# California **Water Plan**
## Update 2009

INTEGRATED WATER MANAGEMENT






Bulletin 160-09 • Department of Water Resources

*Volume* **1**

**The Strategic Plan**

# Navigating Through Water Plan Volumes

California Water Plan Update 2009 presents the latest statewide strategic plan for water management – a roadmap to year 2050. Use this reader's guide to navigate the many volumes that describe California's diverse water conditions and statewide and regional integrated water management.

## The Roadmap

*Where are we and how should California proceed?*

### Volume 1 The Strategic Plan

**California Resources**
Variable and Extreme
Critical Challenges
- *Climate change, population growth, dry years, floods, vulnerable ecosystems and Delta, water quality, aging infrastructure (levees), catastrophic events, data gathering, funding, disadvantaged communities*

**Managing our Resources**
Sustainability
- *Water use efficiency, water quality, stewardship*

Reliability
- *IRWM, water/flood systems*

Reduction of Risk and Uncertainty
**Companion State Plans**
**Integrated Data and Analysis**
**Statewide Objectives and Actions**

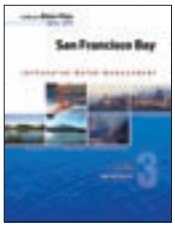
## Options/decision-making

*What can we do?*

### Volume 2 Resource Management Strategies

**A Range of Choices**
27+ management strategies to
- *Reduce water demand*
- *Increase Water Supply*
- *Improve Water Quality*
- *Practice Resource Stewardship*
- *Improve Flood Management*

*How does it look and work at the regional level?*



### Volume 3 Regional Reports

**10 regions and 2 areas of interest**
- *Setting*
- *Water Conditions*
- *Relations with Other Regions*
- *Water and Flood Management*
- *Water Balances*
- *Looking to the Future*
- *Scenario Results*

## Digging deeper

*Want more on what we know and what we want to know?*

### Volume 4 Reference Guide

**An encyclopedic look**
- *Background on California Water Resources*
- *Water Resources Analysis*
- *Emerging Issues*

*What's the metadata on the data?*

### Volume 5 Technical Guide

**Documentation**
- *Assumptions*
- *Data*
- *Analytical Tools and Methods*

***Cover photos***

*1. California State Capitol.*
*2-3. Sacramento-San Joaquin Delta.*
*4. Levee break.*
*5. Agriculture in the Sacramento-San Joaquin Delta.*
*6. San Francisco skyline.*
*All photos courtesy of DWR Photo Lab.*

State of California
California Natural Resources Agency
Department of Water Resources

# California **Water Plan** Update 2009

## Integrated Water Management

## Volume 1 - The Strategic Plan

**Bulletin 160-09**

**December 2009**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State of California

**Lester A. Snow**
Secretary for Natural Resources
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**Mark W. Cowin**
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# Foreword

Water Plan Update 2009 epitomizes collaboration. It reflects the perspectives of many and varied individuals, groups, and government entities representing the full spectrum of issues, concerns, and visions for the future of water management in California. Update 2009 has been enhanced by the leadership of 21 State agencies and departments that oversee or carry out water-related activities. Federal, Tribal, regional, and local entities helped shape the strategic plan—its goals, objectives, and recommendations—and 27 resource management strategies that are key to success.

Update 2009 reflects a new reality for resource management, a blueprint for sustainability, and a new direction for water decisions. This reality includes significant challenges: ecosystems in peril, the uncertainties of climate change and sea level rise, and population growth to name just a few. Update 2009 also spells out the urgencies that demand action: dealing with longer and more pronounced droughts, increased flood risk, threats to the environment, impaired water bodies, and aging infrastructure.

The Water Plan's outreach to Native American Tribes brought about a Tribal Communication Plan and culminated in the first of its kind California Tribal Water Summit in 2009. Update 2009 also introduces new water planning methods with the use of scenarios and response packages while evaluating the effects of future climate change.

This Water Plan marks a dynamic new approach to the way California manages its water resources—statewide and regionally. We must adapt California's water systems more quickly and effectively to keep pace with ever-changing conditions. With new urgency, regions must develop and implement truly integrated regional water management plans as roadmaps to meeting future water demands in sustainable ways. We must also continue our efforts at the statewide level to develop and implement plans for a sustainable Delta and to improve our flood management system. To assure balanced, effective solutions are implemented, we must develop long-term, reliable funding methods to make necessary system improvements and to invest in the continued resilience of California's water resources and the ecosystem that supports them.

In November 2009, the Legislature passed and Governor Schwarzenegger signed a comprehensive water package which is integral to Update 2009. Today, State government has the responsibility and opportunity to work with local partners within a new Delta governance structure to complete and implement plans for improving both the Delta ecosystem and the reliability of water supply derived from the Delta. We also must step up our efforts to integrate this work with our ongoing responsibilities to develop a Central Valley Flood Protection Plan, implement the FloodSAFE California initiative, and improve water storage statewide.

Regional water planning and management is essential for solving California's water issues. Local governments, agencies, and stakeholders have the best understanding of their water management challenges. DWR and other State agencies must partner with local agencies and governments to advance Integrated Regional Water Management, and to implement the new requirements for water conservation and groundwater monitoring. State government can provide expertise, technical assistance, and other essential support activities.

The California Water Plan Update 2009 will help chart our course toward more sustainable, integrated resources management. In broad strokes, this means considering water supply reliability, flood protection, water quality, and environmental stewardship in all resource management decisions. By doing so, we increase our chances of realizing the Water Plan's vision: a productive economy, healthy ecosystem, and desirable quality of life for all Californians.

Mark W. Cowin, Director

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We worked individually and came together as groups—water suppliers and customers; urban and rural residents; environmental advocates; agriculture and other industry representatives; flood protection agencies and organizations; private and public groups; and local, regional, State, federal, and Tribal governments. Strengthened by the progress of Update 2005, but in only half the time, we significantly increased the number of collaborative hours dedicated to discussion, debate, and decision-making as we developed Update 2009. Our perspectives were varied, but we found common ground and our intentions were one—find ways to manage California's precious resource in a way that meets today's demands and the needs of generations to come.

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The Water Plan teams are grateful to the many commentators who contributed to our understanding of California's water resource and its uses. The public took advantage of several opportunities to review and comment on five versions/drafts of Update 2009. DWR received and considered about 335 comment letters and e-mails in preparing this update. Comments came from State, federal, Tribal, and local governments and agencies, nongovernmental organizations, private organizations, and individuals. Find these written comments on the Web at http://www.waterplan.water.ca.gov/comments/update2009/index.cfm?sort=noid.

# Contents


## Volume 1

Chapter 1 Introduction ..... 1-1

Chapter 2 Imperative to Act ..... 2-1

Chapter 3 Companion State Plans ..... 3-1

Chapter 4 California Today ..... 4-1

Chapter 5 Managing an Uncertain Future ..... 5-1

Chapter 6 Integrated Data and Analysis ..... 6-1

Chapter 7 Implementation Plan ..... 7-1

## Volume 2

Chapter 1 Introduction

**Reduce Water Demand**

Chapter 2 Agricultural Water Use Efficiency

Chapter 3 Urban Water Use Efficiency

**Improve Operational Efficiency and Transfers**

Chapter 4 Conveyance — Delta

Chapter 5 Conveyance — Regional / Local

Chapter 6 System Reoperation

Chapter 7 Water Transfers

**Increase Water Supply**

Chapter 8 Conjunctive Management and Groundwater

Chapter 9 Desalination

Chapter 10 Precipitation Enhancement

Chapter 11 Recycled Municipal Water

Chapter 12 Surface Storage — CALFED

Chapter 13 Surface Storage — Regional/Local

**Improve Water Quality**

Chapter 14 Drinking Water Treatment and Distribution

Chapter 15 Groundwater and Aquifer Remediation

Chapter 16 Matching Water Quality to Use

Chapter 17 Pollution Prevention

Chapter 18 Salt and Salinity Management

Chapter 19 Urban Runoff Management

**Practice Resources Stewardship**

Chapter 20 Agricultural Lands Stewardship

Chapter 21 Economic Incentives

Chapter 22 Ecosystem Restoration

Chapter 23 Forest Management

Chapter 24 Land Use Planning and Management

Chapter 25 Recharge Areas Protection

Chapter 26 Water-dependent Recreation

Chapter 27 Watershed Management

**Improve Flood Management**

Chapter 28 Flood Risk Management

**Other**

Chapter 29 Other Strategies

**Volume 3**

North Coast Hydrologic Region

San Francisco Hydrologic Region

Central Coast Hydrologic Region

South Coast Hydrologic Region

Sacramento River Hydrologic Region

San Joaquin River Hydrologic Region

Tulare Lake Hydrologic Region

North Lahontan Hydrologic Region

South Lahontan Hydrologic Region

Colorado River Hydrologic Region

Sacramento-San Joaquin Delta

Mountain Counties

# Acronyms and Abbreviations

| | |
|---|---|
| A&E | Assumptions and Estimates (Report) |
| AB | Assembly bill |
| AB 32 | Global Warming Solutions Act of 2006 |
| ACWA | Association of California Water Agencies |
| B/C ratio | benefit/cost |
| BDCP | Bay Delta Conservation Plan |
| BLM | US Bureau of Land Management |
| Cal EMA | California Emergency Management Agency |
| CAL FIRE | California Department of Forestry and Fire Protection |
| CALSIM | DWR water resources simulation model |
| CALVIN | UC Davis statewide economic engineering water model |
| CASA | California Association of Sanitation Agencies |
| CAT | Climate Action Team |
| CDPH | California Department of Public Health |
| CEC | California Energy Commission |
| CLCA | California Land Conservation Act of 1965 (Williamson Act) |
| CLD | California Levee Database |
| CORP | California Outdoor Recreation Plan (State Parks) |
| CPUC | California Public Utilities Commission |
| CTP | California Transportation Plan |
| CVP | Central Valley Project (federal) |
| CVPM | Central Valley Project Model |
| CWEMF | California Water and Environmental Modeling Forum |
| DAU | detailed analysis unit |
| Delta | Sacramento-San Joaquin River Delta (also referred to as California Delta) |
| DFG | California Department of Fish and Game |
| DOF | California Department of Finance |
| DRMS | Delta Risk Management Strategy |
| DV BRTF | Delta Vision Blue Ribbon Task Force |
| DWR | California Department of Water Resources |
| EO | executive order |
| EPA | US Environmental Protection Agency |
| ERP | CALFED Ecosystem Restoration Program |
| ET | evapotranspiration |
| FEMA | Federal Emergency Management Agency |
| FERC | Federal Energy Regulatory Commission |
| GHG | greenhouse gas |
| HEC-FDA | Flood Damage Assessment software (USACE) |
| IEPR | 2007 Integrated Energy Policy Report |
| IEUA | Inland Empire Utilities Agency |
| IRP | Integrated resources planning |
| IRWM | Integrated Regional Water Management |
| IWRIS | Integrated Water Resources Information System |
| JOC | Joint Operations Center (relative to State and federal collaboration to serve California's water supply and flood management needs.) |

## Acronyms and Abbreviations (cont'd)

| | |
|---|---|
| LCPSIM | Least-Cost Planning Simulation Model |
| LGC | Local Government Commission |
| NAHC | Native American Heritage Commission |
| NFMS | National Marine Fisheries Service |
| NOAA | National Oceanographic and Atmospheric Administration |
| OPR | Governor's Office of Planning and Research |
| PA | planning area |
| PPIC | Public Policy Institute of California |
| RAP | region acceptance process (related to IRWM planning) |
| RDM | Robust Decision-making |
| Regional Water Board | Regional Water Quality Control Board |
| ROD | CALFED Bay-Delta Program's Record of Decision |
| SB | Senate bill |
| SEI | Stockholm Environment Institute |
| SGP | Governor's Strategic Growth Plan |
| SHMP | 2007 Enhanced State of California Multi-Hazard Mitigation Plan |
| State Parks | California Department of Parks and Recreation |
| State Water Board | State Water Resources Control Board |
| SVP | Shared Vision Planning |
| SWAN | Statewide Water Analysis Network |
| SWAP | Statewide Agricultural Production Model |
| SWP | State Water Project |
| SWRR | Sustainable Water Resources Roundtable |
| TAG | Technical Advisory Group |
| TCC | Tribal Communication Committee |
| UC | University of California |
| USACE | US Army Corps of Engineer |
| USBR | US Bureau of Reclamation |
| USDA | US Department of Agriculture |
| UWMP | Urban Water Management Plan |
| Water PIE | Water Planning Information Exchange |
| WEAP | Water Evaluation and Planning System |
| WETCAT | Water-Energy subgroup of Governor's Climate Actin Team |

# Introduction

***Chapter photo.*** Winter runoff in Sierra Nevada stream

# Contents

**Chapter 1. Introduction ..... 1-5**
About This Chapter ..... 1-5
A Guide to Update 2009 ..... 1-5
Volume 1 The Strategic Plan ..... 1-5
Volume 2 Resource Management Strategies ..... 1-7
Volume 3 Regional Reports ..... 1-7
Volume 4 Reference Guide ..... 1-7
Volume 5 Technical Guide ..... 1-9
Building on a Framework ..... 1-9
Influences of Update 2005 ..... 1-9
Fair and Transparent ..... 1-10
An Expanded Process ..... 1-10
Inclusive Water Planning ..... 1-15
Expanded Features ..... 1-17
Progress toward Implementing Update 2005 Recommendations ..... 1-20

## Figures

Figure 1-1 Hydrologic regions, Sacramento-San Joaquin Delta and Suisun Marsh, and Mountain Counties area ..... 1-6
Figure 1-2 Project Organization and Public Process for California Water Plan Update 2009 ..... 1-11

## Boxes

Box 1-1 Updates of the California Water Plan (Bulletin 160 series) ..... 1-8
Box 1-2 State Agencies and Departments Represented on California Water Plan Update 2009 Steering Committee ..... 1-12
Box 1-3 Eight Activities for Update 2009 ..... 1-16

# Chapter 1. Introduction

## About This Chapter

Chapter 1 Introduction outlines the process for preparing *California Water Plan Update 2009: Integrated Water Managements* and its new features. It also explains the organization of all five volumes of Update 2009 and its *Highlights* booklet.

- A Guide to Update 2009
- Building on a Framework
- Progress toward Implementing Update 2005 Recommendations

## A Guide to Update 2009

Updated every 5 years, the California Water Plan provides a framework for water managers, legislators, and the public to consider options and make decisions regarding California's water future. Our goal is to meet Water Code requirements, receive broad support among those participating in California's water planning, and create a useful document for the public, water managers and planners throughout the state, legislators, Tribes, and other decision-makers. The following tells how we arranged Update 2009.

### Volume 1 The Strategic Plan

Update 2005 was the first California Water Plan to explicitly include a strategic plan with a vision, mission, goals, recommendations, and implementation plan. Update 2009 updates and expands these strategic plan elements and presents them in Volume 1 The Strategic Plan (see **Chapter 2 Imperative to Act** and **Chapter 7 Implementation Plan**). A central feature of this update is the oversight of a 21-member State agency steering committee. Its membership represents the complex and many faceted nature of governing California's water resources at the State level. Their participation helped identify companion State plans that have a direct connection with the Water Plan (see **Chapter 3 Companion State Plans**). Challenges of managing California's extreme and variable resources are outlined in **Chapter 4 California Water Today**. The chapter also details water uses and supplies on a statewide basis. Meeting these challenges requires that we account for and reduce uncertainty and risk and that our investments make our water management systems, flood protection systems, and ecosystems more sustainable. This approach to managing our resources through 2050 is outlined in **Chapter 5 Managing an Uncertain Future**. This approach also requires that the water community have improved water resources information and analysis. **Chapter 6 Integrated Data and Analysis** highlights some key actions.

**Figure 1-1** Hydrologic regions, Sacramento-San Joaquin Delta and Suisun Marsh, and Mountain Counties area

## Volume 2 Resource Management Strategies

A key objective of the California Water Plan Update 2009 is to present a diverse set of resource management strategies to meet the water-related resource management needs of each region and statewide. Regional managers can group strategies into response packages, crafting them to provide multiple water and resource benefits. Volume 2 describes 27 resource management strategies that can help meet various water plan objectives:

- Reduce water demand
- Improve operational efficiency and transfers
- Increase water supply
- Improve water quality
- Practice resource stewardship
- Improve flood management

## Volume 3 Regional Reports

California has a wide variety of climates and landforms. This volume is a set of 12 regional reports, each describing the watersheds and water conditions, population and land use, and activities that influence a region's water use and supply reliability. The reports focus on California's 10 hydrologic regions, which correspond to the state's major water drainage basins, and two important regional areas that overlie hydrologic boundaries but encompass communities that share common water issues or interests: the Sacramento-San Joaquin River Delta region and the Mountain Counties area, which includes the foothills and mountains of the western slope of the Sierra Nevada and a portion of the Cascade Range (Figure 1-1 Hydrologic regions, Sacramento-San Joaquin River Delta and Suisun Marsh, and Mountain Counties Area).

Each regional booklet includes a water balance summary—water use and water supply—for years 1998 through 2005 and scenario results that project the region's water needs through year 2050 with the use of three alternative future scenarios and 12 climate change scenarios.

## Volume 4 Reference Guide

In what is informally called "The Encyclopedia Water Plan," Volume 4 provides a more transparent and extensive look at what is presented in volumes 1, 2, and 3. The volume arranges reference articles used in developing Update 2009 into categories and includes an extensive glossary of terms, some with multiple meanings, used throughout the volumes. Beyond the strict categories, the articles fall more generally into the following three areas:

- Background on California Water Resources
- Water Resources Analysis
- Emerging Issues

This Reference Guide is available only online and on the Update 2009 CD.

## Box 1-1 Updates of the California Water Plan (Bulletin 160 series)

The California Water Plan is the State's strategic plan for managing and developing water resources statewide. Since its first California Water Plan, published as Bulletin No. 3 in 1957, the Department of Water Resources has prepared eight water plan updates, known as the Bulletin 160 series. The California Water Code now requires that the Water Plan be updated every five years. Following are descriptions of the past nine statewide water plans.

**Bulletin No. 3** described a comprehensive master plan for the control, protection, conservation, distribution, and use of the waters of California to meet present and future needs for all beneficial uses in all areas of the state to the maximum feasible extent. The plan was intended to indicate the general manner in which California's water resources should be developed to satisfy its potential ultimate water requirements with emphasis on statewide water projects.

Statewide planning studies to update the California Water Plan have continued since 1961. Each update took a distinct approach to water resources planning, reflecting issues or concerns at the time of its publication.

**Implementation of the California Water Plan (1966).** The first of the Bulletin 160 series, Bulletin 160-66, proposed a pattern for implementation of specific parts of the California Water Plan as set forth by the California Water Code. Water policy concerns included flood control and floodplain management, power demands, water-related recreation, the relationship of fish and wildlife to water development, and water quality.

**Water for California: The California Water Plan; Outlook in 1970.** By 1967 the growth rate of California's population had slowed from that of the 1950s; population projections for 1990 and 2020 were reduced. Irrigated acreage estimates were also reduced, and more accurate information on the consumptive use of crops and the extent of water reuse was available. With projects then under construction or authorized, the report concluded that sufficient water supplies would be available to meet most of the 1990 requirements. The trend toward increasing environmental awareness was noted at both the national and state levels.

**The California Water Plan: Outlook in 1974.** This report concluded that the status of available supplies was favorable based on the premise that the Auburn, New Melones, and Warm Springs reservoirs and the Peripheral Canal would be operational by 1980. The report was less conclusive about the extent to which supplies would satisfy future needs, considering new California legislation for wild and scenic rivers. The update included a detailed section on water quality control (or basin) planning written by staff at the State Water Resources Control Board as well as water demand estimates for alternative futures for California population growth and agricultural acreage. Key water policy issues were cooling water for electric energy production, water deficiencies (risk), water exchanges, public interest in agricultural drainage (San Joaquin Drain), water use efficiency (water conservation), economic efficiency (water transfers), and wastewater reclamation.

**The California Water Plan: Projected Use and Available Water Supplies to 2010 (1983).** More of a technical report than were previous editions, this water plan included agricultural models applied for the first time. These were used in assessing the general economic effects of increasing water and energy costs. The report quantified the effect of urban and agricultural water conservation measures and the potential for water reclamation as a means of reducing additional water supply needs. Included in the update was a detailed statewide waterflow diagram titled Hydrologic Balance Network for California 1980.

**California Water: Looking to the Future (1987).** Bulletin 160-87 took a broad view of water events and issues in California. The report also discussed several leading water management concerns including water quality, the Sacramento-San Joaquin Delta, and a wide range of evolving water policies. One of its main conclusions was that in roughly three out of four years, California's water resources, including rights to the Colorado River, were sufficient to meet all of its water needs for the foreseeable future.

**California Water Plan Update: Bulletin 160-93 (1994).** This report discussed how population growth, land use, and water allocations for the environment were affecting water resource management. It differed from the five previous water plan updates by (1) estimating environmental water needs separately and accounting for these needs along with urban and agricultural water demands, (2) presenting water demand management methods as additional means of meeting water needs, and (3) presenting separate water balance scenarios for average and drought conditions. This was the first Bulletin 160 update to incorporate an advisory committee of representatives of interested parties.

**The California Water Plan Update: Bulletin 160-98 (1998).** The 1998 update evaluated water management options that could improve California's water supply reliability. Water management options being planned by local agencies were used as the building blocks to evaluate future water conditions for each of the state's 10 hydrologic regions. Potential local options were integrated with options of a statewide scope to create a statewide evaluation.

**California Water Plan Update 2005: A Framework for Action (2005).** The first update of the 21st century, A Framework for Action represented a fundamental shift in how people look at water resources management. It recognized the need to work cooperatively and to approach water management in a comprehensive, integrated way. It was the product of a collaborative process that brought together the Department of Water Resources with an advisory committee representing urban, agricultural, and environmental interests. For the first time, the state's water plan included a strategic plan, including actions for meeting the challenges of sustainable water uses and reliable water supplies in the face of an uncertain future.

### Volume 5 Technical Guide

The Technical Guide is organized and formatted as a Web portal to document the assumptions, data, analytical tools, and methods used to prepare Water Plan content. It is a living document available online at www.waterplan.water.ca.gov/.

By statute the California Water Plan cannot mandate actions nor authorize spending for its recommendations. Update 2009 makes neither project-specific nor site-specific recommendations; therefore, it does not include environmental review and documentation as required by the California Environmental Quality Act. **Consequently, policy-makers and lawmakers must take further action to adopt the recommendations and actions in this Water Plan and develop funding methods to help in their implementation.** This underscores the need to have broad public participation and support for the Water Plan in order to have its objectives and recommendations realized.

## Building on a Framework

The California Water Plan and its updates have been important sources of information for water planners since 1957 (see Box 1-1 Updates of the California Water Plan). As a master plan, it guides the orderly and coordinated control, protection, conservation, development, management, and efficient use of the water resources of the state (Water Code, § 10005(a)).

Update 2009 uses the same framework presented in Update 2005 and enhances it in several areas:

- Integrates information and recommendations from many State plans and initiatives, particularly those of agencies on the Water Plan Steering Committee
- Incorporates consideration of uncertainty, risks, and resource sustainability into planning for the future to reduce uncertainties, recognize risks to success, and manage for more sustainable water supply, flood management, and ecosystems
- Includes integrated flood management and a drought contingency plan
- Advances climate change adaptation and mitigation strategies
- Includes information from Native American Tribes and proceedings from the 2009 California Tribal Water Summit
- Updates resource management strategies and regional reports
- Extends regional and statewide water balances to include eight years
- Includes a plan for improving data, analytical tools, and information management and exchange
- Further acknowledges that the Water Plan is a living document that will continue to evolve and adapt integrated water management

### Influences of Update 2005

California Water Plan Update 2005 followed a new direction for statewide water resources planning. It addressed California's changing water management by promoting

and supporting integrated regional water management and improved statewide water management systems. Update 2005 charted a Framework for Action as a roadmap to help sustain our water resource use and manage our supplies to ensure that water is available where and when it is needed.

As a strategic plan, the Water Plan should guide us toward meeting statewide and regional water challenges. California Water Plan Update 2009 refines the strategic elements in light of what we, the water community, have learned by following four key process recommendations in Update 2005.

- Expanding the role and participation of other State agencies
- Expanding the role and participation of regional planning efforts
- Engaging communities of interest and communities of place
- Adding a technical advisory group

Features introduced in Update 2005 are now the cornerstone for Update 2009 and for future water plans to help provide California's water leaders with these useful tools:

- Future scenarios
- Regional reports
- Resource management strategies
- Strategic planning document
- Water portfolios and statewide and regional water balances

## Fair and Transparent

To create a fair, open, and transparent process, the California State University Sacramento, Center for Collaborative Policy continued to provide impartial third-party facilitation and mediation design and implementation, and refined the consensus-seeking process. The center ensured members of the Steering Committee, Advisory Committee, and Tribal Communication Committee and participants at regional workshops and forums that their interests, views, and opinions were thoughtfully considered.

The principles of a fair, open, and transparent process will be part of all future updates because they (1) considerably expand public involvement and access to State government's water planning process; (2) seek collaborative recommendations that are stronger, have greater longevity, and are more likely to be adopted by the Governor's Office, Legislature, State, federal, Tribal, and local agencies and governments, resource managers, and land-use planners; and (3) produce a strategic plan with a vision, mission, goals, guiding principles, recommendations, and an implementation plan with objectives and related actions that are specific and near- and long-term.

## An Expanded Process

Update 2005 recognized the vital importance of working with the water community to define issues, identify potential management responses, and evaluate planning steps. The process continued and was expanded for Update 2009 in response to improvements

**Figure 1-2 Project Organization and Public Process for California Water Plan Update 2009**


The project organization and public process design for preparing the Update 2009 builds on the planning framework, lessons, and accomplishments of Water Plan Update 2005. This diagram illustrates the process components. Three overlapping circles depict the participants, relationships, and information exchange between and among the participants, namely government agencies, Tribal governments, and statewide, regional, and local stakeholders. The box beneath the circles represents the technical experts, information, and science supporting the update. Plenary meetings tie them all together.

Circle (1) Collaboration
Circle (2) California Department of Water Resources and Other State Agencies
Circle (3) Public
Box (4) Statewide Water Analysis Network (SWAN)

suggested by the Advisory Committee and others at the end of the Update 2005 process. The Department of Water Resources (DWR) sought the participation of California's water communities, building on the planning framework, lessons, and accomplishments of Update 2005 and following its recommendations (Figure 1-2 Project Organization and Public Process for California Water Plan Update 2009). The process guide can be found in Volume 4 Reference Guide.

Update 2009 truly can be viewed as the state's Water Plan. It has benefited from the first interagency California Water Plan Steering Committee and integrates many State companion plans and initiatives. In addition, a 45-member Advisory committee, expanded regional outreach, greater involvement of California Native American Tribes, and coordination with federal agencies provided broad participation in plan preparation.

## State Agency Steering Committee

For Update 2009, DWR improved interagency coordination to provide a statewide perspective on Water Plan issues by creating the California Water Plan Steering Committee. Committee membership represents 21 State government agencies with jurisdictions over different aspects of California's water resources (Box 1-2 State Agencies Represented on California Water Plan Update 2009 Steering Committee).

**Box 1-2 State Agencies and Departments Represented on California Water Plan Update 2009 Steering Committee**

The Water Plan Steering Committee—composed of the following State agencies, departments, boards, and commissions—provide policy input, oversight, and program management. Committee members have sufficient authority to represent their agencies and allocate staff and resources to Water Plan activities as appropriate. As the committee chair, DWR is responsible for providing administrative and logistical support and for completing Water Plan updates as required by Water Code (§10004 – §10013).

- Air Resources Board
- Business, Transportation and Housing Agency (Caltrans)
- CALFED Bay-Delta Program
- California Emergency Management Agency (Cal EMA)
- California Energy Commission
- California Environmental Protection Agency
- California Natural Resources Agency
- California Public Utilities Commission
- Department of Boating and Waterways
- Department of Conservation
- Department of Fish and Game
- 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 Water Resources
- Governor's Office of Planning and Research
- Native American Heritage Commission
- State Lands Commission
- State Water Resources Control Board and Regional Water Boards

The Steering Committee provided policy input, oversight, program management, and technical assistance in preparing this update. It is at the center of the collaboration circle in which DWR also partnered with federal agencies and Tribal governments and organizations (see Figure 1-2).

### Multidisciplinary Project Teams

The core staff responsible for developing Update 2009 comes from multiple disciplines within DWR and partnering State agencies—drawing on a wide range of scientific, technical, and administrative skills. Other interagency staff work teams consist of topic-specific subject matter experts, including their district/regional offices, as well as facilitators.

Work team leads convened as a group on a regular basis to plan and manage work assignments. Regional leads were liaisons from district/regional offices of DWR and State agencies with regional water planning efforts. A facilitation team managed the public process and helped different groups interact.

### Advisory Committee

A 45-member Advisory Committee continued to play a vital role helping to define issues, identify potential management responses, and evaluate planning steps. Members

of the Water Plan Advisory Committee are invited from statewide organizations to represent communities of interest including agriculture, water purveyors, business, flood protection, environmental advocacy, Tribes, environmental justice advocacy, planners, cities, counties, and rural communities. A list of Advisory Committee members is included as part of the Water Plan's acknowledgments (see the front section of Volume 1).

### Regional Outreach

DWR further refined the Update 2005 process with extensive use of regional workshops and all-region forums to help lay the foundation for regional collaboration and integrated regional water management and planning. The numerous regional workshops informed the Water Plan update about regional water issues and management strategies and the preparation of regional reports.

DWR convened forums to facilitate implementation of Update 2005 recommendations for regional planning. This required engaging interested parties; identifying information, meeting formats, and exchanges; and finding ways to elevate the diverse needs of regions into statewide planning. Within several venues, regional and local governments, Tribes, and organizations provided information and policy input to the California Water Plan:

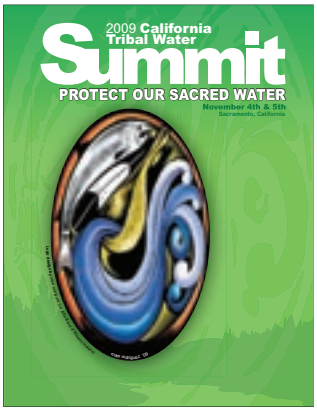
- Annual regional workshops to discuss the Water Plan, share Water Plan staff information needs from the regions, and learn what the regions want from the Water Plan.
- Ongoing conversations in the regions regarding regional reports and activities.
- Annual all-region forums to discuss regional issues that should be considered from a statewide policy perspective. (As an example, water transfers or interregional interactions such as those involving the Delta and Colorado River.)
- Active engagement between regions, the Advisory Committee, and the technical advisory group at the statewide regional and plenary structure.

### Federal Government

The Steering Committee sought policy input and information for the Water Plan from federal agencies working with the California Biodiversity Council and CALFED Agency Coordination Team and through federal-agency panel discussions.

### California Native American Tribes

As with Update 2005, representatives of Tribal water interests sat as members of the Update 2009 Advisory Committee. The Native American Heritage Commission sat as a member of the State Agency Steering Committee. DWR's expanded outreach also included Tribal plenary meetings and increased Tribal participation in regional workshops through pre-workshop gatherings for Tribes. To improve Tribal involvement, DWR sought procedures designed by the Tribes, Tribal communities, and Tribal




*Program cover from the 2009 Tribal Water Summit*

organizations. This helped DWR, the facilitation team, and the Steering Committee organize, design, and deliver Tribal regional input for Update 2009.

A Tribal Communication Committee was formed to develop a Tribal Communication Plan for involving and getting input from California's Tribes. TCC members represented only themselves, not their Tribes, at the meetings. The communication plan has become a foundational document to help guide Update 2009 and future Water Plan updates. (The plan and information about the process is presented in **Volume 4 Reference Guide**.) The sixth goal of the Tribal Communication Plan calls for convening a Tribal water summit during Update 2009 and publishing the summit proceedings in Water Plan Update 2009. The 2009 California Tribal Water Summit was held in November 2009; its proceedings are published in **Volume 4 Reference Guide**. The 10 Tribal Communication Plan objectives are in **Chapter 7 Implementation Plan** as related actions under Objective 12.

