystem health. One common attribute used as an index is the composition of fish and invertebrate communities, relative to historic or reference conditions. The California Stream Condition Index was developed by the State Water Resources Control Board (SWRCB) (Mazor et al., in prep.), as a way to estimate aquatic ecosystem health. The index is based on the presence of aquatic invertebrates, which are sensitive to stream disturbance and pollution. The analysis shows that ecosystem health in most regions appears to be good, except in the urbanized San Francisco Bay and South Coast hydrologic regions (Figure 5-31).

Native Fish Communities. Scientists have mapped the current and historic occurrence of most of California's native fish and many non-native fish (Moyle 2002; Santos et al. 2013). The ratio of current ranges to historic ranges was used to calculate a score for fish communities. The analysis shows that in the northern half of California, most fish communities have nearly all native species present. By contrast, in the agricultural Tulare Lake Basin, urban South Coast, and desert regions, many streams have few and sometimes no native fish species (Figure 5-32).

Figure 5-26 California's Blue and Green Water Footprint



Adaptive and Sustainable Management

Public Perception of Water Systems. The public expects clean and readily available water. Their expectation is usually that this public resource will be provided through State and local agencies, using public funds and based on policies that maintain the resource in trust. Measuring public understanding and support for water management and water policies is one proxy measure for how well State and local agencies are stewarding public trust resources. Three metrics were used to gauge public perceptions of current and future water supply management: (1) security of a region's water supply, (2) threat of climate change effects on water availability, and (3) appropriate management strategies to sustainably manage water systems in the future. The data is from surveys conducted by the Public Policy Institute of California (http://www.ppic.org/main/datadepot.asp).

Security of Water Supply. A little over one-third of respondents were very concerned about the current state of water supplies (Figure 5-33), and a similar proportion were concerned about water availability by 2019 (Figure 5-34), though these perceptions varied by region. A lower regional score is illustrative of a higher level of concern about water supply security for the region.

Threat of Climate Change Effects on Water Availability. At least half of the respondents have some level of concern about the effects on future water availability from droughts influenced by climate change (Figure 5-35). This perception varied only slightly by region. A lower regional score is illustrative of a higher level of concern about the threat of climate change in the region.

Future Sustainable Management of Water Systems. When asked about water management to meet future human needs, half of Californians favored managing and using existing supplies

Box 5-7 Water Footprint as an Index of Sustainability

The California Water Plan includes California's Water Footprint as a broad index of demand for water resources by the people of California. The State's water footprint is a measure of the total volume of freshwater that is used to produce the goods and services consumed by Californians. This water use is measured in terms of the volume of water consumed (i.e., evaporated or incorporated into a product) in a given year. The water footprint has an internal and external component. The internal water footprint is the water required to make the goods that are produced and consumed within California, as well as the direct use of water inside the state. The external water footprint includes the water required to make goods in other places that are then imported and consumed in the state.

Monitoring how California's Water Footprint has changed over time can help planners understand how the state's water resources are being used, as well as how its population is being supported by both internal and external water resources. As shown in Figure A, California's Water Footprint has changed dramatically over the past two decades. During this period, the water footprint has doubled, from about 55 million acre-feet (maf) in 1992 to 100 maf in 2010. During this period, California's internal water footprint has declined, while the external water footprint has grown dramatically, suggesting that the state has become increasingly reliant on external water resources. In addition, California's water resources have been increasingly devoted to products that are exported and consumed outside of the state.

Water footprint assessments address the complex ways in which humans interact with natural systems, such as the water cycle. Much of this complexity has to do with the global nature of California's economy, where goods and services are traded across regions, states, and among distant countries. So, for Californians, the goods and services we consume might be produced in many different places around the world. Thus, California affects and is affected by water resource conditions in other countries and other parts of the United States. A change in water availability elsewhere could affect not only California's economy, but also the way water is used here. Hence, the California Water Sustainability Indicators Framework definition of sustainability implies a need to recognize water use not only within California but also in locations where the products consumed in California are produced. The Water Footprint index helps address this complex task in a systematic way and may be used to address important issues related to sustainable water use in the state. For more information on California's Water Footprint, see in Volume 4, Reference Guide, the article and the 2012 report by the Pacific Institute, "Assessment of California's Water Footprint," at http://pacinst.org/publication/assessment-of-californias-water-footprint/.

Figure A California's Water Footprint

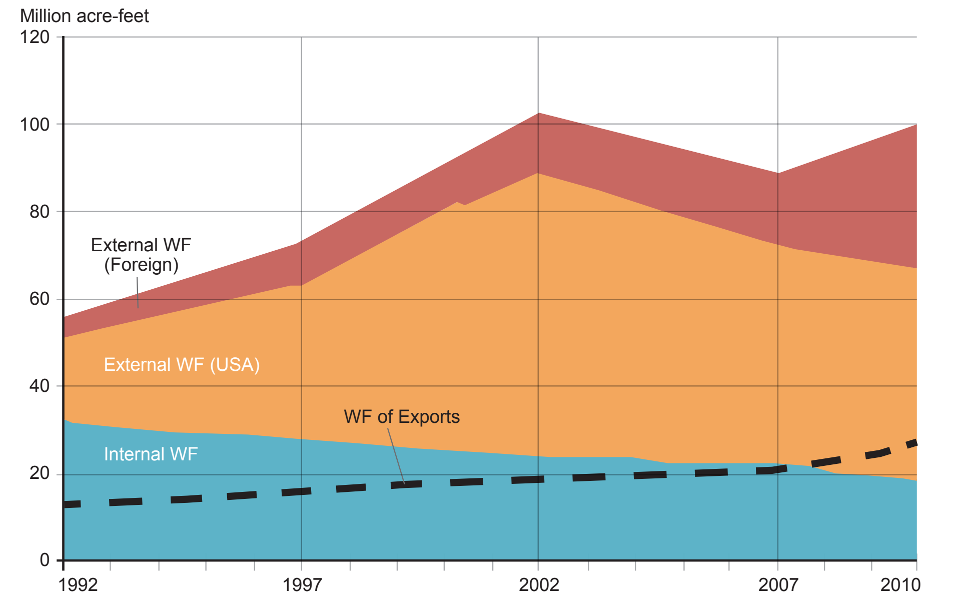


Figure 5-27 California's Energy-Related Blue and Green Water Footprint

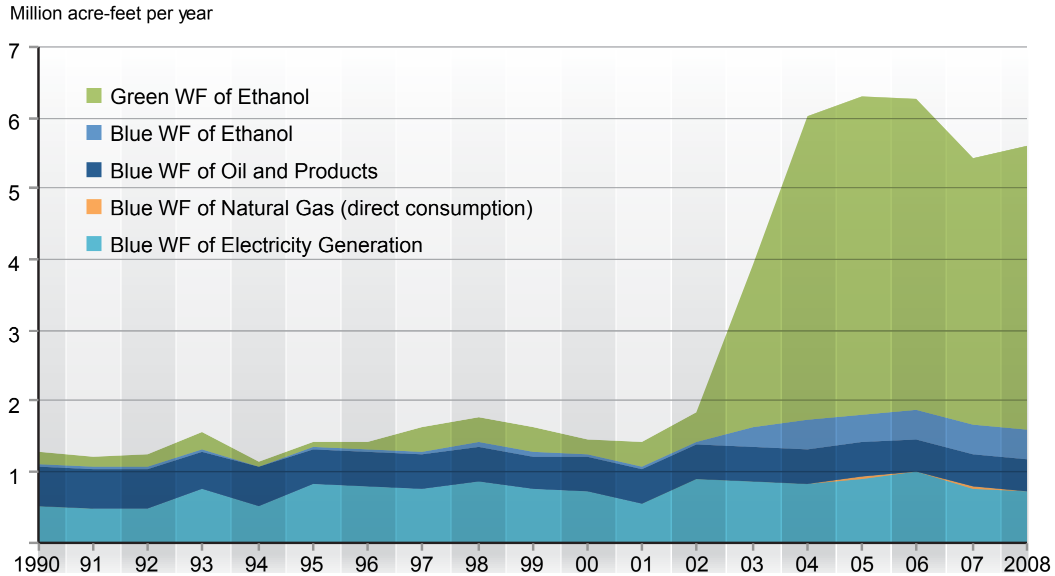
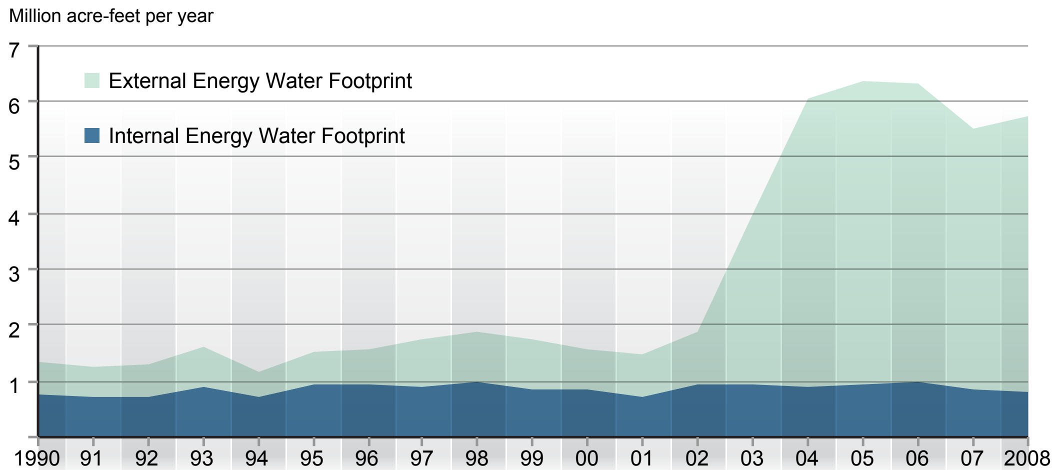


Figure 5-28 California's Energy-Related Internal and External Water Footprint



more efficiently (Figure 5-36). More than half of the people surveyed favored spending more money on improving conditions for native fish, with a third of the people favoring doing so even if their water bills went up (Figure 5-37).

Social Benefits and Equity

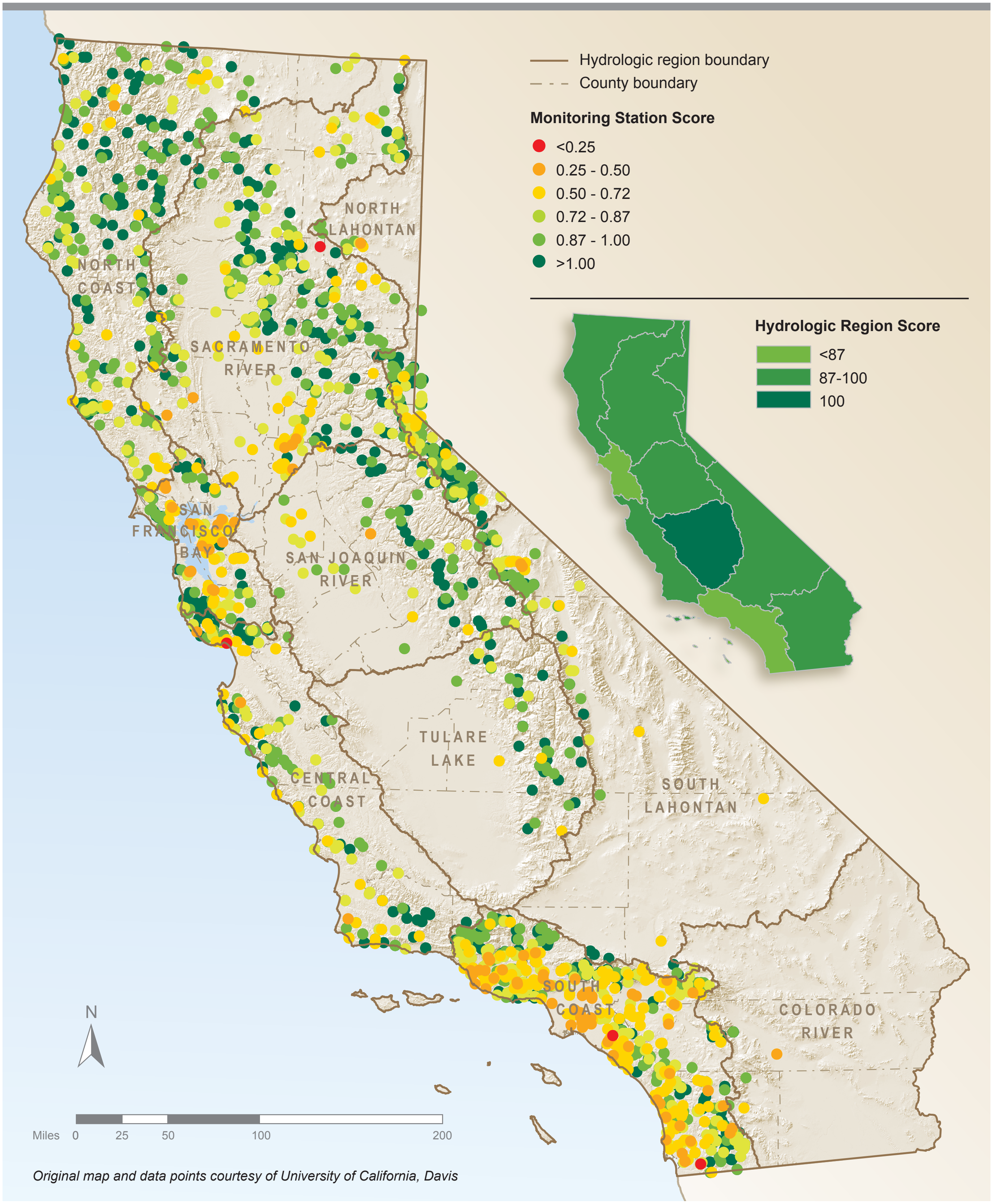
Groundwater and Drinking Water Contamination. Water sustainability rests on the principle that people have equitable access to such public-trust resources as water, and disparities in benefits and burdens are minimized. Accordingly, access to clean drinking water is a key component of water sustainability. In California, there are many contaminants that can and

Figure 5-29 Water Quality Index Score for Hydrologic Regions

Figure 5-30 Geomorphic Process Score for Hydrologic Regions

Original map and data points courtesy of University of California, Davis

Figure 5-31 California Stream Condition Index Score by Site and for Hydrologic Regions



Original map and data points courtesy of University of California, Davis

have made their way into groundwater, the primary drinking-water source for the majority of Californians (State Water Resources Control Board 2013). Because contaminant concentrations can be reduced to levels below legal thresholds through mixing with cleaner source-waters and through treatment, most people drink clean water most of the time in California. The California Legislature passed Assembly Bill 2222 in 2008, requiring the SWRCB to report to the Legislature on communities that rely on contaminated groundwater and the principal contaminants in groundwater. Nitrate was identified as the most common groundwater contaminant originating from human activities and was found to be second overall after arsenic. Certain community water services rely exclusively on groundwater and have exceeded maximum contaminant levels (MCLs) for various contaminants at some time during the last 10 years. The presence of nitrates and the reliance on contaminated groundwater are two indicators that can be used to understand where in California groundwater is affected by contaminants. Regions of California vary in both the concentration of nitrates in groundwater and community reliance on contaminated water (Figure 5-38). Inland and coastal agricultural regions have the highest number of communities reliant on contaminated groundwater exceeding the nitrate MCL of 45 milligrams per liter.

Regional Pilot

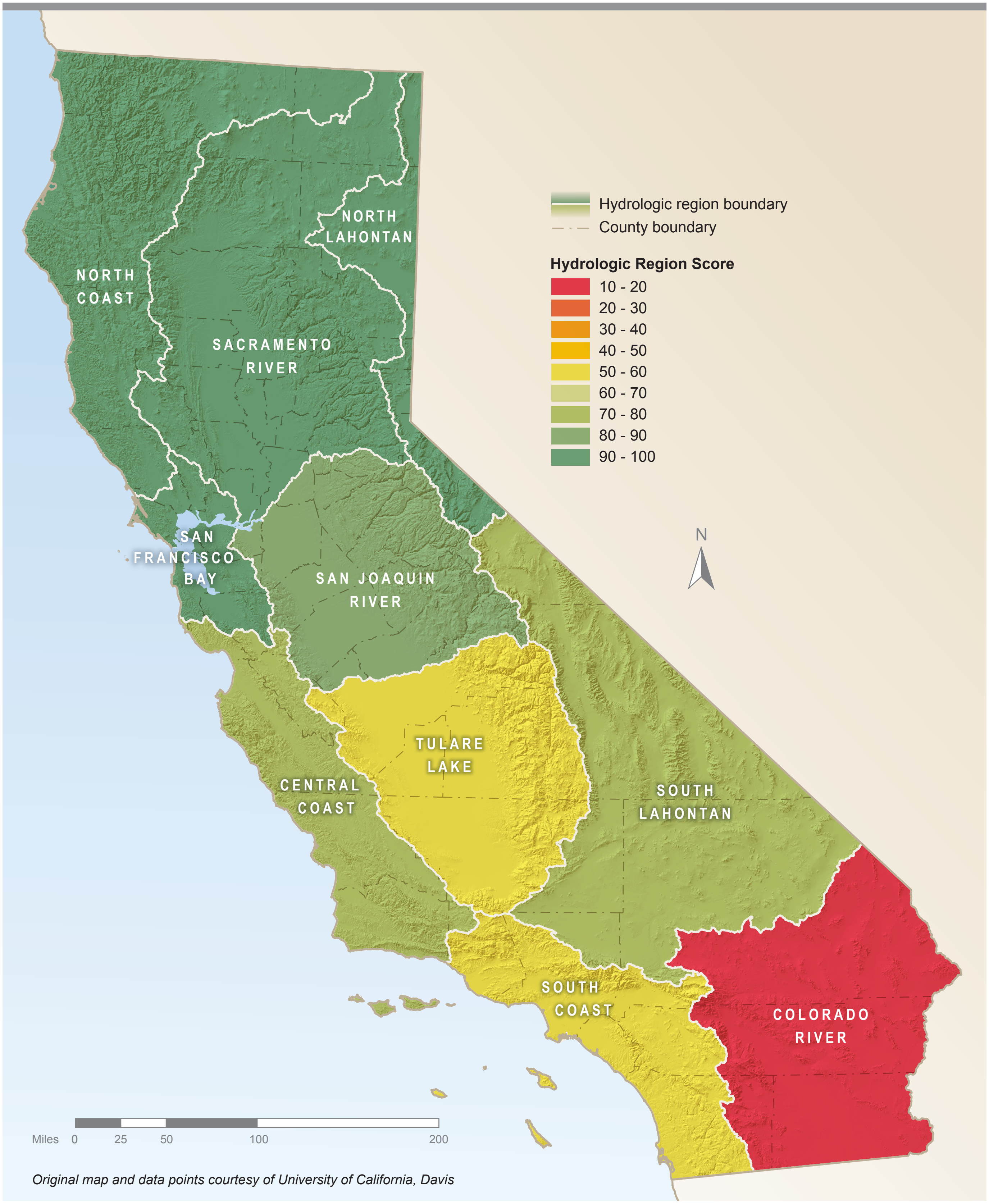
To test the CWSIF at the regional scale, the CWP considered a dozen potential pilot study areas. The Santa Ana Watershed Project Authority (SAWPA) was selected as a willing and able regional pilot partner because of their technical capacity and the fact that they were currently engaging a broad range of stakeholders in regional planning, through their One Water One Watershed 2.0 (OWOW2.0) process (visit http://www.sawpa.org/owow/). The OWOW2.0 process relies on "pillars," which are stakeholder groups focusing on particular issues of regional importance, as well as on advisory committees of member water agencies. In partnership with the SAWPA and the Council for Watershed Health (CWH), goals, objectives, and candidate indicators were developed to test the CWSIF and evaluate water sustainability for the regional pilot. Indicators were selected by the SAWPA and the CWH for the regional scale that had uniform data availability and that corresponded to the OWOW 2.0 goals and objectives. Indicator selection was vetted by the OWOW team and pillars at various stages of development. The findings for the regional pilot are available in Volume 4, *Reference Guide*, in Appendix B of the article "California Water Sustainability Indicators Framework – Final Report."

Summary

IWM is the basis for California's water planning. This umbrella approach recommends that California and its regions consider how a portfolio of resource management strategies, as described in Volume 3, might meet multiple water management objectives, in light of many risks and uncertainties, and ensure sustainable use of water resources. DWR and other entities are conducting various risk assessments so that risks can be better balanced with the rewards for improved management. Update 2013 introduced the CWSIF to ascertain how the objectives of the CWP, associated resource management strategies, and recommended actions would lead to sustainable water use and supply for the state and its 10 hydrologic regions.

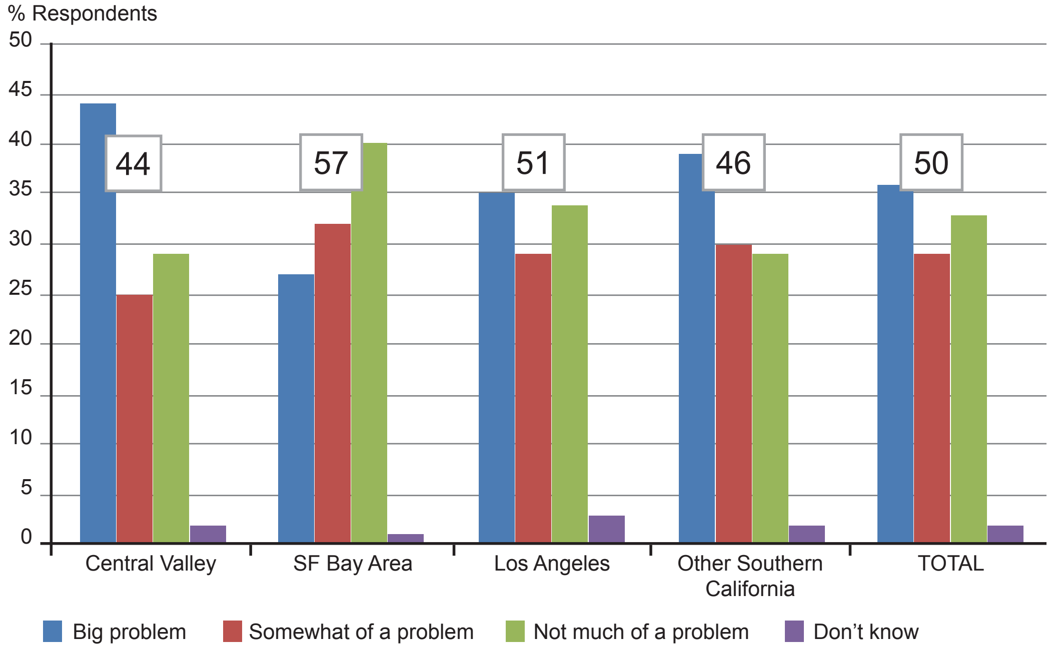
Update 2013 evaluated how statewide and regional water demands might change by 2050 in response to uncertainties surrounding future population growth, land use changes, future climate change, and other factors. These future uncertainties will play out quite differently across the regions of California, so each region will need to choose and implement a portfolio of resource

Figure 5-32 Fish Community Score for Hydrologic Regions



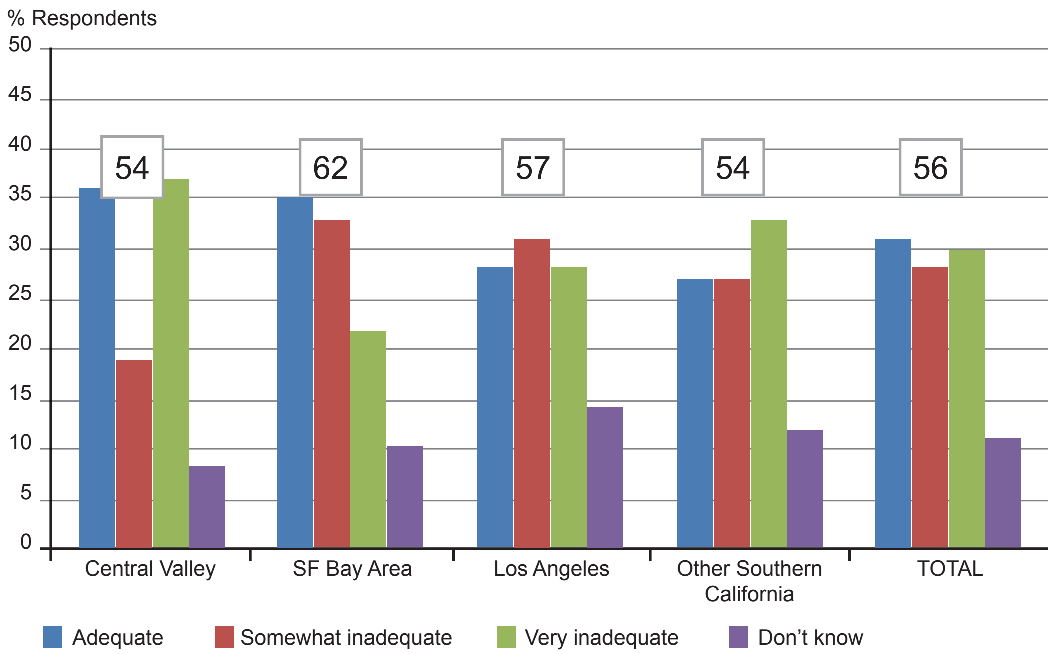
Original map and data points courtesy of University of California, Davis

Figure 5-33 Public Perception by Region of Threats to the Public Water Supply



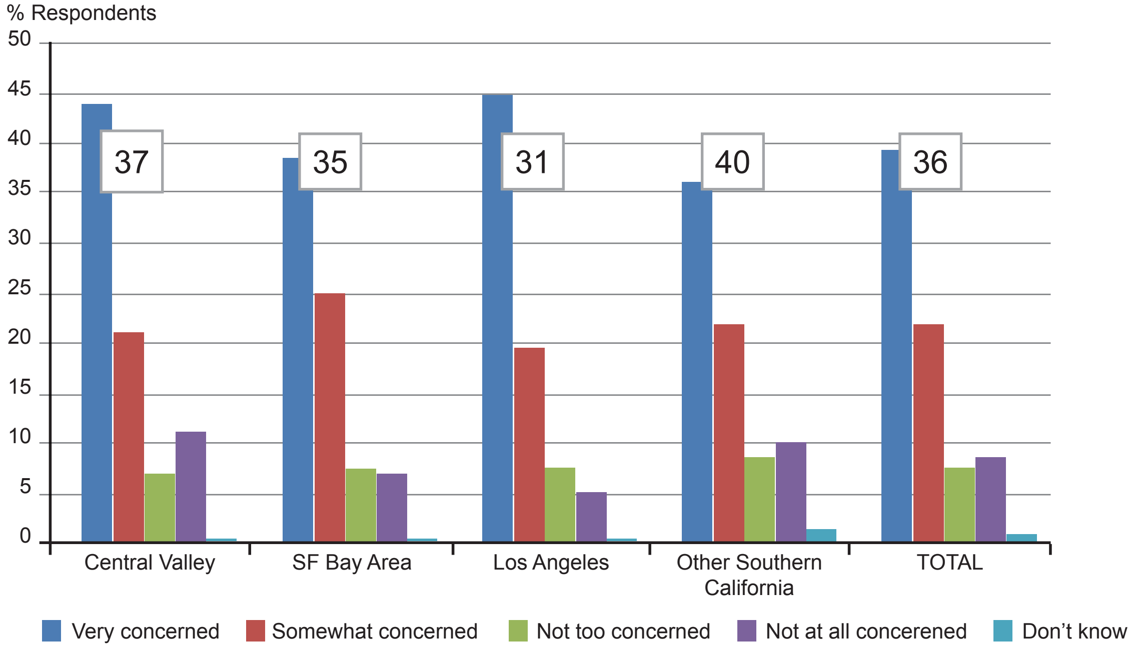
Notes: December, 2012; sample size = 7,315 respondents. Scores are shown in boxes above each regional summary.

Figure 5-34 Public Perception of Security of Future Water Supplies



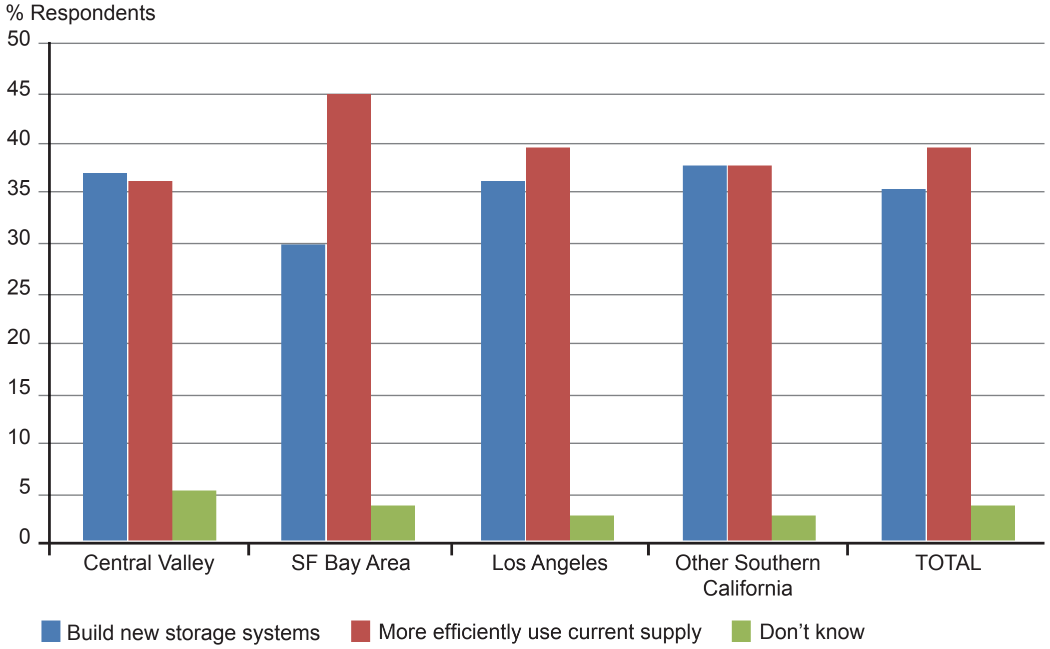
Notes: December 2009; sample size = 1,825 respondents. Scores are shown in boxes above each regional summary.

Figure 5-35 Public Perception of Effects of Climate Change on Future Water Supply



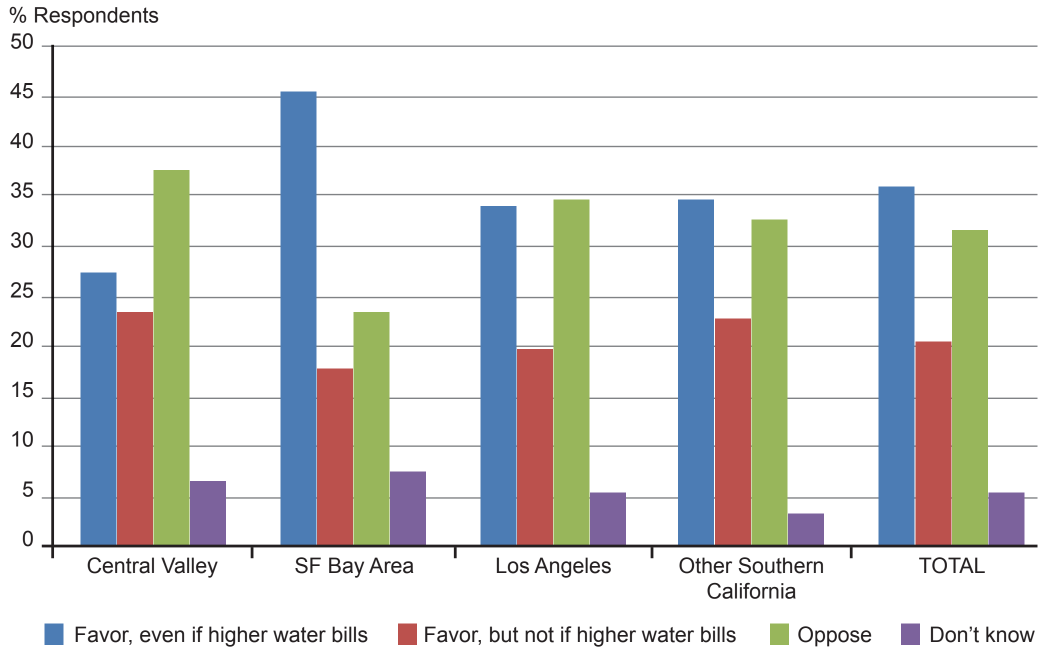
Notes: July 2011; sample size = 4,580 respondents. Scores are shown in boxes above each regional summary.

Figure 5-36 Public Perception of Future Water Management Strategies to Maintain Water Supply



Notes: December 2012; sample size = 3,904 respondents.

Figure 5-37 Public Favor for Improving Conditions for Fish, Including Payment Strategies



Note: December, 2012.

management strategies that consider regional water-management challenges. Update 2013 also conducted a more comprehensive vulnerability analysis for the Sacramento River, San Joaquin River, and Tulare Lake hydrologic regions to test longer term analytical enhancements for the CWP. This analysis tested different response packages, or combinations of resource management strategies, under many future uncertainties. These response packages help decision-makers, water managers, and planners develop and evaluate IWM plans that invest in actions with more sustainable outcomes.