### SWAN and Shared Vision Planning

To improve data, analytical tools, and information management and exchange, DWR convened SWAN (the Statewide Water Analysis Network). This technical advisory group leverages the technical skills, professional interests, and scientific knowledge of interdisciplinary scientists and engineers from public, private, and nongovernmental sectors. A subgroup of SWAN is the Climate Change Technical Advisory Group.

Technical information and recommendations from SWAN were presented to the Steering Committee and Advisory Committee and at regional and plenary meetings and workshops. This voluntary network reviewed and recommended methods to improve information exchange (see Volume 1, Chapter 6 Integrated Data and Analysis).

Through SWAN, DWR is pursuing the approach and methods of Shared Vision Planning (SVP) in the Water Plan to

- achieve better integration and consistency with other planning activities,
- obtain consensus on quantitative deliverables,
- build a common conceptual understanding of the water management system, and
- improve transparency of Water Plan information.

SVP integrates tried-and-true planning principles, systems modeling, and collaboration into a practical forum for making water resources management decisions. The term Shared Vision Planning is most closely associated with the US Army Corps of Engineers, Institute for Water Resources, which has been implementing the approach and methods since the National Drought Study in the 1990s (See www.SharedVisionPlanning.us for additional information).

### Plenary Meetings

Plenary meetings were held annually to allow all the forums engaged in the Water Plan to interact and share ideas.

## Inclusive Water Planning

### Companion State Plans

The Water Plan is a strategic planning document that describes the role of State government and the growing role of California regions in managing the state's water resources. Update 2009 integrates information and recommendations from companion planning documents of other State agencies, particularly those represented on the Steering Committee. Companion State plans and initiatives are those plans and programs by State agencies that have a direct connection with the Water Plan. **Chapter 3** in this volume describes plans used to develop and augment content in the Water Plan, including its objectives and related actions in **Chapter 7 Implementation Plan** and the resource management strategies in **Volume 2**.

### Climate Change

Climate change is already impacting California's water resources—its snowpack, river flows, and sea levels. The effects of climate change on the state's water resources are reported in **Chapter 4 California Today** (in this volume). The effects and potential future effects of climate change are part of the uncertainties water managers face as they plan for the future. Update 2009 promotes ways to develop a common approach for data standards and for understanding, evaluating, and improving regional and statewide water management systems. As we do so, the Water Plan's technical teams weigh the challenges of climate change and incorporate them into databases, projections, and technical analysis. Climate change and uncertainty are discussed in **Chapter 5 Managing an Uncertain Future** and in articles found in **Volume 4 Reference Guide**. Key actions to improve water resources information and analysis, including integration of climate change studies, are highlighted in **Chapter 6 Integrated Data and Analysis**.

DWR is taking a leadership role in adapting to effects of climate change on water resources and systems. In October 2008, the department released *Managing an Uncertain Future: Climate Change Adaptation Strategies for California's Water*. The strategies of this white paper and those in the 2009 California Climate Adaptation Strategy (California Natural Resources Agency) are part of this Water Plan's implementation plan and appear as objectives and related actions (see **Chapter 7 Implementation Plan**). The Climate Change Technical Advisory Group contributed to the preparation of the white paper.

### Integrated Flood Management

Update 2005 recognized that a new approach to flood management was needed to better protect California from the devastating consequences and economic impacts caused by floods and that flood management cannot occur in isolation.

Consistent with the movement toward more integrated forms of water resource management, Update 2009 introduces the concept of integrated flood management—a comprehensive approach to flood management that considers land and water resources

### Box 1-3 Eight Activities for Update 2009

1. **Strategic Plan**

   Review and revise the Water Plan vision, mission, goals, and principles; and update its initiatives, recommendations, and implementation plan. This includes (a) reporting progress on actions associated with Update 2005's 14 recommendations, (b) addressing "Parking Lot" topics from the Update 2005 advisory committee, (c) incorporating issues and initiatives from steering committee members, (d) updating the Water Plan stakeholder/customer survey, and (e) including strategic planning for statewide flood management.

2. **Scenarios**

   Develop multiple scenarios of future California water conditions, and use scenarios to evaluate different combinations of resource management strategies (called response packages) for a range of water demand and supply assumptions plus climate change.

3. **Climate Change**

   Incorporate climate change in Water Plan scenarios to evaluate impacts on California's water resources and water systems, and to identify and recommend statewide and regional adaptation strategies.

4. **Regional Reports**

   Update the Regional Reports for the 10 Hydrologic Regions and for the Sacramento-San Joaquin Delta and Mountain Counties as areas of special concern. Use information from the Integrated Regional Water Management and local water and flood planning efforts to describe critical issues, key initiatives, effectiveness of regional planning efforts, and region-specific response strategies.

5. **Management Strategies and Response Packages**

   Update the 25 Resource Management Strategies with current research and information. Expand strategy narratives to describe their suitability for integrated flood management and their current and future implementation in various regions.

6. **Water Portfolios**

   Estimate and present actual water uses, supplies, and quality (Water Portfolios) for water years 1998 through 2005. Improve methods for representing consumptive and nonconsumptive environmental water, and where reuse of water is occurring.

7. **Analytical Tools**

   Improve information exchange and data integration, data, and analytical tools to inform all Water Plan activities and decisions and to assist California water planners and managers.

8. **Companion State Plans**

   Incorporate findings and recommendations from companion State government plans and Tribal Communication Plan.

at a watershed scale within the context of integrated water management 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. Integrated flood management does not rely on a single approach to flood management, but instead uses various techniques, including traditional (or structural) flood protection projects, nonstructural measures (such as land use practices), reliance on natural watershed functions, and the flood management benefits that can result from other forms of water resource management to create an integrated flood management system.

Integrated flood management is discussed in **Chapter 2 Imperative to Act**; related resource management strategies including flood risk management are in **Volume 2**.

## Water Quality

Water is more than just wet. Beyond the abundance and distribution of water to meet the needs in California, the quality of water can have a significant impact on the management of water. Recommendation 3 of Update 2005 stated, "State government must lead an effort with local agencies and governments to remediate the causes and effects of contaminants on surface water and groundwater quality."

Preparation of Update 2009 involved the coordinated efforts of numerous State agencies and stakeholders in order to take notice of actions currently being taken, identify the issues, and make recommendations to protect and improve water quality methods and strategies that will safeguard public and environmental health while maximizing the uses of water. This coordinated effort will continue to provide solutions to current and future issues surrounding water quality.

## Expanded Features

California Water Plan Update 2005 introduced a Framework for Action to help us sustain our water resource use and manage our supplies to ensure that water is available where and when it is needed. It recommended the use of multiple scenarios to consider a variety of plausible futures. With scenarios, water planners and managers can test the implementation of regionally specific response packages—multiple resource management strategies—and reduce the risk and uncertainty of future water planning, management, and supplies. Other features of Update 2005 included an analytical approach with extended information and tools, use of water portfolios, and regional reports.

Following are some significant accomplishments of California Water Plan Update 2009 that provide California's water leaders with useful tools and should continue to be the cornerstone for water plan updates.

### Assumptions and Estimates Brochure and Data

The California Water Code (§10004.6) requires that an Assumptions and Estimates Report (A&E Report) be published one year before the California Water Plan update is released. The A&E Report (found in **Volume 5 Technical Guide**) describes the most significant data and data sources used to prepare this update. For Update 2009, DWR produced a brochure as part of the A&E Report. The brochure explains how the quantified deliverables—water portfolios, future scenarios, and response packages—would help develop or influence seven of the eight activities for Update 2009 (Box 1-3 Eight Activities for Update 2009). A draft A&E Report was released in January 2007, one year before the release of the public review draft of Update 2009.

### Future Scenarios: Factors That Shape Our Future

To acknowledge that California's water communities do not know with certainty what will happen in the future, Update 2009 presents three plausible yet very different baseline scenarios for 2050, rather than a single "likely future." Each scenario describes a different baseline for 2050, to which the water community would need to respond by implementing a mix of resource management strategies. The scenarios are created by varying assumptions about important factors that affect water use and supplies, but over which the water community has little control, for example, population growth, development patterns, crop markets, industrial productivity, and environmental regulations. The three baseline scenarios developed for Update 2009 are named Current

Trends, Slow & Strategic Growth, and Expansive Growth. More information is given in **Chapter 5 Managing an Uncertain Future**.

### Regional Reports

In compliance with SB 672 (Stats. 2001, ch. 320), a regional report has been prepared for each of the 10 hydrologic regions, as well as the Sacramento-San Joaquin River Delta region and the Mountain Counties overlay area (Figure 1-2 Hydrologic regions, Sacramento-San Joaquin Delta and Suisun Marsh, and Mountain Counties Area). Each report is its own booklet that includes the region's major challenges, current programs and projects, future outlook, and water portfolio.

For Update 2009, DWR expanded the regional reports to include additional information and regional issues:

- Summary of surface water quality
- Regional floods and flood management
- Strategies identified in current Integrated Regional Water Management efforts
- Projected future water demands to the year 2050 for three alternative scenarios
- Water balance summary for eight water years, 1998-2005

These regional reports also have added information about Tribal communities in each region and a brief summary of Tribal water concerns.

### Resource Management Strategies

Update 2009 describes a broad and diverse set of 27 resource management strategies, more than in Update 2005. It updates all resource management strategies that were part of Update 2005 and adds several new strategies on salt and salinity management, forest management, flood risk management, and Delta conveyance.

Resource management strategies strengthen integrated regional water management. They can help regions meet future demands and sustain the environment, resources, and economy, involve communities in decision-making, and meet various goals. A resource management strategy is a project, program, or policy that helps local agencies and governments manage their water and related resources (see **Volume 2 Resource Management Strategies**). These strategies can reduce water demand, improve operational efficiency and transfers of water, increase water supply, improve water quality, practice resource stewardship, and improve flood management. For example, urban water use efficiency is a strategy to reduce urban water use. A pricing policy or incentive for customers to reduce water use also is a strategy. New water storage to improve water supply, reliability, and quality is another strategy. In addition, each strategy can have multiple potential benefits. (For more information about the multiple benefits from resource management strategies, see table in **Volume 2 Resource Management Strategies Chapter 1 Introduction**.)

Each region needs to choose an appropriate mix of strategies based on its own water challenges and management objectives and goals. Factors that can influence water management decisions include growing population, development patterns, crop markets, changing regulations, and evolving public attitudes and values. Future decisions will need to factor in strategies for adapting to and mitigating climate change impacts.

To implement these new features, DWR has made—and we, the water community, need to make—significant analytical changes as described in **Chapter 6 Integrated Data and Analysis**.

### Quantification of Scenarios and Management Responses

Update 2005 introduced several new concepts within the analytical approach for evaluating statewide and regional water conditions (as compared to previous updates). These new concepts help define the long-term direction for the update process. Update 2009 built upon this framework by including additional years in the water balances and portfolios, refining the representation of future scenarios, and more fully describing water management response packages. **Chapter 5 Managing an Uncertain Future** describes the basics behind the development of scenarios for Update 2009 and some of the statewide drivers, and presents three narrative scenarios for conditions through 2050. **Chapter 6 Integrated Data and Analysis** describes the underlying methods for quantifying scenarios, the factors of uncertainty that can drive future water demand and available supply, and a work plan to improve the Water Plan's data and analytical methods and tools.

The key factors of uncertainty affecting future water demand are future land use patterns, population and other demographic patterns, and climate. Future land use patterns affect how much land is devoted to irrigation for agriculture or landscaping. Higher density urban development or water-wise landscaping practices can result in less water applied to landscape irrigation. Future population growth also has a significant effect on future water requirements. Future climate including occurrence of drought and wet years will affect the availability of supply and the additional water required to grow crops and maintain plants used in landscaping.

Water Plan Update 2009 has made significant improvements to the scenarios by considering the potential effect of long-term climate change on future water demands. It includes some modest steps toward quantifying regional response packages. More work will be required in the next Water Plan update to refine this information based on the differing conditions and opportunities in the various regions.

## Progress toward Implementing Update 2005 Recommendations

California Water Plan Update 2005 included an implementation plan with recommendations and related near- and long-term actions. Since Update 2005, State government has initiated and completed many of the recommendations and continues to make progress as we develop more interagency communication and collaboration, as science begins to understand climate change, and as new analytical approaches and tools like scenario-building promise to help us manage our resources into the future.

Following is a sampling of progress on implementation of Update 2005 recommendations.

- Recommendation 4 called for DWR to develop and carry out a comprehensive flood management plan. A flood white paper was part of Update 2005. In 2006, DWR launched a multi-faceted initiative to improve public safety through integrated flood management. The FloodSAFE program is a collaborative statewide effort designed to accomplish five broad goals: reduce the chance of flooding, reduce the consequences of flooding, sustain economic growth, protect and enhance ecosystems, and promote sustainability.
- Recommendation 10 called for California to adapt to climate change, calling for State government to help predict and prepare for the effects of climate change on our water resources and management systems. In 2008, DWR published *Managing an Uncertain Future*, a white paper recommending a series of adaptation strategies for State and local water managers to improve their capacity to handle climate change. These strategies helped inform *2009 California Climate Adaptation Strategy*, a report to the Governor released by the California Natural Resources Agency in 2009.
- Recommendation 11 called for improved water data management and science understanding. DWR technical staff established new networks and groups to share information, e.g., SWAN and the Climate Change Technical Advisory Group, and presented and shared information with existing groups like California Water and Environmental Modeling Forum. Meanwhile, as part of the 2009 Comprehensive Water Package, SB 6[1] Groundwater Monitoring requires for the first time in California's history that local agencies monitor the elevation of groundwater basins to help better manage the resource during average water years and under drought conditions. The bill requires DWR to assist local monitoring entities with compliance with this statute.

A comprehensive list of progress toward implementing Update 2005 recommendations can be found in **Volume 4 Reference Guide**. Meanwhile, more actions, reports, policies, and coordination are planned and will be monitored as a part of future Water Plan updates.

1 Chaptered by Secretary of State as Chapter 1, Statutes of 2009-10, Seventh Extraordinary Session. An act to add Part 2.11 (commencing with Section 10920) to Division 6 of, and to repeal and add Section 12924 of the Water Code relating to groundwater.

# Imperative to Act

***Chapter photo.*** Barge in the Sacramento-San Joaquin Delta.

# Contents

**Chapter 2. Imperative to Act ..... 2-5**
About this Chapter ..... 2-5
A Critical Time ..... 2-5
Greater Drought Impacts ..... 2-5
Increasing Flood Risk ..... 2-6
Declining Ecosystems ..... 2-6
Impaired Water Bodies ..... 2-6
Aging Infrastructure ..... 2-6
Paramount Challenges ..... 2-7
A State of Variability and Extremes ..... 2-7
Multiple Water Uses ..... 2-7
Climate Change ..... 2-9
Future Uncertainty ..... 2-10
An Urgent Roadmap ..... 2-10
Fundamental Lessons ..... 2-10
Update 2009 Strategic Plan ..... 2-12
Recommendations ..... 2-15
Key Initiatives and Commitments ..... 2-15
Coordinating Government Planning and Management ..... 2-16
Integrating Water Management ..... 2-18
Adapting to Climate Change ..... 2-21
Planning for Uncertainty, Risk, and Sustainability ..... 2-22
Conclusion ..... 2-26
Recommendations ..... 2-27

## Figures

Figure 2-1 Integrated Water Management ..... 2-15

## Tables

Table 2-1 Propositions 13 and 50 program estimated costs and water yield benefits. 2-19

## Boxes

Box 2-1 Lester Snow's Perspective on Challenges and the Way Forward ..... 2-8
Box 2-2 Water-Energy Climate Action Team ..... 2-9
Box 2-3 Update 2009 Strategic Plan Elements: Vision, Mission, and Goals ..... 2-12
Box 2-4 Strategic Growth Plan ..... 2-16
Box 2-5 Delta Stewardship Council Tasks ..... 2-17
Box 2-6 Integrated Resource Planning and Management ..... 2-18
Box 2-7 Place Value on Sustainability ..... 2-24

# Chapter 2. Imperative to Act

## About this Chapter

Chapter 2 Imperative to Act lays out the urgent course California must take to ensure that we have enough safe and clean water through year 2050 for California's cities and towns, farms and businesses, and plants and animals when and where they need it. It describes the features of this important roadmap—themes of this Water Plan and elements of its strategic plan. It also includes key policy recommendations for State government and California for the removal of impediments and harnessing of opportunities that will help us achieve the Water Plan's vision, mission, and goals. Details of meeting these goals—through objectives and their related actions—are explained in Chapter 7 Implementation Plan.

## A Critical Time

California is facing one of the most significant water crises in its history—one that is hitting hard because it has many aspects and consequences. Reduced water supplies and a growing population are exacerbating the effects of a multi-year drought. Climate change is reducing our snowpack storage and is increasing sea level and floods. Court decisions and new regulations have resulted in the reduction of water deliveries from the Sacramento-San Joaquin River 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. The current global financial crisis will make it even more difficult to invest in solutions. After experiencing three years of drought, water reserves are extremely low. Even a wet winter in 2010 will not bring total relief.

*California is facing one of the most significant water crises in its history—one that is hitting hard because it has many aspects and consequences.*

### Greater Drought Impacts

Today we are feeling the effects of a major drought. Water year 2009 was the third consecutive dry year for the state. Because of losses caused by this drought, the US Department of Agriculture in September designated all of the counties within the San Joaquin River, Tulare Lake, and Central Coast hydrologic regions as either Primary Natural Disaster Areas or Natural Disaster Areas (statewide total was 21 counties and 29 counties, respectively.) Consequently, the state will enter the 2009-2010 water year with its key supply reservoirs at only 68 percent of average. Even if more precipitation develops during this water year, we cannot assume that statewide water supply will recover in 2010.

## Increasing Flood Risk

Every region of California faces flood risks. Nearly 2 million people in California live within areas that can expect flooding on average of once in 100 years. This means that, on average, approximately 20,000 people per year can expect to be affected by floods. More people are moving into these floodplains and flood-prone areas every day. Sacramento, California's capital, has one of the lowest levels of flood protection of any major city in the nation. Hurricane Katrina provided a vivid reminder of levee vulnerability and consequences of flooding urban areas. Before Katrina, the New Orleans levees were rated as having a 200-year level of flood protection; Sacramento's levees are rated about one half that amount. The threat of catastrophic flooding, especially in the deep floodplains of the Central Valley and Delta, is a continuing concern.

## Declining Ecosystems

The ecosystems in many areas of the state have declined; many species have been listed as threatened or endangered. Problems with watershed health, lack of suitable habitat, competition with invasive species, toxicity, and water operations contribute to the decline. One of the most obvious examples of an ecosystem in crisis is the Sacramento-San Joaquin River Delta. Salmon, delta smelt, and other species are at their lowest levels since their records have been kept, about 50 years. This decline has led to court restrictions and new regulations on Delta diversions.

## Impaired Water Bodies

The quality of groundwater and surface waters varies significantly throughout the state. We need improvements in drinking water treatment, cleanup of polluted groundwater, salt management, and urban runoff management. A high priority is creating healthy watersheds to keep source water free of pollutants like pathogens and chemicals that are regulated or will be regulated in the near future. Recently, some unregulated chemicals and pollutants are emerging as actual or potential contaminants. They can be in pharmaceuticals and personal care products, byproducts of fires and fire suppression, or discarded elements of technology.

## 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 growing population; changing societal values, regulations, and operational criteria; and the future challenges accompanying climate change. California's flood protection system, composed of aging infrastructure with major design and construction deficiencies, has been further weakened by lack of maintenance. State and regional budget shortfalls and a tightened credit market may delay new projects and programs.

# Paramount Challenges

Certain challenges are inherent to California's water resources. They also are paramount. These challenges come from the diversity of our state and from global changes whose effects can only be estimated and may not be understood fully for years to come. Investing in this Water Plan's strategic plan will help us meet these challenges.

*Certain challenges are inherent to California's water resources. They also are paramount. These challenges come from the diversity of our state and from global changes.*

## A State of Variability and Extremes

California is often recognized as a land of extremes—its diversity in cultures, ecosystems, geography, and water resources. However, "variable" would be a more accurate term to describe its water resources. Precipitation, which is the root 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 mountains in the north and eastern parts of California, and most water is used in the valleys and along the coast. In addition, 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 both the threat of too little water to meet needs during droughts and too much water during floods.

The physical and institutional realities within California do not allow for a one-size-fits-all approach to water management and planning. California's State, federal, regional, and local projects and programs must work together to make water available in the right places and times and to move floodwaters.

*The physical and institutional realities within California do not allow for a one-size-fits-all approach to water management and planning.*

Challenges are greatest during dry years and droughts as we have experienced yet again in 2007, 2008, and 2009. In drier years water dedicated to the environment is curtailed sharply, and less water is available for agriculture. Greater reliance on groundwater during dry years results in high costs for many users and more groundwater overdraft. At the same time, water users who have already increased efficiency may find it more challenging to achieve additional water use reductions during droughts. Longer droughts create numerous problems including extreme fire danger, economic harm to urban and rural communities, loss of crops, and the potential for species collapse and degraded water quality in some regions. As competition grows during dry years among water users, water management becomes more complex and, at times, contentious.

## Multiple Water Uses

California's changing and growing demands for water comes from many sectors. The state's population continues to grow, estimated by the Department of Finance to increase from about 36.7 million people in 2005 to about 59.5 million by year 2050. As we prepare for a growing population, we must also identify existing water-related needs and potential solutions for disadvantaged, under represented, and disproportionately impacted communities. (See Box 2-1 for Lester Snow's perspective on challenges.)

*Lester A. Snow is former director of California Department of Water Resources and in 2010 was appointed by Governor Schwarzenegger to serve as Secretary for Natural Resources.*

### Box 2-1 Lester Snow's Perspective on Challenges and the Way Forward

"California will continue to grow as long it is seen as a land of opportunity. Partially because of economic and social pressures elsewhere, this perception — and reality — of California will continue to act as a magnet for millions of people.

Our challenge is to provide water — a clean, reliable supply — to protect our natural environment, the health of our people and our economy. In the 1960s, when the State Water Project was under construction, Department of Water Resources Director William E. Warne noted, 'California's destiny is never, so long as the state grows, to resolve her water problem, but always to work at it.'

The decisions we are making now — how efficiently we use water and where we build our new communities — dictate how much flexibility we will have in the future and what the quality of life will be for the next generation of Californians.

Most land- and water-use decisions in California are made at the local and regional levels, though rarely is such decision-making integrated. For example, land-use planning that encourages low-density development greatly increases per-capita water demand.

Such development patterns also inevitably lead to more dependence on automobiles, which are the largest source of climate-changing greenhouse gas emissions in California. The resulting climate changes will make it more difficult to maintain reliable water supplies.

Low-density development imposes other costs as well — it is generally more costly and difficult to provide flood protection for sprawling suburbs, and this growth reduces the availability of agricultural land. In all, such land uses threaten our water-supply reliability and are costly in many other ways. Land use and water planning must be better integrated to ensure that we make informed resource management decisions.

The statewide participation of cities and counties in the development of Integrated Regional Water Management plans is the best way to address water issues today in a way that will have positive benefits for the future. Successful IRWM planning increases regional self-sufficiency through the implementation of regionally appropriate water resource strategies, thereby assuring the quantity and quality of water for future generations of Californians."

*Lester A. Snow, Director of California Department of Water Resources*
*"Better Land Use, Better Water User" in Los Angeles Times April 9, 2008*

*Water management activities must occur in the context of sustainable resource management and environmental protection and stewardship.*

California is the nation's leading agricultural producer. This multibillion dollar industry plays a vital role in the state's economy and is an important contributor to the world food supply.

Through the California Water Plan, we can learn how State water law, planning, and management intersect with Tribal water issues and find ways to ensure Tribal representation and participation in water planning processes—statewide and regional.

Californians today realize that water is a vital natural resource for people and the environment and that water management activities must occur in the context of sustainable resource management and environmental protection and stewardship.

**Box 2-2 Water-Energy Climate Action Team**

The Water-Energy Climate Action Team (WET-CAT) is one of several subgroups of the Climate Action Team supporting AB 32 Scoping Plan, California's policy blueprint containing the broad overview of the programs, measures, and approaches that will help the state achieve the required reductions of greenhouse gas emissions required under the Global Warming Solutions Act of 2006 (AB 32).

WET-CAT developed five basic strategies for reducing GHG from the water-energy sector: two in water reuse (water recycling and urban water reuse); end-use water conservation and efficiency; reduction of the energy intensity of the water system; and renewable resources development. These strategies make up the related actions for Objective 9 in Chapter 7 Implementation Plan.

Climate Action Team subgroup reports can be found at www.climatechange.ca.gov/climate_action_team/index.html. The water-energy sector summary also is included in Volume 4 Reference Guide.

## Climate Change

*California is already seeing the effects of climate change ... adapting to these changes ... will be among the most significant challenges facing water and flood managers this century.*

California is already seeing the effects of climate change on hydrology (snowpack, river flows), storm intensity, temperature, winds, and sea levels. Planning for and adapting to these changes, particularly their impacts on public safety and long-term water supply reliability, will be among the most significant challenges facing water and flood managers this century.

For more than 200 years, California water and flood management systems have provided the foundation for the state's economic vitality, providing water supply, sanitation, electricity, recreation, and flood protection. However, the climate patterns that these systems were designed for are different now and may continue to change at an accelerated pace. These changes collectively result in significant uncertainty and peril to water supplies and quality, ecosystems, and flood protection; and our water systems cannot be operated as they were originally designed.

Climate change impacts to hydrology and water resources management may be significant. The trends of the last century—especially the increases in hydrologic variability—will likely intensify in this century. Abrupt changes in climate could also strike. We can expect to experience more frequent and larger floodflows and deeper droughts.

During the Update 2009 process, DWR published Managing an Uncertain Future: Climate Change Adaptation Strategies for California's Water (2008). The report urges a new approach to managing California's water and other natural resources in the face of climate change. Its recommendations are incorporated in the Water Plan's objectives and related actions (Chapter 7 Implementation Plan). See also Box 2-2 Water-Energy Climate Action Team.

### Future Uncertainty

California's water and flood managers and planners 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. One simple example of this is that water managers can be certain that the flows in California's rivers will be different next year compared with this year; uncertainty lies in not knowing the 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 further modifications in water operations that are unknown today. There are many uncertainties about how natural and constructed systems function today. For example, scientists are trying to understand the reasons for the pelagic fish decline in the Delta, the condition of levee foundations, and the extent of groundwater recharge and overdraft to name a few.

Change may occur gradually over the long term or short term, or they can occur suddenly. Gradual changes can include things like 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 and flood management systems and the environment and ecosystems can have big influences on how to respond to the changes.

## An Urgent Roadmap

*Californians must fundamentally change how we use and manage water and account for future uncertainty.*

The immediate and changing conditions and ongoing challenges outlined above require that Californians fundamentally change how we use and manage water and account for future uncertainty. We need to make water efficiency and conservation a priority at home, in our communities, on the farm, and at the office. And we must act now to provide integrated, reliable, sustainable, and secure water resources and management systems for our health, economy, and ecosystems today and for generations.

To accomplish this requires a strategic Water Plan with a vision and goals, an implementation plan with objectives and near-term and long-term actions, and recommendations to remove obstacles that stand in our way. The plan must build on fundamental lessons of water resource management learned in recent years.

### Fundamental Lessons

The Update 2009 strategic plan sets a course for action that is urgent yet paved with the fundamental lessons learned by California's water community through the experience of recent years. Update 2009 embodies these fundamental lessons that are listed here.

- Sustainable development and water use, and environmental stewardship foster a strong economy, protect public health and the environment, and enhance our

quality of life. Managing for sustainability relies on the full consideration of social, economic, and environmental values in policy- and decision-making. Sustainable water use ensures that we develop and manage our water and related resources in a way that meets present needs while protecting and enhancing our watersheds and the environment and assures our ability to meet the needs of the future.

- Integrated water management including integrated flood management and Integrated Regional Water Management is the basis of planning for California's water future with actions that provide multiple benefits. Reducing uncertainties and assessing risks to the water supply and flood systems are essential for developing plans that also allow us to sustain our water uses, systems, and resources.
- 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 and 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 floodflows, urban runoff and storm water, 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.
- Management to sustain the California Delta will require that a healthy Delta ecosystem and a reliable water supply for California be co-equal 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 methods 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.

**Box 2-3 Update 2009 Strategic Plan Elements: Vision, Mission, and Goals**

### Vision

California has healthy watersheds and integrated, reliable, and secure water resources and management systems that

- Enhance public health, safety, and quality of life in all its communities;
- Sustain economic growth, business vitality, and agricultural productivity; and
- Protect and restore California's unique biological diversity, ecological values, and cultural heritage.

### Mission

Updating the California Water Plan provides State, federal, Tribal, regional, and local governments and organizations a continuous strategic 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, property, and the health, welfare, and livelihood of the people of California; and
- Evaluate current and future watershed and water conditions, challenges, and opportunities.

### Goals

1. California has water supplies that are adequate, reliable, secure, affordable, sustainable, and of suitable quality for beneficial uses to protect, preserve, and enhance watersheds, communities, and environmental and agricultural resources.
2. State government supports integrated water resources planning and management through leadership, 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-sufficiency.
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 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, that make the system more resilient to change, and that increase the sustainability of water and flood management systems and the ecosystems they depend on.
6. Integrated flood management, as a part of integrated water management, 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.

## Update 2009 Strategic Plan

This strategic plan was developed through processes learned during Update 2005, that is, expand the role and participation of other State agencies and of regional planning efforts, engage communities of interest and communities of place, and add a technical advisory group. Through these processes, we refined the strategic plan elements of Update 2005; they are presented here in Water Plan Update 2009 (Box 2-3 Update 2009 Strategic Plan Elements). For further discussion of the 13 objectives and 115-plus related actions, go to Chapter 7 Implementation Plan.

*Update 2009 maps out the role of State government and the water community to ensure that California has sustainable water uses and reliable water supplies in 2050 for all beneficial uses.*

Update 2009 maps out the role of State government and the water community to ensure that California has sustainable water uses and reliable water supplies in 2050 for all beneficial uses. It describes the paramount challenges that we face today and could

**Box 2-3 Update 2009 Strategic Plan Elements: Guiding Principles (cont)**

### Guiding Principles

1. **Use a broad, stakeholder-based, long-view perspective for water management** to (1) promote multi-objective planning with a regional focus, (2) coordinate local, regional, inter-regional, and statewide initiatives, (3) recognize distinct regional problems, resources, and assets, and (4) emphasize long-term planning (30- to 50-year horizon) while identifying near-term actions needed to achieve the plan.
2. **Promote management for sustainable resources 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 supplies, water conservation, water quality, water infrastructure, flood protection, energy, recreation, land use, economic prosperity, and environmental stewardship on a watershed or ecosystem basis.
3. **Increase regional drought and flood preparedness.** 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.
4. **Increase regional self-sufficiency.** Implement resource management strategies that reduce dependence on long-term imports of water from other hydrologic regions, particularly for meeting additional future water demands and during times of limited supply such as a drought or interrupted supply after a catastrophic event, such as an earthquake. As part of a diverse water portfolio, short-term water transfers between regions that are environmentally, economically, and socially sound, can help increase regional self-sufficiency overall.
5. **Promote regional coordination and collaboration among local governments and agencies, public and private organizations, and Tribal governments and Tribal communities,** particularly those that are involved in activities that might affect the long-term sustainability of water supplies, water quality, and flood protection within the region. Regional planning should include a public review process with open and transparent decision-making and substantive Tribal consultation, as well as education and outreach for the public, tribes, stakeholders, and decision-makers.
6. **Determine values for economic, environmental, and social benefits, costs, and tradeoffs to base investment decisions on sustainability indicators.** Evaluate programs and projects recognizing economic growth, environmental quality, social equity, and sustainability as co-equal 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.
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 and climate change, when making planning, management, and policy decisions.
8. **Apply California's water rights laws, including the longstanding constitutional principles of reasonable use and public trust, as the foundation for public policymaking, planning, and management decisions on California water resources.** Recognize 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. 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.** State-sponsored or public-funded resource management projects must include meaningful community participation in decision-making, and consider factors like community demographics, potential or actual adverse health or environmental impacts, and benefits and burdens of the project on stakeholder groups.
10. **Use science, best data, and local and indigenous peoples' knowledge in a transparent and documented process.** When appropriate and possible, use data, information, planning methods, and analytical techniques that have undergone scientific review.

face in the future, and it sets a course for action to meet California's urgent water challenges. As part of a comprehensive and thoroughly vetted strategic plan, this Water Plan presents clear goals and guiding principles that inform an implementation plan

**Box 2-3 Update 2009 Strategic Plan Elements: Objectives (cont)**

### Objectives

The following is a summary of the Water Plan's 13 objectives. Find further discussion of these objectives and their 115-plus related actions in Chapter 7 Implementation Plan.