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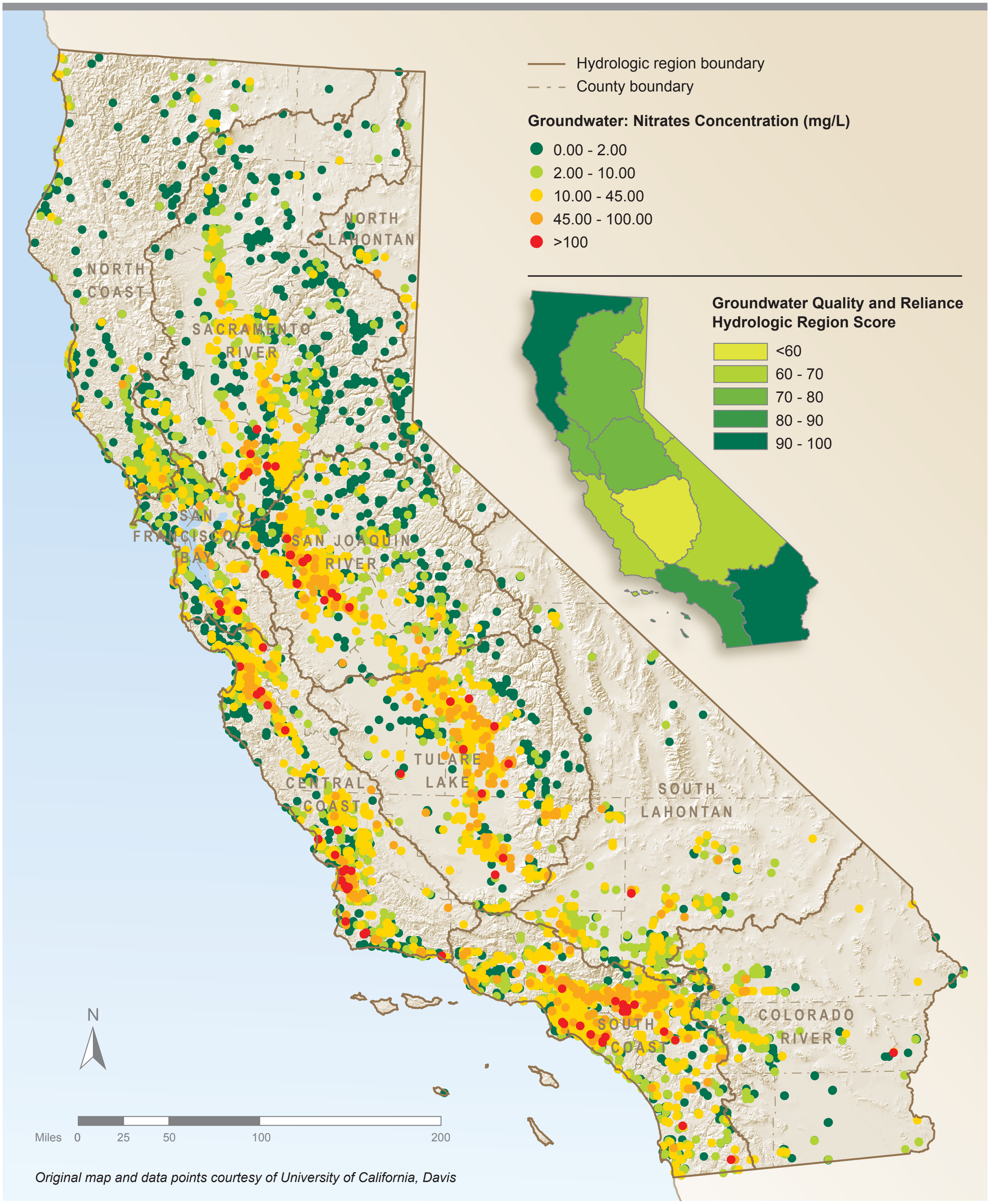
Figure 5-38 Groundwater and Drinking Water Contamination Score for Hydrologic Regions



Original map and data points courtesy of University of California, Davis

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VOLUME 1 - THE STRATEGIC PLAN

CHAPTER 6

Integrated Data and Analysis: Informed and Transparent Decision-Making

Data-collection flights over the Sierra Nevada Mountains. In April 2013, DWR and NASA's Jet Propulsion Laboratory conducted aerial snowpack surveys as part of the Airborne Snow Observatory Program. Aerial surveys measure snowpack depth; spectrometer readings gauge snowpack reflectivity. Combined with data from the traditional manual snow surveys and electronic sensors, this information provides a better estimate of California's water supply. Snowpack information informs reservoir operations for flood control and allows the major water projects to predict water allocations for the coming year.

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Chapter 6. Integrated Data and Analysis: Informed and Transparent Decision-Making

About This Chapter

Chapter 6 describes a roadmap and key actions needed to improve water resources information and analysis for integrated water management (IWM) by State government, particularly the California Department of Water Resources (DWR); many other research institutions; and federal, tribal, regional, and local water management entities. It describes how quality information, robust analysis, and public engagement can inform the key policy components of the California Water Plan (CWP), including desired outcomes, core values, statements of intent, and recommendations. The chapter concludes with needed enhancements to stakeholder process, analytical tools, and information needed to support IWM and more transparent decision-making. Refer to Chapter 8, "Roadmap For Action," in this volume for the objectives and related actions involving integrated data and analysis and water technology.

This chapter is organized into the following sections:

- Purpose and Motivation.
- Informing California Water Plan Policy with Quality Information and Analysis.
- Integrated Data and Analysis.
- Technical Enhancements to Support Integrated Data and Analysis.
- Summary.

Purpose and Motivation

California encounters significant challenges with balancing many diverse interests affected by water policy decisions. These challenges are amplified by fragmented and poorly communicated information that is informed by analyses that cannot fully evaluate the many alternative and often competing water management objectives and tradeoffs. While extensive information affecting water management is collected by many federal, state and regional programs, the information often resides in separate silos. There is a critical need for information sharing and management to support water policy decisions that provide a common and transparent understanding of water problems and potential solutions across many organizations. Achieving IWM with multiple benefits requires a transparent description of dynamic linkages between water supply, flood management, water quality, land use, environmental water, and many other factors. The CWP promotes the use of collaborative processes and technical enhancements consistent with the CWP goals and objectives to assist decision-makers to move California toward a more sustainable future.

Arundo donax, a non-native reed-like grass, negatively affects water quality and supply, decreases flood protection, increases erosion and fire hazards, and displaces riparian habitat and wildlife. Collaborative efforts are underway to replace this invasive species with native riparian vegetation.

Informing the California Water Plan with Quality Information and Analysis

The CWP provides statewide water policy guidance in a numbers of ways. The CWP vision (as presented in the "Vision" section of Chapter 8, "Roadmap for Action") describes a desired future where California has healthy watersheds and integrated, reliable, and secure water resources. The CWP describes several desired outcomes for the future, such as managing resources in a way that provides for public safety, environmental stewardship, and economic stability. Policy guidance is also provided in the core values, objectives, and related actions. During the *California Water Plan Update 2005 process*, DWR worked with the Public Advisory Committee to develop 28 policy questions that the CWP should address quantitatively. Some of the key questions are shown below. See Volume 4, *Reference Guide,* the article, "Policy Questions for the California Water Plan Needing Quantitative Information," for the full list of questions.

- What are estimates of the local, regional, and statewide components of the hydrologic cycle in California?
- What are the current resource management strategies and uses, what are potential future strategies and uses, and how are these estimated for all sectors (agricultural/environment/urban) and all levels (local, regional, statewide)?
- What are some of the benefits and tradeoffs between different resources management strategies?
- How does water scarcity affect the economy, the environment, and all beneficial uses?
- What are the most pressing current and future local, regional, and statewide water management problems and what are potential solutions to the problems?
- How will climate change affect water management in the future?
- How should California manage flood events and floodplains?

It is essential to support policy guidance in the CWP with good science and quality information and analysis. The CWP is building an analytical framework that effectively and collaboratively links water policy with the best available information, science, and technical information and analytical tools. Information should be collected for not only evaluating specific problems, but also to measure the effectiveness of policies, programs, and projects. Analytical tools need to provide information about the benefits, costs, and tradeoffs to address the policy questions described above. The CWP must develop an analytical framework with public engagement that provides a road map for improving information management and analytical tools, and address the day-to-day realities of managing programs with limited resources.

Integrated Data and Analysis

IWM is a foundation of water planning in California and the CWP. This is a multi-objective approach that encourages using a mix of resource management strategies to provide broad benefits. These strategies include water use efficiency, water recycling, desalination, and storage as well as strategies for protecting and improving water quality, managing floodplains, runoff and watersheds, and restoring ecosystems. Volume 3, *Resource Management Strategies, of California Water Plan Update 2013* (Update 2013), identifies numerous strategies to help meet regional and statewide IWM objectives. Communities can plan, invest, and diversify their water portfolios by using these management strategies to become more self-reliant, relying on local supplies and resources, and minimize conflicts with other resource management efforts and other regions.

Currently, many integrated regional water management (IRWM) plans are only integrated in a conceptual sense and do not quantify how proposed regional actions might affect the water management system in other parts of the state. IWM needs better information and analytical tools to connect information about the benefits and tradeoffs about water quality, environmental objectives, economic performance, social equity objectives, and surface water and groundwater interaction. Today, it is difficult to access and compare, much less integrate, information from different local entities to understand and resolve regional water management issues, and it is even more difficult to understand the statewide linkages. To make significant progress toward a more comprehensive scientific understanding, California needs to improve water information exchange and management, and develop integrated analytical tools that can be used to document and share knowledge. Investments in information exchange and integrated analytical tools will help facilitate consensus-based decisions that are a key part of IWM.

The following sections highlight three examples of analysis performed for IWM that have significantly increased the need for improved water management information with robust and transparent technical analysis.

Flood Management

Flood management seeks to include structural and non-structural methods to manage high water events and seeks to enhance the ability of undeveloped floodplains and open spaces to reduce the damage of flood events and the implementation of land use practices that minimize the risk to lives and property while enhancing environmental stewardship. This multifaceted approach to flood management relies on the integration of multiple strategies to achieve the broad goal of improving flood management and reducing risk. Analysis of flood management strategies requires water management information and analytical tools that are useful to daily or hourly time scales. It also requires accurate information on levee construction details, channel capacities, effects of in-channel vegetation and structures, existing and future land uses, and the environmental benefits associated with floodplain inundation.

Ecosystem Restoration and Ecosystem Services

Ecosystem restoration can include changing the flows in streams and rivers; restoring fish and wildlife habitat; controlling waste discharge into streams, rivers, lakes or reservoirs; or removing barriers in streams and rivers so anadromous fish like salmon and steelhead can reach spawning areas. Ecosystem restoration improves the condition of California’s modified natural landscapes and biotic communities to provide for the sustainability and for the use and enjoyment of those ecosystems by current and future generations. In many cases, ecosystem restoration activities include economic benefits in the form of ecosystem services, which are economic goods and services derived from natural systems. Scientists are often only able to estimate environmental and economic benefits of restoration projects qualitatively because of scientific uncertainty about both the effects of proposed projects and how species respond to different environmental factors such as water flow and water temperature. In addition, only limited historical data is usually available on ecosystems, their relative health, and how they would respond to management actions.

Adapting to Climate Change

As a result of global climate change, California's future hydrologic conditions are changing from patterns observed during the past century. There is much scientific uncertainty about how each of the widely varying regions in California will be affected by climate change. Predictions include increased temperatures, reductions to the Sierra snowpack, earlier snowmelt, and a rise in sea level although the degree, extent, and timing of the changes remain uncertain. These changes could have major implications for water supply, flood management, and ecosystem health. See the articles "Climate Change Adaptation Strategies for California's Water" and "The State of Climate Change Science for Water Resources Operations, Planning, and Management" in Volume 4, *Reference Guide*, for a discussion of these changes.

Technical Enhancements to Support Integrated Data and Analysis

This section describes several currently unmet crosscutting actions that are critical for the long-term improvement of California's technical capabilities consistent with the Strategic Analysis Framework envisioned by the California Water and Environmental Modeling Forum (CWEMF) in its 2005 report. (See http://www.cwemf.org for additional information about CWEMF.) Although significant resources are needed to implement them, these activities would greatly enhance the ability of scientists and engineers to support IWM and decision-making in light of uncertainties. They must be viewed as long-term commitments to improve California's technical infrastructure through research, development, and collaboration.

Several agencies and institutions are engaged in long-term efforts to improve California's water resources information and analytical capabilities (see Box 6-1, "Entities Engaged in Long-Term Technical Improvements for Statewide Water Management"). These efforts are focused on detailed models that form the backbone of water management analysis in California. Developing simpler decision support tools ultimately must be verified against these detailed models. Each of the entities in Box 6-1 has long-term strategic plans for technical improvements for their particular area of responsibility. What are missing are the crosscutting actions that transcend the individual efforts to provide widespread integration of water resources information and analysis.

To support IWM, institutions should work together to prioritize and align the water resources information that is collected. Improvements in management of water resources information will make it easier for institutions to report, use, and analyze available information. As relationships between institutions develop, gaps in water management data will become transparent and resources can be allocated to address those data gaps to improve the overall understanding of

Box 6-1 Entities Engaged in Long-term Technical Improvements for Statewide Water Management

- The U.S. Geological Survey is active in a wide range of surface water and groundwater monitoring, development of analytical tools, and analysis of water resources problems.
- The U.S. Army Corps of Engineers is responsible for developing numerous analytical tools used for watershed and flood management analysis.
- DWR maintains several water monitoring programs and is responsible for the development of analytical tools of the Sacramento-San Joaquin Delta.
- DWR and the U.S. Bureau of Reclamation jointly maintain an analytical tool of the Central Valley Water Management System.
- Researchers at the University of California develop and maintain numerous analytical tools as part of specific research projects.

water in California in space and time. Integration of information should begin with the largest users or collectors of water information. The sections below describe three critical areas where technical enhancements are needed to support integrated data and analysis:

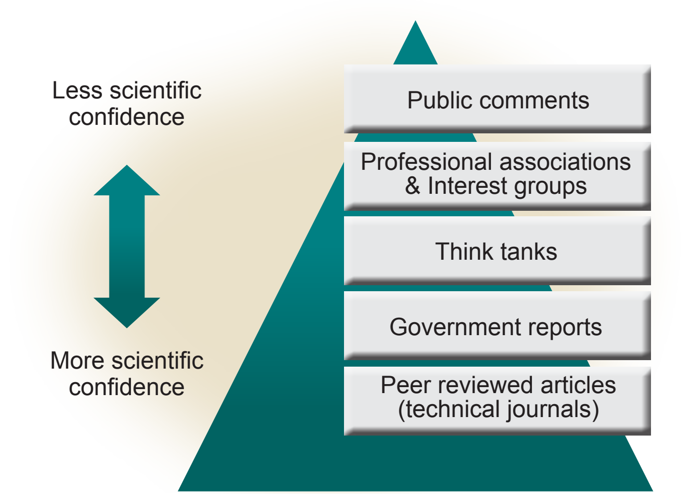
- Linking collaborative processes with technical enhancements.
- Providing effective analytical tools.
- Improving and sharing information.

Linking Collaborative Process to Technical Enhancements

This section describes some of the current processes the CWP has in place and proposes enhancements to this process to be more transparent about the information used to guide water policy. It is important for the CWP to be clear about the scientific confidence and the process it uses for vetting analytical tools and information used to guide water policy. The CWP uses information from many sources. Much of the information is generated by subject matter experts applying analytical tools developed specifically for the CWP. Other information is collected from a wide range of sources including peer-reviewed articles, government agencies, think tanks, professional associations, and public interest groups. Each of these information sources comes with its own scientific confidence with respect to how the information was developed. Figure 6-1 shows how the confidence associated with different information sources might vary.

The CWP employs a rigorous public process to receive feedback on the information used to guide water policy. This includes the use of external expert panels, policy advisory groups, and technical advisory groups to advise the appropriate application of available information and analytical tools. DWR convened the Statewide Water Analysis Network (SWAN) to assist with formulating recommendations on technical improvements needed to support the CWP. (See http://www.waterplan.water.ca.gov/swan for additional information about the activities of SWAN.) SWAN, a voluntary network of scientists and engineers, has met several times during development of Update 2013 to provide advice on the quantitative deliverables for the CWP, including the recommendations contained in this chapter. DWR has also convened a Climate Change Technical Advisory Group to advise DWR on the scientific aspects of climate change, its impacts on water resources, the use and creation of planning approaches and analytical tools,

Figure 6-1 Sources of Information



and the development of adaptation responses. (See http://www.water.ca.gov/climatechange/cctag.cfm for additional information about the Climate Change Technical Advisory Group.) DWR shares information regularly and meets periodically with these advisory groups for the purpose of receiving advice on the scientific confidence and policy relevance of CWP content. After considering all advice received, the CWP relies on the professional judgment of subject matter experts to evaluate sources of information and available analytical tools and decide what and how to apply the available information to develop key findings and recommendations.

Enhancement: Implement Shared Vision Planning

DWR is pursuing the approach and methods of Shared Vision Planning (SVP) in the CWP to achieve these technical goals and outcomes:

- Achieve better integration and consistency with other planning activities.
- Obtain consensus on quantitative deliverables.
- Build a common conceptual understanding of the water management system.
- Improve transparency of the California Water Plan information.

The term Shared Vision Planning is most closely associated with the U.S. Army Corps of Engineers' Institute for Water Resources that has implemented the approach and methods since the National Drought Study in the 1990s. (See http://www.SharedVisionPlanning.us for additional information.)

SVP integrates tried-and-true planning principles, systems modeling, and collaboration into a practical forum for making water resources management decisions. It addresses the need for broad involvement of decision-makers and stakeholders in the technical analysis. Aside from the intensive and continuous collaboration, what defines SVP is the use of collaboratively developed decision support tools that help with plan formulation and evaluation. These SVP tools are designed to be transparent and easy-to-use, and they integrate hydrologic simulations with economic, environmental, and other considerations that are relevant to understanding the water management system. Benefits that result from SVP are a shared understanding and vision of the system, identification of alternatives that are both technically and politically feasible, and increase consensus on implementation of decisions.

DWR believes that the SVP approach can be expanded beyond its current emphasis on model building at the watershed scale to the broader concept of improving California's technical analysis infrastructure (methods and tools) through greater interactions with stakeholders and decision-makers. Through SVP, the needs of stakeholders can inform the development of the analytical tools so that they are more relevant when responding to current and future problems. For further information, refer to Related Action 10.9 in Chapter 8, "Roadmap For Action."

Enhancement: Form an IWM Technical Committee

Technical enhancements cannot occur in a vacuum. IWM requires a collaborative and coherent technical program among State and federal agencies and academia to provide the broadest and most cost-effective solutions to today's technical challenges. Improving communication, cooperation, and collaboration among technical experts and government agency decision-makers is needed for data collection, management, and exchange and analytical tool development and applications. An institutional framework is needed to facilitate and sustain a collaborative and coherent technical program among State and federal agencies and academia. The IWM Technical Committee should consist of entities identified in Box 6-1 and coordinate with related efforts like the Delta Science Plan and ongoing activities of the California Water and Environment Modeling Forum. For further information, refer to Related Action 10.1 in Chapter 8, "Roadmap For Action."

Providing Effective Analytical Tools

Decision-makers often must take action on issues that affect water management when there is significant uncertainty either about the basic scientific understanding of the water management system or about the political or social acceptance of particular water management alternatives. For example, scientists today cannot describe precisely what long-term climate change will mean for water and flood management in California. However, enough is known about the potential impacts to prompt decision-makers to enact a series of measures to reduce greenhouse gas emissions and implement adaptation strategies. Analytical approaches need to be improved to effectively quantify where scientific uncertainties exist, allow for collaborative decision-making to help overcome political and social disagreements, and identify actions that will have sustainable outcomes.

The CWP has identified several technical barriers in effectively evaluating California's future water conditions. Often there is no detailed quantitative information about the costs, benefits, and tradeoffs associated with different water management strategies. Water resources information, analytical tool development, and information management and exchange have not kept pace with growing public awareness of the complex interactions among water-related resources. California lacks a consistent framework and standards for collecting, managing, and providing access to information on water and environmental resources essential for integrated regional resource management. For example, four separate statewide surveys of urban water use by different entities result in duplicative efforts by those reporting the information and these surveys often have inconsistent responses. Improvements to water resources information, information management, and analytical tools can reduce many uncertainties about the state's current and future water resources, how water supplies, demands, and water quality respond to different resource management strategies, how ecosystem health and restoration can succeed, and how California can adapt its water system to reduce controversy and conflicts.

Enhancement: Develop a Common Conceptual Understanding of the Water Management System

One of the greatest obstacles to quantifying consensus-based water management strategies is the lack of a common means of describing quantitatively, clearly, and concisely how water is managed and how it flows in the environment. For example, there are several alternative and scientifically valid ways of approximating the complex relationships between streamflow, groundwater recharge, water diversions, and applied water use. The result is that technical experts, decision-makers, and stakeholders have an extremely difficult time communicating with one another about important features and interdependencies of the water management system. Analytical tools used for complex analyses are too obscure for all but a few people, but decision-makers and stakeholders are often asked to accept results from these complex analyses on faith.

It is necessary to develop a way to describe the different pieces of the water management system conceptually and how the pieces interact with each other. One approach is to use the iterative development process that is widely used in the software development industry to assist with the development of a conceptual model of the water management system. This iterative approach is based on object-oriented thinking and allows a team to identify and describe the relevant aspects of the real world that should be represented in an analytical tool. The conceptual model will be developed collaboratively to document the requirements of the system and a shared understanding of the water management system. For example, Figure 6-2 shows a conceptual model of the water management system with relationships among its components. Figure 6-3 represents a sample schematic of the water management system from the Water Evaluation and Planning System model (see http://www.weap21.org). These two figures represent alternative views of the water management system.

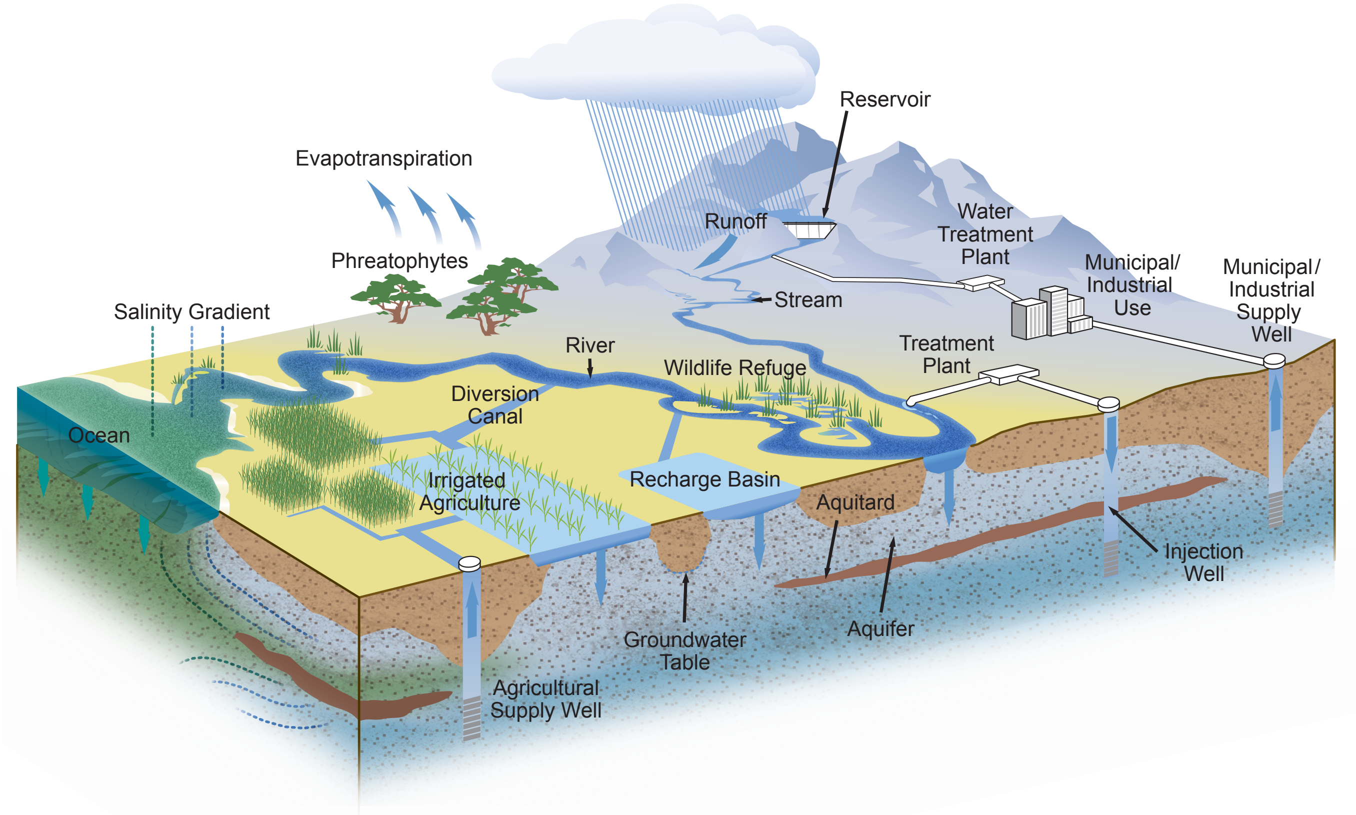
One method for documenting the products developed through an iterative process uses the Unified Modeling Language, which is a visual modeling language based on standard notation to describe systems in terms of objects, relationships, interactions, sequence diagrams, and state changes. Figure 6-4 shows an example describing the relationships between water users and water providers by using Unified Modeling Language standard notation. For further information, refer to Related Action 10.11 in Chapter 8, “Roadmap For Action.”

Enhancement: Develop Common Schematics of the Water Management System

California’s water system is large and complex and has multiple challenges, including a disconnection between areas of water demand and areas of water supply both in space and time. An organized information system is needed that reveals water sources, water supply infrastructure, water needs, water quality, ecosystem functions, flood management, and climate change to identify effective water management actions and potential water system vulnerabilities. It is necessary to create an integrated water resources information system for California where the connectivity between water sources, water supply infrastructure, and water demands are related with their associated data.

Numerous existing schematics of California’s water management system are used by local, State, and federal agencies to perform water planning studies. These schematics are embedded in several planning models that provide incomplete, overlapping, and often inconsistent representations of California’s water management system. For example, models like the Water Resource Integrated Modeling System (WRIMS, formerly known as CALSIM), the California

Figure 6-2 Conceptual Model of Water Management System

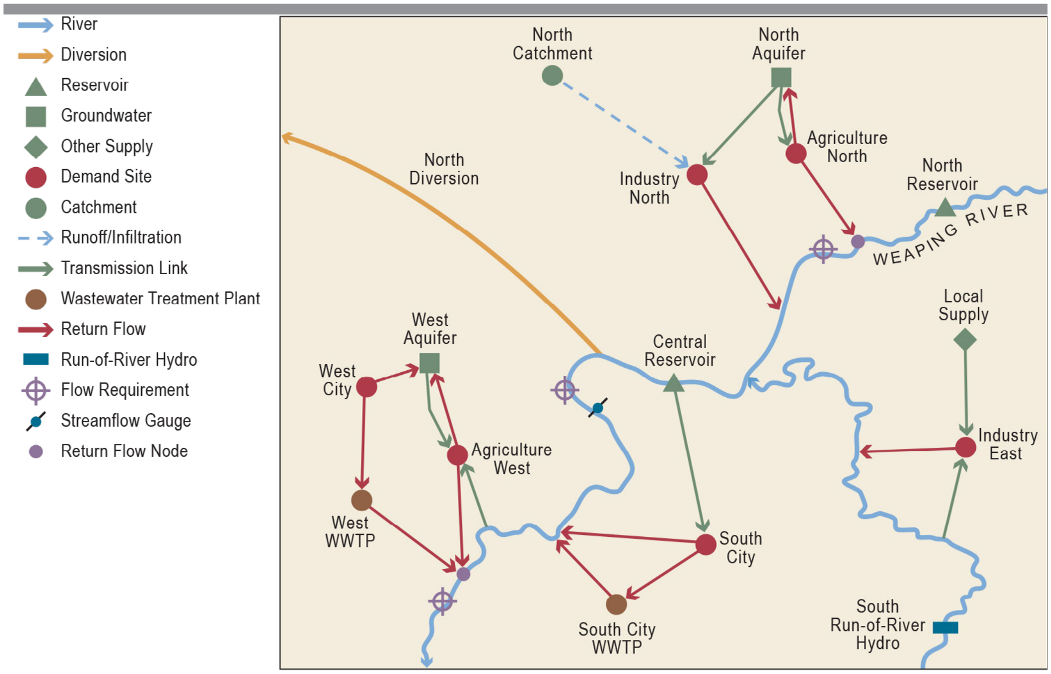


Value Integrated Network Model (CALVIN), Water Evaluation and Planning System (WEAP), and Central Valley Production Model (CVPM) represent water management in portions of the Central Valley, but it is difficult to share data among them and determine whether they use information consistently. These models often represent the water management system at a coarse level and may not provide information at the scale needed for planning by a local water agency. Development of common schematics would facilitate a better understanding of California's water management systems and allow integration with other models and sources of information. A common schematic accompanied by a geodatabase is needed to show the connectivity of California's water resource systems and to serve as a repository of information where data can be shared among governmental and non-governmental institutions. For further information, refer to Related Action 10.8 in Chapter 8, "Roadmap For Action."

Enhancement: Establish Modeling Protocols and Standards

The movement toward IWM has increased the desire and need for integration of water management information and analysis. A critical part of integrated analysis is the development of modeling protocols and standards to allow analytical tools to be linked to each other or used in concert more effectively. This is consistent with the need for standards and protocols for information exchange. CWEMF developed modeling protocols (California Water and Environmental Modeling Forum 2000) that need to be updated and implemented by the entities responsible for model development activities. The objective of the CWEMF modeling protocols is to provide guidance to water stakeholders, decision-makers, and their technical staff as models

Figure 6-3 Sample Schematic of Water Management System



Source: Stockholm Environment Institute 2013

are developed and used to solve California's water and environmental problems. CWEMF identified the following benefits that would be achieved by California's water community from adherence to modeling protocols:

- Improved development of models.
- Better documentation of models and modeling studies.
- Easier professional and public access to models and modeling studies.
- More easily understood and transparent models and modeling studies.
- Increased confidence in models and modeling studies.

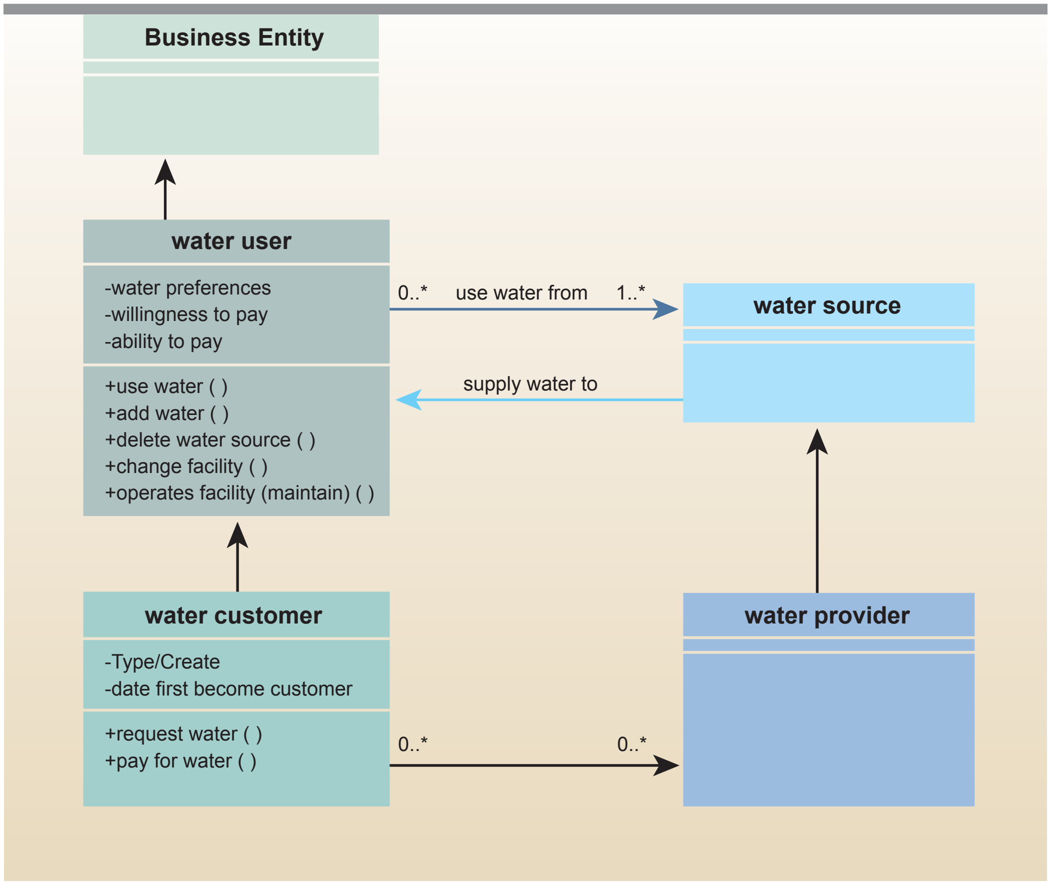
For further information, refer to Related Action 10.12 in Chapter 8, "Roadmap For Action."

Enhancement: Supporting Analysis for the California Water Plan

Many of the policy questions the CWP should address can be quantified in relationship to the resource management strategies described in Volume 3. While there is no existing analytical tool that can quantitatively capture all the complex issues, the CWP is employing analytical tools to systematically evaluate the performance of regional resource management strategies in the face of a number of critical uncertainties, including population growth, land use decisions, and climate change. Chapter 5, "Managing an Uncertain Future," describes uncertainties confronting water managers and how the CWP is quantifying these uncertainties.

The CWP is employing the following guidelines to link policy questions more effectively with quantifiable information:

Figure 6-4 Example Diagram Using Unified Modeling Language Standard Notation



- Apply SVP to develop a common conceptual understanding of the water management system, and seek consensus on the technical studies. See the section above, Linking Collaborative Processes with Technical Enhancements to learn about Shared Vision Planning.
- Develop an integrated analytical framework that captures dynamic linkages between water supplies, flood management, water quality, land use, and environmental stewardship.
- Use an integrated analytical framework to evaluate the full spectrum of uncertainties that confront water planning in California, including climate change, land use decisions, demographic changes, and other factors.
- Evaluate the results of these analyses using an appropriate set of performance metrics, considering robustness and risk.
- Develop a strategy to help evaluate the effectiveness of policy recommendations in the CWP.
- Develop an information exchange system to share results of studies more effectively.

DWR has initiated several technical enhancements that are directly relevant to production of the CWP and are improvements to existing procedures used to quantify core CWP content described in the Assumptions and Estimates Report (see http://www.waterplan.water.ca.gov/cwpu2013/ae). These enhancements have been identified through the CWP collaborative processes and by the technical experts conducting the work. It is expected that implementation will occur over many years and even decades due to the technical complexity of these activities combined with the scarce resources to perform the work. The following is a summary of key CWP deliverables, with a brief description of the technical enhancements underway.

Water Portfolios

The water portfolios are estimates of present water balances of water uses and supplies for each region in California (see Chapter 3, "California Water Today"). The water portfolios are aggregated to spatial scales unique to the CWP, including the detailed analysis unit, planning area, and hydrologic region. Technical enhancements will allow this information to be evaluated at boundaries used by water purveyors and regional water management groups. A significant part of this work is to transition from the existing spreadsheet-based data storage of the water portfolio information to an enterprise data management system that will facilitate sharing of information through the Internet. Additional enhancements are underway to describe the hydrologic cycle components more fully within the water portfolios, groundwater in particular.

Future Scenarios

The future scenarios are part of the CWP analysis to evaluate resource management strategy performance for a range of population growth projections, water demand and supply assumptions, and climate uncertainty. Chapter 5, "Managing an Uncertain Future," describes the work completed for Update 2013 on the future scenarios and provides a summary of the limitations. Future technical enhancements will expand the analysis beyond the Sacramento River, San Joaquin River, and Tulare Lake regions, and explore ways to quantify flood risk reduction and water quality benefits. For further information, refer to Related Action 10.10 in Chapter 8, "Roadmap For Action."

Water Sustainability

The water sustainability deliverable includes the development and application of an analytical framework for identifying, computing, and evaluating sustainability indicators. Chapter 5, "Managing an Uncertain Future," describes the water sustainability work completed for Update 2013. Future technical enhancements will expand the number of indicators evaluated, will refine the spatial scale of indicators to focus on regional sustainability, and will improve upon the decision support tool described next.