1. **Expand Integrated Regional Water Management.** Promote, improve, and expand integrated regional water management to create and build on partnerships that are essential for California water resources planning, sustainable watershed and floodplain management, and increasing regional self-sufficiency.
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.
3. **Expand Conjunctive Management of Multiple Supplies.** Advance and expand conjunctive management of multiple water supply sources with existing and new surface water and groundwater to prepare for future droughts and climate change.
4. **Protect 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.
5. **Expand Environmental Stewardship.** Practice, promote, improve, and expand environmental stewardship to protect and enhance the environment by improving watershed, floodplain, and instream functions and to sustain water and flood management systems.
6. **Practice Integrated Flood Management.** Promote and practice integrated flood management to provide multiple benefits including better emergency preparedness and response, higher flood protection, more sustainable flood and water management systems, and enhanced floodplain ecosystems.
7. **Manage a Sustainable California Delta.** Set as co-equal goals a healthy Delta ecosystem and a reliable water supply for California and recognize the Delta as a unique and valued community and ecosystem to promote and practice management for a sustainable California Delta.
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 times of these events when they occur.
9. **Reduce Energy Consumption of Water Systems and Uses.** Reduce the energy consumption of water and wastewater management systems by implementing the water-related strategies in AB 32 Scoping Plan to mitigate greenhouse gas emissions.
10. **Improve Data and Analysis for Decision-making.** Improve and expand monitoring, data management, and analysis to support decision-making, especially in light of uncertainties, that support integrated regional water management and flood and water resources management systems.
11. **Invest in New Water Technology.** Identify and fund applied research on emerging water technology to make them attainable and more cost effective.
12. **Improve Tribal Water and Natural Resources.** Develop Tribal consultation, collaboration, and access to funding for water programs and projects to better sustain Tribal water and natural resources.
13. **Ensure Equitable Distribution of Benefits.** Increase the participation of small and disadvantaged communities in State processes and programs to achieve fair and equitable distribution of benefits. Consider mitigation of impacts from the implementation of State programs and policies to provide safe drinking water and wastewater treatment to all California communities and to ensure that these programs and policies address the most critical public health threats in disadvantaged communities.

comprising objectives and related actions, near-term and long-range, for all levels of State government, for all communities throughout the state, and for all water users.

Update 2009 outlines actions, resource management strategies, planning approaches, and analytical methods that can help us manage our water resources to achieve sustainable systems. These strategies and methods pay particular attention to the essential role and responsibility of State government in supporting regional water and flood management and improving statewide water and flood management systems.

**Figure 2-1** Integrated Water Management


### Recommendations

Just as we have identified California's urgent needs and the course we must take, we have identified constraints that can impede our way and opportunities that can help us succeed. In this chapter, we present nine recommendations to decision-makers and water users throughout the state (referred to as California) and at executive and legislative branches of State government, the Department of Water Resources (DWR), and other State agencies (referred to as State government). These recommendations are presented at the end of this chapter. They will reduce or remove impediments and leverage resources and opportunities to help implement the Update 2009 strategic plan.

*Recommendations are presented at the end of this chapter. They will reduce or remove impediments and leverage resources and opportunities to help implement the Update 2009 strategic plan.*

## Key Initiatives and Commitments

A primary theme of Update 2005 and Update 2009 is that our policies, decisions, and actions must lead to long-term, sustainable water resource use that enhances our environment, our economy, and our communities. With creative flexibility, discipline, and innovation, we can use our groundwater and surface water resources wisely in ways that sustain their viability, expand the economy, protect the environment, and assure Californians a high quality of life. Our policies and actions must ensure sustainable water uses and reliable water supplies. On these two premises, we have identified foundational actions (use water efficiently, protect water quality, and expand environmental stewardship) and initiatives (expand Integrated Regional Water Management and improve statewide water and flood management systems). See Figure 2-1 Integrated Water Management.

**Box 2-4 Strategic Growth Plan**

In 2006, California voters approved California's Strategic Growth plan, authorizing $42 billion in general obligation bonds for education, housing, levee repair, flood control, parks and transportation infrastructure. In November 2007, the legislature authorized $7.7 billion to address prison overcrowding and improve health care delivery in the prison system. As a result, California is now undertaking the largest infrastructure improvement plan in a generation.

In Water Plan Update 2009, we build on these initiatives and foundational actions by identifying the commitments we must make to water resource management. These commitments are necessary for managing and planning in a way that ensures California's sustainable water use and reliable water supplies through 2050 and for future generations.

- Coordinating government planning and management
- Integrating resource planning and management
- Adapting to climate change
- Managing for uncertainty, risk, and sustainability

*California's water management system is large and complex. Its water governance is very decentralized. Therefore, we need greater cooperation and collaboration among decision-makers at all levels of State, federal, Tribal, regional, and local entities.*

## Coordinating Government Planning and Management

California's water management system is large and complex. Its water governance is very decentralized. Therefore, we need greater cooperation and collaboration among decision-makers at all levels of State, federal, Tribal, regional, and local entities.

### Strategic Growth Council

*The five-member Strategic Growth Council will help State agencies allocate Strategic Growth Plan money in ways that best promote efficiency, sustainability, and support the Governor's economic and environmental goals.*

Senate Bill 732 (2008) established the Strategic Growth Council to improve State agency collaboration and funding and accountability for the Strategic Growth Plan (Box 2-4). The council brings public and State representatives together to chart the best path for growth. The five-member council will help State agencies allocate Strategic Growth Plan money in ways that best promote efficiency, sustainability, and support the Governor's economic and environmental goals. Chaired by the Director of the Office of Planning and Research, the council consists of the secretaries from four State agencies—Natural Resources; Environmental Protection; Business, Transportation and Housing; Health and Human Services—and a public member.

The council will:

- Award and manage grants and loans from Proposition 84 funds to support the development of sustainable communities. The council's responsibilities will include establishing application requirements and evaluation criteria.
- Coordinate the four-member State agencies, as they undertake infrastructure and development projects, to encourage sustainable land use; protect natural resources; improve air and water quality; increase the availability of affordable housing; improve transportation; and meet the goals of the Global Warming Solutions Act (AB 32).

**Box 2-5 Delta Stewardship Council Tasks**

The Sacramento-San Joaquin Delta Reform Act of 2009 established the seven-member Delta Stewardship Council, which is tasked with:

- Developing a Delta Plan to guide State and local actions in the Delta in a manner that furthers the co-equal goals of Delta restoration and water supply reliability;
- Developing performance measures for the assessment and tracking of progress and changes to the health of the Delta ecosystem, fisheries, and water supply reliability;
- Determining if a State or local agency's project in the Delta is consistent with the Delta Plan and the co-equal goals, and acting as the appellate body in the event of a claim that such a project is inconsistent with the goals; and
- Determining the consistency of the Bay-Delta Conservation Plan with the co-equal goals.

- Recommend policies to the Governor, the Legislature, and State agencies that encourage sustainable development.
- Collect and provide data to local governments to help them develop and plan sustainable communities. Although State government has little direct say in local land-use planning, the council will provide leadership and support for locals.

*By establishing the Delta Stewardship Council, the Sacramento-San Joaquin Delta Reform Act provides a governance structure that will direct efforts across State agencies to develop a legally enforceable Delta Plan.*

## Delta Stewardship Council

The Delta Stewardship Council was created under the Sacramento-San Joaquin Delta Reform Act of 2009 as part of the 2009 Comprehensive Water Package (see information about the Governor's and Legislature's package in Chapter 4 California Water Today information under Statewide and Regional Planning and Response). SB 1[1] Delta Governance/Delta Plan establishes the framework to achieve the co-equal goals of providing a more reliable water supply to California and protecting, restoring, and enhancing the Delta ecosystem. By establishing the council, the act provides a governance structure that will direct efforts across State agencies to develop a legally enforceable Delta Plan (Box 2-5 Delta Stewardship Council Tasks). The council consists of seven members with diverse expertise providing a broad statewide perspective.

## Water Plan Collaboration

A 21-member State Agency Water Plan Steering Committee provides policy input, oversight, and program management for development of the California Water Plan. Through the committee, DWR seeks policy input and advice from federal agencies and Tribal governments and their representatives.

## Companion State Plans

State government's leadership and role in the water community requires that the Water Plan incorporate water issues, initiatives, and information from other State agencies.

1 Chaptered by Secretary of State as Chapter 5, Statutes of 2009-10, Seventh Extraordinary Session.

**Box 2-6 Integrated Resource Planning and Management**

Integrated resource planning is a comprehensive approach to resource management and planning that emerged in the late 1980s in the electric power industry. As applied to water management, integrated resource planning is a systems approach that explores the cause-and-effect relationships affecting water resources wherever the planning entity's operations affect water use, quality, and supply. It analyzes all the interrelated water management components in a given region, among regions, or statewide. The focus is on the interrelation of the different water management components with the understanding that changes in the management of one component will affect the others. Because these components are often not confined to the boundaries of a single water management agency, county, or city, a consensus-based, cross-jurisdictional, regional approach may be required to formulate comprehensive, win-win solutions to identified problems.

The work of the Steering Committee revealed a broad overlap of water management and complexity of functions related to water management by many State departments.

A comprehensive water plan must embrace companion State programs and policies in order to better understand the full possibilities and constraints for water managers. Update 2009 attempts to cross-reference and coordinate with other State programs to be as accurate, up-to-date, and complete as possible. Key State plans that informed this Water Plan's strategic and implementation plans and resource management strategies are discussed in Chapter 3 Companion State Plans.

## Integrating Water Management

The new and continuing challenges of California's diverse and extreme conditions require a new approach to water management—one that is multi-faceted. Integrated water management approaches water management at all fronts and on many levels—regionally and statewide, for multiple uses and benefits, with various resource management strategies, for sustaining water uses and systems, and while weighing the risks of uncertain futures. Integrated water management employs the principles of integrated resource planning and management (Box 2-6).

*Regions have opportunities not available to individual water suppliers. Water suppliers that form partnerships with each other and with local governments, Tribes, and organizations in their region can accomplish projects and provide benefits that no single agency can do alone or as cost-effectively.*

Integrated water management provides a variety of benefits, including meeting existing and future water demands, improving the quality of water sources and supplies, providing flexibility to deal with extreme hydrological events such as droughts and floods, and restoring and enhancing ecosystems to help sustain our natural resources. An umbrella approach, integrated water management comprises the principles and actions of Integrated Regional Water Management and integrated flood management.

### Integrated Regional Water Management

Over the past decade, California has improved its understanding of the value of regional planning and made significant steps in implementing Integrated Regional Water Management.

**Table 2-1 Propositions 13 and 50 program estimated costs and water yield benefits**

| Grant program | Water supply and demand reduction benefits (in af/year) | Bond funding (in million$) |
|---|---|---|
| **Proposition 13** | | |
| Groundwater Storage | 340,000 | $245.0 |
| Water Use Efficiency | 60,000 | $65.0 |
| Southern California Integrated Watershed Program | 175,000 | $235.0 |
| Water Recycling | 130,000 | $40.0 |
| **Subtotal** | **705,000** | **$585.0** |
| **Proposition 50** | | |
| Water Use Efficiency | 34,600 | $27.5 |
| Desalination | 31,000 | $46.0 |
| Integrated Regional Water Management | 500,000 | $400.0 |
| **Subtotal** | **565,600** | **$473.5** |
| **Total** | **1,270,600** | **$1,058.5** |

af = acre-feet

from Benefits of Investment in Integrated Regional Water Management, (October 2006)

Regions have opportunities not available to individual water suppliers. Water suppliers that form partnerships with each other and with local governments, Tribes, and organizations in their region can accomplish projects and provide benefits that no single agency can do alone or as cost-effectively. For example, partnerships are allowing local governments and agencies to:

- improve project planning by sharing data, information, and analytical tools;
- improve water supply reliability by establishing emergency connections with neighboring water suppliers;
- increase operational flexibility by participating in regional groundwater and conjunctive management;
- protect water quality by participating in regional watershed management;
- reduce costs by cooperating with other agencies on water and resource management strategies like water conservation and outreach programs;
- facilitate new projects by contributing to local habitat conservation plans; and
- help achieve many other regional resource management objectives.

Partnerships have led to Integrated Regional Water Management plans and regional eligibility for grant funds. Integrated regional water management relies on a diversified portfolio of water strategies. Early coordination with land planning agencies will help water suppliers and land planners anticipate and plan for future growth, and ensure that additional regional growth will not exceed water suppliers' capabilities. Ultimately, regional partnerships will enable optimal and effective management of water and other resources within a region, and the resulting regional plans will provide efficient solutions, consider land uses and other resource issues, and enjoy broad public support.

*Early coordination with land planning agencies will help water suppliers and land planners anticipate and plan for future growth.*

Proposition 84 on the November 2006 ballot provides $1 billion of additional State government investment in Integrated Regional Water Management. Recent experience in the Proposition 50 IRWM grant program, as well as other bond-funded grant programs for water supply projects, indicates that bond funds can provide significant leverage for investment of local funds, which could result in an investment of as much as $5 billion in the state's water infrastructure and programs as a result of the proposition. This investment could result in water supply improvements of 1.2 million acre-feet of water annually (see Table 2-1) and many other regional benefits like improving water quality, healthier ecosystems, and greater flood protection.

### Integrated Flood Management and Emergency Response

Many Californians currently face unacceptable risk of harm and damage from floods. The personal safety and economic stability of large segments of our population rely on flood management systems that do not meet modern engineering standards. The need to improve public safety through integrated flood management is urgent as more people live and work in flood-prone areas and climate changes make large floodflows more likely.

Floodplains are formed by periodic inundation and the deposition of sediment. Over time, the repeated process creates a landform that is favorable for human settlement, due to the relatively flat land, good soils, and easy access to water. Sparse settlements have grown into urban areas, greatly complicating the task of flood management, as many people now live in locations that are within historic floodplains.

Traditionally, flood management practices largely focused on reducing flooding and susceptibility to flood damage through physical measures intended to store floodwaters, increase the conveyance capacity of channels, and separate rivers from adjacent populations. Although this approach may reduce the intensity and frequency of flooding, it limits the natural role of floodplains to reduce flooding in developed areas.

In recent years, flood managers have recognized the potential for natural watershed features to reduce the intensity or duration of flooding. Undeveloped floodplains can store and slowly release floodwaters. Wetlands can act as sponges, soaking up floodwaters, filtering runoff, and providing opportunities for infiltration to groundwater. Healthy forests, meadows, and other open spaces can slow runoff during smaller flood events, reducing peak flows, mudslides, and sediment loads in streams.

A challenge for flood managers is to integrate these natural functions with more traditional flood protection methods, thus reducing floodflow peaks and their subsequent impacts during small and frequent flood events, while simultaneously providing other water resource benefits. To address this integration, the FloodSAFE California initiative and this update of the Water Plan promote the concept of integrated flood management, a comprehensive approach to flood management that considers land and water resources at a watershed scale within the context of integrated water management; employs

both structural and nonstructural measures to maximize the benefits of floodplains and minimize loss of life and damage to property from flooding; and recognizes the benefits to ecosystems from periodic flooding.

Integrated flood management does not rely on a single approach to flood management, but instead uses various techniques, including traditional (meaning structural) flood protection projects, nonstructural measures (such as land use practices), and reliance on natural watershed functions, to create an integrated flood management system. Depending on the characteristics of individual watersheds, this may include the flood-specific management strategy introduced in Update 2009 (Volume 2)—flood risk management—as well as other resource management strategies that can provide flood management benefits including agricultural land stewardship; conjunctive management; conveyance; ecosystem restoration; forest management; land use planning and management; surface storage; system reoperation; urban runoff management; and watershed management.

*Integrated flood management uses various techniques, including traditional (meaning structural) flood protection projects, nonstructural measures (such as land use practices), and reliance on natural watershed functions.*

## Adapting to Climate Change

With the state's water resources already stressed, additional stress from climate change will only intensify the competition for clean, reliable water supplies. While doing its part to reduce greenhouse gas emissions and expand the use of clean energy sources (called mitigation strategies), California's water community must concentrate its efforts on adaptation strategies to respond to the anticipated changes. The Intergovernmental Panel on Climate Change (Fourth Assessment Report 2007) states that adaptation "will be necessary to address impacts resulting from the warming which is already unavoidable due to past emissions." As understanding of climate change increases, the challenge for California's water community is to develop and implement strategies that improve resiliency, reduce risk, and increase sustainability for water and flood management systems and the ecosystems upon which they depend. See discussion of AB Scoping Plan in responses section, Chapter 4 California Water Today.

Water managers must play dual roles when it comes to climate change; they must engage in both mitigation and adaptation.

*Water managers must play dual roles when it comes to climate change; they must engage in both mitigation and adaptation.*

- **Mitigation** refers to the reduction of greenhouse gas (GHG) emissions from water-related energy use. Water utilities use energy to reliably provide quality water to customers, while wastewater utilities in turn use energy to safely collect, treat, and dispose of wastewater to protect public health and the environment. GHG emissions reduction is a critical responsibility of water managers, and efficiency in water and energy use should be pursued at every opportunity. At the same time, though, water already provides enormous benefits to California's energy system and climate change mitigation efforts by generating hydroelectric power, California's largest source of GHG emissions-free energy.
- **Adaptation** refers to the ways in which our society and culture will need to change to cope with a changing climate. Several of the water plan objectives and actions will help California adapt to climate change and are ready for immediate adoption.

## Planning for Uncertainty, Risk, and Sustainability

Update 2009 acknowledges that two initiatives—expand Integrated Regional Water Management and improve statewide water and flood management systems—are central to securing reliable and clean water supplies through 2050. To enhance their effectiveness, Update 2009 incorporates three key considerations into the planning approach:

1. Recognize and reduce uncertainties inherent in the system.

2. Assess the risks that can hamper successful system management and select management practices that reduce the risks to acceptable levels.

3. Keep an eye toward approaches that help sustainability of resources and water and flood management systems.

We elaborate on this approach in Chapter 5 Managing an Uncertain Future.

### Reducing Uncertainty and Assessing Risk

Today, as part of integrated water management (which includes Integrated Regional Water Management and integrated flood management), California's water managers must recognize that conditions are changing and that they will continue to change. Traditional approaches for predicting the future have been based on projecting past trends into the future. Today, there is better understanding 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 and economics.

*Traditional approaches for predicting the future have been based on projecting past trends into the future. Today, there is better understanding that strategies for future water management must be dynamic, adaptive, and durable.*

California's water management system is large and complex, its water governance is very decentralized, and it requires a great deal of cooperation and collaboration among decision-makers at all levels of State, federal, Tribal, regional, and local entities. Update 2005 stressed the importance of a common analytical approach for these entities to understand and manage the system, especially when management actions compete for the same resources. The entities must make sound investments that balance risk with reward, given today's uncertainties and those that may occur in the future.

Update 2009—as will future California Water Plan updates—promotes adopting a common approach for data standards and for understanding, evaluating, and improving regional and statewide water management systems. DWR is developing the Water Plan Information Exchange (Water PIE) for accessing and sharing data and networking existing databases and Web sites, using GIS software to improve analytical capabilities and developing timely surveys of statewide land use, water use, and estimates of future implementation of resource management strategies. IWRIS—Integrated Water Resources Information System—is a working prototype of this system, developed by DWR and released in 2008. IRWIS is accessible at www.water.ca.gov/iwris/.

This approach incorporates consideration of uncertainty, risk, and sustainability into planning for the future:

1. **Uncertainty.** 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.

2. **Risk.** Each undesirable event has a certain chance of occurring and a set of consequences. For example, a chance of a levee failure with a certain sized flood event can be estimated with associated economic and human consequences. Likewise, a specific severity of drought may occur on average of once during a 30-year period and carry economic consequences of many billions of dollars.

3. **By reducing the uncertainties, the "true" risks can be better understood.** Chapter 5 Managing an Uncertain Future and Chapter 6 Integrated Data and Analysis provide more detailed description of this approach, risk assessment, and reducing uncertainty.

## Managing for Sustainability

California's water resources are finite and require more careful management for sustainability of resources than has been practiced during the first 150 years of this state's history. A system that is sustainable should meet today's needs without compromising the ability of future generations to meet their own needs. A sustainable system generally provides for the economy, the ecosystem, and equity.

Over the past few decades, questions have been raised about how sustainable the ecosystem, water use, land use, and other uses are given current management practices and expected future changes. It has become increasingly evident to decision-makers, water managers, and planners that we need to manage for the long-term sustainability of resources. This is especially true in the face of climate change, population growth, degraded and dysfunctional ecosystems, and evolving environmental mitigation measures. See Box 3-7 Place Value on Sustainability.

To achieve sustainability, resource managers and planners must transition from the past model that places value primarily on water supply yield and extraction to a model that values sustainable outcomes. Given the uncertainties and risks in the water system, some management strategies may provide for a more sustainable water supply, flood management, and ecosystems than another set of management strategies. Recognizing that change will continue to occur and that additional uncertainties and risks are likely to surface in the future, water management actions must be dynamic, adaptive, and durable.

*To achieve sustainability, resource managers and planners must transition from the past model that places value primarily on water supply yield and extraction to a model that values sustainable outcomes.*

*"The real prize today is a sustainable system. This may or may not result in increased water supply. The point is that a sustainable system by itself justifies billions in expenditures." Timothy Quinn, Executive Director, Association of California Water Agencies*

### Box 2-7 Place Value on Sustainability

"Because environmental considerations were secondary at best in the middle of the 20th century, the back bone system we operate today is characterized by very high – and unnecessary – levels of conflict between economic and environmental objectives. The clash between these values in recent years has resulted in political and legal conflict, gridlock, and mutual deterioration in the state of both the economy and the environment.

"The central policy goal today, as the Delta Vision recognizes, is to reduce this conflict by investing in a sustainable system. The standard of value in the past for the water industry has generally been the creation of more supply to justify an infrastructure or water management investment. That standard must yield in the future to reflect the enormous value of a sustainable system – one that can provide reliable supplies and a recovering environment far into the future. Similarly, some interests advocate reduced supply as an appropriate measure of value. Both perspectives are off-base.

"The real prize today is a sustainable system. This may or may not result in increased water supply. The point is that a sustainable system by itself justifies billions in expenditures."

*Timothy Quinn, Executive Director Association of California Water Agencies, "Financing the Delta Vision," April 2008*

The Association of California Water Agencies has formally adopted policy principles embracing environmental and economic sustainability as co-equal priorities for water management in California. The ACWA's *Environmental and Economic Sustainability Policy Principles can be found in Volume 4 Reference Guide of this Water Plan.*

## Multiple Future Scenarios

Prior to Update 2005, water plan updates based planning assumptions on a single likely future. Now, the use of multiple future scenarios provides decision-makers, water managers, and planners more information about how different management actions might perform under a range of possible future conditions and uncertainties.

Update 2009 uses three baseline future scenarios to better understand the implications of future conditions on water management decisions—in particular factors of uncertainty to which the water community will need to respond. The scenarios are referred to as baseline because they represent changes that are likely to occur without additional management intervention beyond those currently planned. Each scenario affects water demands and supplies differently. Each scenario includes assumptions about how 80 different factors, like population or irrigated farmland, would describe its future.

- **Scenario 1 – Current Trends.** Recent trends are assumed to continue into the future. In 2050, nearly 60 million people live in California. Affordable housing has drawn families to the interior valleys. Commuters take longer trips in distance and time. In some areas where urban development and natural resources restoration has increased, irrigated crop land has decreased. The state faces lawsuits on a regular basis, from flood damages to water quality and endangered species protections. Regulations are not comprehensive or coordinated, creating uncertainty for local planners and water managers.

- **Scenario 2 – Slow & Strategic Growth.** Private, public, and governmental institutions form alliances to provide for more efficient planning and development that is less resources intensive than current conditions. Population growth is slower than currently projected—about 45 million people live here in 2050. Compact urban development has eased commuter travel. Californians embrace water and energy conservation. Conversion of agricultural land to urban development has slowed and occurs mostly for environmental restoration and flood protection. State government implements comprehensive and coordinated regulatory programs to improve water quality, protect fish and wildlife, and protect communities from flooding.
- **Scenario 3 – Expansive Growth.** Future conditions are more resource intensive than existing conditions. Population growth is faster than currently projected with 70 million people living in California in 2050. Families prefer low-density housing, and many seek rural residential properties, expanding urban areas. Some water and energy conservation programs are offered but at a slower rate than trends in the early century. Irrigated crop land has decreased significantly where urban development and natural restoration have increased. Protection of water quality and endangered species is driven mostly by lawsuits, creating uncertainty.

More detailed descriptions of these scenarios are in Chapter 5 Managing an Uncertain Future.

### Regional Water Portfolios—an Array of Management Responses

A response package is a mix of resource management strategies from Volume 2 designed to provide multiple benefits for a given region under conditions described by a given future scenario. The performance of several different response packages can be compared for each scenario to determine the best performing package. Having response packages for multiple future scenarios can help identify management responses that perform well when compared across the array of possible future conditions.

No single response package will work for all areas of California as each region has its own needs, constraints, and opportunities. Facing an uncertain future, regions need to invest in an appropriate mix of strategies based on Integrated Regional Water Management plans that are diversified, satisfy regional and state needs, meet multiple resource objectives, include public input, address environmental justice, mitigate impacts, protect public trust assets, and are affordable. (See Chapter 4 California Water Today in this volume or chapters in Volume 3 Regional Reports for examples of regional water projects throughout the state.)

*No single response package will work for all areas of California. ... Facing an uncertain future, regions need to invest in an appropriate mix of strategies.*

Response packages help decision-makers, water managers, and planners practice integrated water management, develop Integrated Regional Water Management plans, and promote integrated flood management, thereby providing resource and infrastructure sustainability.

## Conclusion

With new urgency, this Water Plan follows the Update 2005 roadmap to sustainable water uses and reliable water supplies—to use water efficiently, improve water quality, and expand environmental stewardship. Update 2009 marks a new chapter in the way California must manage her water resources. It is the state's blueprint for integrated water management and sustainability—statewide and regional.

Landmark legislation signed by the Governor in November 2009 will provide needed impetus and acceleration to achieve progress in implementing resource management strategies that are critical for regions across the state including urban and agricultural water conservation, monitoring of groundwater basins, and restructuring governance to better address the sustainability of the Delta and to improve water supply reliability.

We must adapt and evolve California's water systems more quickly and effectively to keep pace with ever changing conditions now and in the future. Population is growing while available water supplies are static and even decreasing. Climate change, as evidenced by changes in snowpack, river flows, and sea levels, is profoundly impacting our water resources. The Delta and other watersheds and ecosystems continue to decline. The state's current water and flood management systems are increasingly challenged by legal remedies and regulatory protections, with economic and societal consequences. The entire system—water and flood management, watersheds, and ecosystems—has lost its resilience and is changing in undesirable ways.

*The entire system—water and flood management, watersheds, and ecosystems—has lost its resilience and is changing in undesirable ways.*

So where do we start? — From all directions! — It is imperative that decisions about California water account for and reduce uncertainty and risk, and that investments make our water management systems, flood protection systems, and ecosystems more sustainable. New to this Water Plan is an integration of water resource and flood management. This approach will be challenging, but it can yield significant public safety benefits, protect water supplies, and improve the environment.

Update 2009 may truly be called California's Water Plan because it embodies countless deliberations between and among the brightest minds in government and private agencies, Tribes, cities, farms, industry, and environmental organizations. As a result, Update 2009:

- Provides an investment guide for State, federal, Tribal, and regional strategies to reduce water demand, improve operation efficiency, increase water supply, improve water quality, advance environmental stewardship, and improve flood management;
- Integrates objectives and strategies from numerous State agencies and initiatives and offers more than 115 near- and longer-term actions to achieve them;
- Describes 27 resource management strategies that each region can select from to develop a unique and diverse water portfolio suitable for managing an uncertain future; and
- Outlines new analytical methods and tools to help plan for future effects of climate change, population growth and development patterns, economic change, and other factors outside the water community's control.

We must invest—significantly and uninterrupted—in California's aging and increasingly inadequate water and flood systems. Californians have recognized the need to invest in our water and flood systems through passage of a series of past bonds. Ultimately, California needs more stable and continuous sources of revenue to invest in statewide and regional integrated water management and to build resilience back into the state's water and flood management systems, as well as into the watersheds, groundwater basins, and ecosystems that support them.

*California needs more stable and continuous sources of revenue to invest in statewide and regional integrated water management and to build resilience back into the state's water and flood management systems, as well as into the watersheds, groundwater basins, and ecosystems that support them.*

## Recommendations

California Water Plan Update 2009 identifies the most pressing water management issues and challenges faced statewide and by regions and the available opportunities and assets. Chapter 7 lays out objectives and related actions to achieve reliable water supplies and sustainable water uses through 2050. But impediments remain. They can and may keep California from realizing the goals and full implementation of this Water Plan. Through the Water Plan process, we have developed recommendations to reduce and remove these impediments and leverage resources and opportunities.

These recommendations are as varied as the constraints they are intended to change—institutional, legal, knowledge, information, skills/capacity, resources, funding, schedule, and public awareness. They are directed at decision-makers and water users throughout California (referred to as California) and at the executive and legislative branches of State government, DWR, and other State agencies (referred to as State government).

California needs to act on these recommendations to improve drought contingency planning, make flood management improvements, and adapt to climate change. California needs to invest the water and flood bond funds that the public has approved to implement these recommendations and realize this Water Plan.

1. **California should implement and invest in the Water Plan's actions as the key to achieving its goals and objectives.**

State, federal, Tribal, regional, and local governments and agencies, public and private organizations, and water users should implement the actions of California Water Plan Update 2009 to achieve its goals and objectives. They should in partnership adopt an integrated, collaborative, multi-benefit, and transparent approach toward resource planning and management and infrastructure investments. Californians, acting as individuals, make daily choices that can impact water supplies and quality and not waste water. State government should create incentives for citizens to aggressively participate in water protection and conservation efforts. These efforts may be modeled after energy conservation efforts conducted by the State.

California's local and regional entities, State agencies, federal agencies, and California Native American Tribes should use the California Water Plan as a guiding water policy

document. However, by statute, the California Water Plan cannot mandate actions nor authorize spending for its recommendations. Therefore, DWR has sought participation from other State agencies, federal, Tribal, regional, and local governments and agencies, the public, and nongovernmental entities to develop a California Water Plan with substantial stakeholder input and support. California Water Plan Update 2009 reflects our common priorities and values that promote sustaining California's water and environmental resources and ensuring safe, high-quality, and reliable water supplies and improved flood protection for our communities and industry.

2. **California needs a water finance plan with stable and continuous funding from an array of revenue sources for integrated water management on a statewide and regional basis. The finance plan should recognize the critical role of public-private partnerships and the principle of beneficiary pays; include alternative revenue sources; and guide investment decisions based on sustainability indicators.**

State government should lead an effort to identify and prioritize funding strategies and capacity building to finance regional and statewide water resources planning, programs, infrastructure, monitoring, and technology research. State government needs to clearly articulate when, and for what actions, to use public investments from State and federal sources. California's water finance plan should recognize the critical role of local public and private partnerships and the principle of beneficiary pays; include alternative revenue sources like State bonds, incentive-based water pricing and user fees; and guide investment decisions based on sustainability indicators.

Although recent bond measures have provided a down payment for improving California's water and flood systems and the environment, the State Legislature should conduct a formal assessment of State and local financing mechanisms to provide a continuous, stable source of revenue to sustain the programs described in Water Plan Update 2009. Activities in need of certainty and continuity in funding include but are not limited to the following: regional water planning and management for water efficiency, quality and supplies; environmental stewardship; updating county and city general plans to address climate change impacts and adaptation; inspection and maintenance of flood management facilities; data collection networks; and water-related climate change adaptation research. Additionally, State and local governments and water purveyors should implement incentive programs and cost-avoidance on-bill financing to promote water efficiency improvements and retrofits by urban water users.

3. **California should manage its water resources with ecosystem health and water supply reliability and quality as equal goals, with full consideration of public trust uses whenever feasible.**

Healthy, functioning ecosystems and reliable water supplies are primary and co-equal goals for management that can sustain California's water resources and management systems. To achieve this, State government should exercise continuous supervision

over California's water resources, the flows and quality of rivers, streams and navigable waters, and the lands beneath them and from which they flow.