Water Sustainability Decision Support Tool

Assessing water sustainability requires information about natural and human components of water systems. This information can be conveyed to improve knowledge in a number of ways. Narrative description of how processes work, or how management improves or degrades sustainability, helps to build one type of understanding. Other ways include map-based approaches, showing where opportunities for action exist, and charting and graphing approaches, which can show when or how something is changing. A combination of these approaches can contribute to the knowledge base required to inform sound decisions about sustainability and is the basis of

Snow surveyors measure the water content of the Sierra snowpack, to forecast water supply conditions for the upcoming dry season.

the water sustainability Decision Support Tool (DST) for California collaboratively developed by University of California, Davis, DWR, and the U.S. Environmental Protection Agency (EPA) Region 9 Office. The DST includes the water sustainability indicators discussed in Chapter 5. Additionally, the DST includes two indices (ecological footprint and water footprint) and two indicators based on satellite remote-sensing data (the total water and groundwater flux indicator based on the Gravity Recovery and Climate Experiment [GRACE] satellite data) and the plant growth index (PGI) of land cover change. The purposes for developing the DST include:

1. Reporting status and trends of social, economic, and ecological condition indicators attributable to water sustainability goals and objectives.

2. Visualizing and understanding data and results from the water footprint and water sustainability indicators analyses.

3. Providing policy-relevant planning and implementation information for agency staff and support for public input into planning processes. The overarching goal is to engage state and local policy-makers, planning decision-makers, planning staff, and interested citizens in a conversation about water sustainability.

Available at http://indicators.ucdavis.edu, the DST provides information from global resources about sustainability indicators. It also gives access to the California Water Sustainability Indicators Framework, a foundational document describing the process of developing sustainability indicators, collecting and analyzing data, reporting results, and interpreting the meaning of results for decision-making. It catalogs the indicators proposed for the CWP and gives examples of sustainability indicators evaluated for California. Finally, it provides information about the ecological and water impacts of production and consumption in California, which can contribute to understanding how to become more sustainable.

Finance Decision Support System

The Update 2013 Finance Planning Framework is based on the best available data, tools, models, and subject matter expert opinion. Many technical capabilities will require continued development and refinement to increase uniformity, accuracy, quantitative analysis, and comparability of information and approaches; advance scientific understanding; and generally reduce uncertainty. Here is a partial list of uncertainties to be addressed in future CWP updates:

- Co-dependence of activities.
- Systemic analysis and optimization.
- Standardization of methods, information, and estimates.
- Identification of leveraging opportunities, return on/value of investments, and diminishing returns.
- Assigning economic value to environmental assets and services.
- Avoiding double counting of costs.

Improving and Sharing Information

Water-related information is collected and maintained by many local, regional, State, federal, and tribal governments, agencies, and organizations. A wealth of information already exists, but remains siloed in multiple institutions that do not share information effectively with one another.

There is a need to improve ways of sharing information as quickly as it is collected or generated to support daily operational decisions. Some entities,such as the Metropolitan Water District of Southern California, have made inroads into effective integration of information from its water retailers. In contrast, the CWP does not have a fully transparent linkage between the information collected from local entities and reported at the hydrologic region. In part, this is a result of the labor-intensive process of collecting relevant information across the state and converting it into a useful format for the CWP.

Enhancement: Reduce Information Gaps and Limitations

The CWP describes much of the current water resource information in regional water-flow diagrams (see Volume 2, *Regional Reports*, and Volume 5, *Technical Guide*). Flow diagrams characterize a region's hydrologic cycle. Completing more comprehensive regional flow diagrams and water balances requires more detailed information on land and water use, surface and groundwater supplies, and the ability to differentiate between applied and consumptive water uses. The following categories of information are not uniformly available throughout the state for use by the CWP:

- Land use — native vegetation, urban footprints, nonirrigated and irrigated agriculture.
- Groundwater — total natural recharge, subsurface inflow and outflow, recharge of applied water, extractions, groundwater levels, pumping-induced land subsidence, and water quality. Senate Bill 6, enacted in November 2009, provides a significant improvement in access to groundwater information by requiring local agencies to monitor and publish groundwater levels.
- Surface water — natural and incidental runoff, local diversions, return flows, total stream flows, conveyance seepage and evaporation, runoff to salt sinks, and water quality. Senate Bill 8, enacted in November 2009, provides for improved accounting of location and amounts of surface water diversions.
- Consumptive use — evaporation and evapotranspiration from native vegetation, wetlands, urban runoff, and nonirrigated agricultural production.
- Soil moisture characteristics — water saturation, porosities, and field capacities.
- Environmental/biological data — species monitoring and their habitat water requirements.
- Land elevations and channel bathymetry.
- Current and future price of water by supply source.

The information highlighted above is available for some regions and not for others. For example, methods and data to estimate natural runoff are available for regions such as the Sacramento Valley, where the Sacramento-San Joaquin Delta (Delta) is a central outflow measurement location. In such areas like the South Coast Hydrologic Region, with no central point for outflow measurement and substantial groundwater extraction, the natural runoff is more difficult to estimate. Existing data are not easily gathered or disaggregated to provide convenient access for all areas of interest. In addition, budget constraints limit the data collection and management activities necessary to quantify and track all the water in the state. The result can be data sets consisting only of older, less current information or significant gaps in available information. For further information, refer to Related Actions 10.2, 10.3, and 10.5 in Chapter 8, "Roadmap For Action."

Enhancement: Develop a Strategic Plan to Improve Water-Related Information

The strategy to improve water-related information should include a method to identify and unify institutional data sets, and also to state the objectives of unifying data sets clearly and how information exchange can benefit the diverse needs of different institutions. The goal is not to construct a single repository of water-related information, but to share the available information across many entities effectively. There are many diverse water needs and uses that require specific information to meet the objectives of each institution: supply (both urban and agricultural), quality, land use, flood protection, and environmental water needs. It is important for institutions to understand available data and develop a long-term data management policy that will benefit all institutions involved in water management.

The following steps should be considered when developing a strategic plan for water information:

- Identify what information is collected by different institutions involved in water management and determine how it fits together.
- Collaborate with custodians of water information to identify mission-critical information needs, and focus on the most important areas of information collection and management.
- Identify where there is overlap in information collection and look for areas of institutional collaboration.
- Determine the data needs of local water suppliers and water management agencies. What kind of data would local water management officials like to see and what data should be provided to them from a water management perspective that they do not have access to?
- Construct an agreement for institutions on a method of sharing information that contributes to an understanding of local, regional, and statewide water management.
- Develop methods for water suppliers to communicate with each other and guide discussions about water information management.

For further information, refer to Related Actions 10.2, 10.3, and 10.5 in Chapter 8, "Roadmap For Action."

Enhancement: Integrating Urban Water Management Plans, Integrated Regional Water Management Plans, and the California Water Plan

Urban water management plans and the CWP are required by law to be updated in five-year cycles. Both plans require significant resources to develop information about current and future water uses and water supplies. Both plans are also used to make significant planning and policy decisions about how to invest and how much to invest in California's local and statewide water management systems. Better integration is needed to ensure that both plans are using the best available information so that decision-makers can have confidence in water policy decisions and the public can have confidence in these investments. Similarly, better integration is also needed to ensure consistency between the CWP and integrated regional water management plans.

Enhancement: Water Planning Information Exchange

DWR is building an online information exchange system called the Water Planning Information Exchange (Water PIE) to share water-related information among state, regional, and local agencies and governments, universities, and the public. This type of online information exchange system is being designed to support regional partnerships by providing a common way of developing and sharing information. It will support streamlined development and evaluation of IRWM, agricultural water management, urban water management, and groundwater management plans by providing a common vocabulary, basic information needed to develop effective plans, and a venue for sharing information generated by the plans. The exchange will facilitate collection of water-related information and data across wide ranges of entities that collect and store these types of information and data. An information management system such as Water PIE will also enhance the opportunities for collaboration with academic and research institutions by improving access to the most current information throughout the state. A prototype system called the Integrated Water Resources Information System (IWRIS) was developed by DWR as the first step for Water PIE (see Box 6-2 ,"IWRIS — A Working Information System"). For further information regarding Water PIE, refer to Related Action 10.7 in Chapter 8, "Roadmap For Action."

Enhancement: Hobbes Data and Analytical Tool Management System

The University of California, Davis, is leading the development of a software system, Hobbes, to create an open, organized, and documented quantitative representation of the state's intertied water resources system. Geocoded elements in this database can be interactively converted into tiered networks that can be downloaded and solved by multiple modeling platforms with the appropriate translators depending on user preferences. Many Hobbes tools will be web-based, with exporting capabilities to the most common analytical and modeling software.

The Hobbes Project will include:

- Database standardization and data documentation.
- Geocoded data element representations.
- Open platform with web access.
- Ability to transform database elements into documented model inputs via co-development.
- Focus on data and database structure, organization, and documentation, not specific model platforms.

For further information regarding Hobbes, refer to Related Action 10.8 in Chapter 8, "Roadmap For Action."

Using Trimble R8 Rovers, DWR engineers collect GPS Real Time Kinematic topographic observations to capture the channel cross-sectional geometry at Chowchilla Bifurcation Structure. Topographic data also was collected along the top of the levees and at structures to periodically track the general subsidence trends in the area. Identified trends in the topographic data help hydraulic modelers determine how the conveyance capacity of the channel is changing over time.

Box 6-2 IWRIS — A Working Information System

In May 2008, DWR launched a working prototype of the Water Planning Information Exchange (Water PIE) called the Integrated Water Resources Information System (IWRIS). IWRIS is a data management tool for water resources data. It is a Web-based geographic information system (GIS) application that allows users to access, integrate, query, and visualize multiple sets of data. Some of the databases include DWR Water Data Library, California Data Exchange Center, U.S. Geological Survey streamflow, and Local Groundwater Assistance Grants (AB 303), as well as data from local agencies. IWRIS can be accessed at http://www.water.ca.gov/iwris/.

Enhancement: Applying Tools for Data Visualization and Analytics

Data visualization tools help communicate key messages contained within the volumes of data collected or results generated, which can bring new insights into the behavior of the system or problem being studied. Data visualization represents information through graphical means, such as charts, maps, and animations. Simple examples of data visualization are showing a graph of water flow for a specific location over time or showing reservoir storage over time compared to median values for the same period. Access to innovative and meaningful visualizations can inform decision-makers on the variability of flow or storage within the system and can be combined with other information on channel capacities to consider flood risk or with biological data to assess threats to endangered species. There are numerous existing tools available to visualize and analyze water data and a growing number that allow data to be visualized through the Internet. Water management agencies that collect water data should embrace the application of data visualization tools to assist with making water resources information more accessible to the public and decision-makers.

Summary

California needs significant improvements in its analytical tools and data to evaluate the costs, benefits, and tradeoffs of alternative resource management strategies effectively, and to support decision-making. These improvements must be done in a way that promotes IWM and fosters collaboration. A tremendous amount of work needs to be done to provide the desired quantitative deliverables for future CWP updates. This work will have to be done with limited budgets and considerable uncertainty related to the health of the Delta, future climate change, and droughts. This chapter describes some of the critical activities undertaken recently to improve California's technical information and identifies several critical activities that must be conducted for the next CWP update to continue progress. Refer to Chapter 8, "Roadmap For Action," for the objectives and related actions for integrated data and analysis and water technology.

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VOLUME 1 - THE STRATEGIC PLAN

CHAPTER 7

Finance Planning Framework

Intertie Project Completion Ceremony in Tracy. In May 2014, representatives from the U.S. Congress, U.S. Bureau of Reclamation, California Department of Water Resources, and regional and local agencies gathered for the culmination of a partnership to fund the modernization of the intertie infrastructure.

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Chapter 7. Finance Planning Framework

About This Chapter

California water managers have been directed to provide reliable water supplies, reduce flood risks, increase public safety, help grow the economy, and enhance ecosystems. These same demands have been placed on them with an adage of doing more with less during a time of economic downturn, rising public sector debt, and weakening public support for additional investments. This chapter initiates a process to address challenges in financing the programs and activities outlined in earlier chapters.

Chapter 7 establishes a framework in which multiple requirements, perspectives, and previously non-integrated financing information can be considered. Doing so enables stakeholders, collectively and in context, to consider the issues to be addressed and the decisions to be made. The content in this chapter informs and provides the rationale for the finance objective (Objective 17) and related actions (recommendations) in Chapter 8, "Roadmap For Action." This chapter includes:

- Finance Planning Framework Scope and Process.
    - Limitations of the Update 2013 Framework.
- Key Facts and Findings.
    - Demand for Funding.
    - Expenditures and Fund Sources.
    - Funding and Institutional Organization.
- Framework Components.
    - IWM Scope and Outcomes.
    - IWM Activities.
    - Existing Funding/Expenditures.
    - Funding Reliability.
    - State Government Role and Partnerships.
    - Future Costs.
    - Funding, Who and How.
    - Tradeoffs.
- Next Steps.

Finance Planning Framework Scope and Process

This chapter reflects a first step in comprehensive integrated water management (IWM) finance planning from the State government's perspective and goals. It serves to guide State government-funded investments in IWM. The investment scope includes IWM programs and projects directly administered by State government, as well as future State government IWM loans and grants distributed as incentives to regional and local governments. This chapter is not intended to direct regional or local finance decisions, and it does not intend to modify existing State investment frameworks for ongoing financial activities, such as distribution of currently authorized General Obligation (GO) bonds. This chapter, in conjunction with Chapter 8, "A Roadmap For Action," provides a path for resolving issues described below and for filling information gaps as required to support effective State IWM finance solutions.

Several State agencies and stakeholders worked together to develop this Finance Planning Framework (Framework). The Framework provides a logical structure and sequence for financial plan development. This chapter is organized and presented in the same order as the eight components of the Framework. It begins by describing the scope of IWM, as well as the types of IWM activities that should be considered for funding. It then offers background on how existing infrastructure was financed, along with descriptions of historical federal, State, and local water expenditures since 1985.

Along with Chapter 2, "Imperative to Invest in Innovation and Infrastructure," this chapter reflects initial conversations with stakeholders regarding the role of State government in IWM. These conversations were conducted with regard to the costs associated with all State IWM activities. The Framework includes an estimate of the magnitude of California's investment needs at federal, State, tribal, regional, and local levels. To help decision-makers determine how to meet these investment needs, the Framework provides an assessment of alternatives for future revenue sources. This assessment includes a description of appropriate uses of the revenue sources, any constraints and tradeoffs involved in the application of the various sources, and current applications of the sources. (See Table 7-2.) The Framework recognizes the need to strategically invest in the near term to avoid greater costs in the long term (i.e., the concept of avoided costs).

Note that the terms finance and fund tend to be used interchangeably, and often refer to the other in their own definition. *Fund* refers to a supply or stock of money. *Funding* refers to making a supply of money available for a need, program, or project. *Finance* refers to the management of money, which could include such activities as borrowing or developing a revenue stream.

Limitations of the Update 2013 Framework

While the *California Water Plan Update 2013* (Update 2013) Framework provides a cornerstone for stakeholders to work collaboratively through critical funding needs and issues, develop durable finance mechanisms, and identify reliable revenue sources, it is not yet a comprehensive IWM finance plan. A comprehensive State government IWM investment strategy recommends programs and itemizes costs, finance mechanisms, and revenue sources. To that end, several remaining finance planning components must be completed that were not fully developed during Update 2013, owing to limitations of data/information, resources, and/or time. The "Next Steps" section of this chapter outlines actions to adapt, develop, and apply the Framework during California Water Plan Update 2018 and beyond. It also describes the activities, tasks, and deliverables that the Update 2013 staff and advisory groups want included in the

The Port of Stockton supports 4,500 jobs, exports 1.5 million tons of American products annually, represents $2 billion of private sector investments over the previous five years, and contributes more than $5 million per year in tax revenue.

Framework. It should be noted that even after developing an IWM finance plan, legislators and the governor must take action to implement such a plan.

Key Facts and Findings

Several striking facts and findings emerged in the development of the Framework. Most significantly, there is no single, easily compiled source of information about current and past IWM investments. This lack of integrated information creates several dilemmas. First, simply discussing finance expenditures often devolves into conflict. Second, stakeholders often operate from completely different sets of information prepared for disparate purposes. In most cases, the information is accurate but sometimes incomplete, drawn out of context, and grounded in fundamentally different assumptions. The reliance on information prepared for specific uses to make broader assumptions is problematic.

The Framework evolved as stakeholders worked together to create a common understanding of California's water financing picture. Using a storyboard format, the goal was to establish a financing baseline and shared meaning about the past and current situation.

The facts and findings developed in this process represent a significant step forward in the comprehensive understanding of complex finance mechanisms that, over time, were created in a fragmented fashion. The sections that follow provide an overview of some of the findings and issues to be considered in implementing the Framework.

Demand for Funding

The status of California's water infrastructure, as well as the demands placed upon it, is of national interest. A number of different sources and estimates on demands for funding have been reported. Even with the variation in numbers among experts, the cumulative total is staggering, as demonstrated by the following examples.

An assessment, conducted by the U.S. Environmental Protection Agency in 2011, found that California will need $44.5 billion to fix aging drinking water systems over the next two decades (U.S. Environmental Protection Agency 2013). The survey placed California at the top of a national list of states having major water infrastructure needs. In California and elsewhere, the biggest needs involve repairing and upgrading water transmission and distribution lines.

The American Society of Civil Engineers' (ASCE's) *Infrastructure Report Card for America*, is prepared every four years. Structured as a form of a school report card, it assigns letter grades to each type of infrastructure. The 2012 report card gave California a "C" and assigned the following investment needs for water infrastructure (American Society of Civil Engineers 2012):

- Levees/Flood Control — $2.8 billion per year.
- Urban Runoff — $6.7 billion per year.
- Wastewater — $4.5 billion per year.
- Water — $4.6 billion per year.

Other key highlights from the ASCE evaluation indicate California has 807 high-hazard dams and only 45 percent of the State-regulated dams in California have an emergency action plan.

Information gathered in preparation of the report *California's Flood Future: Recommendations for Managing the State's Flood Risk* (California Department of Water Resources and U.S. Army Corps of Engineers 2013) provided significant facts and findings regarding flood risk and requirements for funding.

- $575 billion in structures are at risk in the 500-year floodplains. This does not include economic impacts on families, communities, local businesses, and entire regions when worksites and public facilities are closed as a result of flood damage.
- More than $50 billion in existing needs have been identified for flood management projects, which exceeds available funding sources.

The Bay Delta Conservation Plan (BDCP) is a 50-year ecosystem plan designed to restore fish and wildlife species in the Delta in a way that also protects California's water supplies while minimizing impacts on Delta communities and farms. The total estimated cost of implementing the BDCP, over the 50-year permit term, is approximately $24 billion (California Department of Water Resources 2013).

Expenditures and Funding Sources

Cross-cut budgets for IWM activities are not compiled at most levels of government. This makes completion of a full assessment of actual investment and fund sources difficult. Beyond the wide variation in how different entities prepare budgets, the sheer number of entities involved in providing water-related services makes accurately compiling budget numbers a daunting task. At the local level, the funding complexities are especially difficult to navigate because activities often occur in proximity to one another, many projects serve multiple purposes, and many activities have multiple fund sources.

Local Expenditures

Local entities, such as special districts, water districts, utilities, and cities, account for the largest portion of IWM expenditures, and this is expected to continue for the foreseeable future. Annual local expenditures statewide for 2010 totaled about $18 billion, as shown in Figure 7-3. Even with a significant investment by these agencies in water expenditures, the water management community reports that water projects at all levels of government are commonly underfunded.

The costs of ongoing operations and maintenance (O&M) for existing facilities, along with regulatory costs, consume a large portion of local agency budgets. In addition, local agency budgets are often unable to allocate funds for replacing aging infrastructure.

With limited funding sources and unreliable funding, financing and O&M are ongoing challenges for agencies. Some funding issues include:

- Competition among agencies for resources, such as workforce, grants, and technical assistance.

- Competition with other public demands for resources. For example, flood management agencies are often supported by local agency general funds and must compete with other public demands for such resources as transportation, parks, social services, education, and health services.
- Reductions in property tax revenues.
- Costs associated with permitting and mitigation of projects.
- Lack of resources in small agencies to prepare funding applications. For example, some of the information requested on grant or loan applications is not typically collected by the agency and not quickly developed. Also, smaller agencies might not have the resources to prepare an effective application.

Agencies also have difficulty raising matching funds for federal programs. Many of the agencies require federal or State funds for major capital improvements; however, with limited methods of local revenue generation, many agencies cannot access some of the available federal funds because they cannot raise the required matching funds.

Local agencies have indicated that they are often constrained in fully utilizing existing fund sources by various statutes and restrictions that govern financing considerations, per the following examples:

- Flood management agencies report they have substantial resistance to increasing property assessments, as evidenced by the passage of Propositions 13 and 218. The majority of flood management agencies depend on some type of property assessment as a revenue source; however, the ability to increase or initiate property assessments to satisfy revenue requirements has been restricted for some time in California.
- Agencies that are partially funded through development fees or special projects assessments can be limited by assessment-zone boundaries. These assessment-zone boundaries impose substantial limitations on the uses of funds. This is important because flooding, water supplies, and water quality are sometimes affected by activities occurring upstream of zone boundaries. In addition, the solution or best management action for providing IWM benefits might be located outside the assessment-zone boundary.

State Funding

State government investments since the turn of the century have been directed to specific purposes (such as to the State Water Project) and used to successfully incentivize local investments in water-related projects.

State government expenditures and fund sources have shifted over time. In recent years, use of the General Fund (general tax base) has decreased and use of publicly financed bonds and special-fund sources have increased. Flexibility in utilizing fund sources is also limited at the State level. For example, several State GO bonds have been authorized since 2001, and State government revenues from special projects and fees have steadily increased from about $1.3 billion in 2001 to $2.7 billion in 2010. Nonetheless, funds for supporting specific IWM activities are not easily adapted to changing IWM priorities. Such funding sources are variable (i.e., annual funding levels) and unpredictable. Existing State bond funding for flood management will be depleted by 2018.

Salinas River National Wildlife Preserve

Federal Funding

The amount of funding flowing to the State from the federal government has also changed over time. These changes in fund sources reflect the perspectives and priorities of State and federal elected officials, as well as public perception and priorities for certain types of water-related expenditures. For example, federal investment has historically been the primary source of funding for flood management, but in the context of changing federal priorities such investment is decreasing relative to State government and local investments.

For most agencies, federal funds are becoming more scarce. The U.S. Army Corps of Engineers (USACE) process for identifying federal interest in flood risk-reduction projects has historically emphasized damage-reduction benefits, while placing less emphasis on other project output, such as ecosystem restoration, regional economic development, and other social benefits. With the fiscal issues facing the federal government, most agencies believe that federal funding programs will continue to be reduced, if not eliminated. As an example, the USACE might not continue to fund studies or ongoing projects at the same rate as in the past. Also, funding a large number of studies and projects over long periods is often inefficient and results in delayed project development and increases project costs.

Operations, Maintenance, and Environmental Mitigation

While there is often funding for constructing new projects, IWM planning and finance have not adequately covered monitoring, operations, maintenance, and environmental mitigation over the life of a project. This has most often been true for State or federal government cost-sharing programs, which generally do not provide assistance with O&M costs, just with construction.

Environmental impacts created long ago, known as legacy impacts, no longer have responsible parties to pay for mitigation.

Debt

California voters, in response to drought and flood, have approved several State GO bonds to fund water projects. Because no additional tax or other revenue stream is created with the issuance of bonds over time, GO bond debt service has taken an increasing share of California's

State budget. California currently allocates about 9 percent of its general fund to total GO bond debt service. Out of the 10 most populous states, California ranks just behind New York for the highest debt-to-personal-income ratio (Office of the State Treasurer 2012).

Total authorized water-related bond debt rose from about $3.8 billion in 1999 to $22.9 billion in 2011, about 20 percent of total bond debt. By comparison, total authorized bond debt across all State government activities rose from $38 billion in 1999 to $128 billion in 2011. On a per capita basis, total GO bond debt rose from $1,130 to over $3,400. (See Table 7-4.)

While California is currently carrying a relatively high level of GO bond debt, debt is not the only metric to plan for or by which economic prosperity should be measured. Borrowing remains a necessary and cost-effective method of financing IWM and many other capital-intensive projects. However, there are risks and costs associated with borrowing that should be fully considered in future financing strategies.

Funding and Institutional Organization

Poor alignment of projects among public agencies affects the ability to fund and deliver efficient and economical multiple-benefit projects. In many cases, related IWM activities, such as water supply, flood, and ecosystem management projects, often in the same location or system, continue to be funded separately.

Overlapping — and sometimes conflicting — responsibilities and priorities among the many regulatory agencies complicate and/or increase the cost of protecting human life, property, economic interests, and the environment. While collaboration among the parties can yield significant benefits, in some cases the agencies are constrained by statutory mandates that prevent innovative solutions and expose the agencies to litigation.

Framework Components

The Framework is a first step toward more fully understanding California's financing picture and finding options to improve the current situation. During the Update 2013 process, a finance storyboard was developed through extensive collaboration with the Public Advisory Committee, Tribal Advisory Committee, Finance Caucus, and other Update 2013 participants. It was developed in response to observations and stakeholder input that there was no common language or understanding of the finance methods and issues across California's geographic regions, IWM strategies, or levels of government (e.g., federal, State, tribal, local). The finance storyboard was the thought process that developed into the Framework described in this chapter.

The purpose of the finance storyboard for Update 2013 and beyond is to provide a framework to organize and describe the suite of issues and methods critical for advancing a statewide IWM finance planning effort. It also provided the structure and the flow of logic required to synthesize a large volume of information and stakeholder input, such that it supports the IWM finance objective (Objective 17) and related actions for State policy-makers. This storyboard also provided an approach for the diverse California Water Plan stakeholders and planning partners to discuss and develop a common language and understanding about the role of State government funding and investment in IWM activities.

The Framework is organized into eight components:

1. IWM Scope and Outcomes.
2. IWM Activities.
3. Existing Funding/Expenditures.
4. Funding Reliability.
5. State Government Role and Partnerships.
6. Future IWM Costs.
7. Funding, Who and How.
8. Tradeoff Analysis.

Each component represents a topic that stakeholders and planners felt needs to be part of any statewide IWM finance planning effort. The sequence of the components represents the necessary chronology of the planning effort. For example, it is necessary to define the scope of IWM (Component 1) before discussing the State Government Role and Partnerships (Component 5). It is also necessary to clarify the role of State government before estimating future funding demand for said role. Note that the traditional finance planning topic of apportioning costs and identifying funding methods does not occur until Component 7.

The following sections describe each component of the Framework.

IWM Scope and Outcomes

The purpose of this section is to define the scope of State government's future involvement in IWM activities along with the expected outcomes. While the high-level synthesis of IWM benefits can be captured in the three broad categories of public safety, environmental stewardship, and economic stability, the further refinement of benefit descriptions below is more useful as a tool for determining if an activity is within the scope of IWM. The Finance Caucus approached this by describing the benefits intended to be achieved from the State's investment in IWM. If a proposed activity creates one or more of the benefits described in Table 7-1, it is within the scope of IWM.

IWM Activities

This section describes the types of IWM activities that need to occur to generate the benefits identified in the preceding section. This section defines the scope of activities encompassed in the finance objective and related actions detailed in Chapter 8, "Roadmap For Action." The activities described below represent opportunities to produce desired outcomes. This section describes investment categories to be used for guiding State government IWM investment (i.e., generally, categories of various types of projects or programs) in a way that is relevant to regional project-level activities. These investment categories were developed in response to several key findings that indicated a need to clarify and refine the methods for categorizing State IWM investments.

Table 7-1 Benefits within the Scope of IWM

IWM Benefit Type	Definition
Affordability	Occurrence of water supplies of sufficient quality, certainty, and cost to enhance or serve disadvantaged communities, sustain diverse portfolios, existing and future of economic activities as well as achieve water costs that enable, at a minimum, current levels of standard of living.
Drought Damage Reduction	The magnitude and probability of economic, social, or environmental consequences that would occur as a result of a sustained drought.
Energy	Efficient use, or increases in production/recovery of, energy associated with managed and unmanaged water use, storage, treatment, distribution and/or reuse.
Environmental	Preservation or restoration of the fish, wildlife, natural processes/functions, habitat and other aquatic resources for the continued viability of natural heritage, self-sustaining ecosystems, and/or biodiversity (e.g., recovery of sensitive species, control of invasive species, adequate water supply and quality).
Flood Damage Reduction	Reduce the adverse impacts of floods to human and natural systems through a portfolio of structural and non-structural measures that address their vulnerability, exposure, and recovery during flood events. This includes pre-flood planning and hazard mitigation, emergency preparedness and response activities, and post-event repairs (including environmental infrastructure repairs).
Food Security	Adequate reliability, affordability, and supply of water, land, and other natural resources to reliability to support domestic production of food, fiber, livestock, and other farm products to meet current and forecasted consumer demands.
Fuel Load Management	Fuel reduction involving the modification of vegetation in order to reduce potential fire threat, reduce the risk of high severity wildfires thereby (1) preserving water quality and natural water treatment processes within watersheds, (2) avoidance of downstream sedimentation impacts on water supply, and/or (3) improve wildlife habitat capability, timber growth, or forage production.
Groundwater Overdraft Reduction	Avoidance of 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 water supply conditions approximate average conditions.
Operational Flexibility and Efficiency	Optimization of existing legal, operational, and management procedures for (and/or physical modifications to) existing water management faculties to improve the efficiency of existing water operations or uses (e.g., irrigation).
Reduce Climate Change Impacts	Development and implementation of strategies that improve resiliency, reduce risk, and increase sustainability for water and flood management systems and the ecosystems upon which they depend.
Water Dependent Recreational Opportunity	Opportunities for water-dependent recreation for California's residents, communities, and visitors now and in the future (e.g., skiing, fishing, kayaking, etc.).
Water Quality	Chemical, physical, and biological characteristics of water, usually in regard to its suitability for a particular purpose or beneficial use for the enhancement or preservation of public and environmental health.
Water Supply and Supply Reliability	Occurrence of water supplies of sufficient quality and certainty to enhance or sustain and grow current types and levels of economic activities, ecosystem health, and maintain quality of life

Categorization of future investments also helps formulate multi-objective, multi-benefit solutions comprised of combinations of the activities described below. Through intensive collaboration with the Update 2013 Finance Caucus, the categories presented below also helped build a common language and improve coordination among diverse bureaucracies. This approach will be useful for aligning funding and finance planning processes across more than 2,300 federal, State, tribal, and local government entities, each with its own planning processes and scales. For example, local entities tend to plan at the project level, while State policy-makers tend to plan at a broader level of investment category.

Two primary categories of investment are innovation and infrastructure, which are further broken down into investment sub-categories. These sub-categories could be used for allocating future State government investments.

Innovation includes actions that improve information, institutional, and technological activities essential for supporting IWM. Innovation categories include:

- **Governance improvements** to promote more coordinated and integrated resources planning among State government agencies and with regional collaboratives and federal agencies.
- **Planning/Public process improvements** to promote and incentivize communication, coordination, and collaboration among water planners/managers, land use planners/decision-makers, and other resource managers at the regional and watershed scale.
- **Strengthening government agency alignment** to improve coordination and consistency among federal, State, tribal, and local government agencies' data/information, plans, programs, policies, and regulations.
- **Information technology improvements** to promote and incentivize water data collection, management, distribution, access, and exchange/sharing, as well as analytical methods.
- **Water technology and science improvements** to advance science, improve and commercialize new water/energy technologies, improve data collection and exchange, and develop analytical tools for IWM.

Infrastructure includes structures and facilities that support human activities (grey infrastructure), as well as naturally occurring assets and services such as wetlands, riparian habitat, and watershed systems (green infrastructure). The categories listed below encompass not only the capital cost of constructing a facility or restoring habitat, but also the long-term operation and maintenance costs that have often been an afterthought to implementation and not adequately financed over their useful life (i.e., the accumulation of significant deferred maintenance and aging infrastructure). Infrastructure categories include:

- **Local and regional projects** including projects contained in integrated regional water management (IRWM), capital improvement, urban water management, and many other local plans. These plans would include different mixes of the California Water Plan's 30 resource management strategies, depending on the region/location.
- **Inter-regional projects** that would benefit two or more regions.
- **Statewide systems** for water, flood, water quality, ecosystems, and wastewater management that provide statewide benefits.

Existing Funding/Expenditures

This section specifies the levels and sources of recent and current IWM expenditures. It includes a brief summary of historical federal, State, and local expenditures based on the defined scope of IWM. Much more detailed data, metadata, and information on this topic are included in Volume 4, *Reference Guide*.

Historical Overview

Historically, funding for water management in California has been provided by a combination of federal, State, and local agencies. Figure 7-1 shows the general historical spending and funding eras over the past 160 years, using broad categories. Starting with the Gold Rush, initial major infrastructure was put in place to bring land into production. Over the next several decades, multipurpose infrastructure projects were built. In the latter decades of the 1900s, investment shifted to include environmental protection projects. Shifts in financing eras are a result of major events, natural and human, and are generally reactive in nature. This past decade has seen several State bonds passed for infrastructure purposes, including flood management, as well as significant federal funding. More information on historical funding can be found in Chapter 3 and in Volume 4, *Reference Guide*.

Local, State, and Federal Expenditures, 1995-2010

Figure 7-2 illustrates the average proportion of water management expenditures by local, State, and federal agencies between 1995 and 2010. Local agencies account for the largest portion of expenditures, averaging $14.6 billion per year, followed by State agencies at $1.9 billion and federal agencies at $805 million per year. Expenditures vary over time, depending on factors such as State and federal appropriations and bond measures.

Figures 7-2 and 7-3 show that local agencies are responsible for the majority of the total expenditures. Between 1995 and 2010, annual project expenditures for water management in California ranged from approximately $12.5 billion to $21.7 billion, as shown in Figure 7-3. This figure shows total expenditures for IWM in California by local, State, and federal agencies. Local expenditures include water management activities by city, county, and special districts State-level expenditures include water management activities in the Natural Resources Agency and California Environmental Protection Agency and general government. Federal expenditures include water management activities in California by federal agencies. Between 1995 and 2010, there were significant short-term bond infusions of funding for specific State projects. In Fiscal Year 2008-2009, federal expenditures had a one-time increase for shovel-ready projects owing to the passage of American Recovery and Reinvestment Act.

Funding Reliability

This section provides a high-level description and qualitative summary of funding sources for IWM currently being used or that have been proposed in the past, and the role of State government bonds. More information on this topic can be found in Chapter 2, “Imperative to Invest in Innovation and Infrastructure.”