State government should protect public trust uses whenever feasible. State agencies should explicitly consider public trust values in the planning and allocation of water resources. State government should protect the public's rights to commerce, navigation, fisheries, recreation, ecological preservation, and related beneficial uses including its Native American Tribes who depend on these resources for subsistence and cultural practices.

4. **State government should effectively lead, assist, and oversee California's water resources and flood planning and management activities that regions cannot accomplish on their own.**

State government should lead water and flood planning and management activities that (a) regions cannot accomplish on their own, (b) the State can do more efficiently, (c) involve interregional, interstate, or international issues, or (d) have broad public benefits. State government should leverage existing governance like the Strategic Growth Council and new governance like the Delta Stewardship Council to provide leadership and to develop and implement consistent water policy across all State agencies and departments.

Critical activities include, but are not limited to (1) preparing California Water Plan 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; (2) operating and maintaining the State Water Project and State-federal flood management system; (3) providing regulatory oversight to protect public health and safety and public trust values, including water quality, environmental protection, flood management, and dam safety; (4) participating in major regional initiatives, and (5) forming public-private partnerships to implement regional programs like the Colorado River Quantification Settlement Agreement.

5. **State and federal government should lead and support planning, monitoring, and scientific research to help California adapt and mitigate for climate change impacts.**

State and federal government should lead and support efforts to predict and prepare for the effects of climate change on our water resources, water management systems, and water-dependent ecosystems. State and federal government should work with and assist researchers to monitor, predict, and prepare for the effects of climate change on California's water and flood protection systems and the environment. DWR should develop alternative flow data to help State, federal, Tribal, regional, and local governments and planners test the potential effects of climate change on different resource management strategies; and to help water facility operators test alternative reoperation strategies.

California is already seeing the effects of climate change on hydrology (snowpack, river flows), storm intensity, temperature, winds, and sea levels. Planning for, mitigating, and adapting to these changes, particularly their impacts on public safety and reliable, high-quality, long-term supplies of water, will be one of the most significant challenges facing water managers this century. Although the existing system has some capacity to cope with climate variability, extreme climatic events may become more frequent with growing populations in their path, demanding improvements in drought and flood preparedness and emergency response and recovery plans.

6. **California should improve the coordination of land use policies and practices; economic development decisions; and water, flood, and natural resource planning and management.**

It is crucial to the success of integrated water and flood management that land-use planning, development, and infrastructure decisions made by local officials and planners, State, federal, and Tribal land managers, the building industry, and homeowners recognize the need to protect groundwater recharge areas, restore natural processes in watersheds to increase infiltration, slow surface runoff and reduce flood peaks, improve water quality, augment the natural storage of water, and increase regional self-sufficiency.

To achieve this:

- State government should coordinate and eventually integrate its statewide and regional resource management and infrastructure initiatives to advance common and consistent principles and incentives for local and regional actions.
- State government should assist local governments with data, technical, and financial assistance.
- Regional partnerships should develop and update Integrated Regional Water Management plans in close coordination with local General Plans; State, federal and Tribal land management plans; watershed management plans; transportation Regional Blueprint Plans; and energy, ecosystem, and resource plans.
- Local governments should update General Plans to address drought, water quality, and flood risks in light of existing and future climate change impacts.
- Federal agencies as trustees of about 50 percent of California lands should partner with local, State, and Tribal governments and agencies in developing their land and resource management and restoration plans.

7. **California should renovate and improve its aging water, wastewater, and flood infrastructure.**

California should maintain, rehabilitate, and improve aging water and flood infrastructure—especially drinking water, sewage treatment and collection systems, and flood protection facilities—operated by State, federal, Tribal, and local entities.

State government should lead an effort, with input from public and private owners of water infrastructure, to identify and prioritize water infrastructure maintenance of

key components with regional or statewide significance. Improvements may include refinements in the way water, flood, and wastewater systems are operated, additional conveyance capacity, and new surface and groundwater storage. This effort should also identify and implement financing strategies for continued public investments in the resulting infrastructure maintenance plan.

8. **California should articulate and update as needed the roles, authorities, rights, and responsibilities of federal, Tribal, State, and local governments and agencies responsible for water resource and flood planning and management.**

California should articulate and update as needed the respective roles, authorities, rights, and responsibilities of federal, Tribal, State, and local governments and agencies responsible for water and flood planning and management, and update them as needed. In light of the growing role of Tribal and local agencies and governments in regional water and flood planning and management, State government should define how to empower, assist, and consult with them to implement their regional water plans and programs.

State government should also conduct an internal review of how State agencies do business and identify ways to make these agencies more efficient, effective, and responsive to Californians. State government should continue an interagency water forum like the State department and agency Steering Committee for Water Plan Update 2009 and leverage the Strategic Growth Council and new Delta Stewardship Council to strengthen coordination among State agencies responsible for water supplies, water quality, flood protection, and environmental stewardship.

9. **California should increase public understanding and awareness of where our water comes from as well as the value and importance of water, water quality, and water conservation to people, ecosystems, and California's economy.**

Water is a limited resource, and State government needs to do more to assist water agencies, local governments, and other partners, such as Tribes and non-governmental organizations, in developing and disseminating information about the importance of water issues, including water supply, water quality, and ecosystem health. Despite experiencing significant droughts and floods, Californians are not sufficiently aware of the critical issues confronting them. It is the responsibility of State government to help the public understand the importance of efficient water use, how to protect water quality, how their actions can benefit or harm the watersheds from which they receive their water and the watersheds in which they live, play, and work.

DWR and other State agencies should make public outreach and education a priority and achieve efficient dissemination of information by forming partnerships with those experienced in water and resource education and media. Outreach should include high-quality, balanced water information, including programs as part of early grade school education. With education, Californians will have a better understanding of where their water comes from, the value and importance of water, challenges and

opportunities to ensuring the co-equal goals of water supply, quality, and ecosystem health. They also will have a better understanding of the benefits, costs, and impacts of the array of resource management strategies described in Volume 2, and especially water conservation and water use efficiency, which must become a public ethic.

# Companion State Plans

***Chapter photo.*** California Capitol Building, Sacramento.

# Contents

**Chapter 3. Companion State Plans ..... 3-5**
About This Chapter ..... 3-5
Water Management in California ..... 3-6
Overview ..... 3-6
Legal Framework ..... 3-7
Agencies and Departments with Water-related Roles and Responsibilities ..... 3-7
California Government ..... 3-8
Federal Government ..... 3-10
Public Agencies, Districts, Local Governments, and Investor-owned Utilities ..... 3-11
Tribal Governments, Organizations, and Communities ..... 3-11
State Agency Coordination through the Water Plan Steering Committee ..... 3-11
Companion State Plans and the California Water Plan ..... 3-13
Companion State Plans ..... 3-13
Water Plan Recommendations, Objectives and Related Actions ..... 3-21
Resource Management Strategies ..... 3-21
Implications and Considerations ..... 3-23
Selected References ..... 3-23

## Figures

Figure 3-1 State agencies with featured plans ..... 3-12

## Tables

Table 3-1 Matrix of companion plans and related objectives ..... 3-21
Table 3-2 Matrix of companion plans and resource management strategy categories ..... 3-22

## Boxes

Box 3-1 State Departments and Agencies Represented on Water Plan Steering Committee ..... 3-6
Box 3-2 Companion State Plans Featured in Update 2009 ..... 3-15

# Chapter 3. Companion State Plans

## About This Chapter

The California Water Plan calls for comprehensive and integrated regional management of California's water resources. To advance State government's leadership and role in the water community and to promote the Water Plan's framework, recommendations, and strategies, the State needs to better incorporate water issues, initiatives, and information from other State agencies in the Water Plan update.

Unlike prior Water Plan updates, which were primarily products of the Department of Water Resources (DWR), Update 2009 truly can be viewed as the state's Water Plan. It has benefited from the first interagency California Water Plan Steering Committee representing 21 State government departments and agencies with jurisdictions over different aspects of water resources and integrates their companion plans and initiatives (Box 3-1).

This chapter describes the Water Plan Steering Committee as a central feature of Water Plan Update 2009 and its efforts to create a plan that embraces companion State programs and policies in order to better understand the full possibilities and constraints for water managers.

The chapter introduces companion State plans—those plans and programs by State departments and agencies that have a direct connection with the Water Plan. It shows how companion State plans were used to develop and augment content in the Water Plan, including its objectives and related actions in Chapter 7 Implementation Plan and the resource management strategies in Volume 2. The chapter concludes with a discussion of the implications of the existing policy framework of companion State plans to shape, guide, and constrain water governance in California, including potential opportunities and impediments for improving water management, integrated resource management, and planning at the statewide and regional levels.

California's water management system is large and complex, its water governance very decentralized, and it requires cooperation and collaboration among decision-makers at all levels of federal, Tribal, State, regional, and local entities. The Water Plan attempts to cross-reference and coordinate with other State programs to be as accurate, up-to-date, and complete as possible.

*California's water management system is large and complex, its water governance very decentralized, and it requires cooperation and collaboration among decision-makers at all levels of federal, Tribal, State, regional, and local entities.*

**Box 3-1 State Departments and Agencies Represented on Water Plan Steering Committee**

- Air Resources Board
- Business, Transportation and Housing Agency (Caltrans)
- CALFED Bay-Delta Program
- California Emergency Management Agency (Cal EMA)
- California Energy Commission
- California Environmental Protection Agency
- California Natural Resources Agency
- California Public Utilities Commission
- Department of Boating and Waterways
- Department of Conservation
- Department of Fish and Game
- 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 Water Resources
- Governor's Office of Planning and Research
- Native American Heritage Commission
- State Lands Commission
- State Water Resources Control Board and Regional Water Boards

# Water Management in California

## Overview

California has a large and complex water system with highly decentralized governance that involves State and federal agencies; Tribal governments; thousands of local agencies, governments, and private firms; and millions of households and farms. Decentralization has a major influence on daily management, planning, and policymaking. Competing and conflicting roles and responsibilities make it difficult to integrate regional water management. Differing roles of the various federal, State, and local governments during planning can create coordination problems. The organizational structure of State government can cause insufficient communication, coordination, and cooperation among numerous State agencies and departments responsible for water.

## 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 furthered through the conditions of American states joining 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 no one, thus protection must be provided by its steward—State government. This interpretation has been upheld by the US Supreme Court. Some, but not all, states include water code in their constitutions.

Inseparable from water, land conservation has been recognized in the California Constitution as meriting special status with respect to taxation.

This special status is implemented, in part, through the California Land Conservation Act (CLCA) of 1965 (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." (Government Code section 51220(a)).

## Agencies and Departments with Water-related Roles and Responsibilities

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

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

Those agencies that are landowners and service providers may also be regulated by regulators.

Together, in addition to roles as landowners, the State and federal governments provide assistance, guidance, scientific review, monitoring, and oversight to local governments

*"It is hereby declared that because of the conditions prevailing in this State the general welfare requires that the water resources of the State be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented, and that the conservation of such waters is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare."*

California Constitution, Article 10, Water

*"To promote the conservation, preservation and continued existence of open space lands, the Legislature may define open space land and shall provide that when this land is enforceably restricted, in a manner specified by the Legislature, to recreation, enjoyment of scenic beauty, use or conservation of natural resources, or production of food or fiber, it shall be valued for property tax purposes only on a basis that is consistent with its restrictions and uses."*

California Constitution, Article 13, Taxation

(city- and county-owned municipal water systems, etc.), Native American Indian Tribes, and special districts.

## California Government

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 State Water Resources Control Board (**State Water Board**) integrates water rights and water quality decision-making authority and is responsible for overall water quality planning. The Water Board and the nine Regional Water Quality Control Boards (**Regional Boards**) 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 California Water Plan. Other State agencies and departments and their roles in water management follow:

- **California Air Resources Board.** Promotes and protects public health, welfare, and ecological resources through the effective and efficient reduction of air pollutants. Through its effort to reduce greenhouse gases in California, ARB plays a role in ensuring water management and use minimizes its greenhouse gas emissions.
- **California Bay-Delta Authority.** Oversees the 23 State and federal agencies working cooperatively through the CALFED Bay-Delta Program to improve the quality and reliability of California's water supplies while restoring the Bay-Delta ecosystem.
- **California Business Transportation and Housing Agency.** 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 for and regulates land and water uses in the coastal zone consistent with the policies of the California Coastal Act.
- **California Department of Conservation.** 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 Boating and Waterways.** Develops public access to the waterways and promotes on-the-water safety with programs that include aquatic pest control in the Sacramento-San Joaquin River Delta, coastal beach erosion control, and grants for vessel sewage pumpout stations.
- **California Department of Fish and Game.** Regulates and conserves the state's wildlife and is a trustee for fish and wildlife resources (FDC § 1802). It is the State's primary department for managing the 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 1600, Streambed Alteration Agreements.

- **California Department of Food and Agriculture.** 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 of 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 Parks and Recreation (State Parks).** Manages more than 270 park units, which protect and preserve culturally and environmentally sensitive structures and habitats, threatened plant and animal species, ancient Native American sites, and historic structures and artifacts. Responsible for almost one-third of California's scenic coastline and manages many of the state's coastal wetlands, estuaries, beaches, and dune systems.
- **California Department of Pesticide Regulation.** Regulates pesticide sales and use and plays a significant role in monitoring for the presence of pesticides and in preventing further contamination of the water resource.
- **California Department of Public Health.** Regulates public water systems; oversees water recycling projects; permits 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 MTBE and other oxygenates; 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.** Provides technical oversight for the characterization and remediation of soil and water contamination.
- **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 California 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.** Restores, protects, and enhances the environment to ensure public health, environmental quality, and economic vitality.
- **California Integrated Waste Management Board.** Manages the estimated 76 million tons of waste generated each year by reducing waste whenever possible, promoting the management of all materials to their highest and best use, and protecting public health and safety and the environment.
- **California Public Utilities Commission.** Regulates privately owned water and other utility companies.

- **Central Valley Flood Protection Board.** Plans flood controls along the Sacramento and San Joaquin rivers and their tributaries in cooperation with the US Army Corps of Engineers.
- **Colorado River Board.** Protects California's rights and interests in the resources provided by the Colorado River.
- **Delta Protection Commission.** Responsible for preparation of a regional plan for the "heart" of the Delta.
- **Governor's Office of Planning and Research (OPR).** Provides legislative and policy research support for the Governor's office. The State Clearinghouse coordinates the State-level review of environmental documents pursuant to the California Environmental Quality Act; provides technical assistance on land use planning and CEQA matters; and coordinates State review of certain federal grants programs.
- **Native American Heritage Commission.** 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.
- **Sierra Nevada Conservancy.** 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, supplying 65 percent of the developed water supply.
- **State Lands Commission.** Manages public trust lands of the State (the beds of all naturally navigable rivers, lakes, and streams, as well as the State's tide and submerged lands along California's more than 1,100 miles of 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.

## Federal Government

Many federal agencies play important roles in the regulation and management of California's water resources:

- **Federal Energy Regulatory Commission (FERC).** Regulates the interstate transmission of electricity, natural gas, and oil. FERC also reviews proposals to license hydropower projects.
- **National Marine Fisheries Service (NOAA Fisheries).** Protects and preserves living marine resources, including anadromous fish.
- **National Park Service.** Manages national parks, including their watersheds.
- **US Army Corps of Engineers.** Plans, designs, builds, and operates water resources projects (navigation, flood control, environmental protection, disaster response, etc.).
- **US Bureau of Land Management (BLM).** Manages federal lands.

- **US Bureau of Reclamation (USBR).** Operates the Central Valley Project (CVP), the largest water project in California; and regulates diversions from the Colorado River.
- **US Department of Agriculture (USDA).** Manages forests, watersheds, and other natural resources.
- **[USDA] Natural Resource Conservation Service.** Provides technical and financial assistance to conserve, maintain, and improve natural resources on private lands.
- **US Environmental Protection Agency (EPA).** Protects human health, safeguarding the natural environment.
- **US Fish and Wildlife Service.** Conserves, protects, and enhances fish, wildlife, and plants and their habitats.
- **US Geological Survey.** Provides water measurement and water quality research.
- **Western Area Power Administration.** Manages power generated by the Central Valley Project.

## 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. 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. Investor-owned utilities may also be involved in water supply activities and are regulated by the California Public Utilities Commission. 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.

## Tribal Governments, Organizations, and Communities

Working with the trust responsibilities of several federal agencies, California's Tribal governments and communities are responsible for meeting the water needs of the residents, businesses, industries, and visitors of their respective reservations, rancherias, and allotment lands held in trust by the federal government. Responsible federal agencies include the US Bureau of Indian Affairs, US Environmental Protection Agency, Indian Health Service, and the US Bureau of Reclamation, among others. Tribal governments and communities may also participate in local, regional, and statewide water planning and management activities at their discretion. Many Tribal communities, however, are served by substandard water systems and contaminated watersheds and groundwater sources in need of major improvements.

## 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 Water Plan Update 2009.

## Figure 3-1 State agencies with featured plans

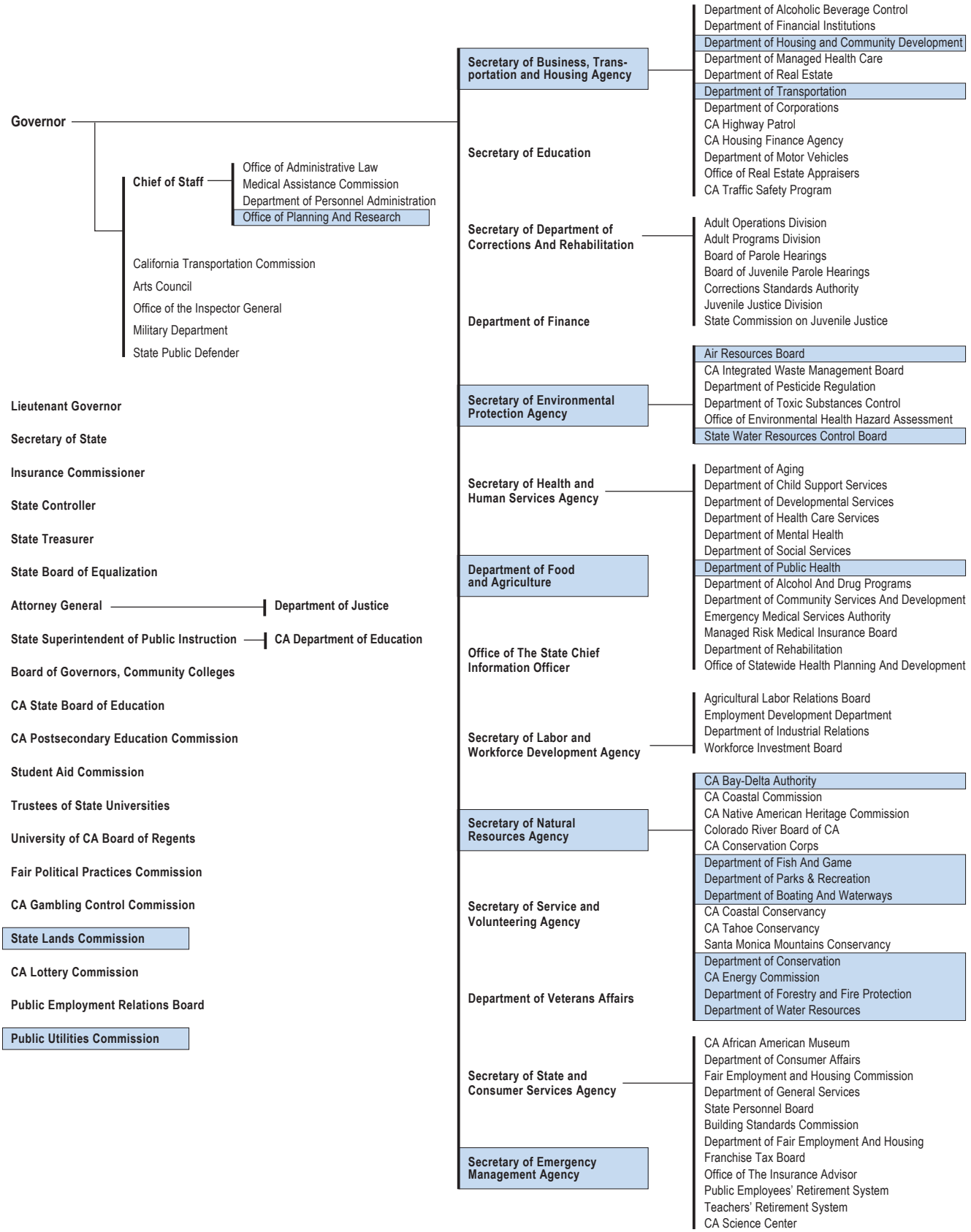


Figure 3-1 shows State government structure and highlights participating agencies and departments. In the past, DWR had performed this role with little formal input from other State agencies. The Steering Committee collaborates to develop a more comprehensive Water Plan that strategically integrates 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 as needed the vision, mission, and goals of the Water Plan, and update its recommendations and implementation plan. Develop multiple scenarios of future California water conditions and use scenarios to evaluate different combinations of resource management strategies (called response packages) for a range of water demand and supply assumptions plus climate change.
- Develop climate change scenarios to evaluate impacts on California's water resources and water systems and to identify and recommend statewide and regional adaptation strategies.
- Update the regional reports for the 10 hydrologic regions and for the Delta and Mountain Counties as areas of special concern. Use information gained from the integrated regional water management 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. 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 1998 through 2005. Improve methods for representing consumptive and non-consumptive environmental water and where reuse of water is occurring.
- Improve information exchange and data integration, data, and analytical tools to inform all Water Plan activities and decisions and to assist California water planners and managers.
- Incorporate findings and recommendations from companion State government plans and initiatives into Update 2009.

# Companion State Plans and the California Water Plan

## Companion State Plans

A major effort of the Steering Committee was to identify other State planning processes, policies, plans, and procedures that had a direct connection with the Water Plan. 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.

A review gathered about 130 State agencies plans with some nexus. Of those at least 40 plans had direct relevance to the Volume 2 Resource Management Strategies, and many informed the recommendations, objectives, and related actions in Volume 1 The Strategic Plan. The companion plans focus on different resources and programs, respective to their agencies, but they each provide part of the overall framework of California's water governance.

The 23 companion plans featured in Update 2009 substantially inform the water planning process (Box 3-2). In some cases, such as with the State Water Board, the relationship is legally required; in others, the relationship draws from a mutual governance responsibility. Short descriptions of the 23 plans follow.

### California Transportation Plan 2025 (Department of Transportation)

The California Transportation Plan (CTP) is a statewide, long-range transportation plan for meeting California's future mobility needs. The CTP defines goals, policies, and strategies to achieve a 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. 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.

*The 23 companion plans featured in Update 2009 substantially inform the water planning process.*

### Delta Vision

By executive order, The Governor established the Delta Vision Blue Ribbon Task Force in 2006 to create a vision to repair the ecologically damaged Sacramento-San Joaquin River Delta and then write a strategic plan that would sustain the Delta while ensuring a reliable water supply. The Governor's order also charged the Cabinet Secretaries to meet as the Delta Vision Committee, review those Delta Vision reports, and make implementation recommendations to the Legislature and Governor. The committee report was filed December 2008. Find this report and other Delta Vision reports at http://www.deltavision.ca.gov/.

#### *Delta Vision Committee Implementation Report*

On December 31, 2008, the Delta Vision Committee submitted its final implementation report to the Governor and Legislature recommending actions on how the Delta should be managed to fulfill its co-equal goals of water supply reliability and ecosystem restoration. The committee praised the work of the Delta Vision Blue Ribbon Task Force, accepting all of the recommended goals proposed by the task force and adopting nearly all of the task force's recommended strategies. The implementation report includes near-term actions necessary to achieve Delta sustainability and to avoid catastrophe.

**Box 3-2 Companion State Plans Featured in Update 2009**

- 2007 Integrated Energy Policy Report (California Energy Commission 2007)
- 2009 California Climate Adaptation Strategy (California Natural Resources Agency)
- California Department of Public Health Strategic Plan 2008-2010 (CDPH 2008)
- California Drought, An Update (DWR Apr 2008)
- California Outdoor Recreation Plan 2008: An Element of the California Outdoor Recreation Planning Program (CORP) (State Parks 2009)
- California Transportation Plan 2025 (April 2006) and 2030 (Caltrans Oct 2007)
- California Water Plan Update 2009 Draft Tribal Communication Plan (Tribal Communication Committee, Summer 2008)
- California Wildlife Action Plan (DFG 2007)
- Climate Change Scoping Plan: A Framework for Change (California Air Resources Board Dec 2008)
- Critical Water Shortage Contingency Plan (Governor's Advisory Drought Panel 2000)
- Delta Vision Committee Implementation Report (31 Dec 2008)
- Delta Vision Strategic Plan-Final (Governor's Delta Vision Blue Ribbon Task Force, Oct 2008)
- Delta Vision: Our Vision for the California Delta (Governor's Delta Vision Blue Ribbon Task Force, 19 Jan 2008)
- FloodSAFE Strategic Plan (DWR May 28, 2008 public review draft)
- General Plan Guidelines (Office of Planning and Research 2003)
- Managing an Uncertain Future; Climate Change Adaptation Strategies for California's Water (DWR Oct 2008)
- Preparing for California's Next Drought – Changes Since 1987–1992 (DWR 2000)
- Regional Water Quality Control Plans (Basin Plans) (Water Boards)
- State of California Multi-Hazard Mitigation Plan (Governor's Office of Emergency Services 2007)
- Strategic Workplan for Activities in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (State Water Boards July 2008)
- Water Action Plan (CPUC Nov 2005)
- Water Boards Strategic Plan 2008-2012 (Water Boards 2008)
- Water-Energy Climate Change Mitigation Strategies-Draft (WETCAT Mar 2008 Draft)

### *Delta Vision Strategic Plan (Blue Ribbon Task Force)*

In October 2008, Governor Schwarzenegger's Delta Vision Blue Ribbon Task Force finalized and adopted the Delta Vision Strategic Plan a comprehensive set of recommendations designed to ensure long-term sustainable management of the Delta.

The plan was developed to balance the need for a reliable water supply for California with protection for the Delta's environmental resources. The Delta Vision Strategic Plan broadens the focus of past efforts to recommend actions that address the full array of economic, natural resource, infrastructure, and governance issues necessary to achieve a sustainable Delta.

### *Delta Vision: Our Vision for the California Delta (Blue Ribbon Task Force)*

In 2007, the Governor's Delta Vision Blue Ribbon Task Force issued a vision document for sustainable management of the Delta (directed by Executive Order S-17-06). Its goal is to manage the Delta over the long term in a way that restores and maintains identified functions and values important to the environmental quality of the Delta and the economic and social well being of Californians. The report presents a comprehensive vision that addresses, water, land use, and institutional and environmental elements; 12 linked and integrated recommendations; and near-term actions.

### Water-Energy Climate Change Mitigation Strategies (WETCAT March 2008 Draft)

The Global Warming Solutions Act of 2006 (AB 32) requires California Air Resources Board to prepare a scoping plan to achieve reductions in greenhouse gas emissions in California. The 2008 scoping plan proposes six greenhouse gas emission reduction strategies for the water sector: (1) water use efficiency, (2) water recycling, (3) water system energy efficiency, (4) reuse of urban runoff, (5) increased renewable energy production, and (6) a public goods charge for water.

### Climate Change Scoping Plan: A Framework for Change (California Air Resources Board 2008)

The Global Warming Solutions Act of 2006 (AB 32) required the Air Resources Board to prepare a scoping plan to achieve reductions in greenhouse gas (GHG) emissions in California. The Scoping Plan, approved by the ARB Board December 2008, provides the outline for actions to reduce California's greenhouse gas (GHG) emissions.

### California Department of Public Health Strategic Plan for 2008-2010

In 2008, the newly established California Department of Public Health (CDPH) released its first strategic plan that defines its mission, vision, core values, goals, and related objectives. The strategic plan will serve as a roadmap for CDPH short- and long-term work through 2010. CDPH narrowed its five goals to areas of public health that require immediate attention while remaining achievable with limited or no additional resources.

### 2007 Integrated Energy Policy Report

The 2007 Integrated Energy Policy Report (IEPR) was prepared in response to Senate Bill 1389 (chapter 568, Statutes of 2002). The report fulfills the requirement of

AB 1389 and was developed under the direction of the California Energy Commission's 2007 IEPR committee. The Energy Commission asserted that the statewide targets should be set to achieve all of the state's cost-effective energy efficiency and strongly supported capturing all cost-effective efficiency savings potential as well as renewable energy development.

### Water Action Plan (California Public Utilities Commission)

On December 15, 2005, the California Public Utilities Commission (CPUC) approved a Water Action Plan for the state that sets policy goals and objectives in regulating investor-owned water utilities and highlights the actions that the CPUC anticipates or will consider taking in order to implement those objectives.

### California Wildlife Action Plan (Department of Fish and Game and Wildlife Health Center at UC Davis)

California Wildlife: Conservation Challenges, the State's wildlife action plan, was developed and produced as a collaboration between the California Department of Fish and Game (DFG) and the Wildlife Health Center at the University of California, Davis. 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.

### 2009 California Climate Adaptation Strategy (California Natural Resources Agency)

To prepare for the expected impacts of climate change, California has developed a statewide adaptation strategy in coordination with efforts targeting greenhouse gas mitigation policies. This is a report to the Governor in response to Executive Order S-13-2008. It synthesizes the most up-to-date information on expected climate change impacts to California for policymakers and resource managers to provide strategies to promote resiliency to these impacts and develop implementation plans for short- and long-term actions. As part of the report, geographical maps and interactive planning tools are available to help local communities assess what climate impacts may happen in their area. As California's adaptation effort continues, more region-specific planning tools will be made available to help communities plan effectively for climate change

### Managing an Uncertain Future; Climate Change Adaptation Strategies for California's Water (DWR)

In October 2008, DWR released a climate change white paper that discusses the need for California's water managers to adapt to impacts of climate change, some of which are already affecting water supplies. The report proposes 10 adaptation strategies in four categories. The primary purpose of the white paper is to identify some of the important challenges California faces from long-term climate change and to recommend

water management adaptation strategies to respond to the effects of climate change. Disturbing trends in the latter 20th century—including earlier snowmelt, an increase in peak floodflows coupled with predictions of longer droughts, and a rise in the sea level—call for immediate and strategic action. Many of the recommended strategies call for more integrated management of State and local water supply and flood systems. The report also identifies the need for additional investment in scientific information used to support decisions about adaptation strategies.

### Preparing for California's Next Drought – Changes Since 1987–1992 (DWR)

In 2000, this report provided input to the deliberations of the Governor's Advisory Drought Planning Panel, which released "Critical Water Shortage Contingency Plan" later in 2000 (see below). After a two-year drier-than-normal period and with the experience of the 1987-1992 drought, DWR initiated "Preparing for California's Next Drought" to review items that DWR should consider in near-term drought planning. The report begins with an overview of California hydrology and water supply, describes conditions encountered in the 1987-1992 drought and summarizes changes in conditions and their implications. The report concludes with a list of actions that the DWR can take to respond to future flood conditions.

### Critical Water Shortage Contingency Plan (Governor's Advisory Drought Planning Panel)

In 2000, the "Critical Water Shortage Contingency Plan" was prepared in response to the commitment in the CALFED Bay-Delta Program's Record of Decision (ROD) that the Governor would convene a panel to develop a "contingency plan to reduce the impacts of critical water shortages primarily for agricultural and urban water uses." The DWR director chaired the panel. The plan identifies available resources and funding mechanisms to reduce the impacts of critical water shortages during initial implementation of the CALFED Bay-Delta Program. The panel's recommended actions were intended to address measures not explicitly contained in the CALFED ROD and to accelerate implementation of actions not scheduled to be carried out in the early year of CALFED Stage 1.

### California Drought, An Update (DWR)

Released in April 2008, this report covers recent hydrologic conditions and impacts since 2000 through water year 2007. It updates the status of selected water management activities having a bearing on drought preparedness and highlights advances in hydroclimate research related to drought.

### FloodSAFE Strategic Plan Public Review Draft (DWR)

In 2006, DWR launched FloodSAFE California. FloodSAFE is the first statewide initiative designed to help improve integrated flood management with a significant emphasis on the Central Valley and Delta, where communities and resources are at

high risk of catastrophic damage. DWR leads the FloodSAFE program with active participation from local, regional, State, Tribal, and federal partners.

### State of California Multi-Hazard Mitigation Plan (Cal EMA formerly Governor's Office of Emergency Services)

Cal EMA, formerly the Governor's Office of Emergency Services, led the effort to complete the 2007 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.

### General Plan Guidelines (Governor's Office of Planning and Research)

The 2003 General Plan Guidelines advises cities and counties how to write a general plan that expresses a community's long-term vision, fulfills statutory requirements, and contributes to creating a great community. Each city and county in California must prepare a comprehensive, long-term general plan to guide its future. OPR is required to adopt and periodically revise guidelines for the preparation and content of general plans. Notably, the 2003 General Plan Guidelines introduced guidance for addressing environmental justice and for developing optional water and energy elements.

### California Outdoor Recreation Plan 2008 (State Parks)

California State Parks' Planning Division develops the California Outdoor Recreation Plan (CORP), the statewide master plan for parks, outdoor recreation, and open space for California. The CORP provides policy guidance to providers of outdoor recreational lands, facilities, and services throughout California, including federal, State, local, and special district agencies. The CORP is also the primary tool for prioritizing Land and Water Conservation Fund grant allocations to local governments. The CORP is updated periodically. The most recent was produced in 2008 and approved in 2009.

### Regional Water Quality Control Plans (State Water Boards)

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 water in California, including surface water and groundwater. They also include programs of implementation to achieve water quality objectives. Basin Plans are developed and adopted by the Regional Boards and then approved by the State Water Board, US Environmental Protection Agency, and the Office of Administrative Law, where required.

### Water Boards Strategic Plan Update 2008-2012 (State Water Boards)

In 2008, the State Water Board and the nine Regional 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 continuously evaluate consistency and effectiveness of program implementation across the Water 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.

### Strategic Workplan for Activities in the San Francisco Bay/ Sacramento-San Joaquin Delta Estuary (State Water Boards 2008)

In December 2007 and January 2008, resolutions adopted by the State Water Boards directed staff to develop a strategic work plan that describes the coordinated activities of the Water Boards to address Bay-Delta issues, prioritizes the scope of individual activities, and specifies timelines and resource needs. It describes high-priority Bay-Delta activities the Water Boards will take through 2013.

The Water Boards recognize that they have 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 workplan identifies activities that will need to be coordinated with other efforts. Overall, the workplan 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.

### California Water Plan Update 2009 Draft Tribal Communication Plan (Tribal Communication Committee 2008)

In 2008, the Tribal Communication Committee prepared the Tribal Communication Plan to help those involved in the California Water Plan—including DWR and all other State and federal agencies—to communicate appropriately and effectively with all California Native American Tribes about water-related issues that may affect them in their territories and ancestral homelands. More specifically, it aims to promote and increase the quality of all California Native American Tribes' participation in California Water Plan Update 2009 and all future Water Plan update processes to ensure the description and inclusion, protection, and advancement of Tribal water and culturally related needs and rights. It identifies key messages, materials, and partners as well as 22 specific actions for communication. It provides a procedure for dispute resolution and criteria for evaluating success of activities.

A longer list of State agency and department plans that relate to water governance can be found in Volume 4 Reference Guide.

**Table 3-1 Matrix of companion plans and related objectives**

| Title | Agency | Water Plan Objectives |
|---|---|---|
| California Transportation Plan 2025 and 2030 | BTH (Caltrans) | 1, 4, 10, 13 |
| Delta Vision Committee Implementation Plan | CALFED / DV BRTF | 5, 6, 7, 13 |
| Draft Water-Energy Climate Change Mitigation Strategies | CARB | 1, 5, 9, 13 |
| California Department of Public Health Strategic Plan (2008-2010) | CDPH | 4, 13 |
| 2007 Integrated Energy Policy Report | CEC | 2, 9, 13 |
| Water Action Plan 2005 | CPUC | 2, 9, 10, 13 |
| California Wildlife Action Plan, DFG | DFG | 3, 5 |
| Managing an Uncertain Future; Climate Change Adaptation Strategies for California's Water | DWR | 1, 2, 3, 5, 6, 8, 9, 10, 11 |
| 2009 California Climate Adaptation Strategy Discussion Draft Public Review Draft | CNRA | 1, 8, 10, 11 |
| Preparing for California's Next Drought: Changes Since 1987–1992 | DWR | 3, 8 |
| Critical Water Shortage Contingency Plan, Governor's Advisory Drought Panel | DWR | 1, 3, 8 |
| California Drought, an Update | DWR | 8 |
| Draft FloodSAFE Strategic Plan | DWR | 6, 8, 13 |
| State of California Multi-Hazard Mitigation Plan (2007) | OES | 8 |
| General Plan Guidelines | OPR | 6, 13 |
| California Outdoor Recreation Plan (CORP) | Parks | 5, 13 |
| Regional Water Quality Control Plans (Basin Plans) | State Water Board | 1, 2, 4, 7, 13 |
| Water Boards Strategic Plan 2008-2012 | State Water Board | 1, 2, 4, 7, 10, 13 |
| Draft Bay-Delta Strategic Work Plan | State Water Board | 4, 7, 10 |
| Update 2009 Draft Tribal Communication Plan* | TCC | 12 |
| * This is a stakeholder generated plan rather than a State agency plan. | | |

## Water Plan Recommendations, Objectives and Related Actions

The objectives and related actions presented in Chapter 7 Implementation Plan are taken in part from DWR's Climate Change Adaptation White Paper dated August 20, 2008, and from other companion State plans. Many objectives derived from companion State plans were developed to meet various resource management and communication goals.

Table 3-1 shows the companion plans that have content related to the Water Plan objectives found in Chapter 7 Implementation Plan.

## Resource Management Strategies

The companion State plans have several connections with the Update 2009 Volume 2 Resource Management Strategies. Table 3-2 (Matrix of companion plans and resource management strategy categories) shows how each featured plan relates to the resource management strategy categories. Several companion plans have cross-cutting recommendations such as the need to both improve water quality and practice resource stewardship.

**Table 3-2 Matrix of companion plans and resource management strategy categories**

| Title | Agency | Reduce Water Demand | Improve Operational Efficiency & Transfers | Increase Water Supply | Improve Water Quality | Practice Resource Stewardship | Improve Flood Mgmt |
|---|---|---|---|---|---|---|---|
| CA Transportation Plan 2025 and 2030 | BTH (Caltrans) | X | | | X | X | X |
| Delta Vision Committee Implementation Plan | CALFED / DV BRTF | X | X | X | X | X | X |
| Draft Water-Energy Climate Change Mitigation Strategies | CARB | X | X | X | | | |
| CA Dept of Public Health Strategic Plan (2008-2010) | CDPH | | | | X | X | |
| 2007 Integrated Energy Policy Report | CEC | X | X | | | X | |
| Water Action Plan 2005 | CPUC | X | | | | | |
| CA Wildlife Action Plan, DFG | DFG | X | X | | X | X | X |
| Managing an Uncertain Future; Climate Change Adaptation Strategies for California's Water | DWR | X | X | X | X | X | X |
| Preparing for California's Next Drought: Changes Since 1987–1992 | DWR | | X | | | X | |
| Critical Water Shortage Contingency Plan, Governor's Advisory Drought Panel | DWR | | X | | | X | |
| California Drought, an Update | DWR | X | X | X | | X | |
| Draft FloodSAFE Strategic Plan | DWR | | | X | X | X | X |
| State of CA Multi-Hazard Mitigation Plan (2007) | OES | | | | | X | X |
| General Plan Guidelines | OPR | X | | | X | X | X |
| California Outdoor Recreation Plan (CORP) | Parks | | | | | X | X |
| Regional Water Quality Control Plans (Basin Plans) | SWRCB | | | X | X | X | X |
| Water Boards Strategic Plan 2008-2012 | SWRCB | X | | | X | X | |
| Draft Bay-Delta Strategic Work Plan | SWRCB | | | | X | X | |
| Update 2009 Draft Tribal Communication Plan | TCC | | | | | | |

*Additional State and other government plans are referenced in the Resource Management Strategies

## Implications and Considerations

The new complexities of managing water resources require rigorous, collaborative, multidiscipline approaches. The formation of the Steering Committee and the use of companion plans to inform objectives and recommendations meet that requirement and mark a substantial change in State water planning.

As may be expected, the convening State agency group has already expanded collaboration opportunities. During this planning cycle, the Steering Committee has assisted with planning for drought, flood management, water reduction goals, climate change, and water-energy efficiency. The role of this group is expected to grow as other planning processes are engaging water planners in their decision processes.

*The new complexities of managing water resources require rigorous, collaborative, multidiscipline approaches. The formation of the Steering Committee and the use of companion plans to inform objectives and recommendations meet that requirement and mark a substantial change in State water planning.*

The inclusion of companion plans is an important step in moving toward comprehensive and integrated water management. The Companion State Plans chapter provides a substantial service to decision-makers by creating:

- A simple reference guide to the agencies and relevant plans
- A more comprehensive view of the complex network of water-related efforts
- More understanding of inter-relationship of policies
- Increased opportunity for collaboration in creating policy
- Opportunities for consistency of State policy
- A multidisciplinary structure for the Water Plan document

The formation of the State agency group has additional benefits for improving communication with the stakeholder community. The State agencies and departments are investigating initiation of more joint efforts. This will result in less cost to the agencies and streamlined interaction for stakeholders. Further, the group provides a simple entrance point for federal, Tribal, regional, and local agencies seeking communication with the State on water issues.

*The formation of a State agency group has additional benefits for improving communication with the stakeholder community.*

*This will result in less cost to the agencies and streamlined interaction for stakeholders.*

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# California Water Today

***Chapter photo.*** Harvesting in the Central Valley

# Contents

**Chapter 4. California Water Today ..... 4-5**
About this Chapter ..... 4-5
Variable and Extreme Resources ..... 4-5
Hydrologic Regions and Areas of Interest ..... 4-7
Climate ..... 4-9
Land Use and Development Patterns ..... 4-12
Land Use Patterns ..... 4-14
Tribal Lands ..... 4-14
Water Conditions ..... 4-14
Environmental Water ..... 4-14
Water Supplies and Uses ..... 4-15
Water Quality ..... 4-26
Project Operation and Reoperation ..... 4-27
Water Governance ..... 4-27
Flood Management ..... 4-29
Critical Challenges ..... 4-29
Dry-year Period (Drought) ..... 4-31
Floods and Flooding ..... 4-31
Environment/Ecosystem ..... 4-33
Climate Change ..... 4-33
Water and Energy ..... 4-38
Contamination of Surface Water and Groundwater ..... 4-40
Delta Vulnerabilities ..... 4-40
Deferred Maintenance and Aging Infrastructure ..... 4-41
Catastrophic Events and Emergency Response ..... 4-43
Data Gathering and Sharing ..... 4-43
Disadvantaged Communities ..... 4-44
Funding ..... 4-44
Responses and Opportunities ..... 4-44
Stewardship and Sustaining Natural Resources ..... 4-44
Regional/Local Planning and Management ..... 4-47
Statewide and Interregional Planning and Response ..... 4-50
Propositions and Bonds ..... 4-59
Federal Government ..... 4-62
References ..... 4-63

## Figures

Figure 4-1 Map of California with major rivers and facilities ..... 4-6
Figure 4-2 Hydrologic regions of California, the Sacramento-San Joaquin River Delta, and Mountain Counties Area ..... 4-8
Figure 4-3 Integrated Regional Water Management planning regions accepted or conditionally accepted by DWR in November 2009 ..... 4-11

Figure 4-4 Sacramento Four Rivers unimpaired runoff, 1906–2008 ..... 4-18
Figure 4-5 San Joaquin Four Rivers unimpaired runoff, 1906–2008 ..... 4-18
Figure 4-6 Total statewide runoff and key reservoir storage end of water years 2006-2009 ..... 4-19
Figure 4-7 California water balance by year, 1998-2005 ..... 4-21
Figure 4-8 Water balance by region for water year 2005 ..... 4-24
Figure 4-9 Regional inflows and outflows, water year 2005 ..... 4-25
Figure 4-10 Potential impacts of continuing drought ..... 4-30
Figure 4-11 Climate change effects in California ..... 4-34
Figure 4-12 American River runoff annual maximum three-day flow ..... 4-36
Figure 4-13 Average annual snowmelt for Upper Feather River Basin ..... 4-38
Figure 4-14 Historical and projected decreasing California snowpack ..... 4-38
Figure 4-15 Historical and projected sea level rise at Golden Gate ..... 4-39
Figure 4-16 Regional population and per capita residential water use in California for water year 2005 ..... 4-46

## Tables

Table 4-1 California population change from 2000 to 2005 by hydrologic region .... 4-12
Table 4-2 California water balance summary, 1998-2005. (Numbers in million acre-feet) ..... 4-22
Table 4-3 Basin plan adoption dates ..... 4-26

## Boxes

Box 4-1 Acronyms and Abbreviations Used in This Chapter ..... 4-9
Box 4-2 About Update 2009 Regional Reports ..... 4-10
Box 4-3 The Rising Economic Efficiency of California Agricultural Water Use ..... 4-13
Box 4-4 Land Use Jurisdiction ..... 4-13
Box 4-5 DFG Streamflow Recommendations Developed in 2008 ..... 4-15
Box 4-6 High-priority List of Streams for Future Instream Flow Studies ..... 4-16
Box 4-7 Groundwater Overdraft ..... 4-19
Box 4-8 Water Portfolio Concept and Key Definitions ..... 4-20
Box 4-9 Investing in Watersheds ..... 4-45
Box 4-10 Complementary Management Approaches: IRWM and Watershed Management ..... 4-48
Box 4-11 Examples of regional water planning efforts ..... 4-49
Box 4-12 New Law Supports Integrated Regional Water Management ..... 4-50
Box 4-13 Mokelumne River Forum and Interregional Conjunctive Use ..... 4-51
Box 4-14 SBxx 1 Appropriations for Integrated Regional Water Management (IRWM) Grants ..... 4-60

# Chapter 4. California Water Today

## About this Chapter

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

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

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

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

## Variable and Extreme Resources

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

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

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

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

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

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

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

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

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

*As we develop and improve water delivery systems, we must also preserve and protect our watersheds and maintain healthy ecosystems. Their health is essential to California's resources and economic future.*

## Hydrologic Regions and Areas of Interest

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

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

**Box 4-1 Acronyms and Abbreviations Used in This Chapter**

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

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

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

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

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

## Climate

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

## Box 4-2 About Update 2009 Regional Reports

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

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

Following are short descriptions of the 10 hydrologic region areas.

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

### The Delta Region and Mountain Counties Area

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

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


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

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

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

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

## Land Use and Development Patterns

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

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

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

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

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

By Jim Rich, Economist, DWR
July 31, 2009

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

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

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

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

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

## Box 4-4 Land Use Jurisdiction

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

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

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

### Land Use Patterns

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

### Tribal Lands

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

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

## Water Conditions

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

### Environmental Water

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

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

### Box 4-5 DFG Streamflow Recommendations Developed in 2008

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

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

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

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

## Water Supplies and Uses

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

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

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

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

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

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

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

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

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

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

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

## Surface and Groundwater—a Single Resource

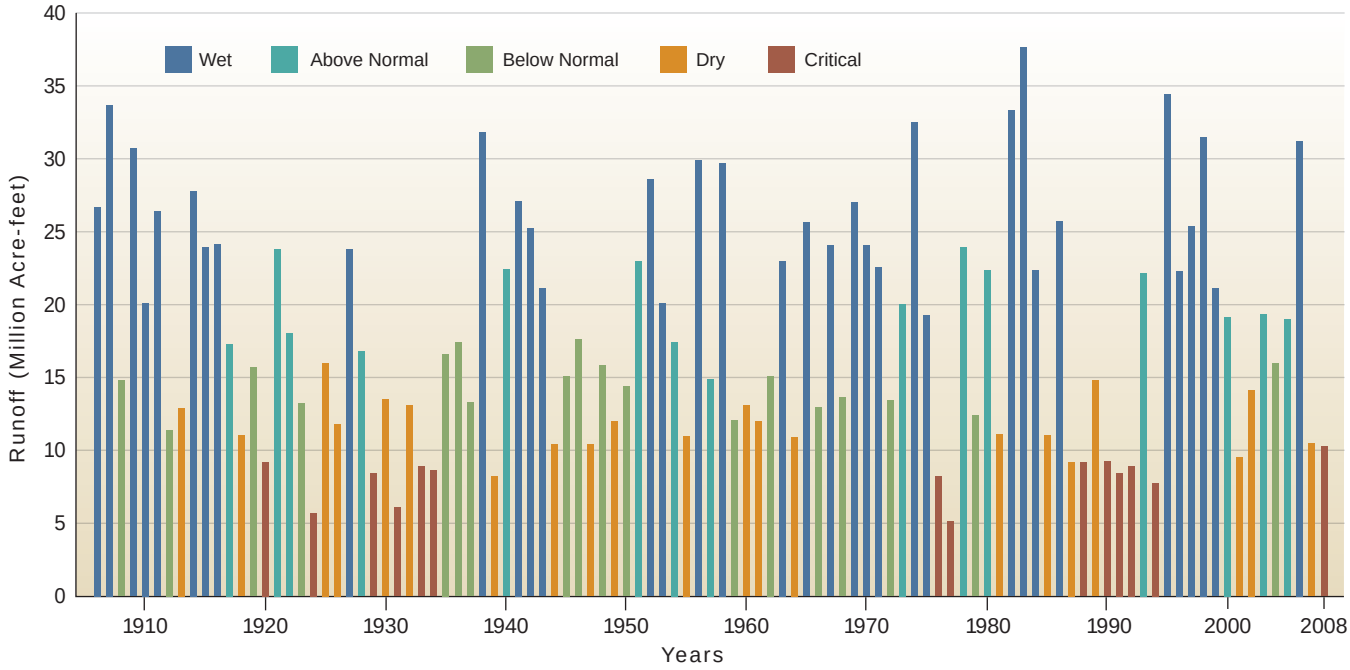
In California, winter precipitation and spring snowmelt are captured in surface water reservoirs to provide both flood protection and water supply to the state. Reservoir storage also factors into drought assessment. The state's largest surface "reservoir" is the Sierra Nevada snowpack, about 15 million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

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

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

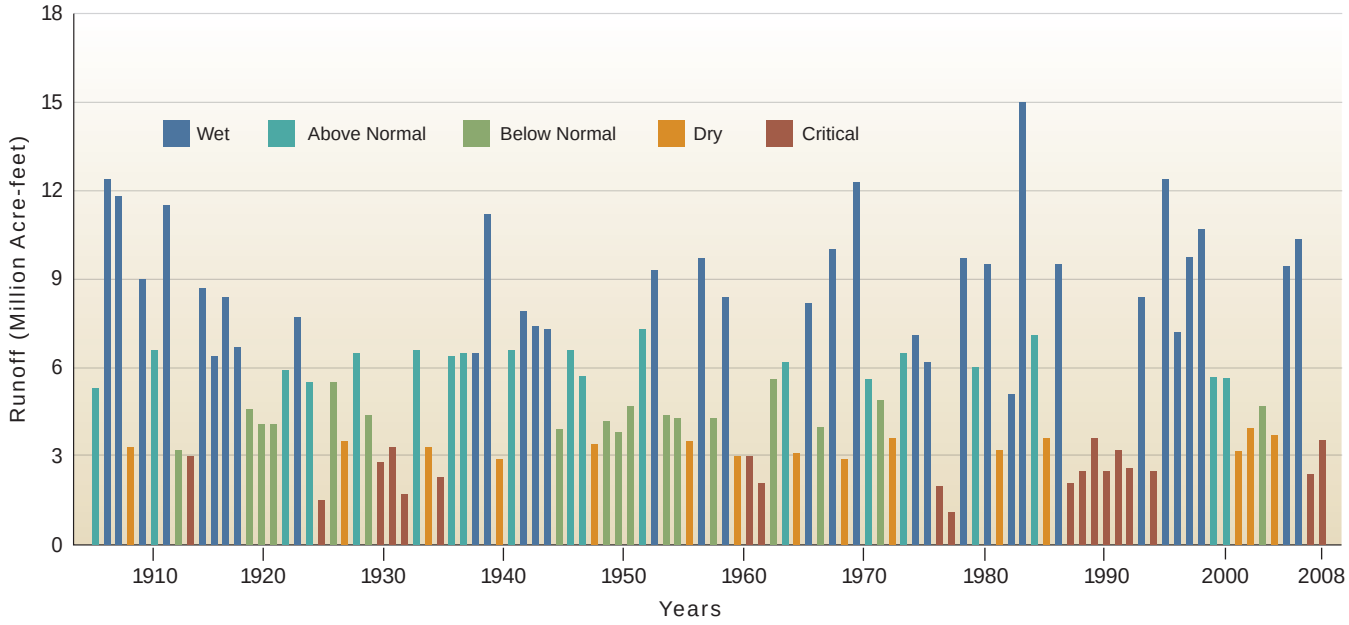
Initial SWP deliveries in 2009 were only 15 percent, although the final allocation was raised to 40 percent after early May snow and rain improved water conditions. Since the SWP began allocating deliveries in 1968, the lowest final allocations have been 35 percent in 2008; 39 percent, 2001; and 30 percent,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

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




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

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




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

### Box 4-7 Groundwater Overdraft

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

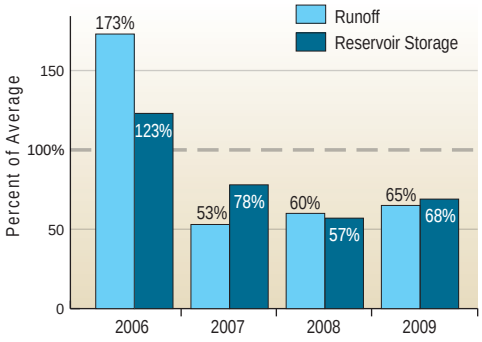
In some cases the term overdraft has been incorrectly used to describe a short-term decline in groundwater in storage during a drought, or to describe a one-year decline of groundwater in storage. A one-year decrease of the amount of groundwater in storage is an annual change in storage and does not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

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

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

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

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




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

*Source: DWR 2009*

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

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

### Box 4-8 Water Portfolio Concept and Key Definitions

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

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

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

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

#### Key Water Supply and Use Definitions

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

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

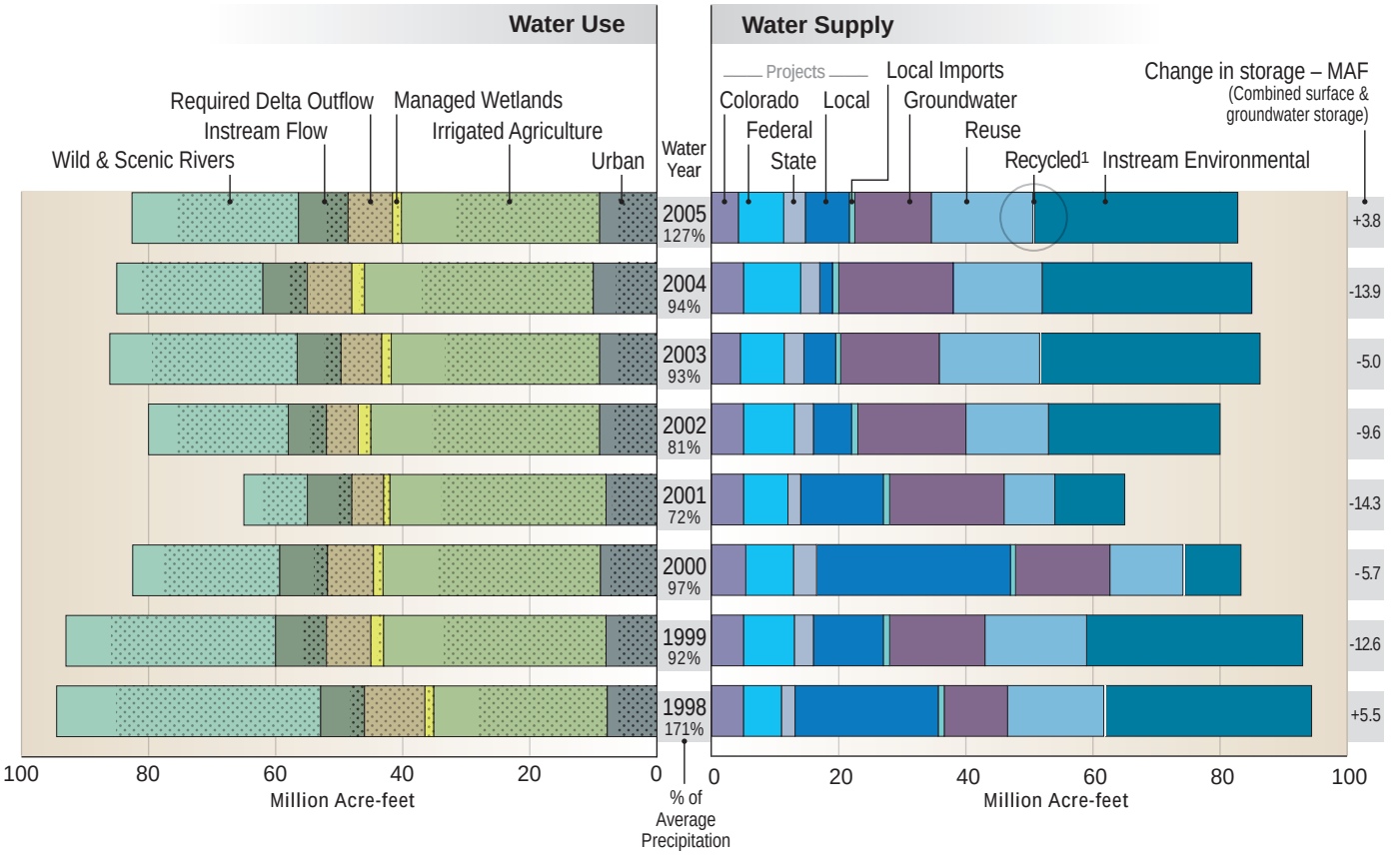
North Coast and Central Coast regions. Most small systems and private wells are located in lightly populated rural areas where opportunities for interconnections with another system, water transfers, or emergency relief are difficult.

### *Colorado River Supplies*

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

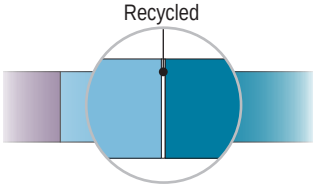
A record eight-year drought in the Colorado River Basin has reduced current reservoir storage throughout the river system to just over 50 percent of total storage capacity.

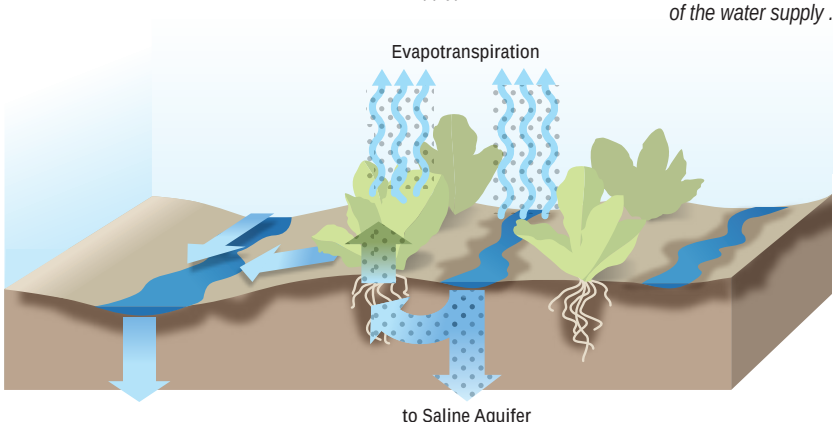
**Figure 4-7 California water balance by year, 1998-2005**




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

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



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

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

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

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

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

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

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

NA=Not Applicable

### Water Portfolio and Water Balances

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

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

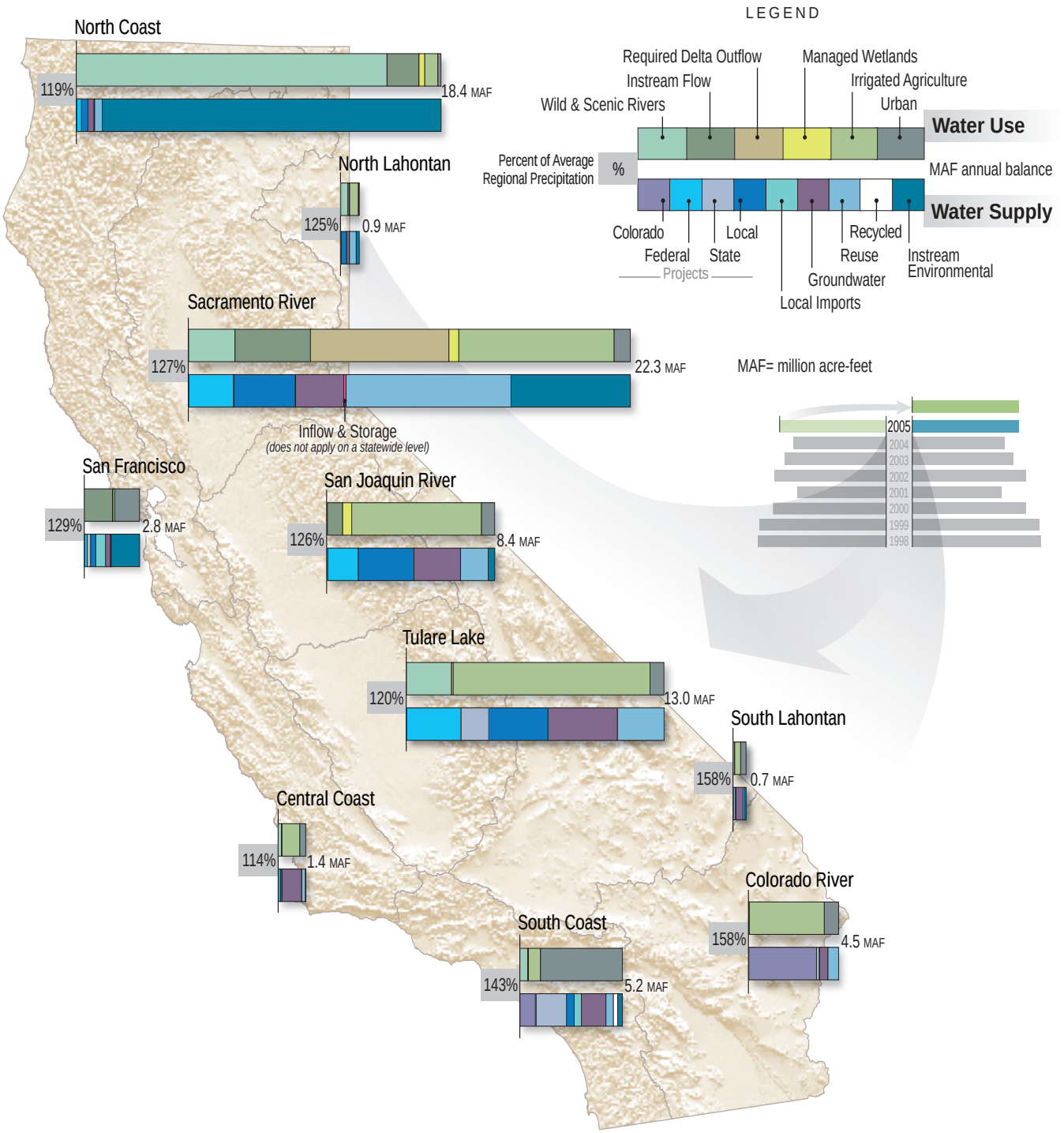
The statewide water balance figure demonstrates the state's variability for water use and water supply. "Water use" shows how applied water was used by urban and agricultural sectors and dedicated to the environment; and "water supply" shows where the water came from each year to meet those uses.