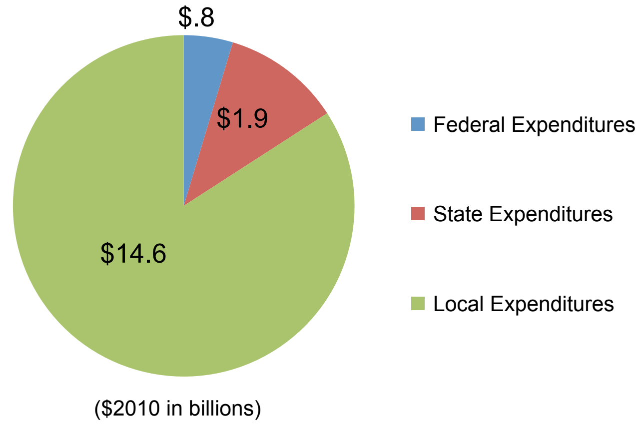
Figure 7-1 History of Funding for Water Management in California

	1850 -1920	1920 -1950	1950 -1970	1970 -2000	2000 - Current
Theme of Era	Development and Growth	Federal Investment	Infrastructure Expansion	Environment, Public Trust	Current State Bond Funding
Significant Actions	• Construction of dams, canals and levees for transportation, agriculture and water supply occurred throughout this period in the Central Valley, Bay Area and, most notably, in the Sac/S.J. Delta	• Central Valley Project • USACE and Bureau of Reclamation involvement in water conservation, water supply, flood management, and wildlife protection projects	• State water project constructed • National Flood Insurance Act of 1968 • Continued flood infrastructure	• Water Resources Development Act passed (1974, 1976, 1986, 1988, 1990, 1992, 1996, 1999, 2000, 2007) • State and Federal environmental laws enacted (Clean Water Act, Endangered Species Act, California Endangered Species Act California Environmental Quality Act)	• State bond funded infrastructure improvements, planning and emergency management preparedness projects

Financing Mechanisms	• Levee construction by land owners and reclamation districts
	• Federal funding of flood control projects (e.g. Los Angeles River and, Sacramento River Flood Control Project)
		• Flood Control Act of 1928 – Authorized the USACE to construct projects on the Sacramento River for flood control
		• Flood Control Act of 1944 authorized the Lower San Joaquin River & Tributaries Project
			• General obligation bonds for State Water Project
			• Utility rates, revenue bonds ,and fees fund local agency projects
			• 1973 statute required local and State cost sharing of projects (Senate Bill 399 Sec 12585.2 of the California Water Code, Amended in 1973 (Chapters 893))
				• Clean Water Act funds variety of Federally authorized projects
				• 1973 Way Bill (California Water Code §12980-12991) set requirements for State funding of non-project levee maintenance and improvement costs
					• Passage of several Propositions with IWM components
					  • Prop 13
					  • Prop 12
					  • Prop 40
					  • Prop 50
					  • Prop 1E
					  • Prop 84

The future of water financing in California remains uncertain. Water management strategies are being integrated, but water management funding is still fragmented, thus limiting opportunities for further investment in water innovation and both green and grey infrastructure. Future financing mechanisms will need to capitalize on federal, State, tribal, regional, local, public, and private cost-sharing. Even with further integration, securing adequate funding will require innovative financing mechanisms, such as those used for other public infrastructure (e.g., transportation).

Figure 7-2 Recent Annual Expenditures on Water Management in California, 1995-2010



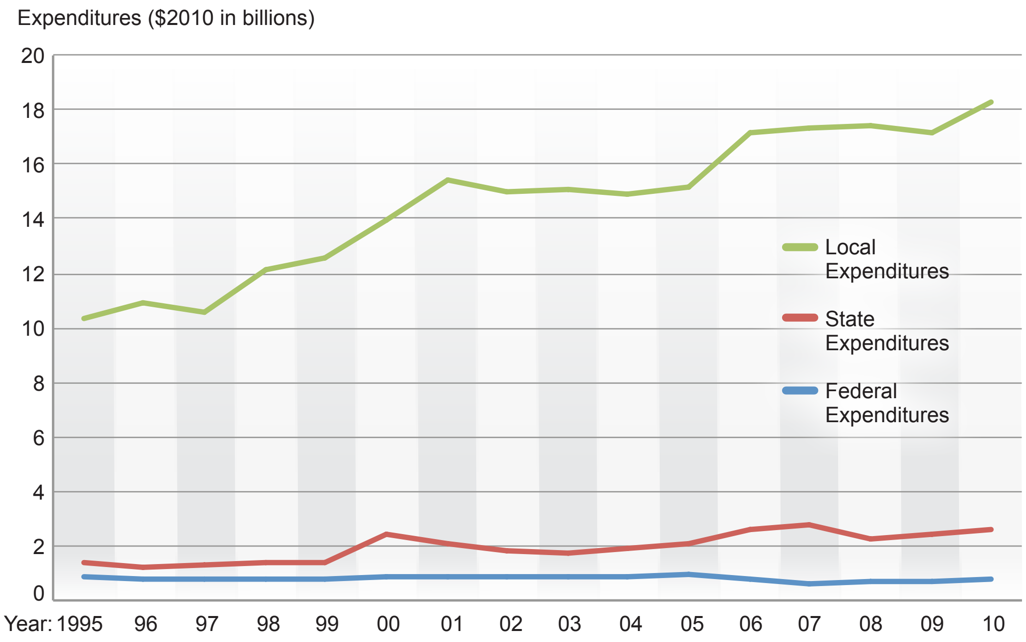
There is no single approach, mechanism, or revenue source for developing a reliable funding portfolio for IWM. Reliable funding will be driven by State, regional, and local interests, and solutions will need to be considered at a regional and/or local scale.

The financing mechanisms and revenue sources described below are presented in Update 2013 as an inventory of tools for advancing IWM activities and programs.

Funding Mechanisms and Revenue Sources

System capital improvements and ongoing O&M costs are typically financed with cash-on-hand or by issuing debt. Cash financing is often supported by user fees or taxes that support a general fund. User fees include volume-usage charges and service fees that typically are fixed, such as

Figure 7-3 Recent Trends in Local, State, and Federal IWM Expenditures (in millions), 1995-2010



residential connection charges. Cash is typically used to pay for O&M costs, while larger capital project costs are primarily financed by issuing debt. Debt financing includes various types of bonds, ranging from GO bonds, which are backed by the General Fund, to builder revenue bonds, which are backed by special assessment districts. Access to different types of capital markets varies across State government and local agencies.

Federal finance strategies usually involve the federal treasury and finance water management projects selected based on benefit-cost analyses. Direct project beneficiaries reimburse the costs through user fees or contractually negotiated commodity charges. For example, Central Valley Project (CVP) water supply contractors pay for water deliveries that finance CVP costs.

State government uses bonds to finance new water-management capital projects, including GO bonds and revenue bonds. GO bonds are backed by the taxing power of the State government and are paid off from the General Fund with interest. Financing for water infrastructure by State government has increasingly relied on GO bonds in recent years. GO bonds provide an infusion of capital to finance construction but may not adequately provide for O&M or ongoing repair costs. State government also uses lease-revenue bonds, which are similar to GO bonds but are not backed by the General Fund and do not require voter approval. Revenue bonds are not supported by the General Fund and are repaid by another revenue stream, typically user fees. (See Box 7-1 for a description of taxes versus fees.)

Local agencies primarily finance their larger water management projects with revenue bonds. Revenue bonds carry a higher interest cost than GO bonds. Some projects are financed by local GO bonds backed by local property taxes, although this is less common because of the two-thirds voting requirements from Proposition 218. Local agencies additionally have access to state revolving fund (loan) programs and state-funded local assistance grants. These typically involve cost-sharing between local and State government agencies.

Table 7-2 summarizes water management revenue sources that have been used or considered by State government and local agencies. Their appropriate uses, feasibility, key tradeoffs, and applicability in California for these revenue sources are also described in Table 7-2.

Federal Revenue Sources

Besides the annual contributions that federal government makes to the Clean Water and Drinking Water State Revolving Funds, several federal revenue sources could provide funding for California IWM. Depending on actions by Congress, funding may be available to the State or local governments. One of the most significant contributors of federal funds over the past few decades has been the Water Resources Development Act. See Box 7-2 for a list of proposed innovative sources of federal funding.

Water Resources Development Act

The Water Resources Development Act (WRDA) refers to a series of public laws enacted by Congress to deal with a range of water resources issues. The first WRDA, passed in 1974 (Public Law 93-251), amended the Flood Control Act of 1954 and authorized the USACE to undertake projects with additional purposes, such as navigation. There have been 10 WRDAs passed since 1974, with the latest passed in 2007. Over the years, it has been expanded to consider

Box 7-1 Taxes vs. Fees

Taxes are paid by the general public for governmental services that provide benefits to the general public, such as public safety. The payment is mandatory, everyone pays, and there does not need to be a nexus between the payer and service provided. The payer, as well as everyone else, receives a benefit.

Fees are paid for the specific government service that directly benefits the payer. The payer has a choice of whether to use the service.

other purposes, such as ecosystem improvements, water resources development, and water conservation.

Congress is currently considering a 2013 WRDA introduced in May. As it is currently written, the legislation would establish a 5-year innovative project financing pilot program. This new pilot program would provide loans and loan guarantees for important flood management, water supply, and wastewater projects.

California General Obligation Water Bonds

This section summarizes data for California water bonds issued between 1970 and present, and other GO bond debt, including schools and other infrastructure, to place the level of water bond debt into context. The intent of this section is to capture what is currently referred to as IWM, which includes water supply, water quality, ecosystem, and flood-management bonds. These water-related bonds have made up a larger portion of total bond debt in recent years. The trend shows an increase in GO bond financing of water projects as a portion of total GO bonds. 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, though they are not discussed in this section summary.

Table 7-3 summarizes water management-related bonds that were passed in California. In 2010 dollars, a total of $32.4 billion in water bonds have been approved in California since 1970. Of this total, $23.2 billion, or 71 percent, of the water bonds were passed since 2000. This shows the pronounced increased reliance on bonds for financing water infrastructure. On California's total GO bond debt of $127.6 billion, the debt service is currently about 9 percent of the General Fund (see Table 7-4).

State GO bonds have become an important source of IWM funding. GO bonds are a fluctuating revenue source because of the intermittent nature of bond approval and sales, making them a somewhat unpredictable and unreliable revenue source for water projects. Table 7-4 shows total authorized state GO bonds as of 1999, 2005, and 2011. Total water bonds were $3.8 billion in 1999, accounting for approximately 10 percent of total authorized State bonds; and increased to $22.9 billion by 2011, or 18 percent of total authorized bonds, largely as a result of Propositions 1E and 84. Currently authorized water-related GO bonds are expected to be fully allocated by 2018.

Figure 7-4 shows that funding for IWM projects has gradually increased as a portion of total bond funding — 10 percent of the total in 1999 to 18 percent by 2011.

Table 7-2 State and Local Water Management Revenue Sources

Revenue Source	Appropriate Uses	Feasibility	Key Tradeoffs	Application in California
General Fund	Activities that benefit the general public	Available each year, but subject to competing uses	Funds are limited	A common source of funding
General Obligation Bonds	Projects that benefit the general public	Commonly used	Subject to voter approval	Commonly used over the decade, but polls have shown reduced public support for large water bonds
Revenue Bonds	Projects where a dependable revenue stream is available	A standard method of financing	None	A typical method of financing for local and State projects
User Fees (includes contractually negotiated commodity charges)	Projects where direct beneficiaries are easily identified.	Potentially works well with clearly defined beneficiaries, less likely to work for projects with significant public benefits	Will focus projects to those with local scope which may undermine IWM efforts. May limit State's ability to increase fees and taxes to support other projects	State Water Project is an excellent example as over 90% of project cost will be repaid by direct beneficiaries (contractors).
Assessment Districts	Can be formed by majority vote, but must support local projects that do not provide a "general" public benefit. Water and storm water projects are generally allowed under assessment districts.	The State could coordinate with local agencies to establish assessment districts.	Assessment districts cannot be used to support general public benefits and, as such, will tend to focus on local projects.	1911 and 1913/1915 assessment districts are widely used by local agencies in California.

Revenue Source	Appropriate Uses	Feasibility	Key Tradeoffs	Application in California
Utility User Tax	Earmarked for a special purpose or used as a general tax	Used by many cities and a few counties	Has to be approved by a ballot measure	Widely used by cities
Impact Fees	Used by local governments to charge new development for the additional cost imposed on existing public infrastructure	Impact fees are generally used in over 90% of local governments in California, thus there is limited opportunities for further expansion.	Deters new development	Widely used in California
Statewide Water Use Fee (Proposed in 2006 and 2011)	Would have been used for State water management activities	Failed to move forward in 2006 and 2011	Could affect local agencies' ability to generate local revenues	Would require a vote
Public Goods Charge	Could fund a variety of IWM activities	Was approved for electricity but sunset in 2011. Never has been tried with water.	Could affect local agencies' ability to generate local revenues	Not yet tried in California, would need a two-thirds vote
Mello-Roos Special Taxes	Areas with new development. It is possible to establish Community Facility Districts (CFDs) in other areas, but this requires a majority vote by residents to tax themselves.	CFDs are most feasible during strong housing markets when there is significant new development.	When housing markets and development slows, forming additional CFDs is difficult and there may be concerns with revenues to pay back existing bonds.	Recently used to finance the Bear River Levee Setback project in Yuba County
Private Investors	Local water projects that generate revenue	Typically have been used as part of design-build process	Interest rates are higher than public debt, and can't be used on State projects.	Limited to local projects
Private-Philanthropic	Traditionally has been used for ecosystem projects	Commonly used	Not a predictable revenue source	Widely used in California

Box 7-2 Federal Funding Sources

Several federal actions could provide funding for California integrated water management (IWM). Depending on actions by Congress, funding may be available to the State or local governments. Some of the proposed innovative approaches include:

- **Federal Water Infrastructure Trust Fund.** The Water Infrastructure Trust Fund, if established by Congress, would create a stable and long-term revenue stream to finance water infrastructure projects. The current proposal under consideration is H.R. 3145 and includes over $10 billion annually with a focus on clean water projects.
- **Water Infrastructure Finance Innovation Act (WIFIA).** The Water Resources and Environment Subcommittee has circulated a draft WIFIA bill (H.R. 3145) and held two hearings on the topic in 2012. One of the main benefits of the proposed program would be to provide low-cost capital to infrastructure projects.
- **National Infrastructure Bank.** An infrastructure bank manages capital and provides loans for infrastructure development. The most recent proposal, H.R. 402, would create a bank similar to the FDIC. The bank would be authorized to issue bonds and subsidies to infrastructure projects, borrow and, in turn, lend to commercial infrastructure projects, and purchase and sell infrastructure loans and securities on the market.
- **Private Activity Bonds.** Congress is considering modifying Private Activity Bond restrictions. Private Activity Bonds are tax-exempt bonds that are available for privately owned water facilities operated by a government unit or charge water rates that are approved by a subdivision of a community. Private agencies are typically not eligible for tax-exempt municipal bonds, which limits access to capital to finance new infrastructure projects.
- **Build America Bonds**. Congress is considering reinstating Build America Bonds. As part of the American Recovery and Reinvestment Act, Congress created Build America Bonds to encourage job creation through infrastructure projects. Eligible projects were not limited to infrastructure and did not allow for private company participation. The bonds stopped being issued in December 2010. Congress is considering reinstating the bonds to target water infrastructure projects.

Figure 7-5 illustrates outstanding GO bond funding for water-related activities over time. Authorized GO bonds and federal funding accounted for approximately two-thirds of total water management expenditures in FY 2012. In recent years, State bond funds have become a larger portion of total water-related investments in California, as federal expenditures have stayed the same or decreased. Annual debt service for outstanding water bonds is approaching $80 per household because water bonds make up a larger proportion of water funding. By comparison, when distributed equally among all households in the state, the total annual debt service amounts to $365 per household (see Volume 4, *Reference Guide*).

State Government Role and Partnerships

This section summarizes the current and future role of State government to support and advance IWM regionally and statewide. It includes a description of current and future State government obligations and commitments, as well as of its role in investing in IWM innovation and infrastructure. A more detailed description of State government's role can be found in Chapter 2, "Imperative to Invest in Innovation and Infrastructure."

Table 7-3 California General Obligation Water Bonds from 1970 to Present

Year	Title	Base Amount (millions)	In 2010 Dollars (millions)
1970	Clean Water Bond Law of 1970 (Prop. 1)	250	1,504
1974	Clean Water Bond Law of 1974 (Prop. 2)	250	1,028
1976	California Safe Drinking Water Bond Law of 1976 (Prop. 3)	175	606
1978	Clean Water and Water Conservation Bond Law of 1978 (Prop. 2)	375	1,123
1982	Lake Tahoe Acquisitions Bond Act (Prop. 4)	85	185
1984	California Safe Drinking Water Bond Law of 1984 (Prop. 25)	75	150
1984	Clean Water Bond Law of 1984 (Prop. 28)	325	651
1984	Fish and Wildlife Habitat Enhancement Act of 1984 (Prop. 19)	85	170
1986	Water Conservation and Water Quality Bond Law of 1986 (Prop. 44)	150	290
1986	California Safe Drinking Water Bond Law of 1986 (Prop. 55)	100	193
1988	California Safe Drinking Water Bond Law of 1988 (Prop. 81)	75	138
1988	California Wildlife, Coastal, and Park Land Conservation Act (Prop. 70)	776	1,427
1988	Water Conservation Bond Law of 1988 (Prop. 82)	60	110
1988	Clean Water and Water Reclamation Bond Law of 1988 (Prop. 83)	65	120
1996	Safe, Clean, Reliable Water Supply Act (Prop. 204)	995	1,471
2000	Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Act (Prop. 13)	1,970	2,632
2000	Safe Neighborhood Parks, Clean Water, Clean Air, and Coastal Protection Bond Act of 2000 (Prop. 12)	2,100	2,805
2002	California Clean Water, Clean Air, Safe Neighborhood Parks, and Coastal Protection Act of 2002 (Prop. 40)	2,600	3,305
2002	Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (Prop. 50)	3,440	4,372
2006	Disaster Preparedness and Flood Protection Bond Act of 2006 (Prop. 1E)	4,090	4,385
2006	Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006 (Prop. 84)	5,388	5,777

Table 7-4 Total Authorized General Obligation Bond Debt in California (in billions)

Category	1999	2005	2011
Miscellaneous	1.7	2.5	3.3
Correctional	4.1	4.1	2.8
TOTAL WATER BONDS	**3.8**	**14.0**	**22.9**
Transportation	5.6	7.2	40.0
Education	22.4	51.1	58.6
TOTAL	**37.7**	**78.9**	**127.6**
Per Capita	1,127.2	2,191.9	3,407.9

Source: California State Controller 2000, 2006, 2012.

In the history of water development in California, the role of federal and State governments has been demonstrated by their investments in water and flood management infrastructure to promote growth and economic development in rural, suburban, and urban communities. These investments resulted in major projects that crossed watersheds and/or had broad-based public benefits. During the past few decades, government's role has also included environmental protection and enhancement. More recently, State government is promoting multi-benefit IWM programs and projects with more sustainable outcomes, and ensuring that disadvantaged communities have safe water and sanitation. (Refer to the "Shared Values for State Government Investment and Prioritization" section of this chapter.)

Basic Obligations

The obligations of State government include:

- **Representing California in government-to-government interactions** with the federal government, other states, and other sovereign nations and tribal governments.
- **Meeting basic public health and safety needs for all Californians** by regulating minimum public health standards and by providing assistance to communities that are unable to meet regulations.
- **Protecting public trust resources** by regulation and in planning and allocation of water resources. The public trust doctrine recognizes that certain natural resources, including water, tide and submerged lands, the beds and banks of navigable rivers, and fish and wildlife resources are owned by the public and held in trust for present and future generations of Californians.
- **Protecting unique real property interests**. The State has a fundamental responsibility to California taxpayers to protect the real property assets owned by the State and reduce State liabilities.

Figure 7-4 Total Authorized State General Obligation Bonds in California

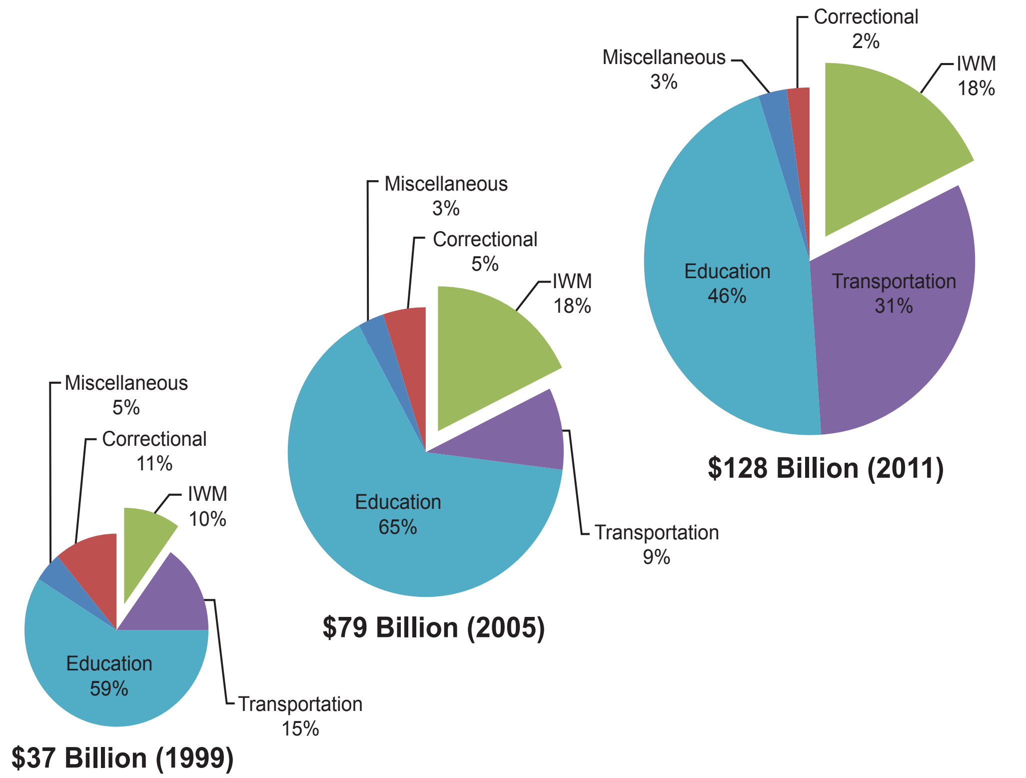
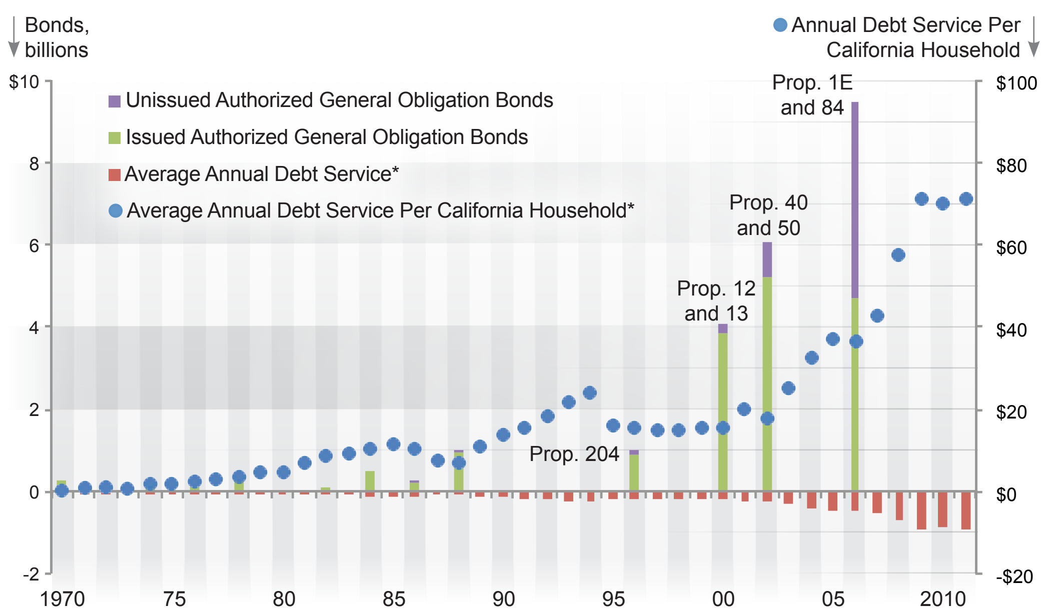


Figure 7-5 General Obligation Water Bond History, 1970-2012



*Debt service is applicable to issued General Obligation bonds only. Data courtesy of the California Department of Finance.

Commitments and Responsibilities

- **Operate and manage the State Water Project.** State government is the owner and operator of the State Water Project (SWP) and has the responsibility (and contractual commitments) to provide reliable water supplies to the water contractors, the financiers and beneficiaries of the SWP.
- **Plan, implement, and maintain the State Plan of Flood Control.** State government has responsibility for providing assurances to construction access, operations, and maintenance for portions of the State's federally authorized flood protection system.
- **Planning, policy research, and technical assistance.** State government performs many critical planning and research activities in support of resource management (executive, legislative, and local government) decisions and advancing water science and technology.
- **Integrate water rights and water quality planning.** Basin plans are prepared for each of the 10 hydrologic regions and by statute become part of the California Water Plan.

Investing in Innovation and Infrastructure

State government has and should take a leading role in investing in innovation and infrastructure actions for the benefit of all regions. Innovation includes a broad range of activities that comprises governance, planning, and process improvements; data; tools; and water technology research and development. State government can also demonstrate leadership by serving as a facilitator and clearinghouse of innovation to ensure that new solutions are fully utilized throughout the state. The State's investment in innovation provides processes and information that aid decision-making throughout the state and support more cost-effective infrastructure investments by regional and local entities.

State government has and should continue to invest in water infrastructure — natural (green) and built (grey) — in partnership with federal, tribal, regional, and local governments; non-profit organizations; the business community; and private entities. This includes supporting IRWM planning and implementation.

State government investments should focus on actions that:

- Regions and communities cannot accomplish on their own.
- Involve interregional, interstate, or international issues.
- State government can do more efficiently and/or cost-effectively (i.e., providing a high return on investment to the benefit of the state's taxpayers).
- Provide broad public benefits.
- Remediate legacy environmental impacts.

Future IWM Costs

This section summarizes anticipated total future IWM costs throughout California and across federal, State, tribal, and local governments. Owing to many data gaps and lack of a consistent methodology, Update 2013 includes a preliminary and cursory estimate of future IWM costs. Additional engineering, economic, and risk characterization studies are needed to develop more accurate projections of California's future IWM funding needs (see the "Next Steps" section, below). That said, based on recent and existing IWM expenditures and a reasonable assumption of needed near-term innovation and infrastructure, it is estimated that at least $200 billion is needed over the next decade. This estimate assumes that future average annual IWM expenditures over the next 10 years would occur at approximately the same rate as current annual expenditures ($20 billion per year, as shown in Figure 7-3). Because authorized GO bonds are almost fully allocated, and federal and State general fund IWM allocations are declining, new finance mechanisms and revenue sources will be needed to sustain current annual expenditure levels. The majority of all IWM investments in California during the next decade will go toward meeting infrastructure needs. A smaller but important portion will go toward innovation to increase return on IWM investments.

The estimate of $200 billion needed for innovation and infrastructure over the next decade encompasses federal, State, and local investments. Local entities will pay the majority of these costs. State government investment in innovation will be only a small portion of this estimate, perhaps less than a few hundred million dollars. State government investment in infrastructure, including financial incentives and cost-sharing with federal, local, and private partners, will depend on future authorizations, funding mechanisms, and revenue sources (as described in the "Funding Mechanisms and Revenue Sources" section, above).

The report, *California's Flood Future*, identified more than $50 billion in needs for specific projects and improvements that are now in the planning cycle. These projects (mostly site specific) collectively would not necessarily provide statewide protection from the 100-year storm event. The total investment needed to reduce risk against the 500-year flood event is assumed to be several times the $50 billion amount. Despite the exposure of 7.3 million people to flooding, willingness to adequately fund flood management for a 500-year storm event has not been demonstrated. For this reason, a conservative estimate for flood management investments, based on what Californians would be willing to accept and pay for, could be at least twice the $50-billion estimate for existing proposed projects, or more than $100 billion.

As previously mentioned, ASCE's 2012 *Infrastructure Report Card for America* gave California a "C" and assigned the following investment needs for water infrastructure:

- Levees/Flood Control — $2.8 billion per year.
- Urban Runoff — $6.7 billion per year.
- Wastewater — $4.5 billion per year.
- Water — $4.6 billion per year.

An assessment, conducted by the U.S. Environmental Protection Agency in 2011, found that California could use $44.5 billion to fix aging drinking-water systems over the next two decades (U.S. Environmental Protection Agency 2013). The survey placed California at the top of a national list of water infrastructure needs. In California and elsewhere, the biggest need was for repairing and upgrading water transmission and distribution lines.

The BDCP is a 50-year ecosystem plan designed to restore fish and wildlife species in the Delta in a way that also protects California's water supplies while minimizing impacts on Delta communities and farms. The total estimated cost of implementing the BDCP, over the 50-year permit term, is approximately $24 billion (California Department of Water Resources 2013).

As another estimate of future IWM costs, there are approximately 10,000 water projects identified by the state's 48 IRWM regional water management groups. Although it is unlikely that every project would be implemented, the total cost of these projects would be several hundred billion dollars.

Funding, Who and How

This section frames the discussion for future IWM financing mechanisms and revenue sources. It describes shared values for guiding State government investments and prioritization, how to allocate State government funding, and desired attributes of future financing mechanisms and revenue sources. More information can be found in Chapter 2, "Imperative to Invest in Innovation and Infrastructure," and in Volume 4, *Reference Guide*.

Shared Values for State Government Investment and Prioritization

An essential first step completed during Update 2013 was identifying shared values to guide decisions related to the Framework. The shared values described below are intended to guide IWM decisions regarding investment and prioritization of State government funds. The scope includes IWM programs and projects directly administered by State government, as well as future State IWM loans and grants that are allocated as incentives to tribal, regional, and local governments. These values can also guide preparation of future criteria for State government funding. These values are not intended to direct tribal, regional, or local finance decisions, and they are not intended to modify existing State investments or ongoing financial activities, such as the allocation of currently authorized GO bonds. The shared values are also not intended to provide guidance for financing of specific projects at any scale (statewide, inter-regional, regional, tribal, or local).

The shared values developed for Update 2013 are grouped into three categories: Prioritization of State Government Investments, Fiduciary Responsibility, and Beneficiary and Stressor Responsibility.

Prioritization of State Government Investments — Investment decisions will include equal regard for economic, environmental, and social criteria.

- Decisions are informed and priorities are set using a process that includes broad stakeholder interests and public participation.
- Preference is given to multi-benefit projects that meet regional or statewide interests.
- Cost and benefit data used in the analysis include monetary and nonmonetary life-cycle costs and benefits with an emphasis on long-term planning. Stranded costs are avoided, and all costs during the life of a project are included in the analysis, such as monitoring, planning, construction, operation, maintenance, mitigation, business disruptions, and externalities.

A community activist speaks with residents of a trailer park in Beaumont, CA, regarding safe drinking water and wastewater management in one of California's many disadvantaged communities.

- Decisions are made using best available data and knowledge, with the understanding that deferring decisions in anticipation of better information can result in increased costs of implementation, hesitation, and missed opportunities to achieve benefits.

Fiduciary Responsibility — State government will be fiscally responsible with State funding.

- Investment decisions account for the availability of future revenues, cost of borrowing, and risks of indebtedness. This includes matching investments with appropriate funding mechanisms and revenue sources.
- Good stewardship of State government funds includes transparency, accountability, discipline to spend reasonably, clarity of purpose, and personal integrity by those entrusted with public funding. Good stewardship engenders trust and increases the public's willingness to pay for future IWM activities.
- State government funding is not redirected from its authorized purpose.
- Amount of time needed to repay debt does not exceed the life of a project. This value applies to fiscal, natural, and all other emergencies.

Beneficiary and Stressor Responsibilities — Those receiving benefits or creating impacts pay for them.

- When beneficiaries can be identified, those receiving benefits pay for them. A nexus and proportionality is established between charges and benefits. This value recognizes the concept of equity regarding value exchange (i.e., paying in proportion to what you receive).
- State government has a responsibility to help communities that cannot help themselves. State funding is also appropriate for helping communities meet State regulations that they cannot fully cover.
- State funding pays for broad statewide benefits.
- State government pays for persistent impacts from historical activities that are no longer creating impacts of the same type or magnitude (legacy impacts), but only in cases where stressors cannot be identified or no longer exist. In some cases, legacy impacts may go unaddressed indefinitely.
- State funding is proportional to the broad public interest. Assignment of costs to entities that currently engage in an activity that involves an area affected by legacy impacts is limited to the entities' current impacts (not legacy impacts). Some legacy impacts may need to be addressed before costs are assigned.

Attributes to Frame Future Deliberations

Update 2013 discusses better organizational alignment of State agencies as a way to expedite implementation of IWM activities and reduce the cost of delivering IWM benefits. (See Chapter 4, "Strengthening Government Alignment," for more details.) One way to improve State government IWM finance is through a more coordinated and consistent funding approach across State government. Such an approach could also provide an opportunity to implement several components of the Framework and advance the shared values for State government investment and prioritization. A coordinated funding approach needs to be designed to increase return on investment, enhance accountability, and improve consistency and efficiency. Other goals for new approaches include allocating State dollars to leverage federal and private funding, increase local flexibility to reflect local and regional conditions, and to advance regional goals and investment priorities with grants and loans. Future deliberations should include, but are not limited to, the following attributes:

- Funding mechanisms that provide a consistent financing framework for State government investments in IWM and achieve the following:
    - Improve cost effectiveness, efficiencies, and accountability.
    - Avoid stranded costs and funding discontinuity.
    - Leverage funding across State government agencies.
    - Increase certainty of desired outcomes.
- Prioritization based on shared funding values, defined principles, goals, objectives, and criteria.
- Prioritization method and rationale for apportioning IWM investment by the categories and subcategories developed in the Update 2013 Framework (i.e., innovation and infrastructure).
- Methods for enhancing stewardship of State government monies at both statewide and regional scales, including strategies to improve the transparency and accountability of State fund disbursements.

Tradeoff Analysis

This section outlines a proposal to develop a decision support system to examine funding scenarios and help analyze tradeoffs. More information can be found in Chapter 6 and Volume 4, *Reference Guide*.

California faces tough decisions and tradeoffs to allocate increasingly scarce funds to support IWM. Water management must compete for financial resources with a myriad of other infrastructure demands. When investment needs exceed existing available funding levels, it becomes increasingly important for decision-makers to prioritize new water projects while accounting for the tradeoffs.

IWM decisions typically involve some type of collaborative process. The decision process can be characterized by two fundamental components, decision support and decision-making. Decision support involves consideration of the entire system and how (or if) a potential project fits within existing infrastructure and policies. Decision-making requires additional information, such as selection criteria, availability of funds, and project costs and benefits. The decision-making process typically results in some type of ranking of alternatives, whereas the decision support process evaluates how a project fits within a system.

A consistent and understandable framework for displaying important costs, benefits, and other impacts of potential projects can help inform these decisions. A Decision Support System (DSS) is a general term for a computer-based approach to provide structured and consistent information for decision-making. When options are numerous, interrelated, and have complex effects, decision-makers need to be able to screen the options, eliminate those that clearly do not meet the project goals and criteria, and identify a smaller number of scenarios that warrant further consideration and analysis. Both the screening step and the detailed analysis step can be greatly assisted by a DSS.

Next Steps

This section proposes actions to adapt, develop, and apply the Framework during Update 2018 and beyond. It describes many activities, tasks, and deliverables that the Update 2013 staff and advisory groups want included in the Framework, but were not completed during the Update 2013 process. In addition to the actions below to improve the Framework, Chapter 8, "Roadmap For Action," contains a finance objective together with several related actions to improve the financing of IWM activities in California.

While the Framework is intended to guide decisions on State government funding, there is value in considering the Framework as a tool for identifying and sequencing all relevant finance planning activities at any level of government. Future water plan updates will continue to advance and refine the Framework. Future work is expected to consider each component (as developed by the Finance Caucus for the Finance Storyboard) of the Framework in the following ways:

- **IWM Scope and Outcomes (Component 1)** — Revisit, clarify, and adapt the scope of IWM to changing conditions and priorities.
- **IWM Activities (Component 2)** — Develop more specificity regarding the types of activities that State government should invest in with a clearer nexus to the types of anticipated benefits.
- **Existing Funding (Component 3)** — Continue to compile and synthesize data that tracks historical water-related expenditures across local, State, and federal governments in California.
- **Funding Reliability (Component 4)** — Work with the State Agency Steering Committee to identify where potential funding gaps exist between the State IWM activities described in Component 2 and existing funding levels and sources. Collaborate with regional water management groups to do the same for local and regional IWM activities.
- **State Role and Partnerships (Component 5)** — Continue to clarify and elaborate on the future role of State government to support a more specific description and estimate of future costs.
- **Future Costs (Component 6)** — Estimate future funding demands by (a) launching IRWM, city, county, and special-district data pull, and (b) working with the State Agency Steering Committee to estimate the funding demand for existing and future IWM activities.
- **Funding, Who and How (Component 7)** — Continue to collaborate with stakeholders and federal, State, tribal, and local governments to investigate and develop finance mechanisms and revenue sources that address the facts and findings detailed in this chapter. Future deliberations should include, but are not limited to, the following attributes:
  - Funding mechanisms that provide a consistent financing framework for State government investments in IWM and achieve the following:
    - Improve cost effectiveness, efficiencies, and accountability.
    - Avoid stranded costs and funding discontinuity.
    - Leverage funding across State government agencies.
    - Increase certainty of desired outcomes.

    - Prioritization based on shared funding values, defined principles, goals, objectives, and criteria.
    - Prioritization method and rationale for apportioning IWM investment by the categories and subcategories developed in the Update 2013 Framework (i.e., innovation and infrastructure).
    - Methods for enhancing stewardship of State government monies at both statewide and regional scales, including strategies to improve the transparency and accountability of State fund disbursements.
- **Tradeoff Analysis (Component 8)** — State government should develop a DSS to provide guidance and leadership for defining uncertainties of future cost, benefits, prioritization, and other tradeoffs. The DSS would inform prioritization of State government expenditures, estimation of expected IWM benefits, and methods for apportioning costs across financiers. It also includes developing a clear and consistent methodology for identifying public benefits associated with the entire range of IWM activities.

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VOLUME 1 - THE STRATEGIC PLAN

CHAPTER 8

Roadmap For Action

Elkhorn Slough at Moss Landing. The recently expanded Moss Landing Power Plant, the California Coastal Conservancy's purchase of land adjacent to Elkhorn Slough to increase land in public trust, and high-value managed strawberry crops all are the result of diverse, highly planned actions.

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Chapter 8. Roadmap For Action

About This Chapter

Chapter 8 provides the *California Water Plan Update 2013* (Update 2013) roadmap to implement integrated water management (IWM) actions. The roadmap considers immediate and changing conditions and priorities, and the ongoing challenges described earlier in Volume 1, and particularly in Chapter 2, "Imperative to Invest in Innovation and Infrastructure." This chapter presents the elements of the roadmap, namely the vision of sustainable and reliable water resources and management systems. The mission statements herein describe collaborative efforts to prepare for California's most pressing statewide and regional water management issues and challenges, the seven goals that set forth the desired outcomes of the California Water Plan (CWP), and the 10 guiding principles that express the core values and philosophies for how the vision, mission, and goals will be achieved.

Update 2013 identifies seventeen objectives and their 300-plus related actions and sub-actions geared toward fulfilling the vision, mission, goals, and principles. Performance measures to gauge progress on those related actions are also specified. (For further discussion regarding these elements, see Box 8-1 and Volume 4, *Reference Guide*, the article "Strategic Planning Guidelines.") The Update 2013 roadmap builds on accomplishments since *California Water Plan Update 2009* (Update 2009), including ongoing implementation of the 2009 comprehensive water legislation, as well as fundamental water-resource management lessons learned. The roadmap includes near-term and long-term actions that describe how Californians can and should step up existing efforts and initiate new ones to provide integrated, reliable, sustainable, and secure water resources and management systems. These efforts will protect public health, public safety, and ecosystems, as well as ensure the stability of the state's economy, today and for future generations.

Background

Required by the California Water Code Section 10005(a), the CWP is State government's strategic plan for managing and developing water resources statewide. By statute the CWP cannot mandate actions or authorize spending for the related actions. Update 2013 makes neither project-specific nor site-specific recommendations; therefore, it does not include environmental review and documentation as would be required by the California Environmental Quality Act (CEQA).

Policy-makers and lawmakers must take definitive steps to authorize the related actions in Update 2013 and appropriate the funding needed for their implementation. At the same time, the plan must be embraced by agencies, voting bodies, and non-profit organizations that can implement the related actions. This underscores the need to have broad public participation and support to realize the Update 2013 objectives and related actions.

Update 2013 builds on and advances a planning transformation that began with the *California Water Plan Update 2005* (Update 2005) process. Update 2005 was the first of the CWP updates to explicitly include a strategic planning approach from preparation to presentation. Since then, the CWP has become a strategic planning document that more fully describes the role of State

Box 8-1 **Elements of the Strategic Plan**

Element	Purpose
Vision	The vision statement describes the desired future for California water resources and management, and serves as a foundation for water and flood planning during the planning horizon.
Mission	The mission statement describes the California Water Plan's unique purpose and its overarching reason for existence. The plan identifies what needs to be done and why, and how Californians will benefit from the proposed actions.
Goals	The goals are the desired outcome of the water plan over its planning horizon. The goals are founded on the statewide vision. Meeting the goals requires coordination among federal, State, tribal, and local governments and agencies.
Guiding Principles	The guiding principles describe the core values and philosophies that dictate how to achieve the vision, mission, and goals. In other words, the guiding principles describe how to make decisions and do business.
Objectives	Each objective targets what needs to be done and why, to accomplish one or more goals.
Related Actions	Related actions tell how an objective will be achieved. They describe specific actions in measurable, time-based statements of intent. They emphasize the results of actions at the end of a specific time frame. Some related actions must be undertaken by State government or communities over whom the California Department of Water Resources has no authority. In these cases, performance measures and time frames must be part of the entities' own strategic plans.
Performance Measures	Performance measures describe what to measure and the method by which to measure, to determine what work was performed and what results were achieved. Performance measures may be short term, intermediate, or long term and can help with accountability and comparisons of how well an action has met a desired goal or objective.

government and the growing role of California's regional collaboratives in managing the state's water resources.

Elements of the Roadmap

The vision, mission, goals, guiding principles, objectives, and related actions build on those presented in Update 2009. In addition, Update 2013 includes four new objectives reflecting important water management topics. These include objectives that promote enhancing public access to waterways, lakes, and beaches; strengthening alignment between land use and water planning; strengthening government agency alignment; and improving water financing. While some related actions for the various objectives were carried over from Update 2009, many were revised or are new for Update 2013.

Vision

California has healthy, resilient watersheds and reliable and secure water resources and management systems. Public health, safety, and quality of life in rural, suburban, and urban communities are significantly improved as a result of advancements in IWM. The water system provides the certainty needed for quality of life, sustainable economic growth, business vitality, and agricultural productivity. California's unique biological diversity, ecological values, and cultural heritage are protected and have substantially recovered.

Mission

Updating the CWP provides federal, State, tribal, regional, and local governments and organizations with a continuous planning forum to collaboratively:

- Recommend strategic goals, objectives, and near-term and long-term actions that would conserve, manage, develop, and sustain California's watersheds, water resources, and management systems.
- Prepare response plans for floods, droughts, and catastrophic events that would threaten water resources and management systems, the environment, and property, as well as the health, welfare, and livelihood of the people of California.
- Evaluate current and future watershed and water conditions, challenges, and opportunities.

Goals

1. California's water supplies are adequate, reliable, secure, affordable, sustainable, and of suitable quality for beneficial uses to protect, preserve, and enhance watersheds, communities, cultural resources and practices, environmental and agricultural resources, and recreation.

2. State government supports integrated water resources planning and management through leadership, assistance, oversight, and public funding.

3. Regional and interregional partnerships play a pivotal role in California water resources planning, water management for sustainable water use and resources, and increasing regional self-reliance.

4. Water resource and land use planners make informed and collaborative decisions and implement integrated actions to increase water supply reliability, use water more efficiently, protect water quality, improve flood protection, promote environmental stewardship, and ensure environmental justice and public access to water bodies, in light of drivers of change and catastrophic events.

5. California is prepared for climate uncertainty by developing adaptation strategies and investing in a diverse set of actions that reduce the risk and consequences posed by climate change, which make the system more resilient to change and increase the sustainability of water and flood management systems and the ecosystems they depend on.

6. Integrated flood management, as a part of IWM, increases flood protection, improves preparedness and emergency response, enhances floodplain ecosystems, and promotes sustainable flood management systems.

7. The benefits and consequences of water decisions and access to State government resources are equitable across all communities.

Guiding Principles

1. **Manage California's water resources and management systems with ecosystem health and water supply and quality reliability as equal goals, with full consideration of public trust uses.** Healthy, functioning ecosystems and reliable, quality water supplies are primary and equal goals for water management to help sustain water resources and management systems. Protect public trust uses whenever feasible, and consider public trust values in the planning and allocation of water resources. State government protects the public's rights to commerce, navigation, fisheries, recreation, ecological preservation, and related beneficial uses, including those of its Native American tribes and other communities that depend on these resources for subsistence and cultural practices.

2. **Use a broad, stakeholder-based, long-view perspective for water management.** Promote multi-objective planning with a regional focus, and coordinate local, regional, interregional, and statewide initiatives. Recognize distinct regional problems, resources, assets, and priorities. Emphasize long-term planning (30- to 50-year horizon) while identifying near-term actions needed to achieve the plan.

3. **Promote sustainable resource management on a watershed basis.** Wisely use natural resources to ensure their availability for future generations. Promote activities with the greatest multiple benefits regionally and statewide. Consider the interrelationship between water uses and supplies, water conservation, water quality, water infrastructure, flood protection, land use, energy generation and consumption, recreation, economic prosperity, and environmental stewardship on a watershed or ecosystem basis.

4. **Increase system flexibility and resiliency.** Evaluate and implement strategies that reduce the impacts of droughts and floods in the region. In California, drought contingency planning and integrated flood management are important components of regional water planning.

5. **Increase regional self-reliance.** Implement resource management strategies that reduce dependence on long-term imports of water from other hydrologic regions for meeting additional future water demands and during times of limited supply, such as a drought or interrupted supply after a catastrophic event (e.g., an earthquake or fire). Reduce reliance on the Sacramento-San Joaquin Delta (Delta) in meeting California's future water demands. Increase regional self-reliance for water by investing in water use efficiency, water recycling, advanced water technologies, local and regional water-supply projects, improved regional coordination of local and regional water supplies, and other strategies. As part of a diverse water portfolio, short-term water transfers between regions that are environmentally, economically, and socially sound can also help increase regional self-reliance overall.

6. **Determine values for economic, environmental, and social benefits; costs; and tradeoffs so as to base investment decisions on sustainability indicators.** Evaluate programs and projects recognizing economic growth, environmental quality, social equity, and sustainability as coequal objectives. When comparing alternatives, determine the value of potential economic, environmental, and social benefits; beneficiaries; costs; and tradeoffs. Include a plan that avoids, minimizes, and mitigates for adverse impacts of IWM projects.

7. **Incorporate future variability, uncertainties, and risk in the decision-making process.** Use multiple future scenarios to consider drivers of change and emerging conditions, such as population growth, land use development patterns, and climate change, when making planning, management, and policy decisions.

8. **Apply California's water rights laws, including the long-standing constitutional principles of reasonable use and public trust, as the foundation for public policy-making, planning, and management decisions on California water resources.** Recognize that certain natural resources — including water, tides, and submerged lands; the beds and banks of navigable rivers; and fish and wildlife resources — are owned by the public and held in trust for present and future generations of Californians. Native American tribes also depend on these natural resources for subsistence and cultural heritage. Effectively applying existing water rights laws and the twin principles of reasonable use and public trust will provide water for future generations while protecting ecosystem values.

9. **Promote environmental justice — the fair treatment of people of all races, cultures, and incomes.** Include meaningful community participation in decision-making for State-sponsored or public-funded resource management projects, and consider such factors as community demographics, potential or actual adverse health or environmental impacts, and benefits and burdens of the project on communities.

10. **Use science, best data, and local and traditional ecological knowledge in a transparent and documented process.** When appropriate and possible, use data, information, planning methods, and analytical techniques that have undergone scientific review.

Objectives and Related Actions

The objectives and related actions presented in this roadmap were developed in part from companion State plans and the Tribal Engagement Plan (refer to Chapter 4, "Strengthening Government Alignment"). Meeting the 17 objectives, shown in Box 8-2, will help achieve Update 2013 goals. Planning and investing in the more than 300 related actions and sub-actions will provide greater system resiliency and help California deal with climate conditions and other future uncertainties and risks.

In addition, performance measures, lead entities, the current funding status, and whether legislation is required to complete the related action have been identified. This supporting information is presented in a table in Volume 4, *Reference Guide*, titled "California Water Plan Related Actions and Performance Measures," and will be used to track the future progress of each related action. (Note that numbering of the objectives and related actions, below, is for ease of identification and does not represent priority.)

Box 8-2 Update 2013 Objectives

1. Strengthen Integrated Regional Water Management
2. Use and Reuse Water More Efficiently
3. Expand Conjunctive Management of Multiple Supplies
4. Protect and Restore Surface Water and Groundwater Quality
5. Practice Environmental Stewardship
6. Improve Flood Management Using an Integrated Water Management Approach
7. Manage the Delta to Achieve the Coequal Goals for California
8. Prepare Prevention, Response, and Recovery Plans
9. Reduce the Carbon Footprint of Water Systems and Water Uses
10. Improve Data, Analysis, and Decision-Support Tools
11. Invest in Water Technology and Science
12. Strengthen Tribal/State Relations and Natural Resources Management
13. Ensure Equitable Distribution of Benefits
14. Protect and Enhance Public Access to the State's Waterways, Lakes, and Beaches
15. Strengthen Alignment of Land Use Planning and Integrated Water Management
16. Strengthen Alignment of Government Processes and Tools
17. Improve Integrated Water Management Finance Strategy and Investments

Note: Subsequently in this chapter, the discussion of each objective, accompanied by its list of related actions, begins on a new page to facilitate the extraction of selected pages by using the "Page Thumbnail" view in Adobe Acrobat®.

Objective 1 — Strengthen Integrated Regional Water Management

> *Strengthen integrated regional water management planning and implementation to maintain and enhance regional water management partnerships and improve regional self-reliance.*

Integrated regional water management (IRWM) is the application of IWM principals at the regional scale to improve public safety, environmental stewardship, and economic stability. IRWM is based on regional water managers and resource planners being best suited and best positioned to manage regional and local water resources to meet regional needs.

The State of California officially embraced IRWM in 2002 with the passage of the IRWM Planning Act (Senate Bill [SB] 1672). The purpose of the act is to:

> …facilitate the development of integrated regional water management plans, thereby maximizing the quality and quantity of water available to meet the state's water needs by providing a framework for local agencies to integrate programs and projects that protect and enhance regional water supplies.

The act encourages:

> …local agencies to work cooperatively to manage their available local and imported water supplies to improve the quality, quantity and reliability of those supplies.

The IRWM Planning Act was followed by the passage of Proposition 50 (2002) and Proposition 84 (2006), which provided $500 million and $1.0 billion, respectively, to support IRWM planning and implementation. State guidelines for the practice of IRWM encourage IRWM planning efforts to be open, inclusive, transparent, and collaborative. IRWM planning processes should include water managers; tribes; local, regional, State, and federal governmental agencies; disadvantaged communities; and non-governmental organizations.

IRWM has profoundly improved water management in California since 2002. There are currently 48 IRWM regions in California that collectively cover about 87 percent of the state's geographic area and 99 percent of the state's population. Although much progress has been made, many opportunities remain for even greater advancement of IRWM and its benefits.

The California Department of Water Resources (DWR) is working with IRWM practitioners and stakeholders to develop the Strategic Plan for the Future of Integrated Regional Water Management in California (IRWM Strategic Plan). The purpose of the IRWM Strategic Plan is to develop a shared vision for the future of IRWM in California and identify measures necessary to achieve the desired future. The plan will:

- Inform the California Legislature about statutory changes needed to sustain IRWM.
- Describe DWR's future role and guide DWR's actions for improving its support of IRWM.
- Recommend to federal, State, and local agencies better alignment of programs and policies to more effectively support IRWM goals.
- Identify for regional water management groups options, tools, and practices for improving the practice of IRWM.

- Inform the general public about the benefits of, and opportunities for, involvement in the IRWM process.

Development efforts for the IRWM Strategic Plan are currently underway and are expected to be completed in 2014. Three principal themes have emerged from stakeholder input and will likely be part of the plan:

- Improve the IRWM process.
- Improve water management tools.
- Align government statutes, regulations, programs, and policies to support IRWM.

Because the IRWM Strategic Plan is a companion State plan for Update 2013, these themes and related actions, including those yet to be determined, are included in this objective. Additional information on the development of the IRWM Strategic Plan is available at http://www.water.ca.gov/irwm/stratplan/.

In addition, performance measures, lead entities, current funding status, and whether legislation is required to complete the related actions below have been identified. This supporting information is presented in a table in Volume 4, *Reference Guide*, titled "California Water Plan Related Actions and Performance Measures," and will be used to track the future progress of each related action.

Related Actions

1.1 The California Department of Water Resources (DWR), through active engagement with agencies, tribes, communities, and stakeholders, will complete the Strategic Plan for the Future of Integrated Regional Water Management (IRWM) in California in 2014.

1.2 DWR and other State agencies should encourage and support regional water management groups to continue, enhance, and expand their regional collaboration and cooperation through IRWM to meet the water management challenges of population growth and climate change, and ensure public safety, environmental stewardship, and economic stability.

1.3 DWR should continue to improve the efficiency and effectiveness of its future IRWM grant programs and processes in coordination with other State agencies and regional water management groups.

1.4 DWR and other State agencies should improve IRWM processes at all levels to encourage broad participation, support collaboration, and facilitate cooperation among stakeholders.

1.5 DWR should perform a needs assessment for under-represented groups and develop strategies for better inclusion of those groups in IRWM.

1.6 DWR and other State agencies should develop and support an IRWM education and awareness program to foster public support and facilitate informed decisions for sustainable water management.

1.7 DWR and other State agencies should improve water management tools, provide technical assistance, and encourage innovation in the areas of collaboration, trade-off analyses, modeling, and data management.

1.8 State government should align its statutes, regulations, programs, policies, and practices to support and strengthen IRWM.

Objective 2 — Use and Reuse Water More Efficiently

Use water more efficiently with significantly greater water conservation, recycling, and reuse to help meet future water demands and adapt to climate change.

Urban and agricultural water use efficiency are important tools for meeting current and future water demands and maximizing beneficial use of the state's water resources. To minimize the impacts on California's natural environment, recover groundwater overdraft, and support meeting statewide and local water demands, our cities and farms must continue to increase water use efficiency and thus maximize benefits from existing and future water supplies. Efficient water use in agriculture must go hand in hand with the adoption of agricultural land stewardship strategies (see Volume 3, Chapter 21, "Agricultural Land Stewardship"), so as to realize multiple benefits and ensure a sustainable food production while protecting and restoring the natural and human environments. Californians have been successful in increasing water-use efficiency measures, such as low-water-use landscaping, water-efficient appliances, and municipal wastewater recycling; however, increasing population and climate change impacts require continued aggressive focus and investment in water-use efficiency efforts.

Key components of California's actions to increase water use efficiency are contained within the 2009 Comprehensive Water Package (SB X7-7), which requires urban water agencies to reduce statewide per capita water consumption 20 percent by 2020 and make incremental progress toward this goal by reducing per capita water use by at least 10 percent on or before December 31, 2015. The bill also requires agricultural water suppliers to measure water deliveries and adopt a pricing structure for water customers based in part on quantity delivered, and, where technically and economically feasible, to implement additional measures to improve efficiency.

Water use efficiency is a fundamental component of California water planning because it integrates and benefits key components of water supply planning and environmental stewardship. It is a key part of the water management portfolio of every water agency, city, county, farm, and business, including State and federal government agencies. Water use efficiency and conservation reduce water demand and, in turn, wastewater generation. This reduces water and wastewater treatment needs, thereby reducing energy demand and greenhouse gas (GHG) emissions. Efficient water use also includes the development of local water supplies, which has the dual benefit of reducing energy demands for water transportation and reducing reliance on water supplies that may be strongly influenced by fluctuating availability. Efficient water use also matches water quality to water use ("fit for use"), primarily to identify water reuse opportunities that minimize the need for high-level and energy-intensive treatment. While these water management issues have statewide impacts, they are primarily implemented at the local and regional levels.

The related actions identified below are specific measures that can be implemented during the term of Update 2013 to support this objective of using and reusing water more efficiently. They focus on increased water education to continue to raise awareness of the need for all Californians to be efficient with use of our shared resource; development of agricultural and urban water plans, tools, and metrics; and preparation of a statewide recycled water strategic plan.

In addition, performance measures, lead entities, current funding status, and whether legislation is required to complete the related actions below have been identified. This supporting information is presented in a table in Volume 4, *Reference Guide*, titled "California Water Plan Related Actions and Performance Measures," and will be used to track the future progress of each related action. These related actions are also supported by additional recommendations in Chapter 2, "Agricultural Water Use Efficiency"; Chapter 3, "Urban Water Use Efficiency"; and Chapter 12, "Municipal Recycled Water," of Volume 3, *Resource Management Strategies*.

Related Actions

2.1 State government should expand public information efforts to promote water conservation in both the urban and agricultural sectors to better inform all Californians about the importance and value of water and about ways to use water more efficiently. The expanded campaign should be designed with specific informational goals and objectives and should operate on a continuous basis in wet years as well as dry years. This campaign will assist local water suppliers and the State in achieving the 2020 urban water use targets.

2.2 State government should establish a water-use-efficiency and alternative-water-supply science and technology program to accelerate the research, development, testing, pilot projects, and commercialization of promising new technologies and techniques to improve agricultural and urban water management and use efficiency. The program should conduct studies in all sectors of water use, including agriculture, municipal and industrial, and in the alternative water supply areas of municipal recycled water, gray water, stormwater capture, and desalination. The program's level of sponsored research should match that of the State's energy-use efficiency research programs.

2.3 The California Department of Water Resources (DWR), in cooperation with agricultural and urban water-use communities, should conduct a study to identify the barriers, costs, and technical assistance required to establish standard agricultural and urban water-use classifications and data standards for water use reporting statewide. The standard classifications would provide more detailed and accurate reporting of California water uses, and allow for water supplier data to be more accurately aggregated at regional and statewide scales for the five-year updates of the California Water Plan.

2.4 DWR should continue to work with the University of California and the California State University systems to refine irrigation strategies and systems that reduce the impact of extreme water shortage conditions (e.g., drought) on California's agriculture. State government should provide more technical assistance to growers to improve on-farm irrigation efficiency, and should expand the California Irrigation Management Information System (CIMIS) network (including remote sensing technology, satellite imagery, etc.), mobile laboratory services, and other water management training and education programs.

2.5 DWR, in cooperation with academic institutions, resource conservation districts, and independent crop advisors, should provide technical assistance to agricultural water suppliers and farmers to implement efficient water management practices (EWMPs) and to evaluate their agricultural water-use efficiency by applying the quantification methods (indicators) described in the 2012 DWR report to the Legislature, "A Proposed Methodology for Quantifying the Efficiency of Agricultural Water Use." Agricultural water suppliers with irrigated acreage equal or greater than 25,000 acres should utilize these methods to quantify and report efficiency improvements in their agricultural water management plans (AWMPs).

2.6 Agricultural and urban water suppliers should report water supply system leakage and spills in their water management plans. Agricultural suppliers should measure and report canal seepage and district outflows. Urban water suppliers should calculate and report unaccounted-for distribution system water.

2.7 DWR, with the California Urban Water Conservation Council and the State Water Resources Control Board (SWRCB), should research, develop, and promote water rate structures that provide customers a water conservation price signal while maintaining needed infrastructure and revenue stability for the water utilities.

2.8 To better educate customers on the appropriate use of water and to improve landscape irrigation efficiency, DWR should research new approaches for measuring landscape area to assist water suppliers in developing customer-specific water budgets. In addition to educational purposes, urban water suppliers should use water budgets to focus their water conservation rebates and programs on those customers using water excessively.

2.9 State government should develop a 2030 Statewide Urban Water Use Efficiency Plan with the goal of further improvements in water use efficiency from the 20x2020 program. Accounting for population growth, the current 20x2020 program will keep the total volume of urban water use in 2020 at about the same as in the year 2000. The goal of the 2030 program should be to replicate the 20x2020 program success by keeping the total volume of statewide urban water use in 2030 at the same level as in 2020, achieved by further reducing per-capita urban water use.

2.10 DWR, with the SWRCB and California Department of Public Health, should prepare a California Municipal Water Recycling Strategic Plan to guide expanded statewide use of recycled water to help sustain statewide water supplies. The strategic plan should include:

- Review and status of implementation of the 2003 Recycled Water Task Force findings.
- Regional assessment and quantification of current and proposed recycled water capacities and demands.
- Evaluation of better alignment of the appropriate level of treatment required for the planned recycled water use in agricultural and environmental applications to create more opportunities for recycled water use and reduce the energy required to produce recycled water.
- Consideration of potential groundwater degradation issues and coordination with Salt and Nutrient Management Plan implementation.
- Regional evaluation of barriers to additional recycled water use and proposing solutions, including indirect and direct potable reuse issues and opportunities, to support continued expansion of recycled water use.

2.11 All levels of government should establish policies and provide incentives to promote better urban runoff management and reuse. Urban and, where feasible, rural communities should invest in facilities to capture, store, treat, and use urban stormwater runoff, such as percolation to usable aquifers, underground storage beneath parks, small surface basins, in drains, or the creation of catch basins or sumps downhill of development. Depending on the source and application, captured stormwater may be suitable for use without additional treatment, or it may be blended to augment local supplies.

Objective 3 — Expand Conjunctive Management of Multiple Supplies

Advance and expand conjunctive management of multiple water supply sources with existing and new surface and groundwater storage to prepare for future droughts, floods, and climate change.

California can prepare for future droughts, flood, and climate change, as well as improve water supply reliability and water quality, by managing the extensive water storage capacity of groundwater basins in closer coordination with existing and new surface storage and other water supply sources when available. The other supply sources include, but are not limited to, recycled municipal water, surface runoff and flood flows, urban runoff and stormwater, imported water, water transfers, and desalination of brackish and sea water.

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

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

Along with more effective use of groundwater storage, better regional and systemwide water management and the reoperation of surface storage reservoirs and related infrastructure of flood and water management systems can provide many benefits in a changing climate. These include capturing higher peak flows to protect beneficial uses of water, such as protecting drinking water quality, providing cold water releases for fish, preventing seawater intrusion, generating clean hydroelectricity, providing recreational opportunities in a warmer climate, and offsetting the loss of snowpack storage by facilitating increased storage of water above and below the ground.

System reoperation of existing flood and water infrastructure will require the active cooperation of many agencies, local governments, and landowners. Successful system reoperation will require that the benefits are evident to federal, tribal, regional, and local partners. Systemwide institutional coordination and cooperation need to occur in advance of responding to extreme hydrologic events that may become larger and more frequent with climate change. In Southern California, several flood management dams operated by the U.S. Army Corps of Engineers could potentially be re-operated to enable temporary storage of storm flows and release of the same at rates that would allow water agencies to capture the released water in spreading basins to augment groundwater supplies.

In addition, performance measures, lead entities, current funding status, and whether legislation is required to complete the related actions below have been identified. This supporting information is presented in a table in Volume 4, *Reference Guide*, titled "California Water Plan Related Actions and Performance Measures," and will be used to track the future progress of each related action. These related actions are also supported by additional recommendations in Chapter 6, “Conveyance — Regional/Local”; Chapter 7 “System Reoperation”; Chapter 8, “Water Transfers”; Chapter 9, “Conjunctive Management and Groundwater Storage”; Chapter 10, “Desalination (Brackish and Sea Water)”; Chapter 12, “Municipal Recycled Water”; Chapter 13, “Surface Storage — CALFED”; Chapter 14, “Surface Storage — Regional/Local”; Chapter 20, “Urban Stormwater Runoff Management”; and Chapter 25, “Recharge Area Protection” of Volume 3, *Resource Management Strategies*.

Related Actions

3.1 The California Department of Water Resource (DWR) and the State Water Resources Control Board (SWRCB) should implement a program to promote public education about groundwater.

3.2 Improve collaboration, coordination, and alignment among State, federal, tribal, local, and regional agencies and organizations to help implement sustainable groundwater management by ensuring that data and tools are evaluated and shared, programs are coordinated, and duplication is minimized.

3.3 DWR, SWRCB, and the Governor’s Office of Planning and Research (OPR) should develop a statewide groundwater management planning Web site or portal to promote easy access to groundwater information, such as well completion reports; well drilling, construction, and abandonment standards; groundwater supply and demand; groundwater level and quality; land subsidence; groundwater recharge and conjunctive management; and groundwater management plans and basin studies.

3.4 DWR should build essential data to enable sustainable groundwater management by expanding and funding the California Statewide Groundwater Elevation Monitoring (CASGEM) Program with the purpose of maintaining baseline groundwater level data, funding and providing technical assistance to improve local groundwater management for long-term sustainability, and monitoring impacts of droughts on groundwater resources.

3.5 Under the CASGEM Basin Prioritization, DWR will improve understanding of California’s high priority groundwater basins by conducting groundwater basin assessment in conjunction with the California Water Plan five-year production cycle, identifying basins in decline with recognition of both short- and long-term aquifer health, assessing impacts of climate change, identifying management practices for sustainable groundwater management that will prevent waste and unreasonable use of groundwater, and reporting key findings to the Legislature.

3.6 DWR should convene a Statewide Groundwater Management Plan (GWMP) Advisory Committee to develop a GWMP Acceptance Process, evaluate and approve the completeness of existing GWMPs with a special focus on high-priority basins that currently are not actively managed, prepare a guidance document of groundwater best management practices, and develop improved standards for sustainable groundwater management by utilizing a public process.

3.7 State government and integrated regional water management (IRWM) groups should advance groundwater management within the framework of integrated water management by identifying and including the goals and objectives of local GWMPs in integrated regional water management plans; ensuring no transfer of impacts among regions;

ensuring that regions accept responsibility for addressing risks resulting from climate change, population growth, and groundwater depletion; adopting stronger standards for local and regional groundwater management; and considering legislation to provide needed local and regional authority to effectively manage groundwater resources.

3.8 DWR and SWRCB should review analytical tools currently being used and assist local agencies in developing improved tools to assess conjunctive management and groundwater management strategies.

3.9 Groundwater management authorities and collaboratives should increase local and regional groundwater recharge and storage to reduce groundwater depletion and enhance statewide water resource resiliency.

3.10 DWR will complete the System Reoperation Study by 2015 to evaluate reoperation of the state's existing water supply and flood management systems.

3.11 DWR and the U.S. Bureau of Reclamation will:

3.11.1 Complete the North-of-the-Delta Offstream Storage, Shasta Lake Water Resources, and Upper San Joaquin River Basin Storage investigations.

3.11.2 Complete the investigation of the further enlargement of the Los Vaqueros Reservoir.

3.11.3 Complete an investigation to raise B.F. Sisk Dam and enlarge San Luis Reservoir.

Objective 4 — Protect and Restore Surface Water and Groundwater Quality

> *Protect and restore surface water and groundwater quality to safeguard public and environmental health and secure California's water supplies for beneficial uses.*

As California's population continues to grow and climate change impacts continue to occur, greater demands will be made on available water supplies, and threats to water quality from known and emerging pollutants will increase, potentially causing further impairments to the waters and their uses. When water quality is impaired, the state is deprived of critical water supplies needed to support its growing population, vital economy, and the environment. Protecting and restoring water quality ensures that water supplies are available for all beneficial uses and all communities. It is also a crucial element of IWM and essential to maintaining healthy watersheds.

Healthy watersheds, or drainage basins, that provide clean and plentiful surface water and groundwater, and support healthy riparian and wetland habitat, are essential to support California's resources and economic future. A watershed approach is hydrologically focused; recognizes the degree to which groundwater and surface water bodies are connected physically; is aware of the linkages between water quantity and water quality; and requires a comprehensive, long-term approach to water resources management that takes system interactions into account. State government efforts to protect and restore water quality are essential but alone cannot support a comprehensive watershed protection approach. Success depends on the integration of federal, State, tribal, regional, and local programs and projects, including land use decisions made by local officials, stakeholder involvement, and the actions of millions of individuals, which, when taken together, can have significant impacts and make a difference.

In addition, performance measures, lead entities, current funding status, and whether legislation is required to complete the related actions below have been identified. This supporting information is presented in a table in Volume 4, *Reference Guide*, titled "California Water Plan Related Actions and Performance Measures," and will be used to track the future progress of each related action. These related actions are also supported by additional recommendations in Chapter 15, "Drinking Water Treatment and Distribution"; Chapter 16, "Groundwater/Aquifer Remediation"; Chapter 17, "Matching Water Quality to Use"; Chapter 18, "Pollution Prevention"; Chapter 19, "Salt and Salinity Management"; Chapter 20, "Urban Stormwater Runoff Management"; Chapter 25, "Recharge Area Protection"; and Chapter 26, "Sediment Management" of Volume 3, *Resource Management Strategies*.

Related Actions

4.1 Protect and restore surface water quality by implementing strategies to protect the past, present, and probable future beneficial uses for all 2010-listed (Clean Water Act, Section 303[d]) water bodies by 2030.