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

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

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

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



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

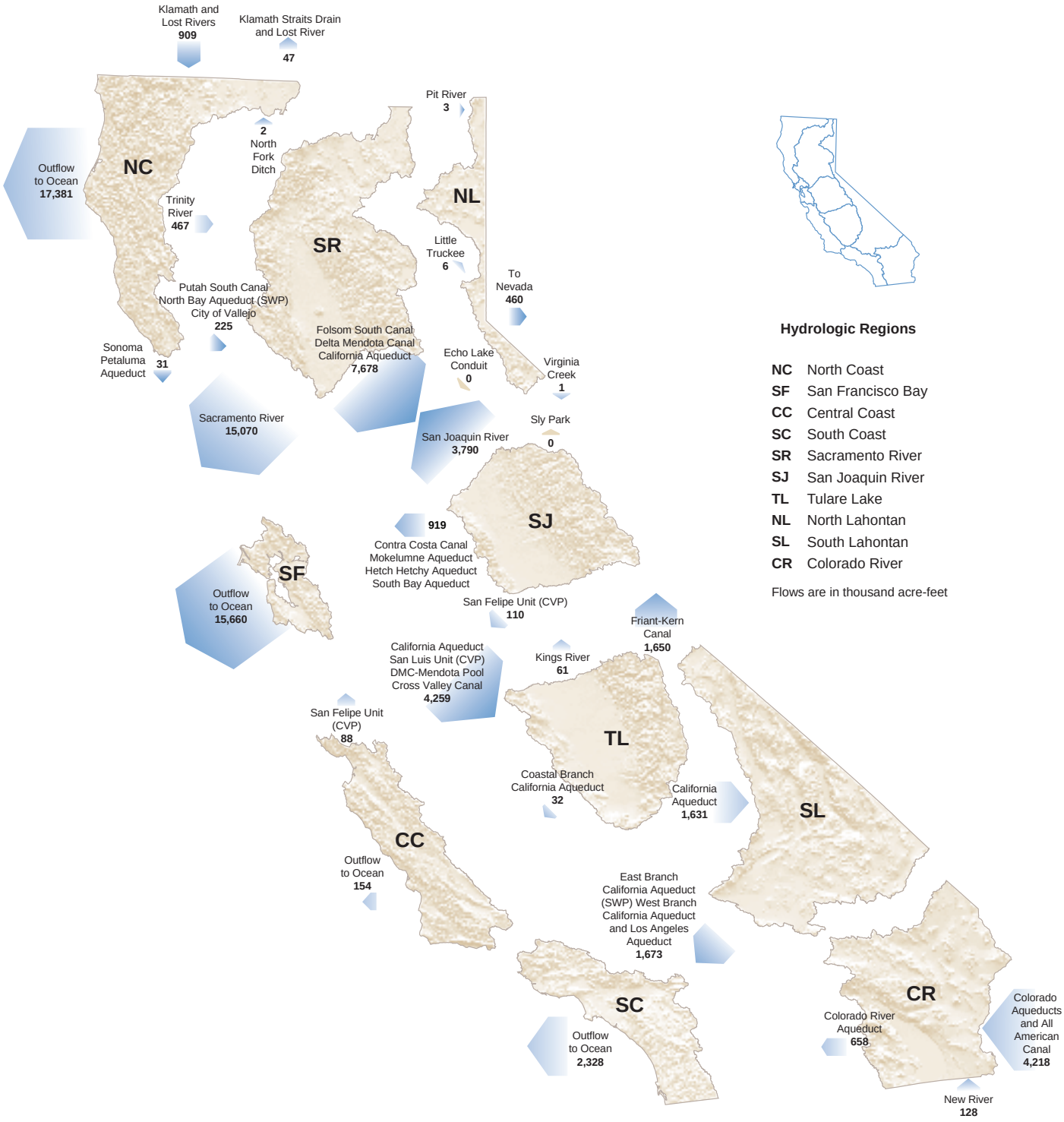


**Table 4-3 Basin plan adoption dates**

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

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

## Water Quality

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

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

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

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

*By law, water quality basin plans prepared by the State and Regional Water Boards when approved become part of the California Water Plan.*

## Project Operation and Reoperation

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

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

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

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

## Water Governance

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

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

### California Constitution

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

### Federal Land Management

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

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

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

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

### Tribal Water Management

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

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

### Flood Management

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

*Traditionally, flood management practices focused on reducing flooding and susceptibility to flood damage largely through the physical measures. In recent years, flood managers have recognized the potential for natural watershed functions and worked to integrate these two methods.*

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

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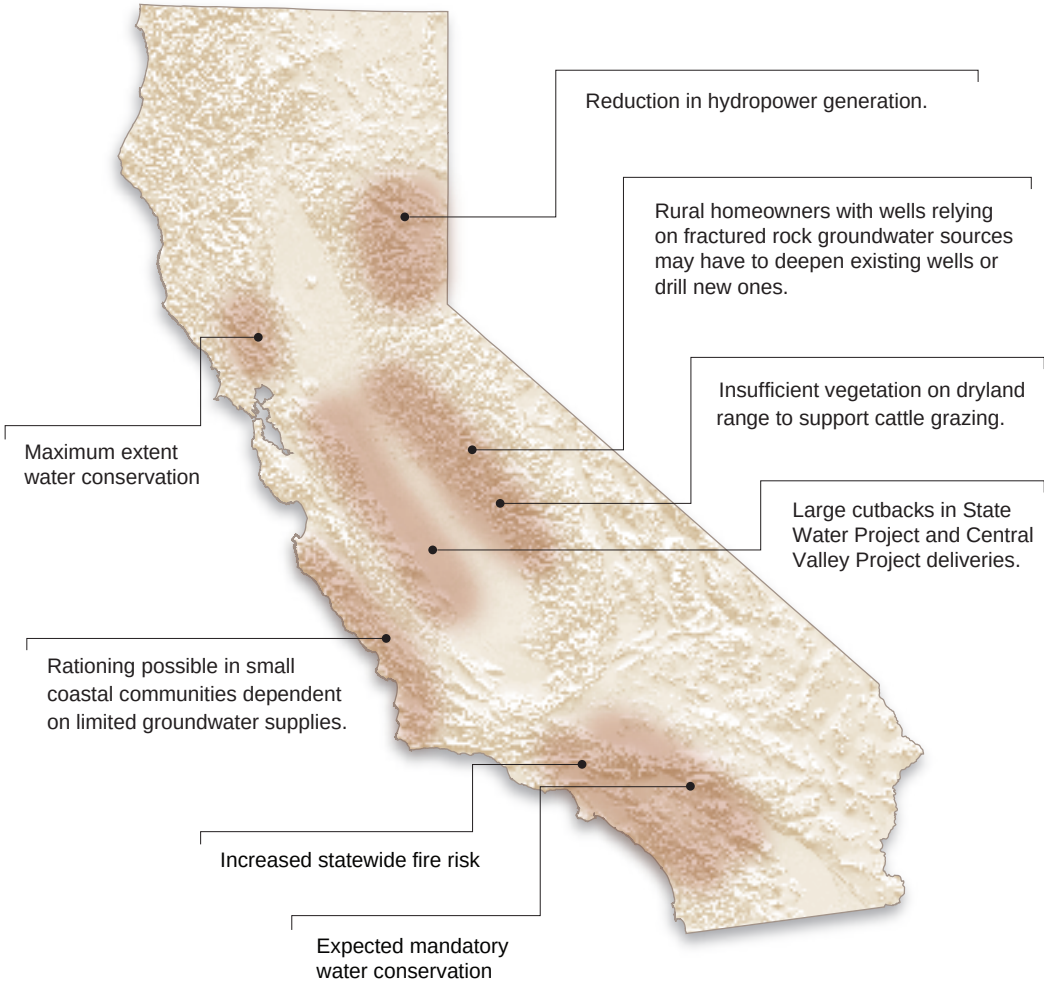
## Critical Challenges

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

**Figure 4-10 Potential impacts of continuing drought**




*Source: DWR 2009*

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

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

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

## Dry-year Period (Drought)

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

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

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

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

*During droughts, California has historically depended upon its groundwater. Because droughts may be exacerbated by climate change, more efficient groundwater basin management will be necessary to avoid additional overdraft and to take advantage of opportunities to store water underground and eliminate existing overdraft.*

## Floods and Flooding

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

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

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

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

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

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

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

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

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

## Environment/Ecosystem

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

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

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

## Climate Change

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

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

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

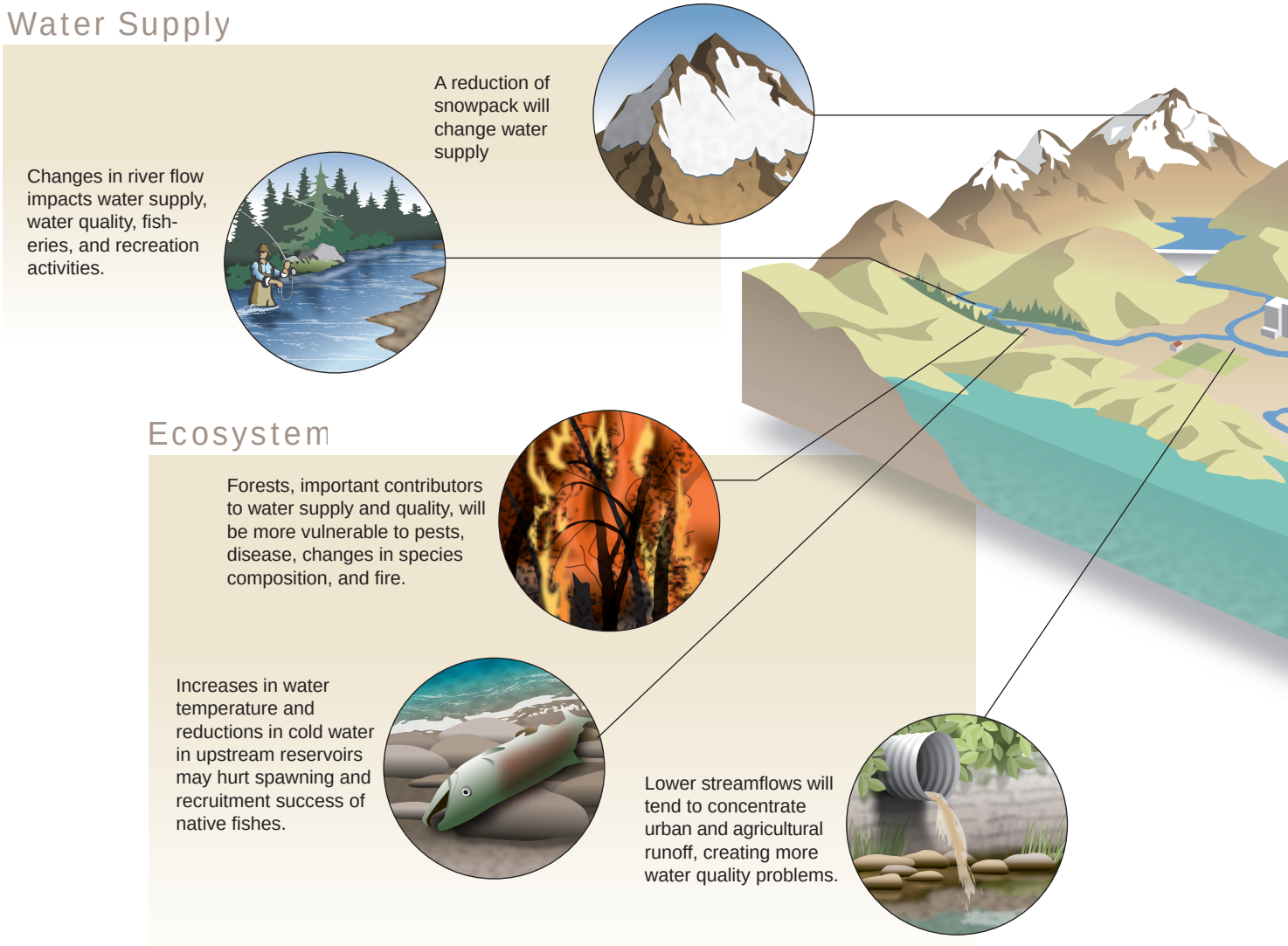
*Reliable water supplies and resilient flood protection require ecosystem stewardship and sustainability to be a primary goal and fundamental activity for water resources management.*

**Figure 4-11** Climate change effects in California

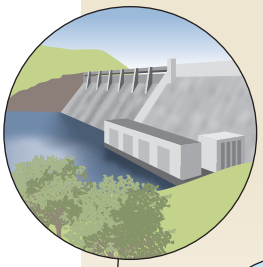
## What are the Expected Impacts from These Changes?

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

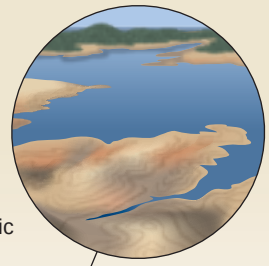
The impacts of these changes will gradually increase during this century and beyond. California needs to plan for water system modifications that adapt to the following impacts of climate change:



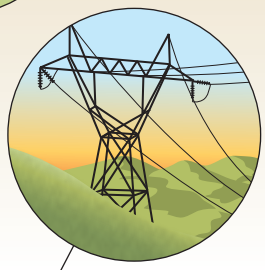
## Water & Power Operations



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



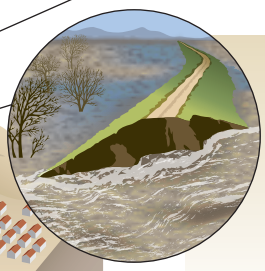
Water supply reliability will be compromised.



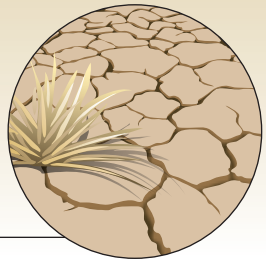
California's hydroelectric power generation may be less reliable; at the same time, higher air temperatures may increase energy consumption through increased use of air conditioning.

Warmer temperatures will affect water demands.

## Flooding & Drought

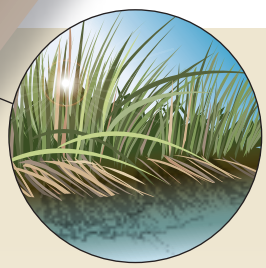


Increased flooding potentially causes more damage to the levee system.



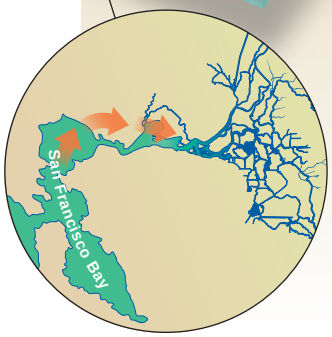
Higher temperatures and changes in precipitation will lead to droughts.

## Coast & Delta



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

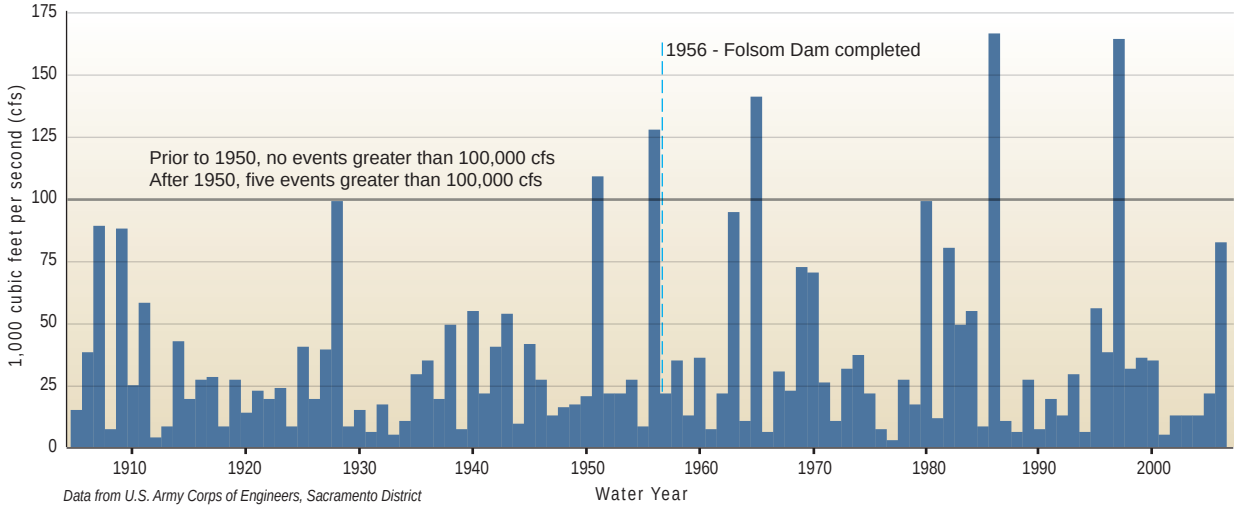
Sea level rise threatens coastal communities and infrastructure, in particular, the water system in the Sacramento-San Joaquin Delta where the existing Delta levees were not designed or constructed to withstand these higher water levels.




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

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

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




*Data from U.S. Army Corps of Engineers, Sacramento District*

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

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

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

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

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

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

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

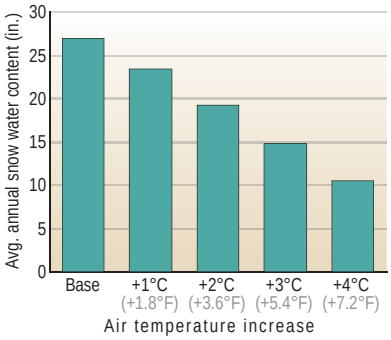
Snowmelt provides an annual average of 15 million acre-feet of water, slowly released from about April to July each year. Much of the state's water infrastructure was designed to capture the slow spring runoff and deliver it during the drier summer and fall months. Based upon historical data and modeling,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

### Sea Level Rise

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

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

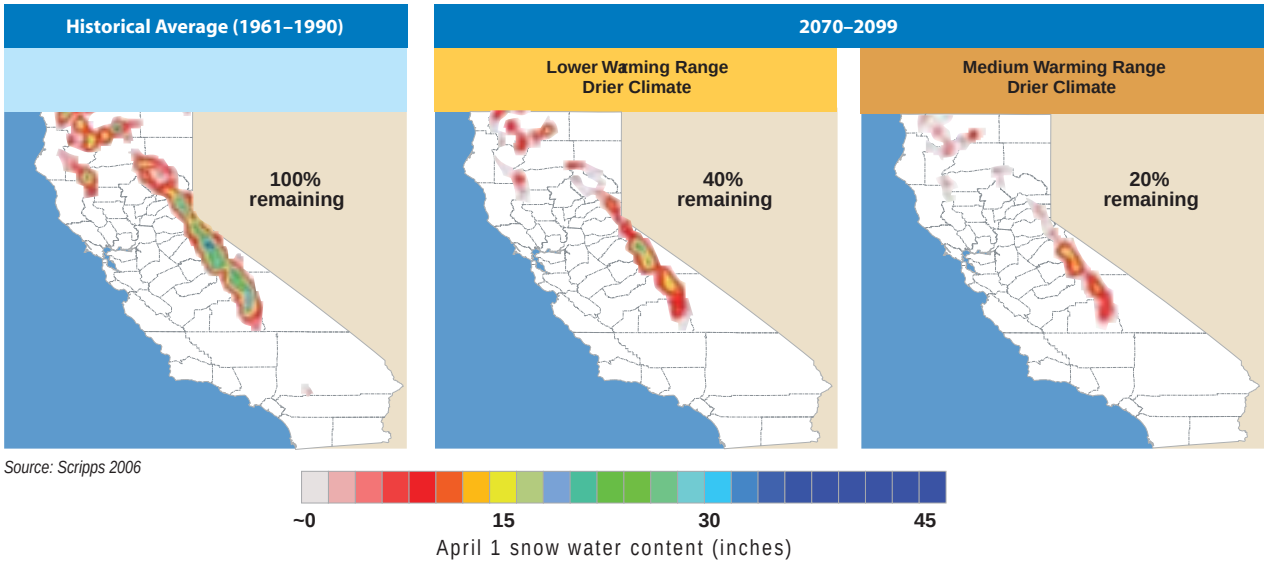
**Figure 4-13 Average annual snowmelt for Upper Feather River Basin**




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

*Source: DWR 2009*

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



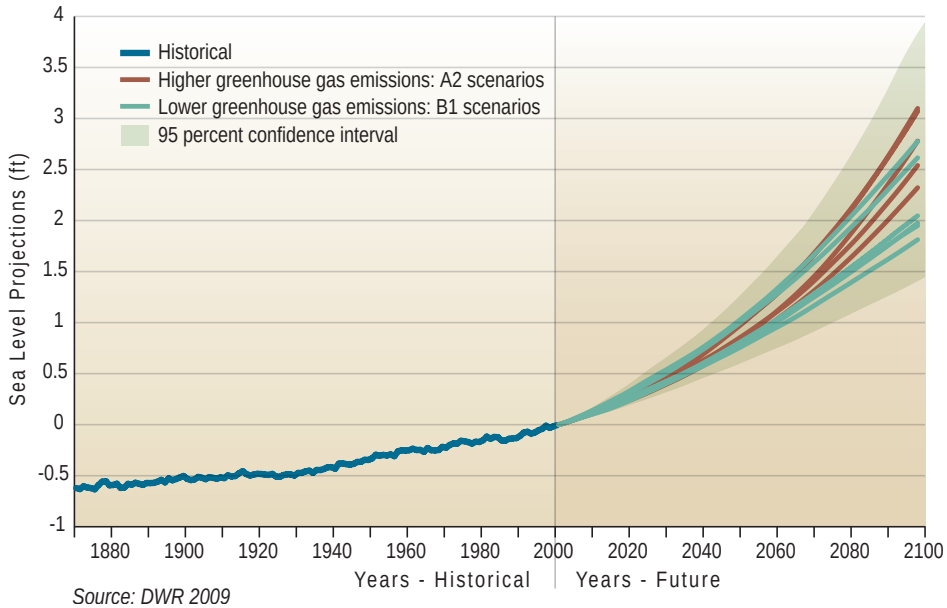

*Source: Scripps 2006*

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

## Water and Energy

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

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




*Source: DWR 2009*

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

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

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

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

## Contamination of Surface Water and Groundwater

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

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

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

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

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

## Delta Vulnerabilities

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

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

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

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

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

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

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

## Deferred Maintenance and Aging Infrastructure

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

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

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

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

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

## Levees

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

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

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

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

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

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

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

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

## Catastrophic Events and Emergency Response

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

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

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

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

## Data Gathering and Sharing

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

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

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

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

### Disadvantaged Communities

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

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

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

### Funding

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

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

## Responses and Opportunities

### Stewardship and Sustaining Natural Resources

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

**Box 4-9 Investing in Watersheds**

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

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

## Watershed and Resource Restoration Programs

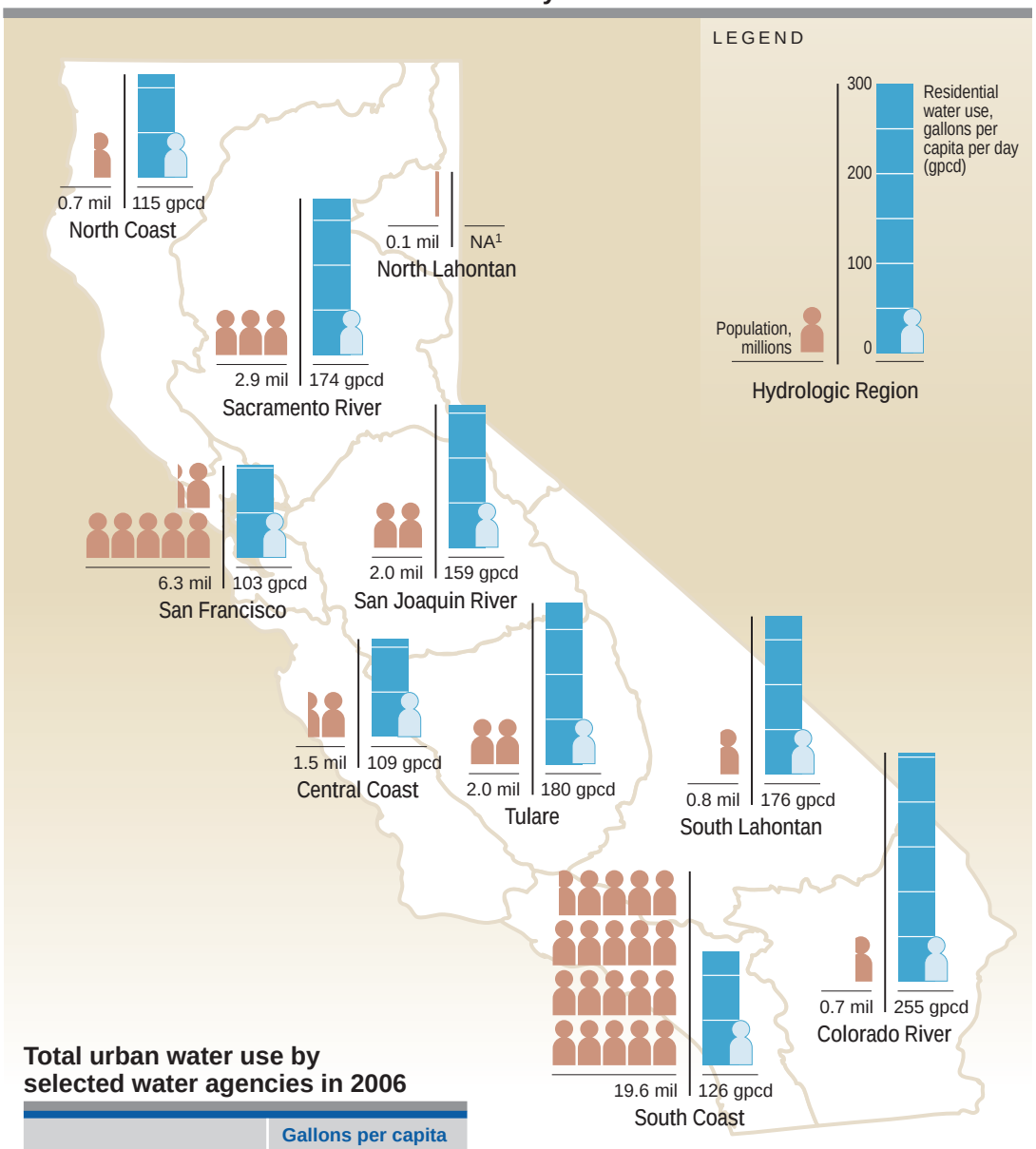
The DWR Watershed Program works with locally led stewardship efforts to integrate the needs of communities, urban and rural, with resource management that sustains watershed ecology. The program strives to inform and educate people about their watersheds and the benefits and values that those watersheds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

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

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

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

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




### Total urban water use by selected water agencies in 2006

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

Developed by DWR staff using PWSS date from 2006

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

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

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

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

### Conservation: 20 percent Reduction by 2020

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

Some of DWR's conservation efforts include:

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

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

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

## Regional/Local Planning and Management

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

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

*Water managers are learning that planning for sustainable water use must address multiple resource objectives—water use efficiency, water quality protection, and environmental stewardship—and consider broad needs—economic growth, environmental quality, and social equity.*

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

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

## Coordination of Water and Land Use Planning

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

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

## Integrated Regional Water Management and Planning (IRWM)

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

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

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

## Box 4-11 Examples of regional water planning efforts

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

### North Coast

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

### Sacramento River

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

### San Francisco Bay

- Mocho Groundwater Demineralization Plant
- Water Saving Hero Campaign

### North Lahontan

- Merrill Davies Meadow Restoration Project

### San Joaquin River

- Yosemite Spring Park Utility Company Improvements

### Central Coast

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




### Tulare Lake

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

### South Coast

**Los Angeles**

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

**Santa Ana**

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

**San Diego**

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

### South Lahontan

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

### Colorado River

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

*Regional strategies information provided by Roundtable of Regions*

### Box 4-12 New Law Supports Integrated Regional Water Management

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

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

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

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

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

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

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

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

## Statewide and Interregional Planning and Response

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

## Box 4-13 Mokelumne River Forum and Interregional Conjunctive Use

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

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

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

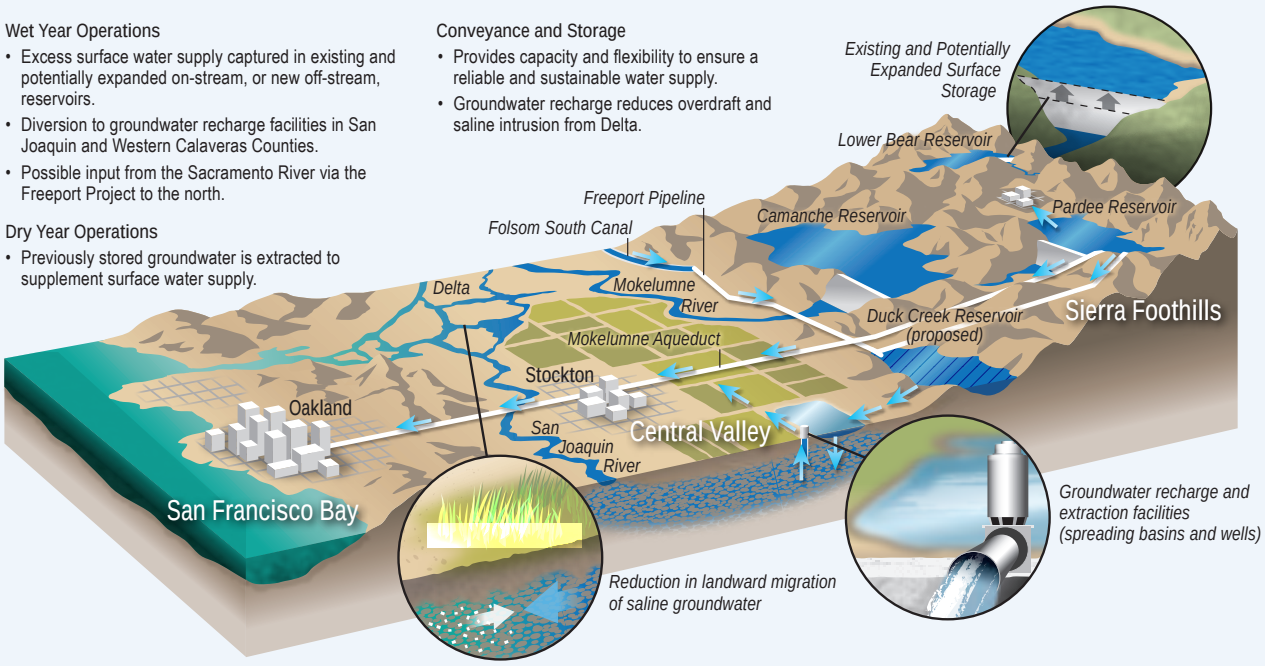
The forum has recently begun to expand its discussions to consider environmental principles and alternative water management solutions, such as demand-side management and the use of treated storm water and disinfected wastewater for groundwater recharge.

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

### Mokelumne River Forum Members

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

### Elements of the Mokelumne River Integrated Regional Conjunctive Use Project



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

## Recent Litigation

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

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

## Recent Legislation

### *2009 Comprehensive Water Package*

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

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

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

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

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

### *Strengthening Flood Protection*

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

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

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

### California FloodSAFE Program

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

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

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

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

### Recent Drought Response

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

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

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

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

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

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

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

### *2009 Drought Water Bank*

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

## Governor's Strategic Growth Plan

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

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

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

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

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

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

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

### AB 32 – California Global Warming Solutions Act of 2006

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

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

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

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

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

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

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

### *Sea Level Rise*

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

The order contained four key actions:

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

## State Water Resources Control Board (California Water Boards)

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

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

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

### Delta and Suisun Marsh Planning and the Delta Vision

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

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

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

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

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

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

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

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

### SWAN (Statewide Water Analysis Network)

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

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

## Propositions and Bonds

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

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

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

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

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

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

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

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

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

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

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

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

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

The bond funds will fund four critical flood protection projects:

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

### Proposition 84

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

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

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

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

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

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

## Federal Government

### Water for America Initiative

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

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

The initiative will

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

### American Recovery and Reinvestment Act of 2009

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

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

### Federal Water Action Plan

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

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

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

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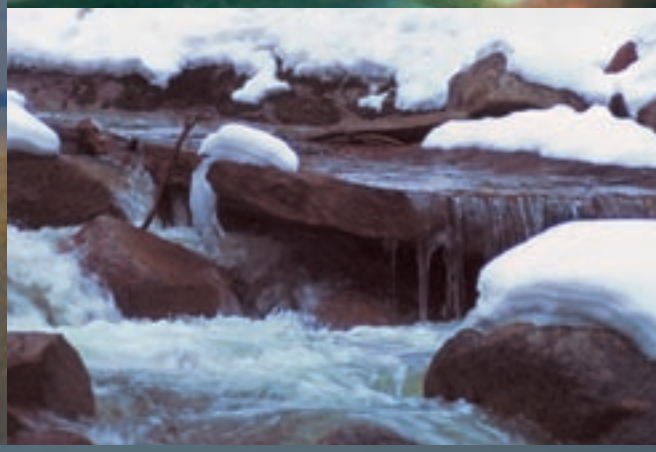
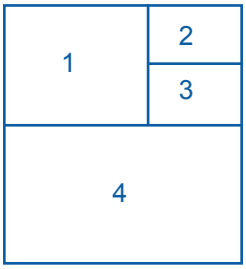
# Managing an Uncertain Future






***Chapter photos:***

1. ***Levee break.***
2. ***Salmon***
3. ***Snowpack melting***
4. ***Avocado trees stumped because of drought.***

# Contents

**Chapter 5. Managing an Uncertain Future ..... 5-5**
About This Chapter ..... 5-5
Planning Approach ..... 5-5
Overview ..... 5-5
Traditional Planning Approach—The Past is a Model for the Future ..... 5-6
New Planning Approach—Anticipate Change ..... 5-7
Recognizing and Reducing Uncertainty ..... 5-10
Assessing Risk ..... 5-10
Accounting for Risk ..... 5-12
Risk Assessment Examples ..... 5-14
Managing for Sustainability ..... 5-16
What is Sustainability? ..... 5-17
Sustainability Indicators ..... 5-18
Examples of Managing for Sustainability ..... 5-20
Water Scenarios 2050—Factors That Shape Our Future ..... 5-22
Water Plan Baseline Scenario Descriptions ..... 5-23
Scenario Factors Affecting Future Water Demands ..... 5-27
Looking to the Future—Statewide Scenario Water Demands ..... 5-31
Summary ..... 5-35
Selected References ..... 5-35

## Figures

Figure 5-1 Understanding flood risks ..... 5-13
Figure 5-2 Probability of a number of simultaneous levee failures from a seismic event during a 25-year exposure period(2005-2030) ..... 5-15
Figure 5-3 Delivered supply, surplus, and shortages for the Hotter and Drier, Miss Goals Scenario under the 2005 IEUA Urban Water Management Plan ..... 5-17
Figure 5-4 Variation in precipitation for Sacramento Valley floor ..... 5-30
Figure 5-5 Change in average annual temperature for Sacramento Valley floor ..... 5-30
Figure 5-6 Change in future statewide water demand by scenario ..... 5-31
Figure 5-7 Change in future regional water demand by scenario ..... 5-34

## Tables

Table 5-1 Scenario factors affecting urban water demand ..... 5-28
Table 5-2 Scenario factors affecting agricultural water demand ..... 5-28
Table 5-3 Unmet environmental water objectives by scenario ..... 5-29

## Boxes

Box 5-1 Uncertainty, Risk, and Sustainability ..... 5-6
Box 5-2 Abbreviations and Acronyms Used in this Chapter ..... 5-7
Box 5-3 Sources of Future Change and Uncertainty ..... 5-11
Box 5-4 Sustainable Water Resources Roundtable Sustainability Principles ..... 5-18
Box 5-5 SWRR Sustainability Indicators ..... 5-19

# 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. The chapter presents an approach using multiple future scenarios for making these evaluations and examples of what was learned during preparation of this Water Plan update.

- Planning Approach
- Recognizing and Reducing Uncertainty
- Assessing Risk
- Managing for Sustainability
- Water Scenarios 2050 – Factors That Shape Our Future
- Summary

## Planning Approach

### Overview

Update 2005 included a framework for improving water reliability through two initiatives. One initiative placed emphasis on integrated regional water management to make better use of local water sources by integrating multiple aspects of managing water and related resources such as water quality, local and imported water supplies, watershed protection, wastewater treatment and water recycling, and protection of local ecosystems. The second initiative placed emphasis on maintaining and improving statewide water management systems.

These two initiatives are still at the root of the strategic plan in Update 2009 to secure reliable and clean water supplies through 2050. As with Water Plan Update 2005, this update acknowledges that planning for the future is uncertain and that change will continue to occur (see Box 5-1). Update 2009 enhances the effectiveness of the two initiatives by incorporating three key considerations into 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 sustainability of the resources and water and flood systems.

### Box 5-1 Uncertainty, Risk, and Sustainability

**Uncertainty.** Uncertainty is what we don't know about the system. For example, engineers don't know the foundation conditions under all California levees. Uncertainty can be reduced by reducing data gaps to increase knowledge.

**Risk.** Most risks originate from hazards like floods, earthquakes, and droughts that would still occur even if all uncertainty could be removed. We want to reduce uncertainty so we have a clearer view of what the risks to the system are.

Risk = probability of the occurrence (times) consequences of the occurrence

**Sustainability.** A system or process that is sustainable has longevity and resilience. A sustainable system manages risk, but cannot eliminate risk. A sustainable system generally provides for the economy, the ecosystem, and social equity. For Update 2009, sustainability is not a specific desired result, but is more of an approach or way of seeking longevity and resilience that will continue to be developed in future water plans. For example, planning ways to eventually eliminate drafting more groundwater than can be recharged over the long-term is one approach for improving sustainability.

This chapter provides a general description of this planning approach. Chapter 6, Integrated Data and Analysis, provides more detail on needed data and analytical tools for integrated water management.

## Traditional Planning Approach—The Past is a Model for the Future

Water managers have always recognized the variable waterflow 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 the main reasons that Californians built early water projects. Early in California's water development history, personal observations, and experience were often the best data available to help size water facilities because recorded data did not exist.

A system to record waterflow conditions over time gradually improved information available to water managers. **However, the main assumption governing water 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 were used as models of potential future conditions.** In addition, historical records were generally used to establish trends, such as population growth, that were assumed to continue into the future.

This static view of the range of possible future conditions worked fairly well when the demands on the resources were considerably lower than now. Early designers may have thought they understood the variability of storm events and the range of streamflows that could occur and the likelihood that a reservoir would refill in a given year, but generally they did not fully understand the interrelationships among ecosystem issues, flood management issues, water availability issues, water use issues, and water quality issues.

**Box 5-2 Abbreviations and Acronyms Used in this Chapter**

| | |
|---|---|
| ACWA | Association of California Water Agencies |
| B/C | benefit/cost ratio |
| CAT | Climate Action Team |
| CLD | California Levee Database |
| DRMS | Delta Risk Management Strategy |
| DWR | California Department of Water Resources |
| HEC-FDA | USACE Flood Damage Assessment software |
| IEUA | Inland Empire Utilities Agency |
| LCPSIM | Least-Cost Planning Simulation Model |
| LGC | Local Government Commission |
| RDM | Robust Decision-making |
| SGC | (Governor's) Strategic Growth Council |
| SWRR | Sustainable Water Resources Roundtable |
| USACE | US Army Corps of Engineer |
| Water PIE | Water Planning Information Exchange |

The early approach to flood planning focused on flood damage reduction and public safety. These projects were designed to control and capture floodflows using structural measures such as dams, levee systems, bypasses, and channel enlargements. Although these projects provided significant flood protection benefits, some of these early structural projects caused unintended consequences of larger 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 fuller acknowledgement of the uncertainties inherent in the system and the risks that the system actually faced, the system management was relatively simple compared with today's standards. Conditions appeared more certain and less risky than they actually were. 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

*Traditional approaches for predicting the future based solely on projecting trends will no longer work.*

Today, as part of integrated regional water management and integrated flood management, California's water and resource managers must recognize that conditions are changing and that they will continue to change. Traditional approaches for predicting the future based solely on projecting trends will no longer work. Today, there is better understanding 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.

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 Water Plan Update 2005 stressed the importance of a common analytical approach for these entities to understand and manage the system, especially when management actions may compete for the same resources. The entities must make sound investments that balance risk with reward, given today's uncertainties and those that may occur in the future. Update 2005 also emphasized the benefits of integrated regional water management. Now, Update 2009 adds integrated flood management into this framework.

*The California Water Plan promotes ways to develop a common approach for data standards and for understanding, evaluating, and improving regional and statewide water management systems, and for common ways to evaluate and select from alternative management strategies and projects*

The California Water Plan promotes ways to develop a common approach for data standards and for understanding, evaluating, and improving regional and statewide water management systems, and for common ways to evaluate and select from alternative management strategies and projects. The Department of Water Resources (DWR) is developing the Water Planning Information Exchange (Water PIE) for accessing and sharing data and networking existing databases using GIS software to improve analytical capabilities and developing timely surveys of statewide land use, water use, and estimates of future implementation of resource management strategies.

The California Water Plan 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, land use and development patterns, environmental conditions, the climate, and many other factors that affect water use and supply may change by 2050. To anticipate change, our approach to water management and planning for the future needs to incorporate consideration of uncertainty, risk, and sustainability.

*To anticipate change, our approach to water management and planning for the future needs to incorporate consideration of uncertainty, risk, and sustainability.*

1. **Uncertainty.** 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. DWR has begun the process of incorporating climate change information into its operation and planning process in order to reduce uncertainty of how climate may impact California's water resources in the future. Additional efforts will be needed in order 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 the Volume 4 article, "The State of Climate Change Science for Water Resources Operation, Planning, and Management". Chapter 6, Integrated Data and Analysis, provides a description of how uncertainty is being quantified in Update 2009.

2. **Risks.** Uncertainties about future conditions result in water-related risks. Each undesirable 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 sized 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 economic consequences.

   By reducing the uncertainties described above, the "true" risks can be reduced. State government and other entities are performing more risk assessments that can be used in future planning to balance risk with reward from 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. More information on these risk assessments can be found in later in this chapter.

3. **Sustainability.** Given the uncertainties and risks in the water system, some management strategies may provide for more sustainable water supply and flood management systems and ecosystems than another set of management strategies. Recognizing that change will continue to occur and that additional uncertainties and risks are likely to surface in the future, water management must be dynamic, adaptive, and durable.

We have no way of predicting the future, but we can construct scenarios. Future scenarios can be used to help us better understand the implications of future conditions on water management. This Water Plan considers three plausible, yet very different, future scenarios as a way to consider uncertainty and risk and to improve resource sustainability. One scenario is a projection of current trends. Another scenario considers lower population growth and other factors that may require less intensive use of resources. A third scenario covers the possibility of more expansive population growth and other factors that would result in more intensive use of resources.

*This Water Plan considers three plausible, yet very different, future scenarios as a way to consider uncertainty and risk and to improve resource sustainability. The concept is to not plan for any one given future as in past water plan updates, but to look at how each future scenario could be managed.*

The concept is to not plan for any one given future as in past water plan updates, but to look at how each future scenario could be managed. Certain combinations of management strategies, or response packages, may prove to be appropriate regardless of the future conditions. This is especially true if the response packages have a degree of adaptability to differing conditions that may develop. A general description of the scenarios can be found later in this chapter. More details on the approach used to quantify the scenarios can be found in Chapter 6 Integrated Data and Analysis.

## Recognizing and Reducing Uncertainty

There are two broad types of uncertainty:

- The first type of uncertainty is from the inherent randomness of events in nature such as the occurrence of an earthquake or a flood. This type of uncertainty is known as *aleatory* uncertainty and cannot be reduced by collection of additional data. However, additional data may allow better quantification of uncertainty.
- The second type of uncertainty can be attributed to lack of knowledge or scientific understanding. This type of uncertainty is known as *epistemic* (knowledge-based) uncertainty. In principle, epistemic uncertainty can be reduced with improved knowledge that comes from collection of additional information.

Although it is not necessary to categorize uncertainty for the Water Plan update into these two types of uncertainty, it is important to improve data collection and analytical tools.

*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. It is useful to consider how change may occur: gradual changes over the long-term or more rapid or sudden changes over the short-term.*

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 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 River Delta (the Delta), the condition of levee foundations, and the extent of groundwater recharge and overdraft to name a few.

For the purposes of considering potential future changes and their inherent uncertainties, it is useful to consider how change may occur: gradual changes over the long-term or more rapid or sudden changes over the short-term. Gradual changes can include things like 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 how to respond to the changes. Box 5-3 shows some sources of future change and uncertainty.

## Assessing Risk

With improved understanding of uncertainties, risks facing future operation of the system can be better assessed. Most risks originate from hazards like floods, earthquakes, and droughts. But risks can also be due to other issues like water demands growing faster than anticipated, salt water intrusion, or land subsidence caused by

## Box 5-3 Sources of Future Change and Uncertainty

### Sources of Gradual 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 Delta water exports 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 affect 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 the use of 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 Sacramento-San Joaquin River 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.** Even though more is known about earthquakes, their location, timing, magnitudes can cause 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 cause disruption of surface and groundwater supplies.
- **Intentional Disruption.** Vandalism, terrorist acts, and even cyber threats pose serious potential impacts to the operational capability of water delivery and treatment systems.
- **Fire.** Wildfire in local watersheds can change the runoff characteristics and 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 listings of endangered species can require significant changes to the operation of the water system and the distribution of water supplies between agricultural, urban and environmental uses.
  - **Plumbing Codes.** Future changes in plumbing codes, like the one for installing ultralow flush toilets, could allow use of innovative water fixtures to conserve water.
  - **Emerging Contaminants.** The nature and impact of contaminants may be changing in the future, especially as new health and ecological risk information is obtained.

*"To stave off water crises in an age of climate change, humans are going to have to manage water, energy and ecosystems together in a system, undeveloped as yet, that takes into account their complex interconnection."*
Peter Friederici
The Next Market Crunch: Water, July 2008

groundwater overdraft. DWR defines risk as the probability that some undesirable event will occur, which is usually linked with a description of the corresponding consequences of that event, or:

Risk = the probability of the occurrence (times) the consequences of the occurrence

For example, the risk for a flooding hazard is determined as follows:

- Probability equals the frequency of the storm event that causes a levee to fail, say 1 percent chance each year.
- Consequences equal the effects of the floodwater from the levee failure upon the human and natural environment; say $100 million in damages.
- The annual risk would be 0.01 X $100 million, or $1 million per year.

Figure 5-1 further demonstrates risk for flooding from a levee failure.

## Accounting for Risk

Although it is impossible to account for all sorts of uncertainty and risk in a planning study, techniques can be used to acknowledge their existence and to assign some quantitative importance to them in the analysis. These techniques include direct enumeration, sensitivity analysis, scenario analysis, probability analysis, game theory, robust decision methods, stochastic simulation. Planners may combine analyses, such as performing scenario analysis supported by probability analysis.

- **Direct enumeration.** With this technique, all possible outcomes are listed. Although this would provide decision-makers an idea of the possible outcomes of an action, it does not provide any clue to the probability of one event happening over another. Also, given the complex relationships that are involved in most water resource-related studies, all possible outcomes are not likely to be known.
- **Sensitivity analysis.** In sensitivity analysis, the values of important factors can be varied to test their effects upon the system being analyzed. These factors can be tested one at a time to find ones that have a significant impact on the results and those that do not. An example of this would be to vary the assumption about future energy costs. If different energy costs do not have a significant effect upon the relative ranking of the proposed project relative to its alternatives, the analyst may feel more comfortable with the project. Although sensitivity analysis is relatively easy to do, it has drawbacks: (a) it frequently assumes that the appropriate range of values is identified and that all values are equally likely to occur, and (b) the results of the analysis are often reported as a single, most likely value that is considered precise.
- **Scenario analysis.** Scenario analysis is similar to sensitivity analysis except groups of factors are tested to together in a methodical way. Each scenario includes factors that support a given theme or story. For example, one scenario could include factors that imply high growth in demand for water and another could include factors that support low growth in demand for water. In this way, scenarios can be compared. Water Plan Update 2009 uses scenario analysis to consider possible future conditions.

**Figure 5-1 Understanding flood risks**

Flood risk is generally accepted to include both the probability of flooding and the consequences that would result from flooding. Flood risk is commonly calculated as:


**(Probability) x (Consequence) = FLOOD RISK**

So, for a predominantly agricultural area that currently floods about once every 50 years causing about $10 million worth of damage, the risk for this area is:

**1/50 x $10 million = $200,000 per year**

If we improve the levee protection so that it floods about once every 100 years, the risk is cut in half and reduced to:

**1/100 x $10 million = $100,000 per year**

However, if the area begins to be urbanized with new homes, businesses, and infrastructure being added, the consequences resulting from flooding become much greater. So, if the consequences of flooding as a result of urbanization rise from $10 million to $100 million, the flood risk is greatly increased:

**1/100 x $100 million = $1,000,000 per year**

So, even when we significantly improve the level of flood protection, we can still end up having higher flood risks if at the same time we increase the consequences by putting more people and infrastructure in the floodplain. A long term goal should be to reduce flood risk.

*DWR defines risk as the probability that some undesirable event will occur, which is usually linked with a description of the corresponding consequences of that event*

- **Probability analysis.** Although it is recognized that the "true" values of planning and design variables and parameters are not known with certainty and can take on a range of values, it may be possible to describe a variable or parameter in terms of a probability distribution. For example, for a normally distributed variable or parameter, indicators such as mean and variance can be identified which would allow confidence intervals to be placed around point estimates. In other words, instead of saying the benefit/cost (B/C) ratio for a project is 1.20, we might be able to say that we are 90 percent confident that the B/C ratio exceeds the value of 1.15, which gives the decision-makers more information to consider.

- **Robust decision methods.** Robust decision methods are designed to help decision-makers identify solutions (or resource management strategies) that are robust across a wide range of plausible future conditions. These methods are particularly useful when uncertainties cannot easily be characterized using probability distributions. Many argue, for example, that we do not know enough about how the climate may change in response to greenhouse gas emissions and other natural changes, to assign meaningful probabilities to individual climate scenarios. Robust Decision-making (RDM) is a specific robust decision method that systematically identifies the key vulnerabilities of promising water management strategies and then guides the development of more robust options.
- **Stochastic simulation.** This is also known as Monte Carlo simulation or model sampling. An example of this type of analysis is the US Army Corps of Engineer's (USACE) software program, HEC-FDA (Flood Damage Assessment) that directly incorporates uncertainties into a flood damage analysis. For example, direct inputs into this program include frequency/discharge, stage/discharge, and structural inventories for which stage/damage curves are determined within the program. FDA statistically assigns error bands around all of these relationships, and then through a Monte Carlo analysis, samples within the various relationships' error bands in order to determine expected annual damage. Although this program is still subject to the same fundamental sources of uncertainty (model specification and data collection/measurement), at least it explicitly attempts to incorporate uncertainty into the flood damage analysis.

## Risk Assessment Examples

*The Water Plan encourages all resource planners to incorporate risk assessments into their planning for integrated regional water management, which includes integrated flood management.*

As mentioned, risk assessments provide a way to quantitatively consider the uncertainties that relate to events of interest. DWR and others are beginning to conduct more risk assessments as part of planning for the future. The Water Plan encourages all resource planners to incorporate risk assessments into their planning for integrated water management, which includes integrated flood management. This provides the basis for balancing risks with rewards in planning for more sustainable outcomes. Some examples of ongoing risk assessments are given here.

**Delta Risk Management Strategy.** The Delta Risk Management Strategy (DRMS) recently completed a study evaluating Delta issues from the perspective of the risks from levee failures and ways to reduce those risks (URS 2009).

DRMS provides a framework for evaluating major threats to the Delta levee system and the impacts that levee failure can have on the Delta ecosystem and economy, the State's water delivery system and other infrastructure, and those who rely on the exports of fresh water from the Delta. The purpose of DRMS is to:

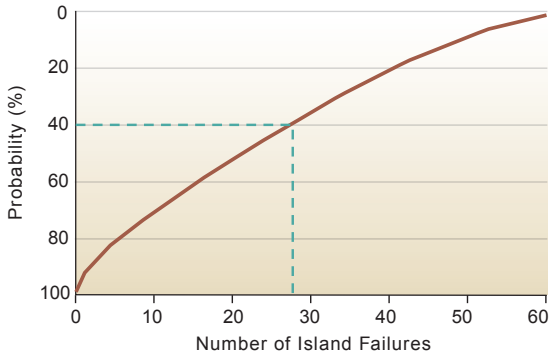
- Evaluate the risk and consequences to the state (e.g., water export disruption and economic impact) and the Delta (e.g., levees, infrastructure, and ecosystem) associated with the failure of Delta levees and other assets considering their exposure to all hazards (seismic, flood, subsidence, seepage, sea level rise, etc.) under present as well as foreseeable future conditions. The evaluation

assesses the total risk as well as breaking the risk down for individual islands.

- Propose risk criteria for consideration of alternative risk management strategies and for use in management of the Delta and the implementation of risk-informed policies.
- Develop a management strategy, including a prioritized list of actions to reduce and manage the risks of consequences associated with Delta levee failure.

For more information on DRMS, visit the Web site at www.drms.water.ca.gov/.

**Figure 5-2 Probability of a number of simultaneous levee failures from a seismic event during a 25-year exposure period (2005-2030)**




Source: Adapted from DRMS Risk Report (URS/JBA 2008c), Figure 13-4

The DRMS assessment provides preliminary estimates of the probability that multiple islands will flood simultaneously during a 25-year exposure period due to a seismic event as shown in Figure 5-2. For example, there is a 40 percent probability of a major earthquake causing 27 or more islands to flood at the same time in the 25-year period from 2005 to 2030. DRMS estimated that if 20 islands were flooded as a result of a major earthquake, the export of fresh water from the Delta could be interrupted for about a year and a half. Water supply losses of up to 8 million acre-feet would be incurred by State and federal water contractors and local water districts.

*There is a 40 percent probability of a major earthquake causing 27 or more islands to flood at the same time in the 25-year period from 2005 to 2030.*

**California Statewide Levee Database.** California has more than 13,000 miles of levees that protect residential and agricultural lands. The levee failures in New Orleans during hurricane Katrina prompted DWR to initiate development of a state-of-the-art levee database for the purpose of better understanding and managing levees. The California Levee Database (CLD) will support an efficient and effective approach for assessing levee reliability, risk assessment factors, and structural data impacting individual levee reaches. The CLD is being coordinated with a similar nationwide database being developed by the USACE.

**DWR Economic Analysis for Flood Risk Management.** DWR has prepared its Economic Analysis Guidebook (DWR 2008 www.water.ca.gov/economics/guidance.cfm) with procedures for consistent economic analysis for the large list of flood risk reduction studies and projects that are under way or will be started over the next several years. These include major analyses for the Central Valley Flood Protection Plan, the State Plan of Flood Control, regional flood management planning, and various grant programs.

Because of its considerable water management partnerships with the federal government, DWR has a policy that all economic analyses conducted for its internal use on programs and projects be fundamentally consistent with the federal Economics and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G), which was adopted by the US Water Resources Council on March 10, 1983, and is currently being revised for the first time in 25 years. In addition, The USACE requires that risk analysis be conducted for all of its flood damage

reduction studies. For agencies seeking USACE funding and/or levee certification, approved risk analyses must be applied. USACE guidance on risk analysis can be found in:

- EM 1110-2-1619, Risk-Based Analysis for Flood Damage Reduction Studies, August 1996 and
- ER 1105-2-101, Risk Analysis for Flood Damage Reduction Studies, January 2006

**Least-Cost Planning Simulation Model.** DWR developed the Least-Cost Planning Simulation Model (LCPSIM) to evaluate risks of water supply shortages. It is a yearly time-step simulation/optimization model that assesses the economic benefits and costs of enhancing urban water service reliability at a regional level (www.water.ca.gov/economics/models.cfm). The LCPSIM output includes the economically efficient level of adoption of reliability enhancement measures by type, including the cost of those measures. The LCPSIM accounts for the ability of shortage event management (contingency) measures, including water transfers, to mitigate regional costs and losses associated with shortage events as well as the ability of long-run demand reduction and supply augmentation measures to reduce the frequency, magnitude, and duration of those shortage events. Forgone use is the difference between the quantity of water demanded and the supply available for use.

Presenting Uncertainty About Climate Change to Water-Resource Managers. This report documents a series of three workshops conducted by RAND Corporation with the Inland Empire Utilities Agency (IEUA) in Southern California in fall 2006 (Groves et. al 2008b). The workshops were supported by modeling to explore how different descriptions of uncertainty about the effects of climate change and other key factors on IEUA's projected supply and demand might influence water managers' perceptions of risk and preferences for new infrastructure investments, changes in operational policies, and adoption of regulatory measures. RAND used RDM analysis, a new approach to decision support when conditions present deep uncertainty. RDM uses computational methods to identify scenarios likeliest to break assumptions embedded in a long-term resource-management plan.

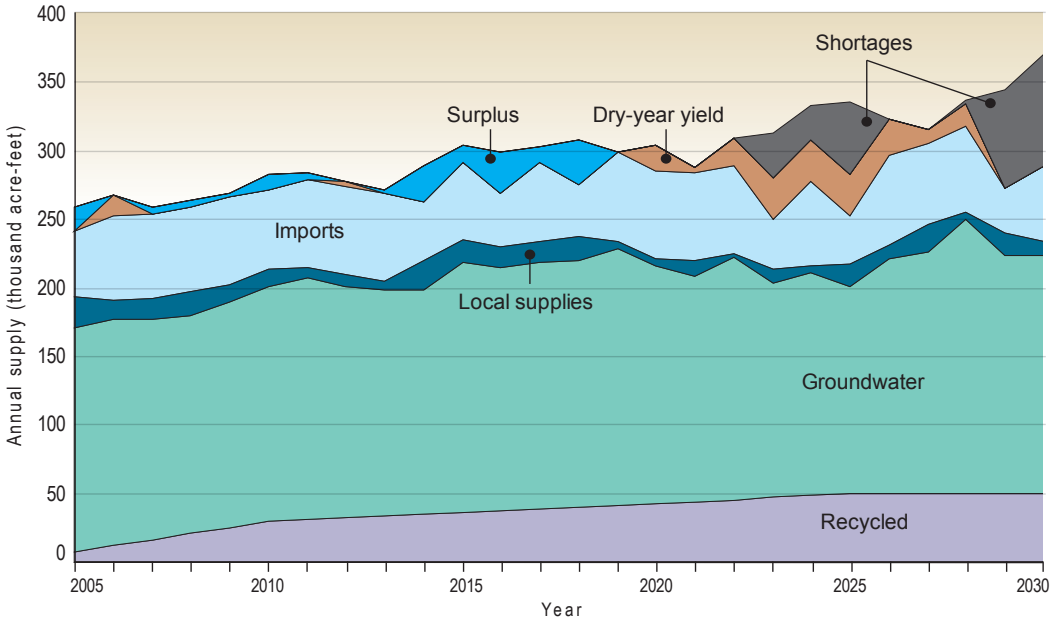
The report presents a decision analysis of potential IEUA-region water-planning responses using three different formulations of uncertainty: traditional scenarios; long-term, probabilistic forecasts; and policy-relevant scenarios. The modeling showed periods of water shortages under different scenarios. As one example, Figure 5-3 shows estimated supply conditions for one scenario.

*California's water resources are finite and require managing—management that may be different than what has been practiced during the first 150 years of the state's history.*

## Managing for Sustainability

Over the past few decades, questions have been raised about how sustainable are our ecosystems and water use, land use, and other resources, given current management practices and expected future changes. California's water resources are finite and require managing—management that may be different than what has been practiced during the first 150 years of the state's history.

**Figure 5-3 Delivered supply, surplus, and shortages for the Hotter and Drier, Miss Goals Scenario under the 2005 IEUA Urban Water Management Plan**




*Results of one climate scenario show supplies, surplus, and shortages.*



## What is Sustainability?

The word "sustainability" has been widely used in recent years for a wide variety of planning activities, and often no definition is provided with its use. The need for "sustainable development" or "sustainable use of resources" may have somewhat different meanings depending on the perspective of the user. A system or process that is sustainable can generally continue indefinitely. The intent here is not to give a strict definition, but to portray the concepts of longevity and resilience. A system that is sustainable, should meet today's needs without compromising the ability of future generations to meet their own needs. A sustainable system generally provides for the economy, the ecosystem, and social equity.

For this Water Plan, incorporating the concept of resource sustainability into water planning is an ongoing process or approach that will continue to be developed in future water plan updates. The process includes broad principles for planning for sustainability rather than defining a specific desired outcome. See Volume 4 Reference Guide for copy of DWR's Sustainability Policy dated April 2009.

*Since 2002, the Sustainable Water Resources Roundtable (SWRR) has brought together State, federal, corporate, nonprofit, and academic sectors to advance understanding of the nation's water resources and to help develop tools for understanding and ensuring their sustainability.*

Since 2002, the Sustainable Water Resources Roundtable (SWRR) has brought together State, federal, corporate, nonprofit, and academic sectors to advance understanding of the nation's water resources and to help develop tools for understanding and ensuring their sustainability (acwi.gov/swrr/index.html). SWRR concluded that discussions of water sustainability offer the most promise when there is an understanding of major driving forces like population, income, land use, climate change, and energy use. SWRR identified a set of four sustainability principles for water resource management

**Box 5-4 Sustainable Water Resources Roundtable Sustainability Principles**

Discussions of water sustainability offer most promise when they take place with an understanding of major driving forces like population, income, land use, climate change, and energy use. To help it navigate within such a context, SWRR identified a set of four sustainability principles for water resources management:

1. **The value and limits of water.** Water supports all life and provides great value. While water is abundant, people need to understand and appreciate that it is limited in many regions, that there are environmental and economic costs of depleting or damaging water resources, and that unsustainable water and land use practices pose serious risks to people and ecosystems. A renewable natural resource is sustainable only if the rate of use does not exceed the rate of natural renewal.
2. **Shared responsibility.** Water does not respect political boundaries. Sustainable management of water requires consideration of the needs of people and ecosystems up- and down-stream and throughout the hydrologic cycle, and avoiding extreme situations that may deplete water in some regions to provide supplies elsewhere.
3. **Equitable access.** Sustainability suggests fair and equitable access to water, water dependent resources, and related infrastructure. Equitable access requires continuous monitoring to detect and address problems as they occur, and means to correct the problems.
4. **Stewardship.** Meeting today's water needs sustainably challenges us to continually address the implications of our water resources decisions on future generations and the ecosystems upon which they will rely. We must be prepared to correct policies and decisions if they create adverse unintended consequences.

*The Sustainable Water Resources Roundtable, SWRR, November 2007*

(see Box 5-4 SWRR Sustainable Principles and Volume 4 Reference Guide article "Sustainable Water Resources Roundtable Report").

## Sustainability Indicators

SWRR states, "Indicators represent a way to measure progress. They can provide a metric for understanding the extent to which water resources are managed to meet the long-term needs of our social, economic, and environmental systems. In essence, they can help us understand whether or not the nation is on a sustainable course in its management of water and related resources." SWRR has developed a set of 14 key sustainability indicators (see Box 5-5 SWRR Sustainability Indicators) that can be useful to other entities developing their own indicators. A more detailed list of indicators is included in the Volume 4 Reference Guide, "Draft Compendium of Feb. 5, 2008 Sustainable Water Resources Roundtable, National Indicators Draft Framework: Nov. 20, 2007."

Sustainability indicators may vary depending on the water agency or region of California. Defining indicators is an ongoing, iterative process for most entities. The CALFED Bay-Delta Program has been developing performance measures for water supply reliability, water quality, levee system integrity, and ecosystem restoration since its Record of Decision in 2000. The Water Plan team will develop indicators to accompany the various management actions selected for implementation.

## Box 5-5 SWRR Sustainability Indicators

**A. Water availability.** People and ecosystems need sufficient quantities of water to support the benefits, services and functions they provide. These indicator categories refer to the total amount of water available to be allocated for human and ecosystem uses.

1. **Renewable water resources.** Measures of the amount of water provided over time by precipitation in a region and surface and groundwater flowing into the region from precipitation elsewhere. USGS considers renewable water resources to be the upper limit of water consumption that can occur in a region on a sustained basis.
2. **Water in the environment.** Measures of the amount of water remaining in the environment after withdrawals for human use.
3. **Water use sustainability.** Measures of the degree to which water use meets current needs while protecting ecosystems and the interests of future generations. This could include the ratio of water withdrawn to renewable supply.

**B. Water quality.** People and ecosystems need water of sufficient quality to support the benefits, services, and functions they provide. This indicator category is for composite measures of the suitability of water quality for human and ecosystem uses.