4.1.1 Implement a statewide strategy to efficiently prepare, adopt, and implement total maximum daily loads (TMDLs), which result in water bodies meeting water quality standards, and adopt and begin implementation of TMDLs for all 2010-listed water bodies by 2019.

4.1.2 Manage urban runoff volume to reduce pollutant loadings, reduce wet weather beach postings and closures by 75 percent by 2020, eliminate dry weather beach closures and postings and, where applicable, promote stormwater capture and re-use for development of sustainable local water supplies.

4.1.3 Take appropriate enforcement actions and innovative approaches as needed to protect and restore the beneficial uses of all surface waters.

4.2 Protect and restore groundwater quality by improving and protecting groundwater quality in high-use basins by 2030.

4.2.1 Communities should implement an integrated groundwater protection approach to improve and protect groundwater in high-use basins that:

A. Evaluate and regulate activities that impact or have the potential to impact beneficial uses.

B. Recognize the effects of groundwater and surface water interactions on groundwater quality and quantity.

C. Encourage and facilitate local management of groundwater resources.

4.2.2 State government should identify strategies to ensure that communities with contaminated groundwater have a clean and reliable drinking water supply, which may include remediation of polluted or contaminated groundwater, surface water replacement, and/or groundwater treatment.

4.2.3 State government should implement the recommendations in the State Water Resources Control Board's (SWRCB's) Report to the Legislature on addressing issues associated with nitrate contaminated groundwater.

4.2.4 The SWRCB and regional water quality control boards (RWQCBs) should help groundwater users and management authorities to maintain high-quality groundwater basins through application of antidegradation directives using waste discharge requirements and the remediation of polluted or contaminated groundwater.

4.2.5 Regional and local stakeholders should prepare salt and nutrient management plans for each groundwater basin/subbasin in California by 2016. These salt/nutrient management plans should be prepared as outlined in the SWRCB's Water Quality Control Policy for Recycled Water, adopted May 14, 2009. The RWQCBs should incorporate salt and nutrient management plans into basin plans, where appropriate.

4.3 Evaluate existing water quality protection and restoration, and the relationship between water supply and water quality, and describe the connections between water quality, water quantity, and climate change, throughout California's water planning processes.

4.3.1 As part of the California Water Plan, the SWRCB should evaluate existing water quality problems in the state, prioritize the most pressing problems, and prepare policy recommendations to guide the State's water management activities, including protection and restoration of water quality through the integration of statewide policies and plans, regional water quality control plans (basin plans), and the potential effects of climate change on water quality and supply.

4.3.2 RWQCBs should consistently organize basin plans to provide a clear structure that readily conveys key elements (e.g., beneficial uses, potential impacts of climate change, water quality objectives, goals for watersheds, plans for achieving those goals, and monitoring to inform and adjust the plans) and that fully integrates other water quality control plans, such as the California Ocean Plan and Water Quality Control Plan for Enclosed Bays and Estuaries.

4.3.3 RWQCBs should adopt basin plan amendments through a collaborative process that involves third parties and incorporates SWRCB requirements and stakeholder interests. An example is the Santa Ana RWQCB's Basin Plan amendment initiated with funding assistance from stakeholders as required in the SWRCB's Recycled Water Policy.

4.3.4 State Government should continue to support efforts of the California Water Quality Monitoring Council to develop a centralized Geographic Information System (GIS) database (EcoAtlas) that displays watershed information, including watershed boundaries, TMDLs, monitoring data, water body types, assigned Beneficial Uses, wetlands, California Rapid Assessment Method scores, vegetation types, and other data. A key component of effective water quality planning is access to pertinent watershed information so that regulatory actions can strategically protect and improve watershed aquatic resources.

4.4 To protect source water and safeguard water quality for all beneficial uses, State government should implement the recommendations from the following California Water Plan Resource Management Strategies found in Volume 3: pollution prevention, matching water quality to use, salt and salinity management, urban stormwater runoff management, groundwater/aquifer remediation, recharge area protection, municipal recycled water, drinking water treatment and distribution, agricultural lands stewardship, ecosystem restoration, forest management, land use planning and management, sediment management, and watershed management.

4.5 The California Department of Public Health (CDPH) will continue to implement its Small Water System Program Plan to assist small water systems (especially those serving disadvantaged communities) that are unable to provide water that meets primary drinking water standards.

4.5.1 CDPH will share the Small Water System Program Plan with relevant federal, tribal, State, regional, and local agencies, as well as stakeholders, to foster additional opportunities for funding, coordinate construction projects in communities, and to assist in local and regional planning efforts.

4.5.2 CDPH will utilize GIS tools to identify large water systems in close proximity to targeted small water systems, and conduct targeted outreach to these large water systems to encourage them to consolidate the small systems into their service area.

4.5.3 CDPH will work with stakeholders to identify obstacles to consolidation (including financial, legal, and local issues) and develop possible actions to address these obstacles.

4.5.4 CDPH will participate in statewide planning efforts to address the water infrastructure needs of small water systems. CDPH should seek input from other states and the federal government on innovative, successful efforts to address the needs of small water systems, and should share its results on implementation of its Small Water System Program Plan.

Objective 5 — Practice Environmental Stewardship

> *Practice, promote, improve, and expand environmental stewardship to protect biological diversity and sustain natural water and flood management systems in watersheds, on floodplains, and in aquatic habitats.*

Development patterns and other natural stressors have contributed to the loss of more than 90 percent of California's wetlands and riparian forests that existed before the Gold Rush. The loss of this rich habitat threatens many native species and biodiversity. Climate change increases the impact of this threat and makes the need for new restoration, expanded conservation areas, and environmental stewardship even more urgent.

An environmental stewardship strategy embraces sustainable, long-term, cost-effective, reduced-risk options that provide multiple public benefits. Expanding environmental stewardship will be critical to maintaining the state's biodiversity. The most robust approach to sustain fish, wildlife, and plant populations is to conserve enough variety and amount of habitat to sustain diverse and healthy (e.g., viable, abundant) populations. Successfully restoring aquatic, riparian, and floodplain species and natural communities typically involves at least partial restoration of physical processes driven by interaction with water.

Projects that preserve, enhance, and restore biological diversity and ecosystem processes are likely to be more sustainable, operating as desired and with less maintenance, and more resistive to exotic species and adaptive to climate impacts. These projects work with, rather than against, natural processes that distribute water and sediment. These processes include the flooding of floodplains, the natural pattern of erosion and deposition of sediment, the balance between infiltrated water and runoff, and large seasonal variation in stream flow. This, in turn, makes such projects less susceptible to the effects of catastrophic events and minimizes the cost and effort of maintenance. Not maintaining physical processes often leads to displacement of native species by exotic species, which presents another huge barrier to ecosystem restoration.

Increasing habitat conservation and/or establishing or restoring habitat connectivity is among the top options to pursue, especially with impacts of climate change. Connectivity of habitat is also essential to allow for the movement and adaptation of species in response to climate change. Identifying areas in project design planning, which will be resilient and able to capture the broadest range of species, is an important challenge but one that can reduce near-term and long-term management conflicts (National Fish, Wildlife & Plants Climate Adaptation Partnership 2012).

In addition, performance measures, lead entities, current funding status, and whether legislation is required to complete the related actions below have been identified. This supporting information is presented in a table in Volume 4, *Reference Guide*, titled "California Water Plan Related Actions and Performance Measures," and will be used to track the future progress of each related action. These related actions are also supported by additional recommendations in Chapter 21, "Agricultural Land Stewardship"; Chapter 22, "Ecosystem Restoration"; Chapter 23, "Forest Management"; Chapter 26, "Sediment Management"; and Chapter 27, "Watershed Management" of Volume 3, *Resource Management Strategies*.

Related Actions

5.1 Governments and the private sector should work together to create and maintain a network of protected reserve areas across the state that builds on existing conservation investments, and provides refuge areas and migration corridors that allow species to adjust to conditions associated with climate change. The network should include river corridors that connect high elevations to valleys and reestablish natural hydrologic connections between rivers and their historic floodplains (California Natural Resources Agency 2009). The California Natural Resources Agency should support and develop the following:

5.1.1 Establish and maintain a comprehensive, inter-jurisdictional inventory of current conservation areas and candidate high-priority conservation areas to coordinate future conservation efforts.

5.1.2 Work with partners at landscape scales to maximize use of existing conservation programs (e.g., easement, management, mitigation), particularly the conservation titles of the Farm Bill, the private lands programs focused on endangered species, and other federal and State private-lands incentive programs to conserve private lands of high conservation value, to enhance habitat values, and maintain working inland water landscapes under climate change.

5.1.3 Identify species and habitats particularly vulnerable to transition under climate change (e.g., cool-water to warm-water fisheries) and develop management strategies and approaches for adaptation.

5.1.4 Support or create funding sources to develop and utilize models and monitoring data to identify and map high-priority inland water areas/watersheds (i.e., refugia) for conservation by using information on species distributions (current and projected), habitat classification, land cover, and geophysical settings (including areas of rapid change and slow change).

5.1.5 Identify and address conflicting management objectives within and among federal, State, and tribal conservation agencies and private landowners, and seek to align policies and approaches.

5.2 All agencies that own and operate water and flood management systems should include actions in their respective natural resource management plans that restore natural processes of erosion and sedimentation in rivers and streams and increase the quantity, diversity, quality, and connectivity of riverine and floodplain habitats. Local planning activities, including integrated regional water management (IRWM), urban water management plans, watershed management plans, natural community conservation plans, habitat conservation plans, and other water resource or floodplain focused planning efforts, should include objectives to meet these goals.

5.2.1 Re-establish one million acres of contiguous natural riparian, wetland, and floodplain habitat that is subject to periodic flooding for at least 50 percent of the river miles in the regions. This can contribute to Assembly Bill 32 greenhouse gas reduction goals through enhanced carbon sequestration. IRWM and regional flood management plans that incorporate corridor connectivity and restoration of native aquatic and terrestrial habitats to support increased biodiversity and resilience to a changing climate should receive additional credits in State government water and flood grant programs. (See Objectives 1, 2, and 6.)

5.3 State and federal governments should encourage, prioritize, and identify financing for actions to protect, enhance, and restore at least one million acres of upper watershed forests and meadows that act as natural water and snow storage. These actions should include efforts to reduce the risks and impacts of catastrophic wildfire. This measure improves water supply reliability, protects water quality, safeguards high-elevation habitats, and supports carbon sequestration and forest-based economies. (See Objectives 1, 3, and 4.) (Association of California Water Agencies 2013; California Air Resources Board 2008)

5.4 Governments and the private sector should develop and support programs that pay private landowners and managers to protect and improve habitat and nature's water-related services, including flood protection, water quality, groundwater recharge and storage, reversal of land subsidence, prevention of large wildfires, shading of rivers and streams, and reduced soil erosion.

5.5 Governments and the private sector should work to incorporate the economic value of nature's goods and services into natural resource management decisions. Such recognition should include development of ways to measure and report the economic value of those services and the financial return from investment in their protection and enhancement.

5.6 Federal, tribal, State, and local agencies should provide greater resources and coordinate efforts to control invasive species and prevent their introduction (California Department of Fish and Game 2007).

5.7 State and federal government should work with dam owners/operators, tribes, and other stakeholders to evaluate opportunities and technologies to reintroduce anadromous fish to upper watersheds. Re-establishment of anadromous fish upstream of dams may provide additional flexibility in providing cold water downstream in conjunction with water and flood systems reoperation strategies. State and federal governments should develop funding sources to support partnerships in constructing fish passage at dams and to assist removal of obsolete dams that pose a public safety and/or ecological risk.

5.8 State, federal, and local government should identify and prioritize protection of lands of San Francisco Bay and the Delta that will provide the habitat range for tidal wetlands to adapt to and shift with sea level rise. A climate change resilient San Francisco Bay and Delta should include creating greater flood flow capacity by construction of setback levees on islands and removal of strategic island levees that also creates opportunities for tidal wetland and riparian restoration. Such lands and actions can help maintain estuarine ecosystem functions and act as storm buffers, protecting people and property from flood damages. (San Francisco Estuary Partnership 2007)

5.9 State government should prioritize, expand, and support Delta islands and Suisun Marsh subsidence reversal and land accretion projects to help reestablish equilibrium between land and estuary elevations. Sediment-soil accretion is a cost-effective, natural process that can help sustain the Delta and Suisun Marsh ecosystem, and reduce communities' risks from flooding, as well as sequester carbon and restore estuarine ecosystem functions.

5.10 State and federal government should fund natural resource protection agencies to continue work to determine fishery needs and provide funds for water right holders to meet those needs.

Objective 6 — Improve Flood Management Using an Integrated Water Management Approach

> *Promote and practice flood management that reduces flood risk to people and property and maintains and enhances natural floodplain functions using an IWM approach. An IWM approach utilizes a systemwide perspective and considers all aspects of water management, including public safety and emergency management, environmental sustainability, and economic stability (which includes water supply reliability, water quality, and system and community resiliency).*

Flood management has traditionally had the single purpose of protecting people and property that could be harmed by flood waters by separating them from the flood. In contrast, flood management using an IWM approach seeks to protect people and property exposed to flooding, while also addressing the quality and functioning of ecosystems, the reliability of water supply and water quality, and economic stability (including both economic and cultural considerations). This shift changes the focus of flood management from managing flood water to managing floodplains, thus allowing for both a local/regional and a systemwide context.

Today, one in five Californians live in a floodplain. There are more than 20,000 miles of levees, over 1,500 dams, more than 1,000 debris basins, and other facilities statewide that manage flood water and provide flood risk reduction. Traditionally, Californians have reduced the risk of flooding through actions like building dams, levees, and other facilities that constrain floodwaters and provide protection to people from the harmful aspects of flooding, but these facilities also diminish the natural benefits of floods. These facilities face a number of challenges, including reaching the end of their useful life, inadequate operations and maintenance, insufficient capacities, and stressors resulting from climate change. Climate change may cause sea levels to rise, produce higher tides, shift precipitation patterns toward more intense winter storms, and produce higher peak flows, thereby increasing the state's flood risk.

A collection of laws passed in 2007 and 2008 focused attention on flooding and the risks it poses. These laws intended to promote a new perspective for managing floods. Despite the amount of progress and improvements that have been made since the passage of these laws, Californians still face an unacceptable level of flood risk. Current infrastructure strains to meet existing objectives, and changing climatic conditions could exacerbate this situation. With climate change and other changing conditions, improving system flexibility and adaptability must be a foundational strategy, especially with respect to water and flood system operations and management.

Flood management is evolving from the more narrowly focused traditional approaches toward an IWM approach. This more integrated approach includes a mix of structural and non-structural approaches to reduce flood risk and enhance the ability of undeveloped floodplains and other open spaces to behave more naturally to absorb, store, and slowly release floodwaters during small and medium-size events. Flood management using an IWM approach considers land and water resources on a watershed scale to maximize the benefits of floodplains; minimize loss of life and damage to property from flooding; recognize the benefits to ecosystems from periodic flooding; and provide other potential benefits, such as water supply reliability, water quality improvements, and increased recreation opportunities. Flood management using an IWM approach extends the range of resource management strategies that could be employed and leads to addressing a wide variety of needs. Using an IWM approach encourages an increased understanding of the cause and effect of different management actions. Additionally, the IWM approach is tailored to the physical attributes of a hydrologic region or watershed; the presence of undeveloped floodplains; the type of flood hazards (e.g., riverine, alluvial fan, coastal); and the areal extent of flooding.

An IWM approach requires unprecedented institutional alignment and cooperation among public agencies, tribal entities, land owners, interest-based groups, and other stakeholders. This approach relies on blending knowledge from a variety of disciplines, including engineering, planning, economics, environmental science, public policy, and public information. It is not a one-time activity but rather an ongoing process. The following actions provide policy recommendations for improving flood management by using an IWM approach, which are supported by additional recommendations in Chapter 4, "Flood Management," in Volume 3, *Resource Management Strategies*.

In addition, performance measures, lead entities, current funding status, and whether legislation is required to complete the related actions below have been identified. This supporting information is presented in a table in Volume 4, *Reference Guide*, titled "California Water Plan Related Actions and Performance Measures," and will be used to track the future progress of each related action.

Related Actions

6.1 Agencies at all levels should utilize integrated water management (IWM) principles that consider flood risk, mitigation, and protection of natural floodplain functions for planning and implementing flood management projects. Collaborate with planners, engineers, scientists, regulators, and other stakeholders to identify flood risk reduction and floodplain restoration strategies that can be used in local and regional planning efforts, such as integrated regional water management plans, general plans, regional economic and transportation plans, resource conservation plans, floodplain management plans, and others. This should include best management practices (BMPs) for coastal zones, alluvial fans, headwaters, and riverine floodplains in urbanized and non-urbanized areas.

6.2 State government should periodically update the 2013 *California's Flood Future Report: Recommendations for Managing the State's Flood Risk* (California's Flood Future), which further advances the recommendations developed as part of the original California's Flood Future effort.

6.3 Local agencies should work together in regions to develop regional flood risk assessments to evaluate potential adverse impacts of flooding on life, property, infrastructure, the environment, and the economy. The risk assessments should be developed through regional collaboration among local, state, and federal stakeholders, and based on a consistent methodology, appropriate to the region, for flood risk assessment. This assessment should include a determined acceptable level of flood risk for people, property, and the environment within the region. The flood risk assessments should include a set of digital maps for planning and communication of flood risk to agencies, the public, elected officials, and other stakeholders.

6.4 State government should develop comprehensive economic evaluation guidance for flood risk assessment and other flood management activities. The economic evaluation guidance should include methods to evaluate ecosystem services and other IWM benefits and should be adaptable to different areas of the state.

6.5 Local agencies should work together regionally to develop regional flood risk management plans based on regional risk assessments and define short-term and long-term goals, objectives, actions, and associated implementation strategies for reducing flood risk, as well as define opportunities to enhance natural floodplain functions and provide other IWM benefits. These plans should reflect a collaborative, stakeholder-based process addressing the unique regional and statewide interests, critical needs, and priorities. These plans should address, as appropriate: the locally identified level of flood protection; flood risk and flood damage reduction and mitigation strategies, including natural floodplain function; operations and maintenance; and local, regional and state IWM strategies.

6.6 State government should work with federal and local agencies to develop a statewide flood management investment approach. This approach would evaluate short- and long-term financing needs, as well as available investment strategies, and should lay out potential future investment alternatives for flood management statewide. This action will also be informed by the outcomes of Objective 17.

6.7 State government should take appropriate action to facilitate revenue generation and support regional flood risk management. This includes an evaluation of existing financing mechanisms and legal frameworks to facilitate the development of regional flood-risk reduction financing.

6.8 State government should collaborate with planners, engineers, scientists, regulators, and other stakeholders to develop BMPs for land use planning that achieve flood risk reduction and protection of natural floodplain functions. BMPs should be developed for local planning (e.g., general plans, land use regulations) that is conducted by cities and counties and for regional planning (e.g., sustainable communities strategies and blueprint plans) that is conducted by regional planning agencies. Land use planning BMPs should be developed for coastal zones, alluvial fans, headwaters, and riverine floodplains in urbanized and non-urbanized areas.

6.9 State government should work with federal and local agencies to develop a comprehensive regional vulnerability analysis approach and set of regional adaptation strategies for climate change impacts on flood risk and floodplain ecosystems.

6.10 State government should create and coordinate statewide and regional environmental regulatory working groups to improve and streamline regulatory review processes that will address critical flood-risk reduction projects, flood system maintenance, flood emergency response, and floodplain restoration (see Objective 16). State and federal environmental regulatory agencies, in collaboration with regional stakeholders, should take actions to streamline regulatory review while recognizing the unique differences among geographical regions of the state.

6.11 State government should develop a comprehensive set of materials and tools to assist public agencies in obtaining accurate information on flood risk and floodplain conditions and increase public awareness of flood risks and potential IWM solutions in that region. State government should develop regional and statewide indicators of flood risk and floodplain conditions and create online regional and statewide flood risk and floodplain information resources for government agencies and for the public. These resources should include regional maps with information on flood risk and floodplain conditions and indicators; outreach and communication tools, including tailored outreach materials as needed to meet the unique needs of each region; and materials that clarify the roles and responsibilities of local, state, tribal, and federal agencies in flood risk reduction and floodplain restoration efforts, including emergency response.

6.12 State government should increase support for flood emergency preparedness, response, and recovery programs to reduce flood risk by identifying data and forecasting needs; conducting statewide flood emergency management (EM) exercises; working with locals to improve flood EM plans; and supporting increased coordination between flood EM responders, planners, facility managers, and resource agencies (see Objective 8).

6.13 In June 2012, the Central Valley Flood Protection Board adopted the first Central Valley Flood Protection Plan (CVFPP). Prepared by the California Department of Water Resources, the plan presents a long-term vision for improving integrated flood management in the Central Valley and achieving a more flexible, resilient, and sustainable flood management system over time. In implementing this vision, State government should take the following actions consistent with the goals of the CVFPP:

6.13.1 Update the CVFPP in years ending in 2 and 7.

6.13.2 Continue to work with local and regional entities and the federal government to plan and refine physical improvements to the State Plan of Flood Control.

6.13.3 Periodically update the Flood Control System Status Report, which provides information on the current status and conditions of State Plan of Flood Control facilities.

6.13.4 Continue to develop criteria and guidance to assist local cities and counties in demonstrating an urban level of flood protection consistent with State law.

6.13.5 Continue to develop policies, guidance, and funding mechanisms to implement flood management projects by using an IWM approach in the Central Valley.

6.13.6 Continue to develop guidance and take actions to support wise management of floodplains and residual flood risks present in floodplains protected by the State Plan of Flood Control.

6.14 In May 2013, the Delta Stewardship Council adopted the Delta Plan. The Delta Plan was developed to guide State and local agencies to help achieve the coequal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. To support the implementation of the Delta Plan, the following flood-related actions should be taken:

6.14.1 The Legislature should establish a Delta Flood Risk Management Assessment District with fee authority (including over State infrastructure).

6.14.2 The Legislature should fund State agencies to evaluate and implement a bypass and floodway on the San Joaquin River near Paradise Cut.

6.14.3 The Legislature should require adequate levels of flood insurance for residences, businesses, and industries in flood-prone areas.

6.14.4 The Legislature should consider statutory and/or constitutional changes that would address the State's potential flood liability.

6.14.5 State government should evaluate whether additional areas both within and upstream of the Delta should be designated as floodways and should include the consideration of the anticipated effects of climate change in these areas.

6.14.6 State government should develop criteria to define locations for future setback levees in the Delta and Delta watershed.

6.14.7 State and local agencies and regulated utilities that own and/or operate infrastructure in the Delta should prepare coordinated emergency response plans to protect the infrastructure from long-term outages resulting from failures of the Delta levees. The emergency procedures should consider methods that also would protect Delta land use and ecosystem.

6.14.8 The U.S. Army Corps of Engineers (USACE) should consider a variance that exempts Delta levees from the USACE's levee vegetation policy.

Objective 7 — Manage the Delta to Achieve the Coequal Goals for California

> *Manage the Delta as both a critically important hub of the California water system and as California's most valuable estuary and wetland ecosystem. Achieve the two coequal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.*

After years of slow decline, the condition of the Delta's watery ecosystem, as measured especially by the population of wild salmon and other native fishes, has gone critical. Today, all those who depend on or value the Delta are, in a word, afraid. Delta residents face the possibility of floods from the east when the rivers flow strongly and of salinity intrusion from the west if they flow feebly. Fishermen, both commercial and recreational, fret about the future of salmon and other species. Water suppliers that receive water from the Delta find those supplies insecure and subject to interruption by weather vagaries, levee failures, or pumping restrictions imposed in the desperate attempt to stem the decline of fish.

In 2009, the Legislature made its latest, most determined bid to find solutions, passing the Delta Reform Act and associated bills. First and foremost, it declared that State policy toward the Delta must henceforth serve two "coequal goals" (see Box 8-3):

- Providing a more reliable water supply for California.
- Protecting, restoring, and enhancing the Delta ecosystem.

These goals, the Legislature added, must be met in a manner that:

- Protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.

By affirming the equal status of ecosystem health and water supply reliability, the Legislature changed the terms of the conversation. It changed them further with the following pronouncement: "The policy of the State of California is to reduce reliance on the Delta in meeting California's future water supply needs through a statewide strategy of investing in regional supplies, conservation, and water use efficiency." Here was recognition that, for the sake of the water system and the Delta both, a partial weaning of the one from the other will be required.

With the package of 2009 water bills, the Legislature also established the Delta Stewardship Council with a mandate to resolve long-standing issues and to develop a Delta Plan. The Delta Plan is California's plan for the Delta, prepared in consultation with, and to be carried out by, all agencies in the field: the SWRCB, which allocates water rights and protects water quality; DWR, which is the State's water planner and operator of the State Water Project; the California Department of Fish and Wildlife (DFW), which is responsible for the welfare of the living system of the Delta; the Delta Protection Commission, which oversees land use and development on low-lying Delta islands; and many more agencies, State and local.

In addition, performance measures, lead entities, current funding status, and whether legislation is required to complete the related actions below have been identified. This supporting information is presented in a table in Volume 4, *Reference Guide*, titled "California Water Plan Related

Box 8-3 Delta Policy on the Coequal Goals

The policy of the State of California is to achieve the following objectives that the Legislature declares are inherent in the coequal goals for management of the Delta:

1. Manage the Delta's water and environmental resources and the water resources of the state over the long term.
2. Protect and enhance the unique cultural, recreational, and agricultural values of the California Delta as an evolving place.
3. Restore the Delta ecosystem, including its fisheries and wildlife, as the heart of a healthy estuary and wetland ecosystem.
4. Promote statewide water conservation, water use efficiency, and sustainable water use.
5. Improve water quality to protect human health and the environment consistent with achieving water quality objectives in the Delta.
6. Improve the water conveyance system and expand statewide water storage.
7. Reduce risks to people, property, and State interests in the Delta by effective emergency preparedness, appropriate land uses, and investments in flood protection.
8. Establish a new governance structure with the authority, responsibility, accountability, scientific support, and adequate and secure funding to achieve these objectives.

Source: Water Code Section 85020

Actions and Performance Measures," and will be used to track the future progress of each related action. These related actions are also supported by additional recommendations in Chapter 5, "Conveyance — Delta," and Chapter 21, "Agricultural Land Stewardship," of Volume 3, *Resource Management Strategies*.

Related Actions

7.1 State or local public agencies undertaking covered actions must file certifications of consistency with the Delta Stewardship Council. Certifications of Consistency must include detailed findings that demonstrate how the covered action is consistent with all the policies of the Delta Plan.

7.2 Provide a more reliable water supply for California by implementing the following:

7.2.1 All water suppliers should fully implement applicable water efficiency and water management laws, including urban water management plans; the 20 percent reduction in statewide urban per capita water usage by 2020; agricultural water management plans; and other applicable water laws, regulations, or rules.

7.2.2 The California Department of Water Resource (DWR), in consultation with the Delta Stewardship Council, the State Water Resources Control Board (SWRCB), and others, should develop and approve guidelines for the preparation of a water supply reliability element as part of the update of an urban water management plan, agricultural water management plan, integrated water management plan, or other plan that provides equivalent information about the supplier's planned investments in water conservation and water supply development. The expanded water supply reliability element should include the details recommended in the

Delta Plan. Water suppliers that receive water from the Delta watershed should include an expanded water supply reliability element in their water management plans, starting in 2015.

7.2.3 DWR and the SWRCB should establish an advisory group with other state agencies and stakeholders to identify and implement measures to reduce impediments to achievement of statewide water conservation, recycled water, and stormwater goals. This group should evaluate and recommend updated goals for additional water efficiency and water resource development.

7.2.4 DWR, the SWRCB, the California Department of Public Health (CDPH), and other agencies, in consultation with the Delta Stewardship Council, should revise State grant and loan ranking criteria to be consistent with Water Code section 85021 and to provide a priority for water suppliers that includes an expanded water supply reliability element in their adopted urban water management plans, agricultural water management plans, and/or integrated regional water management (IRWM) plans.

7.2.5 DWR and the U. S. Bureau of Reclamation (USBR) will complete the Bay Delta Conservation Plan (BDCP) (both the Habitat Conservation Plan/Natural Communities Conservation Plan and the Environmental Impact Report/ Environmental Impact Statement), a 50-year ecosystem-based plan designed to restore fish and wildlife species in the Delta in a way that protects California's water supplies while minimizing impacts on Delta communities and farms. Upon adoption of the BDCP and receiving the necessary permits by the regulating agencies, DWR and the USBR will implement the 22 proposed conservation measures in the BDCP to help wildlife and reverse the decline of native fish populations in the Delta.

7.2.6 DWR, in coordination with the SWRCB, CDPH, California Public Utilities Commission (CPUC), California Energy Commission (CEC), USBR, California Urban Water Conservation Council, and other stakeholders, should develop a coordinated statewide system for water use reporting. Water suppliers that export water from, transfer water through, or use water in the Delta watershed should be full participants in the database.

7.2.7 DWR, in consultation with the SWRCB and other agencies and stakeholders, should evaluate and include in the next and all future California Water Plan updates information needed to track water supply reliability performance measures identified in the Delta Plan, including an assessment of water efficiency and new water supply development, regional water balances, improvements in regional self-reliance, reduced regional reliance on the Delta, and reliability of Delta exports, and an overall assessment of progress in achieving the coequal goals.

7.2.8 Immediately provide financial incentives and technical assistance through the IRWM plans and the Local Groundwater Assistance Program to improve surface water and groundwater monitoring and data management.

7.3 Water quality in the Delta should be maintained at a level that supports, enhances, and protects beneficial uses identified in the applicable SWRCB or regional water quality control board (RWQCB) water quality control plans.

7.3.1 The SWRCB should update the Bay-Delta Water Quality Control Plan objectives as follows:

A. By June 2, 2014, adopt and begin to implement updated flow objectives for the Delta, which are necessary to achieve the coequal goals.

B. By June 2, 2018, adopt, and as soon as reasonably possible, implement flow objectives for high-priority tributaries in the Delta watershed that are necessary to achieve the coequal goals.

7.3.2 The SWRCB and RWQCBs should work collaboratively with DWR, California Department of Fish and Wildlife (DFW), and other agencies and entities that monitor water quality in the Delta to develop and implement a Delta Regional Monitoring Program that will be responsible for coordinating monitoring efforts so Delta conditions can be efficiently assessed and reported on a regular basis.

7.3.3 DFW and other appropriate agencies should prioritize and implement actions for non-native invasive species from the *Conservation Strategy for Restoration of the Sacramento-San Joaquin Delta Ecological Management Zone and the Sacramento and San Joaquin Valley Regions* (California Department of Fish and Game 2011).

Objective 8 — Prepare Prevention, Response, and Recovery Plans

Prepare prevention, response, and recovery plans for floods, droughts, and catastrophic events to help residents and communities, particularly disadvantaged communities, make decisions that reduce the consequences and recovery time of these events when they occur.

An overall purpose of this objective is to prepare prevention response and recovery plans that coordinate the actions by State agencies, local governments, business and industry, and citizens.

The State Multi-Hazard Mitigation Plan (SHMP) is the official statement of California's statewide hazard mitigation goals, strategies, and priorities. Hazard mitigation can be defined as any action taken to reduce or eliminate long-term risk to life and property by natural and human-caused disasters. The SHMP classifies hazards into a hierarchy of primary impacts (earthquake, flood, wildfire); secondary impacts (vulnerable levees, landslides, tsunamis); climate-related hazards (drought, heat, severe storms); and other (terrorism, hazardous materials release, dam failure).

The hazards of floods and droughts have an obvious nexus to water planning. Other hazards, such as earthquakes and wildfire, have a less obvious nexus, but they can have impacts on and from water. As California grows, it faces the dual challenges of addressing vulnerabilities in the built and natural environment while accommodating growth and change in ways that avoid or mitigate future vulnerabilities.

Of these hazards, drought differs in the timing of the impacts. The impacts of drought are typically felt first by those most reliant on annual rainfall — ranchers engaged in dry land grazing, rural residents relying on wells in low-yield rock formations, or small water systems lacking a reliable source. Drought impacts increase with the length of a drought, as carryover supplies in reservoirs are depleted and water levels in groundwater basins decline. However, unlike earthquakes, fires, or floods, drought onset is slow, allowing time for water suppliers to implement preparedness and response actions to mitigate reductions in normal supplies.

In addition, performance measures, lead entities, current funding status, and whether legislation is required to complete the related actions below have been identified. This supporting information is presented in a table in the Volume 4, *Reference Guide*, entitled "California Water Plan Related Actions and Performance Measures," and will be used to track the future progress of each related action.

Related Actions

8.1 Communities in floodplains should consider the consequences of flooding and should develop, adopt, practice, and regularly evaluate formal flood emergency preparedness, response, evacuation, and recovery plans (see Objective 6).

8.1.1 State government should assist disadvantaged communities located in floodplains to prepare for and recover from flood emergencies.

8.2 The California Department of Water Resource (DWR) should review scientific literature and climate change models to evaluate if water suppliers should plan for more than three consecutive dry years as currently required for the water shortage contingency section of urban water management plans. DWR, working through a public process, could include any recommended changes in its Report to the Legislature on the Status of the 2015 urban water management plans.

8.3 Following the official end of the current drought and as part of the “after action” drought evaluation, DWR will update the California Drought Contingency Plan, which includes:

A. Articulation of a coordinated strategy for preparing for, responding to, and recovery from drought.

B. Assessment of state drought contingency planning and preparedness.

C. Description of State government’s role and responsibilities for drought preparedness.

D. Identification of needed improvements for drought monitoring and preparedness.

E. Identification of measures to mitigate the economic, environmental, and social risks and consequences of drought events.

F. Assessment of and adaptation to the impacts of drought under existing and future conditions, including climate change.

G. Identification of needed improvements to real-time surface water and groundwater monitoring programs.

H. Identification of needed research in drought forecasting.

I. Identification of needed research of the indices and metrics for assessing the levels of drought.

8.4 DWR will work with the California Governor’s Office of Emergency Services (Cal OES) to develop preparedness plans to respond to other catastrophic events, such as earthquakes, wildfires, chemical spills, facility malfunctions, and intentional disruption, which would disrupt water resources and infrastructure.

8.5 Cal OES, the California Governor’s Office of Planning and Research, and the California Natural Resources Agency should lead an effort to update the State Emergency Plan and State Multi-Hazard Mitigation Plan to strengthen consideration of climate impacts to hazard assessment planning, implementation priorities, and emergency responses.

8.6 Cal OES, DWR, and the Delta counties should work together to develop a catastrophic flood response plan for the Delta region. This plan should support an integrated response within the Delta and increase communication efforts between stakeholders and federal, State, tribal, local, and private agencies.

8.7 Cal OES will work with appropriate agencies to update the San Francisco Bay Area Catastrophic Earthquake Response Plan and incorporate lessons learned from the 2013 Golden Guardian exercise.

Objective 9 — Reduce the Carbon Footprint of Water Systems and Water Uses

Maximize the efficient use of California's surface and groundwater supplies through integrated policies and strategies that reduce the carbon footprint of water while meeting the needs of a growing population, improving public safety, fostering environmental stewardship, and supporting a stable state economy.

In December 2008, the California Air Resources Board (ARB) approved the AB 32 Scoping Plan, which included six measures for reducing the energy intensity and resulting GHG emissions of water uses and water and wastewater management systems. These six measures were included as related actions in Update 2009.

In early 2013, ARB initiated activities to update the AB 32 Scoping Plan to evaluate the mix of AB 32 policies to ensure that California is on track to achieve the 2020 GHG reduction goal. The AB 32 Scoping Plan update will define ARB's climate change priorities for the next five years and lay the groundwork to reach post-2020 goals set forth in Executive Orders S-3-05 and B-16-2012. The AB 32 Scoping Plan update will highlight California's progress toward meeting the "near-term" 2020 GHG emission reduction goals defined in the original Scoping Plan (2008). It will also evaluate how to align the State's longer-term GHG reduction strategies with other State policy priorities, such as for water, waste, natural resources, clean energy and transportation, and land use.

In October 2013, ARB released a "Discussion Draft" of the AB 32 Scoping Plan Update. ARB expects to release a public review draft in late January 2014, with board adoption of the final Scoping Plan Update in spring 2014. Additional information is available on the ARB's Web site at: http://www.arb.ca.gov/cc/scopingplan/scopingplan.htm.

In addition, performance measures, lead entities, current funding status, and whether legislation is required to complete the related actions below have been identified. This supporting information is presented in a table in Volume 4, *Reference Guide*, titled "California Water Plan Related Actions and Performance Measures," and will be used to track the future progress of each related action.

Related Actions

9.1 State government should provide cap-and-trade funding to make water and wastewater conveyance, treatment, and distribution/collection systems more energy efficient.

9.2 The California Department of Water Resources (DWR), the State Water Resources Control Board (SWRCB), and other State agencies should continue to leverage State funding sources with local funding for implementation of regional water management plans, including water and energy efficiency projects and climate change mitigation and adaptation activities.

9.3 DWR, SWRCB, and other State agencies should provide incentives to increase water conservation and energy efficiency in agricultural and food processing sectors, industrial processes, and residential and commercial buildings and landscaping.

9.4 DWR, SWRCB, the California Energy Commission, and other State agencies should update and implement new water-related energy conservation measures and energy efficiency standards for water use.

9.5 The SWRCB and other State agencies should support resource-recovering wastewater treatment projects.

9.6 DWR, SWRCB, and other State agencies should work with non-governmental carbon registries to develop standardized methodologies and protocols to enable the collection of accurate and comparable data on embedded energy and carbon in water systems.

9.7 State government should evaluate the appropriate relationship between ratepayer and public financing of greenhouse gas (GHG) emissions reduction projects in the water and wastewater sectors.

9.8 State government should support local agency models for pricing and rate structures that promote water use efficiency while ensuring stabilization of local agency finances and affordability for low-income households.

9.9 DWR, SWRCB, and other State agencies should support local groundwater management that contributes to enhanced water quality and water supply reliability while reducing the energy intensity of groundwater pumping.

9.10 The SWRCB and the regional water quality control boards should modify their policies, permits, and monitoring guidelines to reflect regional climate change scenarios and other best-available climate science.

9.11 State government should facilitate partnerships between local water, wastewater, and energy utilities to further implement joint water-energy programs, including model programs of efficient landscape and agricultural irrigation.

9.12 State government should increase its role in developing policies, providing financial incentives, and employing regulatory alignment to reduce the carbon footprint of water systems and water uses.

9.13 State government should conduct an independent peer review of the existing, water-related AB 32 Scoping Plan measures, to determine the real GHG emissions reductions achieved to date and assess the technical feasibility and cost-effectiveness of those measures.

9.14 State government should promote water-energy conservation outreach and education.

Objective 10 — Improve Data, Analysis, and Decision-Support Tools

Improve and expand data management, analysis, and decision-support tools to advance IWM, given demographic, land use, climate, environmental, and institutional uncertainties.

The actions described here are intended to promote significant improvements in how water managers monitor, develop, and share water information to support IWM of California's water resources by making data more standardized and accessible, supporting critical updates of analytical tools, and fostering technical collaboration to support policy decisions. Investment in our analytical capabilities lags far behind the growing challenges facing water managers. Significant new investment in technical capabilities is needed to prepare for the impacts from extended droughts, floods, and climate change, as well as to improve management of the Delta and other complex water operations.

Sound technical information is critical to making policy decisions. Improving communication, cooperation, and collaboration among technical experts and government agency decision-makers goes hand in hand with improving our technical capabilities related to data collection, management, and exchange and analytical tool development and applications. To accomplish this, it is essential to organize and resource an institutional framework to facilitate and sustain a collaborative and coherent technical program among State and federal agencies and academia. Such an effort would take advantage of related activities under the recently developed Delta Science Plan and ongoing activities of the California Water and Environment Modeling Forum.

This objective and its related actions rely heavily on information contained in Chapter 6, "Integrated Data and Analysis." The related actions were informed by advice from the Statewide Water Analysis Network (SWAN), which serves as the technical advisory group for the CWP. SWAN consists of technical experts from federal, State, and local agencies; universities; non-governmental organizations; consultants; and tribes. Additional sources of information include the Update 2013 featured companion State plans described in Chapter 4, "Strengthening Government Alignment," particularly the Delta Plan from the Delta Stewardship Council and the recommendations from the Alluvial Fan Task Force. The actions were also informed by the CWP's State Agency Steering Committee, Public Advisory Committee, and Tribal Advisory Committee, as well as stakeholder input at workshops to discuss the Update 2013 objectives and related actions.

In addition, performance measures, lead entities, current funding status, and whether legislation is required to complete the related actions below have been identified. This supporting information is presented in a table in Volume 4, *Reference Guide*, titled "California Water Plan Related Actions and Performance Measures," and will be used to track the future progress of each related action.

Related Actions

10.1 The California Department of Water Resources (DWR) should form an integrated water management (IWM) technical committee to improve communication, cooperation, and collaboration among and between technical experts and government agency decision-makers related to data collection, management, and exchange and analytical tool development and applications. The committee should be comprised of DWR, State Water

Resources Control Board, California Department of Public Health, California Public Utilities Commission, Delta Stewardship Council, California Energy Commission, U.S. Bureau of Reclamation, U.S. Army Corps of Engineer's Hydrologic Engineering Center, California Council for Science and Technology, University of California, California State University, and other interested State and federal agencies, and should work in partnership with the California Water and Environmental Modeling Forum, California Urban Water Conservation Council, regional water management groups (IRWMs), and interested California Native American Tribes, local agencies, non-governmental organizations, and stakeholders.

Improve Water Data and Information

To improve water data and information, DWR should take the following actions, in coordination with the IWM technical committee described under Related Action 10.1:

10.2 Establish standards and protocols for data collection and management that facilitate sharing of information among agencies and modeling studies. This would include identifying and cataloging existing water data for California; creating a water data dictionary; and developing standards and metadata for water data monitoring, collection, and reporting.

10.3 Develop a strategic plan for data management that prioritizes long-term improvements in the monitoring network, supports risk-based decision-making, and identifies adequate resources for long-term maintenance of, and access to, water management information.

10.4 Improve drought planning and preparation by:

- 10.4.1 Developing drought metrics (indicators) with the goal of providing early detection and determination of drought severity.
- 10.4.2 Developing and improving monitoring of key indicators of regional water vulnerabilities.
- 10.4.3 Improving the system of stream gauging for the purpose of managing water resources in low-flow conditions and improving the accuracy of seasonal runoff and water supply forecasts.
- 10.4.4 Improving groundwater monitoring and assessment by providing technical and financial support to develop real-time monitoring of groundwater data.
- 10.4.5 Expanding the existing surface water and groundwater monitoring networks, where needed.

10.5 Develop a strategy and implementation plan for measuring, compiling, and reporting water use and water quality data. The accurate measurement of water use and water quality, as well as the timely publication and broad distribution of the resulting data, will facilitate better water planning and management, especially in the context of managing aquifers more sustainably. These enhancements will also facilitate the development of more accurate water budgets.

10.6 Sponsor science-based, watershed adaptation research and pilot projects to address water management and ecosystem needs, improve aquatic species and habitat monitoring, and develop an accessible and standardized database for reporting watershed and headwater conditions.

Improve Data and Information Exchange

To improve data and information exchange, DWR should take the following actions, in coordination with the IWM technical committee described under Related Action 10.1:

10.7 Develop the Water Planning Information Exchange (Water PIE) to facilitate sharing data and networking existing databases among federal, State, tribal, regional, and local agencies and governments; nonprofit organizations; and citizen monitoring efforts. The Water PIE data framework will help improve analytical capabilities and develop timely surveys of statewide land use, water use, and estimates of future implementation of resource management strategies. Potential beneficiaries of the Water PIE will include urban water management plans, agricultural water management plans, groundwater management plans, integrated regional water management plans, and the California Water Plan.

10.8 Support establishment of an open, organized, and documented quantitative representation of the State's intertied water system to serve as a common and standardized data platform for model development and analysis by federal, State, tribal, regional, and local water planners.

10.9 Implement Shared Vision Planning or similar collaborative modeling approaches to integrate tried-and-true planning principles, systems modeling, and collaboration into a practical forum for making more informed and durable water resources management decisions.

Improve Analytical Tools

To develop and use analytical tools more effectively, DWR should take the following actions, in coordination with the IWM technical committee described under Related Action 10.1:

10.10 Expand the Central Valley Planning Area-based analytical tool and scenario studies developed during the California Water Plan Update 2013 to assess future vulnerabilities and management responses in the other hydrologic regions for California Water Plan Update 2018. The regional analytical tools and analyses should include evaluation of water supply reliability, water efficiency and new water supply development, regional water balances, improvements in regional self-reliance, reduced regional reliance on the Delta, and reliability of Delta exports. Over time, these tools should be enhanced to include metrics for water quality, economics, flood exposure, public safety, energy, and environmental factors by which to evaluate a greater number of the resource management strategies identified in Volume 3 of California Water Plan Update 2013.

10.11 Develop a shared conceptual understanding, analytical framework, and quantitative description of how California watersheds and water management systems are represented in analytical tools at different spatial and temporal scales for use by federal, State, tribal, regional, and local agencies and organizations.

10.12 Support the California Water and Environmental Modeling Forum in updating its 2000 modeling protocols and standards to provide more current guidance to water stakeholders and decision-makers, as well as their technical staff, as models are developed and used to solve California's water and environmental problems.

Objective 11 — Invest in Water Technology and Science

Identify, develop, and prioritize research needs for new technologies; advance development and implementation of existing and emerging tools, technologies and innovations; and encourage partnerships in water-related technology and science to promote more efficient, effective, and sustainable water resources management and a better scientific understanding of California's water-related systems.

The related actions for this objective were significantly informed by the CWP Water Technology Caucus and the California Council for Science and Technology (CCST). The CWP Water Technology Caucus is a statewide, topic-based workgroup designed to support development of Update 2013 through in-depth discussions and deliberations of innovation, applied research and development, and technology. The Water Technology Caucus helped identify and expand information associated with statewide and regional opportunities and challenges for implementing new water technologies in California. The statewide and regional information helps inform technology planning efforts, pilot projects, and investments by federal, State, tribal, regional, and local governments; non-governmental organizations; and private applied research and innovation initiatives. This collaborative process can lead to the commercialization of new water technologies; an enhanced focus on California water research, information, and data needs (see also Objective 10 — Improve Data, Analysis, and Decision-Support Tools); and a better scientific understanding of California's water-related systems.

The Water Technology Caucus worked closely with California research and academic institutions working on water technology initiatives to develop the water technology-related actions for Update 2013. Innovations in science and technology have long been recognized as a key driving force of economic growth, especially in high-technology economies such as California's. However, State government has limited resources and is seeking ways to most effectively encourage and sustain an environment where innovation can flourish.

In early 2012, the CCST initiated the California's Water Future Project to identify and describe technology innovation and/or systems approaches currently under development or available for application. These innovations can be used in California, on a statewide, regional, local, or project basis, for immediate adoption and within the next five to 10 years to enhance California's IWM; efficient water use; effective groundwater management; and environmental restoration and sustainable management, including optimization of river systems for state-determined goals. The project goals were to make specific recommendations regarding:

- Technologies that appear to have the most promise for California over the next 5-10 years.
- Policy and process changes needed to commercialize and more broadly deploy identified innovation.
- Understand potential impacts and consequences of technology implementation.

The target audience for the California's Water Future Project is anyone in the science and technology community with an interest in water; DWR; and federal, State, and local policy-makers. Additional information on CCST's Water Future Project is available in Volume 4, *Reference Guide*.

State government will continue to work with California research and academic institutions — such as the California Academy of Sciences, California Council on Science and Technology, the University of California, California State University, and other universities and colleges — to identify and prioritize applied research projects leading to the commercialization of new water technologies and better scientific understanding of California's water-related systems.

In addition, performance measures, lead entities, current funding status, and whether legislation is required to complete the related actions below have been identified. This supporting information is presented in a table in Volume 4, *Reference Guide*, titled "California Water Plan Related Actions and Performance Measures," and will be used to track the future progress of each related action.

Related Actions

11.1 Federal, State, tribal, regional, and local governments; non-governmental organizations, California research and academic institutions, and private applied research and innovation initiatives should work together to identify, prioritize, and fund applied research projects with a goal to commercialize new water technologies and advance cost and energy-efficient emerging tools and technologies. The California Council for Science and Technology (CCST) should play a leadership role to facilitate collaboration among the above-mentioned organizations and entities to encourage fuller implementation of existing, effective water technologies — in support of more integrated, aligned, and sustainable water management.

11.2 Advance new water technology to improve Data Management and Modeling by implementing the following actions:

- 11.2.1 Develop and implement a standardized protocol and implementation plan for water use and water quality monitoring and reporting necessary for sustainable California water planning and management.
- 11.2.2 Develop a standardized protocol and guidelines for distributed data storage and retrieval for database managers with all data linked to the appropriate metadata.
- 11.2.3 Development of effective interactive data portals, such as the California Department of Water Resources' (DWR's) Water Planning Information Exchange (Water PIE) and UC Davis's Hobbes, should continue with a high priority.
- 11.2.4 Support the maintenance of current modeling protocols and standards that provide guidance to water stakeholders and decision-makers, as well as their technical staff, as models are developed and applied to solve California's water and environmental problems. The California Water and Environmental Modeling Forum should continue to have a major role in this important effort.

11.3 Advance new water technology to improve both in situ (on-site) and remote sensing for data acquisition by implementing the following actions:

- 11.3.1 Coordinate in situ sensing and remote sensing systems more closely and expand existing monitoring networks (both in situ and remote) using mature wireless-sensor technology to improve the spatial and temporal resolution of measurements of hydrometeorological variables.

11.3.2 Develop practicable mechanisms for closer coordination between the scientific and technical experts that develop, operate, maintain, and use in situ sensor networks and remote sensing instruments, when this coordination can appreciably enhance the value of both data collection efforts.

11.3.3 Adapt satellite sensor output to operational use, where it is demonstrated that the satellite readings represent mature technologies and are being produced on an ongoing basis, making them reliable sources of information for water-resources decision-making over the long term. Examples of this include snow-covered areas and albedo products (http://www.nohrsc.noaa.gov/nh_snowcover/), the UC Irvine real-time, high-resolution Satellite precipitation (http://hydis.eng.uci.edu/gwadi/), and global drought information (http://drought.eng.uci.edu/).

11.3.4 Increase use of airborne sensor platforms as a compliment to satellite platforms for sustaining data acquisition, providing a gap-fill between satellite missions, and as a cost-effective strategy for collecting data that is of high value but for limited regions at limited times (e.g., snow water resources).

11.3.5 Provide opportunities and incentives for meaningful partnerships between the National Aeronautics and Space Administration, universities, State and local agencies, and non-governmental organizations and the private sector to accelerate development and testing of new remote sensor capabilities, including accurately measuring chemical and physical attributes of freshwater bodies from unmanned aerial vehicles (drones).

11.3.6 Increase investments in capacity building for use of remote sensing in water resources management applications and decision-making processes, and increase outreach and communication to inform the water resources management community of potential use and application of satellite data, as well as their limitations.

11.3.7 Develop standardized strategies and protocols for quantifying uncertainty in measurements, and communicating the uncertainty to models or decision-making processes that ingest the measurements.

11.4 Advance new water technology to improve efficiencies for the water-energy nexus by implementing the following actions:

11.4.1 Employ smart grid technologies for water and energy conservation, management, and renewable energy technologies for water treatment and transport processes.

11.4.2 Further integrate water and energy planning and research at the statewide level by enhancing and expanding the efforts by the State's key water and energy management agencies that have made important strides in identifying areas where water and energy planning can be integrated.

11.4.3 Develop analytical methods and tools to help incorporate water-energy nexus considerations in local and regional water and energy plans and assessments, and energy and emission reduction benefits into water conservation and alternate supply analysis.

11.4.4 Develop and utilize multiple benefit analysis to determine cost-effectiveness of investments both in water and energy systems.

11.4.5 Develop analytical methods and tools to help evaluate the water demands of energy technologies in the planning process for energy systems and encourage the use of water-efficient cooling technologies in thermoelectric power facilities.

11.5 Advance new water treatment technology by implementing the following actions:

11.5.1 Further develop and deploy more robust general-purpose membranes with an emphasis on lower cost and energy-efficient use and those that remove contaminants not now efficiently removed (e.g., boron, contaminants of emerging concern), for use in seawater desalination, brackish water treatment, and wastewater and water reuse applications, and recovery of beneficial salts and minerals for reuse.

11.5.2 Continue developing energy recovery technologies for application to membrane separation technologies.

11.5.3 Further develop and deploy smart control technologies to ensure more dependable operation of treatment facilities, including water/wastewater treatment facilities that are remotely located (distributed treatment).

11.5.4 Further develop and deploy advanced water-treatment technologies capable of efficient removal from water of pharmaceuticals and personal care products (PPCPs) and emerging organic contaminants (EOCs).

11.5.5 Deploy brine disposal technologies, already used outside of California, on a larger scale for brine disposal into marine environments and inland areas.

11.5.6 Further develop and deploy wastewater cleanup and recycling technologies focused on producing water for drinking, irrigation, processing, groundwater recharge, and other uses.

11.5.7 Develop technologies to reduce chemical use and increase energy efficiency, such as engineered wetlands for wastewater treatment and ecosystem enhancement.

11.5.8 Develop and deploy anaerobic digestion technology that converts manure produced by confined animal operations into a stabilized fertilizer with a considerable fraction of the nitrogen in the inorganic form.

11.5.9 Continue development of disinfection technologies for water that provide better disinfection efficiency for waterborne human pathogens while not creating additional public health or environmental hazards.

11.5.10 Improve technologies for residential point-of-use (POU) and point-of-entry (POE) treatment.

11.6 Advance new water technology to improve watershed management by implementing the following actions:

11.6.1 Improve watershed data and performance modeling, including improvements in the cost and efficiency of data acquisition and modeling, and by providing real-time and continuous watershed data (including surface and groundwater data) to enhance scenario-planning analysis capabilities.

11.6.2 Conduct groundwater recharge area mapping and develop related spatial data and models to identify groundwater recharge opportunities.

11.6.3 Expand the scientific and engineering knowledge base needed for more effective floodplain restoration to promote wetlands development, aid groundwater recharge, provide suitable habitat for aquatic and terrestrial species, and provide a trap for nutrients and sediment.

11.7 Advance new water technologies to improve agricultural water use efficiency by implementing the following actions:

11.7.1 Improve the cost effectiveness and accuracy of on-farm and district-level water measurement devices (flow rate and volume) and soil moisture-sensing technologies to increase water management data accuracy and control and help quantify the efficiency of agricultural water uses.

11.7.2 Develop higher water-efficient irrigation system technologies to help optimize water- and energy-use efficiency, and enable water district deliveries on a real-time basis to maximize on-farm water use efficiency and support drip/micro irrigation methods.

11.7.3 Develop and improve technologies for irrigation scheduling, including remote sensing, weather-based, and/or crop/soil-based technologies.

11.7.4 Develop cost-effective irrigation system monitoring platforms for evaluating irrigation performance criteria in real time, including both water and energy.

11.7.5 Develop the data necessary for identifying opportunities for shared use of water supplies (e.g., water exchanges between agricultural and urban users) and opportunities for local groundwater treatment (primarily salts) as a new or alternate water source for irrigation.

11.7.6 Continue the development of drought-resistant and/or salt-tolerant plant varieties.

11.8 Advance new water technology to improve urban water use efficiency by implementing the following actions:

11.8.1 Promote the continued development of Advanced Metering Infrastructure (AMI) to provide multiple benefits to utilities and their customers, including near real-time water use information and the quicker identification of leaks, thereby promoting more efficient water use (e.g., individual apartments, remote access to water use data).

11.8.2 Incorporate the best available plumbing codes in the development of plumbing code and efficiency standards for low-flow appliances and fixtures, such as toilets, clothes, and dish washers in the home, as well as low-flow cleaning technologies in the commercial and industrial sectors.

11.8.3 Improve the measurement accuracy of outdoor landscape area and its related water use to help improve the efficiency of residential and commercial outdoor water use.

11.8.4 Continue development of the technologies necessary to improve commercial/residential stormwater management with benefits of reduced pollution and runoff and often increased local groundwater recharge.

Objective 12 — Strengthen Tribal/State Relations and Natural Resources Management

Strengthen relationships with California Native American Tribes that acknowledge and respect their inherent rights to exercise sovereign authority and ensure that they are incorporated into planning and water resources decision-making processes in a manner that is consistent with their sovereign status.

Update 2005 recommended that DWR and other State agencies invite, encourage, and assist the participation of tribal government representatives in statewide, regional, and local water-planning processes and to access State funding for water projects. As part of Update 2009, the Tribal Communication Committee prepared the comprehensive *Tribal Communication Plan* (Tribal Communication Committee 2008) for the CWP (as presented in Update 2009, Volume 4, *Reference Guide*). The 10 *Tribal Communication Plan* objectives were included in the Update 2009 related actions. (Refer to the *Tribal Communication Plan* for a definition of California Native American Tribes.)

For Update 2013, a Tribal Advisory Committee was convened, and a Tribal Water Summit for the update was held in April 2013. The summit included the development of the *Guiding Principles and Statement of Goals for Implementation*. This objective incorporates the related actions from Update 2009, the 2013 Tribal Water Summit *Guiding Principles and Statement of Goals for Implementation*, and the 2013 Tribal Water Summit implementation objectives.

In addition, performance measures, lead entities, current funding status, and whether legislation is required to complete the related actions below have been identified. This supporting information is presented in a table in Volume 4, *Reference Guide*, titled “California Water Plan Related Actions and Performance Measures,” and will be used to track the future progress of each related action.

Related Actions

12.1 State government, in collaboration with California Native American Tribes, should, where it is within the State’s authority, address tribal water rights, including tribal water rights dating back to time immemorial; federally reserved water rights; jurisdiction; and trust responsibilities, including individual allotments, by:

12.1.1 Convening a task force to articulate a consistent State policy and protocol that recognizes tribal water rights in all aspects of water planning, including supply, timing, flows, quality, and quantity.

12.1.2 The U.S. Bureau of Indian Affairs and the State Water Resources Control Board (SWRCB), in collaboration with California Native American Tribes, developing joint training on State, federal, and tribal water rights, including trust responsibilities, the implications for different tribal trust lands (reservations, rancherias, and individual allotments) and jurisdiction.

12.2 State government should write legislation and contracts in a way that enables California Native American Tribes to be a lead agency and directly receive and manage State funding (as fiscal agent or otherwise) for water planning and management.

12.3 The California Department of Fish and Wildlife and California Native American Tribes will develop and initiate pilot projects to develop resource management plans, characterized by the integration of Traditional/Tribal Ecological Knowledge and western science. This will include identifying existing examples of partnerships and launching pilot projects.

12.4 State agencies should use Tribal Ecological Knowledge to inform their work and decisions, including establishing baseline resource conditions and developing options to share information in ways that protect specific details about cultural resources.

12.5 State agencies, in collaboration with California Native American Tribes, should develop and conduct trainings for agencies on tribal sovereignty, trust responsibilities, cultural awareness/sensitivity, and Traditional/Tribal Ecological Knowledge by developing a curriculum with a tribal working group, establishing consistent training protocols for all agencies, and initiating trainings.

12.6 State and federal agencies, in coordination with California Native American Tribes, should identify, coordinate, and provide technical training for California Native American Tribes, to increase technical capacity — including, but not limited to, basic training modules (e.g., Basic Inspector Academy, geographic information systems, small water systems operations, such advanced technologies as LiDAR and satellite imagery) — and establish criteria and protocols for ensuring training vendors preferred by California Native American Tribes are utilized.

12.7 State agencies should engage tribal communities in compiling and developing climate change adaptation and resilience strategies that will mitigate climate impacts to their people, waterways, cultural resources, or lands.

12.8 The SWRCB should, in collaboration with California Native American Tribes, propose a statewide beneficial use definition that respects and acknowledges cultural and subsistence use of water and this definition should be adopted in statewide water quality control plans.

12.9 State agencies and California Native American Tribes should utilize and implement communication strategies, protocols, and procedures that are developed and/or implemented by California Native American Tribes, including but not limited to the Tribal Communication Plan, U.N. Declaration on the Rights of Indigenous Peoples, 2013 Tribal Water Summit Guiding Principles and Goals, and tribal memoranda of understanding.

12.10 State agencies, in collaboration with California Native American Tribes, should enhance tribal outreach, communication, coordination, collaboration, and the work of tribal liaisons by identifying and implementing strategies to strengthen tribal involvement in State outreach and engagement approaches; clarify tribal liaison roles and responsibilities; and identify options for creating a statewide network of tribal liaisons to address multiple aspects of tribal concerns (e.g., legal, policy, and local conditions).

12.11 State agencies should engage in meaningful consultation by encouraging and moving toward earlier involvement by California Native American Tribes (at the design/planning stages); initiating consultation for programmatic decisions as well as project-level decisions; understanding individual California Native American Tribes' protocol for consultation, adjusting timelines to allow adequate time to bring items before tribal councils and leaders; conducting meetings on tribal lands; and documenting tribal comments.

Objective 13 — Ensure Equitable Distribution of Benefits

Increase the voice of small and disadvantaged urban and rural communities in State processes and programs to achieve fair and equitable distribution of benefits. Provide access to safe drinking water and wastewater treatment for all California communities and ensure programs and policies address the most critical public health threats in disadvantaged communities.

Update 2005 recommended that DWR and other State government departments and agencies should invite, encourage, and assist representatives from disadvantaged communities and vulnerable populations, and the local agencies and private utilities serving them, to participate in statewide, regional, and local water planning processes and to get equal access to State funding for water projects. State policy establishes social equity and environmental justice (EJ) as State planning priorities to ensure the fair treatment of people of all races, cultures, and income, in particular those having experienced significant disproportionate adverse health and environmental impacts.

To enforce the fair treatment clause, four key requirements must be met:

- Disadvantaged and disproportionately affected communities must be identified and engaged.
- The water-related needs of these communities must be determined and potential solutions developed and funded.
- The impact of water management decisions on these communities must be considered and mitigated.
- All State programs must be evaluated to document progress.

A number of efforts to better address EJ and economically disadvantaged community concerns have advanced since Update 2005.

In 2008, the California Public Resources Code, Section 75005(g), was added to define a “disadvantaged community” (DAC) as a community with a median household income of less than 80 percent of the statewide average. A “severely disadvantaged community” is one with a median household income of less than 60 percent of the statewide average.

The current DWR guidelines for IRWM funding, allocated through voter-approved Propositions 84 and 1E, identify statewide priorities among which is a goal to “ensure equitable distribution of benefits.” For implementation grants, DWR has prioritized proposals that:

- Increase the participation of small communities and DACs in the IRWM process.
- Develop multi-benefit projects with consideration given to affected DACs and vulnerable populations.
- Address safe drinking water and wastewater treatment needs of DACs.

In 2012, California Water Code Section 106.3 was added to declare that the established policy of the State recognizes every human being as having the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes. All relevant State agencies, including DWR, SWRCB, and CDPH, are required to consider this State policy when revising, adopting, or establishing policies, regulations, and grant criteria when those policies, regulations, and criteria are pertinent to the uses of water described in this section.

Other initiatives have also moved forward, including:

- Final Report to the Governor's Office August 20, 2012, Governor's Drinking Water Stakeholder Group, Agreements and Legislative Recommendations.
- CDPH's Small Water System Program Plan.
- SWRCB's Small Community Wastewater Grant Program.

Even with all these efforts, one of the challenges that State agencies and water systems express about trying to address the needs of DACs is simply answering these two questions: "Who are DACs?" and "Where are DACs?"

The CWP can provide guidance and tools for identifying disadvantaged and EJ communities. It is vitally important to identify community needs. Many water, wastewater, and flood projects are not developed for these communities, and yet they can affect them. It is important to understand that even projects that convey "general" public benefit may not proportionally benefit EJ communities or DACs. For example, conservation programs that depend heavily on toilet and washing machine rebates will have greater penetration in middle- and upper-income communities than they will in poorer communities that purchase less frequently and cannot afford the initial outlay for the fixture. These problems are resolved by taking community concerns into account during the project design phase to ensure equitable benefits.

Another concept that plays into the measurement of impacts is the cumulative effects and incremental burden of a project. It is understandable that water agencies would look at other water projects in determining the impact of their project, but that practice ignores the reality of DACs. That is, these communities endure so many challenges on a daily basis, that one more, from any source, only adds to what may already be an excessive burden.

Finally, planners should develop multi-benefit projects with consideration given to affected DACs and vulnerable populations. This is particularly true in already affected communities. For example, if an agency is developing a flood management project, it would be prudent to look at developing the project in ways that will provide flood protection, as well as open space, wildlife habitat, and/or recreational opportunities, to DACs and vulnerable populations.

In addition, performance measures, lead entities, current funding status, and whether legislation is required to complete the related actions below have been identified. This supporting information is presented in a table in Volume 4, *Reference Guide*, titled "California Water Plan Related Actions and Performance Measures," and will be used to track the future progress of each related action.

Related Actions

13.1 Ensure implementation of the policy goals of California Water Code Section 106.3 (Assembly Bill [AB] 685), which state that every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes.

13.1.1 State agencies should ensure that the goals established by the policy — safe, clean, affordable, and accessible water adequate for domestic uses — are reflected in agency planning.

13.1.2 State agencies should give preference to actions that advance the policy and strive to avoid taking actions that adversely affect the human right to water.

13.1.3 State agencies should track actions undertaken to promote the policy and make information relevant to the human right to water available to the public.

13.1.4 Governor's Office of Planning and Research (OPR) should provide access to resources defining public participation best practices to State agencies, through its local government roundtable and the OPR Web site. State agencies should implement best practices, within available resources, for public participation in agency decision-making by California's diverse population.

13.1.5 State agencies should facilitate access by rural and urban disadvantaged communities (DACs) and California Native American Tribes to state funds for water infrastructure improvements.

13.1.6 State agencies should ensure the effectiveness of accountability mechanisms protecting access to clean and affordable water.

13.1.7 In consultation with State agencies, OPR should provide guidance and/or guidelines to inform and assist State agencies in implementing California Water Code Section 106.3 (AB 685).

13.1.8 State agencies are encouraged to review their policies, regulations, and funding criteria for consistency with California Water Code 106.3 (AB 685).

13.2 Increase environmental justice (EJ) and DAC participation in State agency water-related planning, programs, processes, and projects.

13.2.1 The California Department of Water Resources (DWR) and the other California Water Plan (CWP) State Agency Steering Committee members should incorporate EJ issues of precautionary applications, cumulative health impact reductions, public participation, community capacity building and communication, and meaningful participation in current and future CWP update processes and other programs.

13.2.2 DWR grant and loan recipients should demonstrate participation by DACs and vulnerable populations and their advocates to seek their participation in water planning programs, including the CWP update and integrated regional water management (IRWM) plans and other local water planning processes.

13.3 Support financial mechanisms to facilitate improved and sustainable wastewater removal systems.

13.3.1 The State Water Resources Control Board (SWRCB) and DWR should establish incentives for substandard septic or small wastewater systems to connect with municipal, regional, or other upgraded wastewater systems.

13.3.2 Local and regional agencies should be encouraged to establish introductory, then graduated, wastewater rates to allow a period of adjustment for new and affordable rates.

13.3.3 DWR, the California Department of Public Health (CDPH), SWRCB, the California Public Utilities Commission (CPUC), and other State agencies should evaluate and create a consistent metric for water affordability.

13.4 Remove barriers to local and regional funding for water projects conducted to support DAC and EJ communities.

13.4.1 The SWRCB, CDPH, DWR, and other State agencies should work with DACs and vulnerable populations and their advocates to review State government funding programs and develop or revise guidelines that make funding programs more accessible to DACs and EJ communities.

13.4.2 The SWRCB, CDPH, DWR, and other State agencies should implement and expand technical assistance programs developed in collaboration with DAC/EJ communities and their advocates to provide them with resources, expertise, and information leading to more successful access to funding.

13.5 Provide incentives for the consolidation, acquisition, or improved management of small water systems.

13.5.1 CDPH should establish incentives for large water systems to consolidate with small water systems or others without access to safe drinking water.

13.5.2 CDPH should encourage drinking water providers and other governmental and non-governmental entities to conduct outreach and education for customers and shareholders regarding proposed consolidations.

13.5.3 CDPH should support efforts to improve licensing and training options for small water system operators.

13.6 CDPH should continue to implement its Small Water System Program Plan to assist small water systems (especially those serving DACs) that are unable to provide water that meets primary drinking water standards.

13.6.1 CDPH should share the Small Water System Program Plan with relevant federal, State, and local agencies, as well as stakeholders, to foster additional opportunities for funding, coordinate construction projects in communities, and assist in local and regional planning efforts.

13.6.2 CDPH should utilize geographic information system (GIS) tools to identify large water systems in close proximity to targeted small water systems, and conduct targeted outreach to these large water systems to encourage them to consolidate the small systems into their service area.

13.6.3 CDPH should work with stakeholders to identify obstacles to consolidation (including financial, legal, and local issues) and develop possible actions to address these obstacles.

13.6.4 Relevant State agencies should cooperate with local agencies in efforts to specifically determine and address the water infrastructure needs of individual domestic well users and small water systems with less than 15 connections.

13.6.5 CDPH should seek input from other states and the federal government on innovative, successful efforts to address the needs of small water systems, and should share its results on implementation of its Small Water System Program Plan.

13.7 State and federal agencies should coordinate to better address water-related problems in DACs and vulnerable populations.

13.7.1 State and federal agencies should coordinate to better collect and maintain data on EJ communities and DACs.

13.7.2 The SWRCB, CDPH, DWR, and other State and federal agencies should coordinate their review of current monitoring and regulatory programs to identify and address gaps in available data and monitoring programs that affect DACs and vulnerable populations.

13.7.3 CDPH, DWR, and SWRCB should initiate more data collection, study, and analysis to develop options, recommendations, strategies, and programs to assist DACs.

Objective 14 — Protect and Enhance Public Access to the State's Waterways, Lakes, and Beaches

Protect and enhance public access to the state's waterways, lakes, and beaches for cultural, recreational, and economic purposes consistent with maintaining healthy ecosystems.

Public access to our natural waterways, lakes, and beaches has been embedded in the California's Constitution since the founding of the state. Activities such as boating, fishing, exploring the beach, and swimming are an important part of our heritage, our culture, our identity, and our economy. California's Legislature has repeatedly acknowledged the importance of developing the state's water resources to provide more public access and more recreational opportunities through our water supply, watershed protection, and flood management projects. The rich variety of recreation opportunities created by the state's natural, managed, and constructed water bodies supports public health and welfare, sustains healthy businesses and communities, and promotes wise use of our abundant natural resources. Critical to maintaining California's heritage is the need to protect and enhance public access to the state's waterways, lakes, and beaches for the foreseeable future. Doing so will require the development and implementation of related actions that guide decision-makers tasked with managing the state's waterways, lakes, and beaches.

The related actions below are a compilation of guidance from strategic planning documents for agencies as diverse as California State Parks, the Sierra Nevada Conservancy, and the Delta Stewardship Council. This is a new objective for the CWP, so it is expected that the related actions and performance measures will become more comprehensive as more agencies with public access responsibilities participate in the next CWP update. More information on this subject is available in Volume 3, Chapter 31, "Water-Dependent Recreation."

In addition, performance measures, lead entities, current funding status, and whether legislation is required to complete the related actions below have been identified. This supporting information is presented in a table in Volume 4, *Reference Guide*, titled "California Water Plan Related Actions and Performance Measures," and will be used to track the future progress of each related action. These related actions are also supported by additional recommendations in Chapter 30, "Water and Culture," and Chapter 31, "Water-Dependent Recreation," of Volume 3, *Resource Management Strategies*.

Related Actions

14.1 Respect and Protect. State government will respect and vigorously protect waterways, lakes, and beaches for beneficial public use.

14.1.1 The State will support the regulatory responsibilities of the California Coastal Commission (beach access), Bay Conservation and Development Commission (San Francisco estuary access), State Water Resources Control Board (SWRCB) (water quality and supply), State Lands Commission (navigation), California Department of Fish and Wildlife (DFW) (inland fisheries), and others that protect beneficial uses such as fishing, boating, and other public access rights.

14.1.2 State conservancies — such as the Sacramento-San Joaquin Delta Conservancy, Tahoe Conservancy, and Sierra Nevada Conservancy — should acquire and/or protect sensitive landscapes, such as key watershed lands and wetlands, flood conveyance zones, riparian woodlands, and vernal pools with important natural resource and scenic values, and significant beneficial public uses. The conservancies, including the State Coastal Conservancy, should protect and/or acquire land to maintain public access to waterways, lakes, and beaches.

14.1.3 The State should protect recreational resource values threatened by the effects of climate change by using strategies of reinforcement, adaption, and/or retreat as feasible.

14.1.4 As water resources are developed, flood management facilities are envisioned, and sea level rise is accommodated, State government, including, but not limited to, the California Department of Water Resources (DWR) and the California Department of Transportation, should protect and minimize impacts on cultural and recreational uses.

14.2 Research and Planning. State government should engage in statewide research and planning to meet California's unmet and growing demand for safe public access to waterways, lakes, and beaches.

14.2.1 State agencies, such as the California Department of Parks and Recreation (California State Parks) and DWR, should document and regularly report on the water-dependent recreational trends of California's growing population, the public health and economic benefits of recreational activities, and threats to the tourism and lifestyle benefits of California's water-dependent recreational infrastructure.

14.2.2 State agencies, such as California State Parks and DWR, should report on the feasibility of incorporating public access facilities into each water resources development and flood management infrastructure project, watershed protection efforts, and environmental restoration projects funded by the State and federal governments. Consider multi-benefit projects that increase waterfront accessibility, create more inclusive access opportunities, support commercial and recreational fishing, encourage economic revitalization, promote excellence and innovation in urban design, enhance cultural and historic resources, and are resilient to a changing climate. Plan to include, where feasible, levee crown widening in levee improvement projects to accommodate multi-purpose recreational trails and bike lanes.

14.2.3 State conservancies, such as the State Coastal Conservancy, Bay Conservation and Development Commission, and California State Parks should collaborate with local agencies to systematically plan to reinforce, adapt, and/or relocate recreational opportunities threatened by sea level rise and transportation or wastewater infrastructure adaptations.

14.2.4 California State Parks should lead comprehensive recreation resource planning of the state's inland waterways, engaging the public, recreation providers, policy-makers, advocacy groups, and public officials. Consider facilities that provide opportunities for the top outdoor recreation activities identified in the *Survey of Public Opinions and Attitudes on Outdoor Recreation in California*, especially those benefiting disadvantaged communities.

14.3 Enhance. All State agencies with public access responsibilities should, in concert with local agencies, enhance safe public access by providing water-dependent recreational facilities and programs that support beneficial uses, and/or improve the social and economic sustainability of federally funded and State-funded infrastructure, watershed protection, and environmental restoration projects.

14.3.1 State agencies, including DWR, California State Parks, and all state conservancies, should facilitate and/or construct water-dependent recreation projects that spur the economic development of disadvantaged communities, provide environmental stewardship benefits, enhance natural resource values, protect or relocate existing recreational opportunities, and meet the regional demand for healthy outdoor recreation opportunities for all Californians, especially children.

14.3.2 The Delta Protection Commission and Sacramento-San Joaquin Delta Conservancy should encourage partnerships between other State and local agencies, local landowners, and business people to expand water-dependent recreation and tourism in the Delta and Suisun Marsh, while minimizing adverse impacts on non-recreational landowners. Use California State Parks' *Recreation Proposal for the Sacramento-San Joaquin Delta and Suisun Marsh* and the Delta Protection Commission's *Economic Sustainability Plan* as guides.

14.3.3 As California's population increases, State agencies, such as DWR, DFW, and California State Parks, should increase water-dependent recreation opportunities on existing public land, where feasible. State government should also pursue acquisition opportunities that provide open space and public access to water features, such as the ocean, lakes, rivers, streams, and creeks, where demand exceeds supply.

14.3.4 State agencies should prioritize construction of water-dependent recreation facilities identified in integrated regional water management (IRWM) plans; active-use facilities, such as multi-use trails for equestrians, hikers, walkers, and bikers, which improve public health; boating trails; facilities that mitigate or adapt to climate change; facilities that increase the safety of anglers, swimmers, and boaters; and facilities that provide environmental education, such as water conservation and water quality information.

14.4 Promote. All State agencies with waterfront public access responsibilities should cooperate with local agencies, businesses, and the general public to promote healthy outdoor recreation, resource-based tourism, and environmental stewardship to benefit public health and welfare, improve the environment, and grow the economy commensurate with protection of public property rights.

14.4.1 All State conservancies, DWR, DFW, and California State Parks should improve outreach and education to children and in disadvantaged communities that will improve public health, support California's outdoor lifestyle, and promote wise use of water resources.

Objective 15 — Strengthen Alignment of Land Use Planning and Integrated Water Management

Strengthen the alignment of goals, policies, and programs for improving local land-use planning and IWM.

The way in which we use land has a direct relationship to agriculture, water supply, water quality, flood management and hazard mitigation, and other water topics. For example, compact urban development patterns in urban areas can reduce water demand, improve water quality, limit the amount of development in floodplains as well as avoid conversion of agricultural lands, reduce costs for water-related infrastructure, and reduce GHGs. Also, directing development away from agricultural lands allows for multi-objective management of those lands, which includes agricultural land stewardship, floodplain management, water quality improvement, and habitat conservation.

Cities and counties have primary responsibility for land use planning and regulation in California. Land use planners consider water throughout the local land-use planning process, and water is a critical element in adopting sustainable land-use planning policies. Stronger collaboration between land use planners and water planners can promote more sustainable land-use patterns and greater integration of IWM into local land-use plans. It can also lead to IRWM plans that more accurately reflect and support local government land use and growth policies.

State government has an important role to play in strengthening the alignment of land use and IWM. Existing programs include SB 610 and SB 221 of 2001, which establish processes for coordinating land use and water supply planning. Also, State flood legislation enacted in 2007 requires local general plans to include specific policies to reduce flood risk. Established in 2008, the Strategic Growth Council awards grants for sustainable communities planning, which can integrate IWM at both the regional and local levels.

By enhancing its role, State government can facilitate stronger collaboration between land use planners and water planners. It can provide additional regulatory and financial incentives for local and regional plans that integrate IWM through encouraging compact, sustainable development patterns. Finally, State government can provide technical tools and data resources to make it easier for local governments to prepare land use plans that integrate IWM. Recently DWR partnered with Sonoma State University's Center for Sustainable Communities to develop an "Integrated Water and Land Management Tool." The final report, summary, user guide, and tool are available at the following Web links:

- Final Report — http://www.waterplan.water.ca.gov/docs/cwpu2013/vol4/landuse-DWR-Report-October15-2013-2.pdf.
- Summary and User Guide — http://www.waterplan.water.ca.gov/docs/cwpu2013/vol4/landuse-DWR-SummaryUserGuide-Oct-15-2013.pdf.
- Tool (Microsoft Excel Calculator) — http://www.waterplan.water.ca.gov/docs/cwpu2013/vol4/LandUse-toolcalculator.xls.

The land use resource management strategies (RMSs) are cross-referenced to many other RMSs, including Agricultural Land Stewardship (ALS). In furtherance of aligning land use planning and water, the land use objective incorporates ALS-related actions, including the comprehensive toolbox and "Framework" in the ALS RMS that can inform agricultural land stewardship activities at different levels of planning. These strategies can be used in developing projects that affect agricultural land by providing an integrated and collaborative framework to address changing uses of agricultural land, from mitigating its loss to valuing its multiple benefits. For more information, see https://agriculturallandstewardship.water.ca.gov/.

Many decision-makers in local, regional, and State government believe strengthening the links between land use planning and ALS are essential to achieving the CWP vision and IWM. To that extent, project investments in floodplain management, land use planning, and agricultural and economic viability with environmental and habitat benefits are consistent with State and regional polices.

In addition, performance measures, lead entities, current funding status, and whether legislation is required to complete the related actions below have been identified. This supporting information is presented in a table in Volume 4, *Reference Guide*, titled "California Water Plan Related Actions and Performance Measures," and will be used to track the future progress of each related action. These related actions are also supported by additional recommendations in Chapter 21, "Agricultural Land Stewardship," and Chapter 24, "Land Use Planning and Management," of Volume 3, *Resource Management Strategies*.

Related Actions

15.1 State Government should provide additional regulatory and financial incentives to developers and local governments to plan and build using compact and sustainable development patterns.

- 15.1.1 Regulatory incentives include further streamlining of California Environmental Quality Act (CEQA) review for infill projects and further reductions in brownfields liability for innocent purchasers.
- 15.1.2 Financial incentives include developing criteria for State grant and funding programs that incentivize compact and sustainable development.

15.2 The Governor's Office of Planning and Research (OPR) should provide guidance and financial incentives for integration of integrated water management (IWM) considerations in general plan updates and Sustainable Communities Strategy (SCS), including both substantive and planning process guidance.

15.3 Local governments should integrate relevant IWM considerations into their general plan updates. IWM considerations relevant to land use planning include water supply, water quality, flood risk management, agricultural land stewardship, and climate policies (mitigation and adaptation).

15.4 The Strategic Growth Council should provide guidance and financial incentives for regional planning agency integration of relevant IWM considerations into SCSs, transportation blueprint plans, and other regional plans.

15.5 Regional planning agencies should integrate IWM considerations into their SCSs, transportation blueprint plans, and other regional plans.

15.6 Local governments should ensure that urban water management plans inform and reflect integrated regional water management (IRWM) plan preparation and implementation, to further IWM integration in local land-use planning that promotes compact and sustainable development.

15.7 Local governments should implement specific land-use planning and regulatory measures to reduce flood risks, consistent with IWM principles and best management practices (BMPs) for land use planning.

15.7.1 Measures include preservation of existing floodplains, aquifer recharge areas, and alluvial fans; restoration of natural floodplain functions; and design measures to increase post-flood resiliency. See Objective 6, Related Action 6.8 regarding the process for developing land use planning BMPs.

15.8 The California Department of Water Resources (DWR) should assist local governments and developers with implementing the *Integrating Water and Land Management: A Suburban Case Study and User-Friendly, Locally Adaptable Tool*, which calculates life-cycle water infrastructure costs for different development patterns.

15.9 State government should evaluate the effectiveness of the 2007 flood management legislation in achieving coordination of land use planning, flood planning, and natural resources. State government should recommend changes to existing laws and their implementation to increase their effectiveness as appropriate.

15.10 State government, in collaboration with local government, non-governmental organizations, and stakeholders, should evaluate the effectiveness of SB 610 and SB 221 in coordinating land use and water supply planning, and recommend changes to existing laws and their implementation, as appropriate.

15.11 State government should invest in innovation and technology for assessment of land use, water supply, and flood conditions to further integrate water management and land use.

15.11.1 State government should provide funding, technical information, and BMPs, and publicize accurate and relevant water resources information for use by local governments and developers. State government could serve as an information clearinghouse for regional water supply, water quality, flood management, agricultural land stewardship, and climate change vulnerability information that local governments can use in preparing general plans and evaluating development applications.

15.12 Agricultural Land Stewardship should be considered for plans and projects that affect agriculture.

15.12.1 State government should provide leadership on promoting a common approach for State agencies with regard to plans and projects affecting water management and agriculture that takes into consideration the multiple uses of the land, including agricultural production, flood protection, habitat conservation and restoration, and water supply benefits.

15.12.2 Plans and projects affecting water management and agricultural lands should consider developing an agricultural land stewardship plan and as appropriate use the toolbox of agricultural land use strategies identified in the agricultural land stewardship resource management strategy.

15.12.3 State government should work with others to assure that State and federal funding criteria consider incorporating agricultural land stewardship strategies for land use plans and projects affecting agricultural lands.

Objective 16 — Strengthen Alignment of Government Processes and Tools

Improve, align, and transform processes and administrative tools (incentives and oversight) — at all levels of government — used for water planning, public engagement, program/project implementation, and policy- and regulation-setting to advance IWM.

As water managers move to IWM, regulatory and other requirements designed to achieve actions with a single management objective can appear to work at cross purposes. Multi-benefit projects may require complex considerations that balance needs and trade-offs. In addition, IWM project implementers often report that they must navigate what seems to be a labyrinth of laws, regulations, and permits that sometimes leads to project delays and mounting planning and compliance costs. These impediments can ultimately create significant difficulties in meeting public safety, environmental stewardship, or economic goals. This objective seeks to establish an approach to assist in aligning activities, honor regulatory goals, and facilitate successful implementation of projects.

The need for improved government alignment is being recognized at all levels of government and in multiple planning processes. For example, the Strategic Growth Council, California Water Commission, Resource Conservation Districts, Water Plan State Agency Steering Committee, California Biodiversity Council, and IRWM Regional Water Management Groups all have stated that the following issues impede broader and better implementation of IWM projects:

- Uncoordinated and fragmented water governance and responsibilities among numerous federal, tribal, State, and local agencies and organizations.
- Patchwork of unaligned agency planning, programs, projects, policies, and regulations.
- Unintended consequences from mismatching or conflicting policies or regulations.
- Inadequate sharing of data, information, and knowledge resulting from institutional silos.
- Duplication of effort, expertise, and resources.
- Focus on single-purpose projects.
- Inadequate partnerships among federal, State, tribal, local, private,
- Project delays and mounting planning and compliance costs.

Understandably, project planning in California is technically complex and location-appropriate because of wide variations of climates, landforms, and institutions, as well as a diverse, place-based range of cultures associated with rural, suburban, and urban communities. Project partners, such as implementers and regulatory agencies, may have different perspectives on what they hope a project or program should achieve. Those responsible for operations and maintenance may have yet another perspective. Also, State and federal agencies may have different perspectives and responsibilities regarding a project.

The need for alignment is well understood among all levels of government and stakeholders. This CWP objective of strengthening agency alignment is based on several key principles:

- Agencies will remain autonomous.
- Action will be voluntary.
- No new institutions or organizations will be created to manage alignment.

- Action will occur at multiple organizational levels.
- No single agency can solve all of a project's or program's issues by itself.

Implementing the related actions for this objective, in coordination with other CWP objectives, will help achieve the following outcomes:

- Improved communication, coordination, and collaboration.
- Aligned planning, programs, projects, policies, and regulations for water and associated watershed, land, and ecosystem management.
- Shared processes, tools, data, information, knowledge, and expertise.
- Collaborative, place-based solutions using best available science, traditional knowledge, and other sources of information.
- Watershed-scale, multi-benefit water and resource stewardship programs to solve multiple resource issues.
- More public-private partnerships to advance all aspects of IWM (planning, project implementation, financing, monitoring, maintenance, data collection and exchange, analytical methods and tools, research, technology, and science).

A primary purpose for improving communication, cooperation, collaboration, and alignment among government agencies is to expedite efficient and cost-effective implementation of resource management strategies and multi-objective projects. This includes collaboration with regulatory agencies to reduce time and avoid costs to implement IWM projects while protecting and enhancing natural resources. Achieving IWM requires that data management, planning, policy-making, and regulation occur in a very collaborative, consistent, and regionally appropriate manner.

Instead of creating new institutions or organizational structures to manage alignment, agencies are encouraged to utilize simple self-organizing principles, practices, and tools to coordinate and collaborate outside of traditional silos and hierarchical management approaches. Alignment should not alter agencies' authority or responsibility, and is achieved by agencies working together — early and often. For example, a collaboration has been established between the 42-member California Biodiversity Council (http:www.biodiversity.ca.gov) and the Update 2013 process to better align planning processes and more efficiently interact with federal, State, and local agencies. One result was a joint convening of the Workshop to Align Agency Conservation Plans, Policies, and Programs held in October, 2012. The outcome of this workshop led to the February 6, 2013, California Biodiversity Council Meeting in Davis, California, where the co-chairs committed to a new resolution for the Council, *Strengthening Agency Alignment for Natural Resource Conservation*, described further in Chapter 4, "Strengthening Government Alignment."

One of the related actions offers strategies for improving the alignment, effectiveness, and implementation of water regulations. It recommends agencies set regulations that focus on regionally appropriate outcomes (goals or targets — the What), establish performance measures/indicators to evaluate progress, and include an adaptive management approach as a part of compliance. The action also recommends that the regulatory agency give regional collaboratives, such as the IRWM Regional Water Management Groups or Resource Conservation Districts, an option to develop an implementation and monitoring plan that describes the resource management strategies the group will use to achieve the regulations' intended outcomes in their area of the state (the How).

In addition, performance measures, lead entities, current funding status, and whether legislation is required to complete the related actions below have been identified. This supporting information is presented in a table in Volume 4, *Reference Guide*, titled "California Water Plan Related Actions and Performance Measures," and will be used to track the future progress of each related action.

Related Actions

16.1 To advance integrated water management (IWM), federal, State, tribal, and local government agencies should strengthen alignment among their data, plans, programs, policies, and regulations. More specifically, they should:

16.1.1 Collaborate to develop consistent policies for advancing IWM at a regional scale, and use a broad and diverse mix of administrative tools to implement their policies, including technical assistance and data support; financial incentives; and State funding, guidelines, and regulations.

16.1.2 Adopt the "Strengthening Agency Alignment for Natural Resource Conservation" resolution (April 2013) vision, goals and principles, developed with extensive input from 42 federal and State agencies, including multiple Water Plan State Agency Steering Committee members, among others.

16.1.3 Utilize the best practices and tools recommended in the "Strengthening Agency Alignment for Natural Resource Conservation" resolution.

16.1.4 Participate on the Biodiversity Council's Interagency Alignment Team.

16.2 State government should more effectively coordinate the work of multi-agency collaboratives, and utilize them to align and implement State water policies and promote IWM. This should include developing and maintaining a shared and easily accessible interagency inventory/repository of processes and tools for strengthening government agency alignment. Examples of multi-agency collaborative include, but are not limited to, the Strategic Growth Council, California Biodiversity Council, Delta Stewardship Council, Ocean Protection Council, Water Plan State Agency Steering Committee, Conservancies and Resource Conservation Districts, California Council on Science & Technology, and California Landscape Conservation Cooperative.

16.3 State government agencies should hire, assign, or train staff with collaboration and conflict resolution knowledge, skills, and abilities (KSA), whose primary job is to work with other federal, State, tribal, regional, and local agencies, organizations, and communities to improve interagency communication, cooperation, collaboration, and alignment.

16.3.1 California Department of Human Resources (Cal-HR) should convene an interagency working group to develop standard language describing collaboration and conflict resolution KSAs for use in duty statements where this core competency is a minimum qualification.

16.3.2 State agencies should include this standard KSA language in duty statements for staff and management classifications to promote State agency collaboration and alignment, and they should require incumbents in these classifications to complete facilitation training.

16.3.3 State agencies should be encouraged to build internal support, provide necessary training, and provide clear direction to staff to meet the objective of improving, aligning, and transforming processes and administrative tools.

16.4 Federal and State government agencies should use a more inclusive, collaborative, and outcome-based approach for setting consistent and aligned water policies and regulations that are regionally appropriate. More specifically, they should:

16.4.1 Recognize regional and local diversity by assisting, enabling, and empowering regional water collaboratives, such as Regional Water Management Groups (IRWM) and Resource Conservation Districts, to determine how State water policies are implemented in their planning regions and/or watersheds.

16.4.2 Focus on intended and regionally appropriate outcomes (goals and objectives) when setting water policies, regulations, guidelines, and resource management plans for California. Agencies should establish performance measures/indicators to evaluate progress toward achieving desired outcomes, and include an adaptive management approach as a part of regulatory compliance.

16.4.3 Provide a voluntary program for regional collaboratives, such as Regional Water Management Groups (IRWM) and Resource Conservation Districts, to develop an implementation and monitoring plan that describes the resource management strategies (actions) the group will implement to achieve the regulations' intended outcomes in their planning regions and/or watersheds, as appropriate for their local conditions and resources.

16.4.4 Utilize voluntary, outcome-based and system-scale (watershed and ecosystem) approaches for regulatory and permitting processes, and engage project proponents collaboratively, earlier and more often during the process.

16.4.5 The California Department of Water Resources (DWR) and other State agencies should survey regional collaboratives, such as Regional Water Management Groups (IRWM), to determine what technical assistance they need to facilitate collaboration and support change in regulatory approaches.

16.5 State government should convene regulatory working groups, in collaboration with federal, tribal, and local governments, to improve and streamline regulatory review and permitting processes for implementing IWM projects more expeditiously. These regulatory working groups should take the following actions in collaboration with regional stakeholders, while recognizing the unique differences among California's geographical regions:

16.5.1 Identify critical resource needs of regulatory agencies necessary to adequately implement regulatory programs and proposed regulatory alignment actions to support IWM, including science, tools, data, policy, guidance, and agency personnel.

16.5.2 Maximize the use of existing mechanisms such as habitat conservation plans and natural community conservation plans.

16.5.3 Review and streamline permit processes to improve efficiency and reduce costs, delays, inconsistencies, and associated adverse impacts, and develop regional permitting processes for recurrent actions and operation and maintenance activities.

16.5.4 Develop and adopt region-specific guidance on ecosystem restoration, water quality improvement, and environmental stewardship strategies to expedite review.

16.5.5 Develop and adopt specific guidance to expedite emergency response and public safety projects for high-risk areas.

16.5.6 Evaluate and adjust regulatory staff assignments to improve regulatory review and permitting processes at a regional scale, facilitate earlier staff involvement in planning phases for complex projects, and identify resource gaps.

16.5.7 Compile, maintain, and utilize regional knowledge bases (data, information, and science), including information on endangered species, sensitive habitat, water quality, and other baseline information.

16.5.8 Develop and maintain regional environmental mitigation databases and mitigation banks to address the varying mitigation requirements among multiple regulatory programs and agencies in each region and across regions.

16.5.9 Develop a multi-agency permitting guidebook that includes a description of the relevant permits, permit applications, and permitting guidance for common and more routine IWM projects.

Objective 17 — Improve Integrated Water Management Finance Strategy and Investments

State government uses consistent, reliable, and diverse funding mechanisms with an array of revenue sources to support statewide and regional IWM activities. State government also makes future investments in innovation and infrastructure (green and grey) based on an adaptive and regionally appropriate prioritization process.

This objective and the related actions are based on collaboration involving several State agencies, advisory committees, topic-based caucuses (particularly the Update 2013 Finance Caucus), and other CWP stakeholders who, together, developed a Finance Planning Framework (Framework), a new feature of the CWP. The Framework provides a logical structure and sequence for financial plan development. The related actions in this section were developed to respond to and leverage the challenges and opportunities that emerged during the Update 2013 finance planning effort, as detailed in Chapter 7, "Finance Planning Framework."

The scope of the related actions is limited to IWM programs and projects directly administered by the State, as well as future State IWM loans and grants distributed as incentives to regional and local governments. These actions are intended to inform and guide State government investment and finance. They are not intended to direct regional or local finance decisions. They also are not intended to modify existing State investment frameworks for ongoing financial activities, such as distribution of currently authorized General Obligation bonds. While the actions below include recommendations for enhancing the way the State invests in IWM, they do not include recommendations for new revenue sources. Chapter 7 and Related Action 17.7 provide a path for resolving issues and filling information gaps, which is required as a precursor to proposing new or enhanced revenues.

Continuing to use and advance the Update 2013 Framework will enable stakeholders to collectively and in context consider the issues to be addressed and the decisions to be made. The Framework discussed in Chapter 7 evolved as stakeholders worked together to create a common understanding of California's water financing picture. Using a storyboard format, the goal was to establish a financing baseline and shared meaning about the past and current situation.

The related actions are intended, in part, to incorporate several aspects of the Framework in State government actions. For example, the Shared Finance Values for State Investment and Prioritization have been represented, where appropriate. These values were developed collaboratively through the Update 2013 Finance Caucus and, in addition to guiding the development of the related actions, are to be used in guiding IWM decisions regarding investment of State government funds. Another overlying purpose of these related actions is to increase the certainty that investments will achieve the intended benefits, improve the return on State investment, and enhance accountability by:

- Increasing the reliability, predictability, and level of State IWM funding for statewide and regional water programs and projects.
- Providing a consistent method for allocating, awarding, and disbursing State funding for water innovation and infrastructure programs and projects.
- Avoiding the use of funding earmarks.

- Including regional accounts to continue IRWM to increase flexibility, reflect local and regional conditions, and advance regional goals and investment priorities.
- Providing proactive planning that implements consistent rules and standards for allocating State funding.

In addition, performance measures, lead entities, current funding status, and whether legislation is required to complete the related actions below have been identified. This supporting information is presented in a table in Volume 4, *Reference Guide*, titled "California Water Plan Related Actions and Performance Measures," and will be used to track the future progress of each related action.

Related Actions

17.1 Regional and local entities should continue investing in integrated water management (IWM) activities, based on regional and local conditions, goals, priorities, and solutions. Reliable and effective water-finance planning should continue at the regional and local levels in partnership with State government. Locally sponsored initiatives will continue to be a cost-effective approach for planning and implementing IWM innovation and infrastructure (green and grey) to provide multiple benefits to their respective jurisdictions. Regional and local investments should be augmented and amplified with federal and State public funding.

17.2 State government should continue to provide incentives for regional IWM (IRWM) activities that achieve State goals or provide broad public benefits. This includes assisting regions technically and financially to develop and implement their IRWM plans and/or help achieve State government goals and interests. State government should continue to enhance incentives for regional activities and invest in infrastructure (green and grey) that provides a public benefit *and* would not otherwise be cost effective.

17.3 State government should improve and facilitate access to federal and State public revenue sources.

17.3.1 State government should develop a central online resource catalog to describe different funding programs, potential IWM revenue sources, and a how-to guide explaining how to apply for funding from these programs.

17.3.2 State government should provide guidance and assistance to local agencies on how to apply for funding that includes technical and financial assistance, as well as training for regions that do not have the capacity or resources to apply for funding or manage grants.

17.3.3 State government should inventory federal funding sources and provide guidance for partnering with, or leveraging, federal funding.

17.4 The governor and the Legislature should broaden the ability of (and create guidelines and limitations for) public agencies to partner with private agencies, entities, and organizations for IWM investments.

New policies are required to overcome the following limitations that have restricted their use:

- Private financing rates are generally higher due to tax effects. Local bond financing options would typically be tax exempt for the bondholder and therefore have lower interest rates.
- The prohibition of their use for State government projects restricts public-private partnerships (P3s) to local projects.

17.5 State government should develop a more reliable, predictable, and diverse mix of finance mechanisms and revenue sources to continue to invest in IWM innovation activities and infrastructure (green and grey) that have broad public benefits, including, but not limited to, General Funds and General Obligation bonds. An important role of State government is to invest in innovation activities having broad public benefits that include improving State water governance, improving water planning and public engagement, strengthening government agency alignment, enhancing information technology (data and analytical tools), advancing water technology and science, and investing in infrastructure (green and grey). These activities should be conducted in collaboration with the ongoing regional and local innovation activities.

Finance mechanisms used for these IWM innovation activities should:

A. Improve cost effectiveness, efficiencies, and accountability.

B. Avoid stranded costs and funding discontinuity.

C. Leverage funding across State government agencies.

D. Increase certainty of desired outcomes.

E. Enable prioritization based on shared funding values, defined principles, goals, objectives, and criteria.

17.6 State government should reduce planning and implementation time frames and costs associated with IWM activities by clarifying, aligning, and reducing redundancies among State government agencies' policies, incentive programs, and regulations.

17.6.1 Develop the scope and methodology and prepare a Return on State Government Investment report card through the California Water Plan update collaborative process (5-year interval) that would track the occurrence of benefits/value derived from State government investments (and leveraged local investments) by using specific criteria and sustainability indicators.

17.6.2 Convene an interagency IWM finance alignment group that includes State planning, resource management, and regulatory agencies to identify and implement finance policies, procedures, and protocols for the enhancement of State government transparency, accountability, flexibility, and cost efficiencies. This finance alignment group would recommend ways to reduce duplication and fragmentation among State government agencies' policies, incentive programs, regulations, and budgets.

17.7 The California Water Plan Update 2018 process will refine and advance the eight components of the Finance Planning Framework as described in the "Next Steps" section of Chapter 7, "Finance Planning Framework." Future work will cover each component of the Framework in the following ways:

A. IWM Scope and Outcomes (Component 1) — Revisit, clarify, and adapt the scope of IWM to changing conditions and priorities.

B. IWM Activities (Component 2) — Develop more specificity regarding the types and levels of activities that State government should invest in with a clearer nexus to the types of anticipated benefits.

C. Existing Funding (Component 3) — Continue to compile and synthesize data that tracks historical water-related expenditures across federal, State, and local governments in California.

D. Funding Reliability (Component 4) — Work with the State Agency Steering Committee to identify where potential funding gaps exist between the State IWM activities described in component 2 and existing funding levels and sources. Collaborate with regional water management groups to do the same for regional and local IWM activities.

E. State Role and Partnerships (Component 5) — Continue to clarify and elaborate on the role of State government to support a more specific description and estimate of future costs.

F. Future Costs (Component 6) — Estimate future funding demands by (a) launching IRWM, city, county, and special district data pull; and (b) work with State Agency Steering Committee to estimate the funding demand for existing and future IWM activities.

G. Funding, Who and How (Component 7) — Continue to collaborate with stakeholders and federal, State, tribal, and local governments to investigate and develop solutions that address the facts and findings detailed in Chapter 7, "Finance Planning Framework." This work will include, but will not be limited to:

    i. Funding methods that provide a consistent financing framework for State government investments in IWM.
    ii. A prioritization method and rationale for apportioning IWM investment by the categories and subcategories developed in the California Water Plan Update 2013 Finance Planning Framework (i.e., Innovation and Infrastructure activities).
    iii. Methods for enhancing stewardship of State government monies at both statewide and regional scales, including strategies to improve the transparency and accountability of State fund disbursements and their outcomes.
    iv. Achieve the improvements described in Related Action 17.5.

H. Tradeoffs (Component 8) — State government should develop a Decision Support System (DSS) to provide guidance and leadership for defining uncertainties of future costs, benefits, prioritization, and other tradeoffs. The DSS would inform prioritization of State government expenditures, estimation of expected IWM benefits, and methods for apportioning costs across investors and financiers. It also includes developing a clear and consistent methodology for identifying and quantifying public benefits associated with the entire range of IWM activities.

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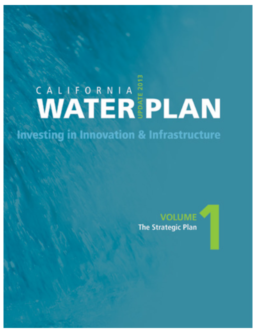
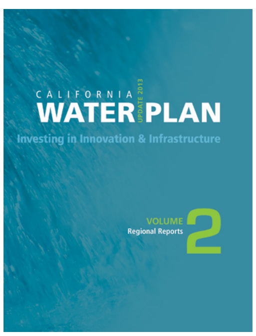
Navigating Water Plan Update 2013

Update 2013 includes a wide range of information, from a detailed description of California's current and potential future conditions to a "Roadmap For Action" intended to achieve desired benefits and outcomes. The plan is organized in five volumes — the three volumes outlined below; Volume 4, *Reference Guide*; and Volume 5, *Technical Guide*.



VOLUME 1, The Strategic Plan

- Call to action, new features for Update 2013, progress toward implementation.
- Update 2013 themes.
- Comprehensive picture of current water, flood, and environmental conditions.
- Strengthening government alignment and water governance.
- Planning (data, analysis, and public outreach) in the face of uncertainty.
- Framework for financing the California Water Plan.
- Roadmap for Action — Vision, mission, goals, principles, objectives, and actions.



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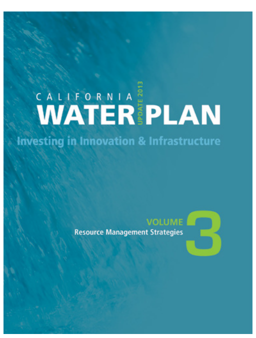

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Integrated water management *is a comprehensive and collaborative approach for managing water to concurrently achieve social, environmental, and economic objectives. In the California Water Plan, these objectives are focused toward improving public safety, fostering environmental stewardship, and supporting economic stability. This integrated approach delivers higher value for investments by considering all interests, providing multiple benefits, and working across jurisdictional boundaries at the appropriate geographic scale. Examples of multiple benefits include improved water quality, better flood management, restored and enhanced ecosystems, and more reliable water supplies.*

Edmund G. Brown Jr.
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John Laird
Secretary for Natural Resources
Natural Resources Agency

Mark Cowin
Director
Department of Water Resources

DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

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