4. **Quality of water for human uses.** Measures of the quality of water used for drinking, recreation, industry, and agriculture.
5. **Quality of water in the environment.** Measures of the quality of water supporting flora and fauna and related ecosystem processes.
6. **Water quality sustainability.** Composite measures of the degree to which water quality satisfies human and ecosystem needs.

**C. Human uses and health.** People benefit from the use of water and water-dependent resources, and their health may be affected by environmental conditions.

7. **Withdrawal and use of water.** Measures of the amount of water withdrawn from the environment and the uses to which it is put.
8. **Human uses of water in the environment.** Measures of the extent to which people use water resources for waste assimilation, transportation, and recreation.
9. **Water-dependent resource use.** Measures of the extent to which people use resources like fish and shellfish that depend on water resources.
10. **Human health.** Measures of the extent to which human health may be affected by the use of water and related resources.

**D. Environmental health.** People use land, water and water-dependent resources in ways that affect the conditions of ecosystems.

11. **Indices of biological condition.** Measures of the health of ecosystems.
12. **Amounts and quality of living resources.** Measures of the productivity of ecosystems.

**E. Infrastructure and institutions.** The infrastructure and institutions communities build enable the sustainable use of land, water and water-dependent resources.

13. **Capacity and reliability of infrastructure.** Measures of the capacity and reliability of infrastructure to meet human and ecosystem needs.
14. **Efficacy of institutions.** Measures of the efficacy of legal and institutional frameworks in managing water and related resources sustainably.

*The Sustainable Water Resources Roundtable (SWRR) November 2007*

## Examples of Managing for Sustainability

It is becoming increasingly evident to decision-makers, water managers, and planners of the need to manage for the long-term sustainability of resources. This is especially true in the face of climate change, population growth, and evolving environmental protections.

Water Plan Update 2005 was the first California Water Plan to emphasize integrated regional water management as a key component in managing for sustainability. To ensure that water use is sustainable, California water management must be based on three foundational actions: use water efficiently to get maximum utility from existing supplies, protect water quality to safeguard public and environmental health and secure the state's water supplies for their intended purposes, and expand environmental stewardship as part of water management responsibilities. These actions support two initiatives that water management must pursue to ensure reliable water supplies: first, expand integrated regional water management; and second, improve statewide water and flood management systems.

*Integrated regional water management enables regions to implement strategies appropriate for their own needs and helps them become more self-sufficient. Regions must rely on a diversified portfolio of resource management strategies needed to cope with changing and uncertain future conditions.*

Integrated regional water management enables regions to implement strategies appropriate for their own needs and helps them become more self-sufficient. Regions must rely on a diversified portfolio of resource management strategies. This diversification is essential to provide the flexibility needed to cope with changing and uncertain future conditions. To minimize the impacts of water management on natural environment and to ensure sustainable systems and uses, water and resource managers and planners must use water efficiently, protect water quality, and expand environmental stewardship. Sustainable development relies on policies, decisions, and actions that give full consideration to social, economic, and environmental issues.

*Sustainable development relies on policies, decisions, and actions that give full consideration to social, economic, and environmental issues.*

There are numerous examples of entities planning for more sustainable outcomes. Many of these are based on Integrated Regional Water Management plans, each relying on portfolios of management strategies that fit their specific needs. Following are a few examples of how different entities are approaching the need for sustainability.

### Strategic Growth Council

*A primary motivation for creating the SGC as described in the legislation is to improve coordination among State government agencies to promote more sustainable communities in California.*

In September 2008 Governor Arnold Schwarzenegger signed SB 732, creating the Strategic Growth Council (SGC). A primary motivation for creating the SGC as described in the legislation is to improve coordination among State government agencies to promote more sustainable communities in California. The SGC is a cabinet level committee that is tasked with coordinating the activities of state agencies to:

- improve air and water quality,
- protect natural resource and agriculture lands,
- increase the availability of affordable housing,
- improve the transportation system,
- promote public health, and
- assist State and local entities in the planning of sustainable communities and meeting the goals of AB 32 (California Global Warming Solutions Act).

### Association of California Water Agencies - Sustainability Principles

In 2008 the Association of California Water Agencies (ACWA) developed a set of policy principles for environmental and economic sustainability. According to ACWA, sustainable policies are those which provide levels of ecological and economic well-being that can persist over time. These principles were developed because ACWA member agencies believe that California's water policies today are unsustainable. See Volume 4 for the complete set of principles. The five overriding principles adopted by ACWA are listed here.

- Reliable, adequate water supplies and a healthy ecosystem must be primary co-equal goals for sustainable water management.
- Sustainable solutions will require comprehensive programs that combine substantial investments in ecosystem enhancement and water supply infrastructure.
- Providing reliable, high quality water supplies remains the primary mission of ACWA's public agency members.
- Water investment and management decisions must recognize that investing in an environmentally sustainable system serves the economic interests of water users statewide.
- New investments are required to progress toward sustainability and adapt to changing environmental conditions like climate change.

*"The real prize today is a sustainable system. This may or may not result in increased water supply. The point is that a sustainable system by itself justifies billions in expenditures."*
*Timothy Quinn, Executive Director, Association of California Water Agencies*

### Local Government Commission

The Local Government Commission (LGC) is a nonprofit, nonpartisan, membership organization that provides inspiration, technical assistance, and networking to local elected officials and other community leaders dedicated to creating healthy, walkable, and resource-efficient communities. The LGC web portal (www.lgc.org/index.html) includes useful information on community planning and principles that form the basis for LGC's work on livable, sustainable communities.

### Sustainability Symposium White Paper

The Sacramento Chapters of the American Society of Civil Engineers' Environmental & Water Resources Institute and Committee on Sustainability together with the Floodplain Management Association convened a symposium on July 23, 2009, to discuss the future of water resources management as a critical means of advancing and preserving sustainability of California's communities. The symposium brought together policymakers, community leaders, resource managers, regulators, land use planners, and environmental advocates. The outcomes of workshop are described in a white paper, "A Time for Changing Values, Ideas, and Solutions in Water Management: Addressing Sustainability of California's Communities" (2009). The paper is located in Volume 4 Reference Guide. The key recommendations summarized from the White Paper are:

- Establish a Water Sustainability Subcommittee within the Governor's Strategic Growth Council with the mandate to help develop, coordinate, and circulate key water resource management strategies and their associated sustainability challenges to various departments, agencies, and the general public.

*The sustainability symposium brought together policymakers, community leaders, resource managers, regulators, land use planners, and environmental advocates.*

- Encourage laws and policies that will better reflect the value of water resources to the State and its residents.
- Create a system that provides economic incentives to advance community sustainability through effective water management.
- Create statewide goals, policies and priorities for water management in California to support sustainable communities.
- Examine and address efficacy of current mechanisms used to govern beneficial use of water.

### The Water Wiki

*Sustainable Water Resources Roundable (SWRR)*

SWRR serves as a forum to share information and perspectives that will promote better decision-making in the United States regarding the sustainable development of the nation's water resources. SWRR began a Web Wiki to support ongoing discussions on sustainability. Readers can view information already on the Wiki and contribute their own information and ideas for viewing by others. The Water Wiki can be found at waterwiki.wik.is/.

## Water Scenarios 2050—Factors That Shape Our Future

What will California look like in 2050? Will the population growth keep pace with recent trends? Will the pattern of climate change continue? Will the protection of water quality and endangered species be driven mostly by lawsuits, creating a patchwork of legal requirements? We have no way of predicting the future, but we can construct some plausible scenarios. Future scenarios can be used to help us better understand the implications of future conditions on water management.

For Update 2009, we evaluated different ways of managing water in California depending on different future conditions for different regions of the state. The ultimate goal is to evaluate how alternative regional response packages, or combinations of resource management strategies from Volume 2, perform under different future conditions. The different future conditions are described as future scenarios. Together the response packages and future scenarios show what management options could provide for sustainability of resources and ways to manage uncertainty and risk at a regional level.

In Update 2009, the Water Plan has made significant improvements to the scenarios by considering the potential effect of long-term climate change on future water demands. More work will be required in the next Water Plan update to refine this information based on the differing conditions and opportunities in the various regions. The following subsections summarize the scenarios and show how they were used in estimating future water demands for meeting those demands.

## Water Plan Baseline Scenario Descriptions

Before Water Plan Update 2005, water plan updates based planning assumptions on a single "likely future." Now, the use of multiple future scenarios provides decision-makers, water managers, and planners more information about how different management actions might perform under a range of possible future conditions.

Update 2009 has three future scenarios through the year 2050 to which the water community would need to respond regionally by implementing a mix of resource management strategies. The scenarios are referred to as baseline because they represent changes that are plausible and could occur without additional management intervention beyond those currently planned. Each scenario affects water demands and supplies differently. Each scenario includes assumptions about how different factors, like population or irrigated farmland, would describe its future. The title of each scenario—Current Trends, Slow & Strategic Growth, and Expansive Growth—tells us something about how different factors, like population, irrigated farmland, or background water conservation (plumbing codes, natural replacement, actions water users implement on their own, etc.) are assumed to change over time. These are factors of uncertainty over which the water community has little control yet affect future water demand for the urban, agricultural, and environmental sectors.

- **Scenario 1 – Current Trends.** For this scenario, recent trends are assumed to continue into the future. In 2050, nearly 60 million people live in California. Affordable housing has drawn families to the interior valleys. Commuters take longer trips in distance and time. In some areas where urban development and natural resources restoration has increased, irrigated crop land has decreased. The state faces lawsuits on a regular basis: from flood damages to water quality and endangered species protections. Regulations are not comprehensive or coordinated, creating uncertainty for local planners and water managers.
- **Scenario 2 – Slow & Strategic Growth.** Private, public, and governmental institutions form alliances to provide for more efficient planning and development that is less resources intensive than current conditions. Population growth is slower than currently projected—about 45 million people live here. Compact urban development has eased commuter travel. Californians embrace water and energy conservation. Conversion of agricultural land to urban development has slowed and occurs mostly for environmental restoration and flood protection. State government implements comprehensive and coordinated regulatory programs to improve water quality, protect fish and wildlife, and protect communities from flooding.
- **Scenario 3 – Expansive Growth.** Future conditions are more resource intensive than existing conditions. Population growth is faster than currently projected with 70 million people living in California in 2050. Families prefer low-density housing, and many seek rural residential properties, expanding urban areas. Some water and energy conservation programs are offered but at a slower rate than trends in the early century. Irrigated crop land has decreased significantly where urban development and natural restoration have increased. Protection of water quality and endangered species is driven mostly by lawsuits, creating uncertainty.

On the following pages are narrative descriptions of the three scenarios including factors of uncertainty that can be used in the modeling analysis.

## Scenario 1 – Current Tends

### *Economic and Financial*

**Population and land use.** In 2050, nearly 60 million people live in California. The state's metropolitan areas have continued to grow and past development patterns continue, spreading boundaries and absorbing once-rural areas like the Sierra Nevada foothills.

**Agriculture.** Irrigated crop land has decreased in some areas where urban development and natural resource restoration have increased. Some agricultural lands remain in production with land conservation agreements. Through a combination of advanced agricultural practices (e.g., multicropping) and technology, the agriculture industry has been able to increase the intensity of production as it also shifts to higher value permanent crops.

### *Institutional and Political*

California continues to face lawsuits on a regular basis to protect water quality and endangered species. In addition the state has been held liable for billions of dollars in damages from a series of flood events. Response to these lawsuits largely has been on a case-by-case basis, which has created a lot of uncertainty for cities and water managers about future regulatory requirements. Many groundwater basins lack active management. Regulations are not comprehensive or coordinated, creating uncertainty for local planners and water managers.

### *Natural Systems*

Climate change has affected California's natural systems. Sea level rise has begun to disrupt ecosystems and communities in coastal areas and ongoing tidal wetland restoration. The biggest impact is in the Delta where levees protect low-lying lands, many which were already below sea level. Air temperatures have increased throughout the state, and precipitation patterns have become more variable. Loss of mountain snowpack is significant, and peak river flows occur earlier in the spring.

### *Technological*

Water and energy are inherently linked, especially in California. Technology has modestly decreased energy use in water treatment and distribution. Water treatment technology allows more cost-effective clean up of groundwater and brackish water. Meanwhile, some advancement in residential appliances and irrigation technology has increased water use efficiency.

### *Social Practices*

**Land use.** Limited and expensive land forces families to look for affordable homes in the state's interior valleys. Commuters spend more time getting to and from work. Still, Californians have not abandoned the mild-temperature coastal areas. The state's population growth in inland areas has been more than twice that of any other state.

**Water and energy conservation**. Californians have continued to take advantage of existing rebate incentive programs to improve water and energy conservation.

## Scenario 2 – Slow & Strategic Growth

### *Economic and Financial*

**Population and land use.** Population growth has slowed substantially relative to Department of Finance forecasts. In 2050, nearly 45 million people live in California. Californians still locate to the Central Valley as well as the coastal counties. However, growth patterns have become more compact. Clustered urban development patterns have reduced the need for conversion of rural lands that currently provide opportunities for open space, habitat restoration, and refuges that harbor protected and endangered species.

**Agriculture.** Compact urban development and economic incentives have slowed the conversion of agricultural land to urban development. Most agricultural land conversion occurs for environmental restoration and flood protection purposes rather than residential development. Today, strong policies are in place to preserve prime agricultural lands.

### *Institutional and Political*

Inspired by a series of legal decisions, California's legislature has worked with private, nonprofit, and local agencies to successfully implement comprehensive and coordinated programs to protect and improve water quality, protect fish and wildlife, and protect communities from flooding. These new programs include both regulatory controls and economic incentives. Increased institutional cooperation and agreements among groundwater users facilitate more sustainable use of groundwater basins and increase opportunities for conjunctive use.

### *Natural Systems*

(Same as Current Trends) Climate change has affected California's natural systems. Sea level rise has begun to disrupt ecosystems and communities in coastal areas and ongoing tidal wetland restoration. The biggest impact is in the Delta where levees protect low-lying lands, many which were already below sea level. Air temperatures have increased throughout the state, and precipitation patterns have become more variable. Loss of mountain snowpack is significant, and peak river flows occur earlier in the spring.

### *Technological*

The West Coast was an early adopter of green technology. Fifty years ago, venture capitalists backed innovated technology as the industry realized that there was money to be made in clean energy. Water treatment technology allows more cost-effective clean up of groundwater and brackish water. New advancement in residential appliances and irrigation technology has significantly increased water use efficiency.

### *Social Practices*

**Land use.** Compact development patterns have eased commuter travel as families now find work where they live, and more people are using mass transit. For the coastal communities, compact development has made some housing more affordable and lessened impacts on sensitive coastal habitat.

**Water and energy conservation.** Californians have embraced aggressive water and energy conservation measures, significantly more than Current Trends, by upgrading residential appliances, installing water efficient landscapes, and investing in renewable energy sources even when utility rebates are not available.

## Scenario 3 – Expansive Growth

### *Economic and Financial*

**Population and land use.** California's population has grown at a faster rate than projected by the Department of Finance. We have 70 million people living here in 2050. To accommodate those growing numbers, California urban areas have spread and moved into areas that were once rural and in areas susceptible to flooding and fire.

**Agriculture.** Irrigated crop land has decreased significantly in some areas where urban development and natural resource restoration have increased. Some agricultural lands remain in production with land conservation agreements. Through a combination of advanced agricultural practices (e.g., multicropping) and technology, the agriculture industry has been able to increase the intensity of production as it also shifts to higher value permanent crops.

### *Institutional and Political*

(Same as Current Trends) California continues to face lawsuits on a regular basis to protect water quality and endangered species. In addition the state has been held liable for billions of dollars in damages from a series of flood events. Response to these lawsuits largely has been on a case-by-case basis, which has created a lot of uncertainty for cities and water managers about future regulatory requirements. Many groundwater basins lack active management.

### *Natural Systems*

(Same as Current Trends) Climate change has affected California's natural systems. Sea level rise has begun to disrupt ecosystems and communities in coastal areas and ongoing tidal wetland restoration. The biggest impact is in the Delta where levees protect low-lying lands, many which were already below sea level. Air temperatures have increased throughout the state, and precipitation patterns have become more variable. Loss of mountain snowpack is significant, and peak river flows occur earlier in the spring.

### *Technological*

(Same as Current Trends) Water and energy are inherently linked, especially in California. Technology has modestly decreased energy use in water treatment and distribution. Water treatment technology allows more cost-effective clean up of groundwater and brackish water. Meanwhile, some advancement in residential appliances and irrigation technology has increased water use efficiency.

### *Social Practices*

**Land use.** Families prefer low density housing and many seek rural residential properties. These development patterns have expanded urban areas away from existing infrastructure. Mass transit usage is the same as under Current Trends, but the annual miles driven has increased as due to farther commute distances.

**Water and energy conservation.** Californians have continued to take advantage of existing rebate incentive programs to improve water and energy conservation, but at a slower rate than Current Trends.

## Scenario Factors Affecting Future Water Demands

Future water demand is affected by a number of factors like population growth, planting decisions by farmers, size and type of urban landscapes, and background water conservation measures (like plumbing codes, natural replacement, actions water users implement on their own, etc.). Water Plan Update 2009 quantifies several factors that together provide a description of future water demand for the urban, agricultural, and environmental sectors. Each of these factors is varied between the three scenarios to describe some of the uncertainty faced by water managers. For example, no one can predict future population growth. The three scenarios use three different, but plausible values of future population when determining future urban water demands.

In this section we describe some of the key factors of uncertainty used to quantify urban, agricultural, and environmental water demands for Update 2009. Values for the key factors of uncertainty that affect urban demand (population, single-family homes, multi-family homes, commercial employees, and industrial employees) are reported in Table 5-1 for 2005 and 2050 under each of the three baseline scenarios. The 2050 population for the expansive growth scenario is about 60 percent higher than that for the Slow & Strategic growth scenario.

*Key factors of uncertainty that affect urban demand are population, single-family homes, multi-family homes, commercial employees, and industrial employees.*

**Table 5-1 Scenario factors affecting urban water demand**

| Scenario factors for urban water demand | Year 2005 | Future scenarios – Year 2050 | | |
|---|---|---|---|---|
| | | Current Trends | Slow & Strategic Growth | Expansive Growth |
| Population (millions) | 36.7 | 59.5 | 44.2 | 69.8 |
| Single-family housing units (millions) | 7.9 | 13.3 | 10.0 | 14.7 |
| Multiple-family housing units (millions) | 4.3 | 5.8 | 4.5 | 6.6 |
| Commercial employees (millions) | 19.0 | 36.5 | 28.0 | 40.4 |
| Industrial employees (millions) | 1.7 | 1.9 | 1.9 | 1.9 |

**Table 5-2 Scenario factors affecting agricultural water demand**

| Scenario factors for agricultural water demand (area in millions of acres) | Year 2005 | Future scenarios – Year 2050 | | |
|---|---|---|---|---|
| | | Current Trends | Slow & Strategic Growth | Expansive Growth |
| Irrigated land area | 8.7 | 8.0 | 8.4 | 7.6 |
| Multicropped area | 0.5 | 0.6 | 0.6 | 0.6 |
| Irrigated crop area | 9.2 | 8.6 | 9.0 | 8.3 |

*Key factors of uncertainty that affect agricultural water demand are irrigated land area, multicrop area, and individual cropping patterns.*

The 2005 and 2050 values for the key factors of uncertainty that affect agricultural water demand (irrigated land area, multicrop area, and individual cropping patterns) are reported in Table 5-2 under each of the three baseline scenarios. Each of the scenarios shows a decline in irrigated acreage over existing conditions. The amount of acres devoted to planting more than one crop per year on the same land (known as multicropping) increases in all scenarios.

*In the Water Plan scenarios, currently unmet environmental objectives are used as a surrogate to estimate new requirements that may be enacted in the future to protect the environment. These are some of the major unmet objectives and do not include all environmental objectives in the state.*

In the Water Plan scenarios, currently unmet environmental objectives are used as a surrogate to estimate new requirements that may be enacted in the future to protect the environment. These unmet objectives are instream flow needs or additional deliveries to managed wetlands that have been identified by regulatory agencies or pending court decisions, but are not yet required by law. An estimate of the ranges of unmet environmental water objectives for each water year from 1998 through 2007 are shown in Table 5-3 for 10 separate objectives. Table 5-3 also shows the range of unmet objectives used in the three Water Plan scenarios, which were varied from year to year based on hydrologic conditions. These are some of the major unmet objectives and do not include all environmental objectives in the state. In particular, they do not include additional water to protect species in the Delta resulting from the December 2008 Delta Smelt Biological Opinion issued by the US Fish and Wildlife Service or to protect salmon and several other species resulting from the June 2009 biological opinion by the National Marine Fisheries Service.

A significant improvement to the Water Plan scenarios in Update 2009 is a quantitative look at the uncertainty surrounding future climate change. Each of the three Water

**Table 5-3 Unmet environmental water objectives by scenario**

| Unmet environmental water objectives (values in thousand acre-feet per year) | Historical[1] range 1998-2007 | Future scenarios range (based on year type) | | |
|---|---|---|---|---|
| | | Current Trends | Slow & Strategic Growth | Expansive Growth |
| American River (Nimbus) DF&G Study | 15-798 | 58-687 | 141-798 | 15-514 |
| Stanislaus River (Goodwin) | 0-137 | 10-93 | 20-137 | 0-34 |
| ERP #1 Delta Flow Objective | 0-293 | 0-98 | 0-293 | 0 |
| ERP #2 Delta Flow Objective | 0-76 | 0-34 | 0-76 | 0 |
| ERP #3 San Joaquin River at Vernalis | 0-148 | 43-83 | 62-148 | 0-18 |
| ERP #4 Sacramento River at Freeport | 0-242 | 0-149 | 0-242 | 0-41 |
| Trinity River below Lewiston | 5-344 | 47-180 | 99-344 | 5-34 |
| San Joaquin River below Friant | 56-356 | 155-318 | 251-356 | 56-277 |
| Level 4 Refuges Sacramento Region | 17-26 | 20-23 | 20-26 | 17-22 |
| Level 4 Refuges San Joaquin Region | 20-63 | 24-40 | 27-63 | 20-22 |

[1] This column represents the range of additional annual volume of water that would have been needed during 1998-2007 if the listed environmental objectives had been in place. These values are used as a surrogate to estimate new environmental requirements that may be enacted in the future.

Plan scenarios was evaluated against 12 separate climate scenarios identified by the Governor's Climate Action Team (CAT). Each of the 12 CAT 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 are used in the Water Plan scenarios with other factors to estimate future water demands. Refer to Chapter 6 Integrated Data and Analysis and the article in Volume 4 Reference Guide, "Overview of Climate-change Scenarios Being Analyzed" for additional information on the CAT climate scenarios.

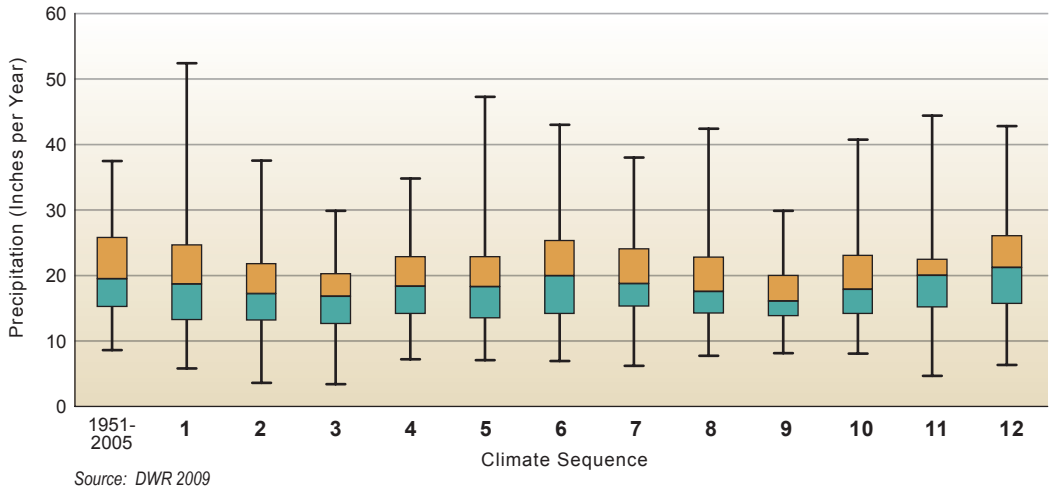
*A significant improvement to the Water Plan scenarios in Update 2009 is a quantitative look at the uncertainty surrounding future climate change. Each of the three Water Plan scenarios was evaluated against 12 separate climate scenarios identified by the Governor's Climate Action Team (CAT).*

Figure 5-4 shows the variation in average annual precipitation for the Sacramento Valley floor for both the 1951–2005 historical period and for the 12 CAT scenarios of future climate for the years 2006–2100. The variation in precipitation is represented as a boxplot (also known as a box-and-whisker diagram or plot), which is a convenient way of graphically summarizing a large data set with five numbers (the smallest observation, lower quartile (Q1), median (Q2), upper quartile (Q3), and largest observation). For example, for the 1951–2005 historical period, the boxplot shows a minimum value of about 8.5 inches in the driest year, a median value of 19.5 inches per year, and a maximum value of 37.5 inches in the wettest year. The precipitation values used to generate the boxplot are the spatial average over the valley floor within the Sacramento River Hydrologic Region. Similar boxplots were developed for the other nine hydrologic regions.

Figure 5-5 shows the trend in the change in average annual temperature for the Sacramento Valley floor for each climate sequence compared against the 1951–

**Figure 5-4** Variation in precipitation for Sacramento Valley floor

*Historical 1951-2005 period and 12 scenarios of future climate years 2006-2100*

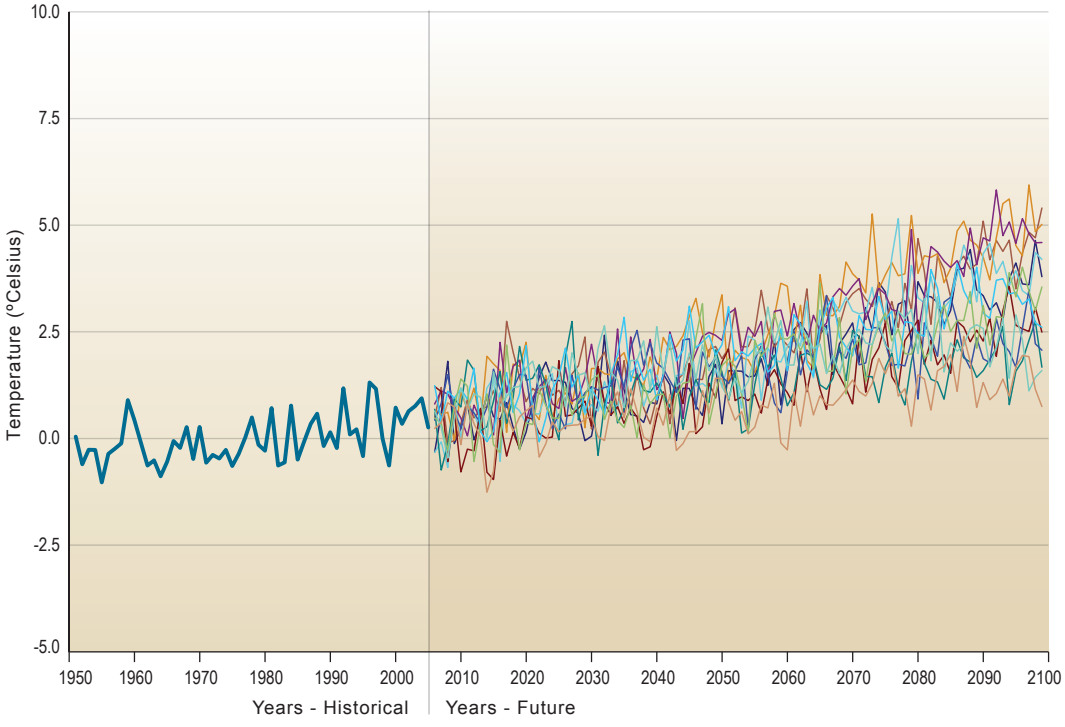



Source: DWR 2009

**Figure 5-5** Change in average annual temperature for Sacramento Valley floor

*Historical 1951-2005 average for historical period and 12 scenarios of future climate years 2006-2100*

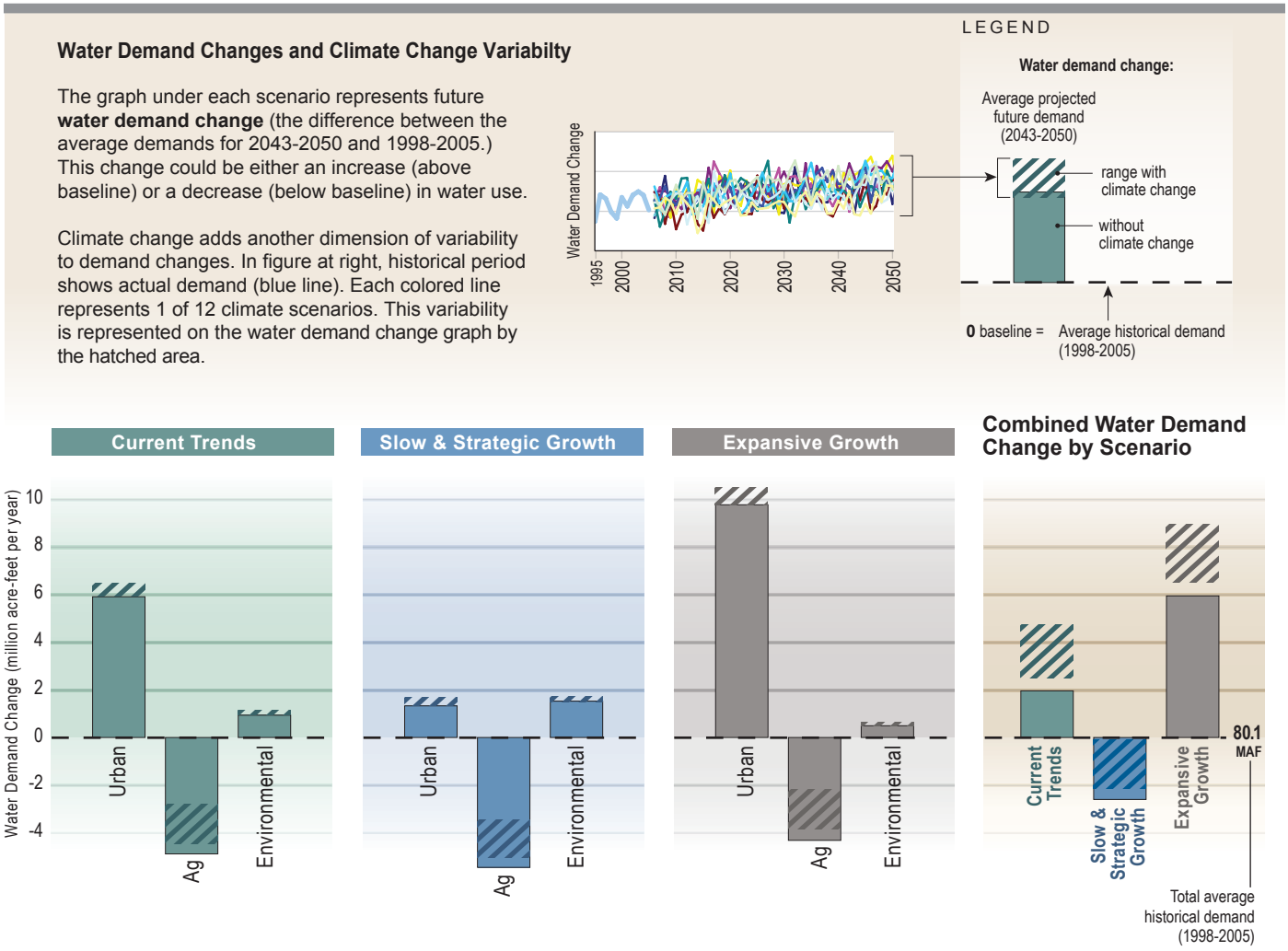
In this figure, historical period shows actual temperature (blue line). Each colored line represents 1 of 12 climate sequences.




Source: DWR 2009

2005 historical average. A distinct upward trend in temperature change is shown in each climate scenario. However, there is considerable year-to-year fluctuation and different expectations for the long-term magnitude in temperature change. While the absolute change in temperature varies from region to region, the relative change in average annual temperature follows a similar pattern in all regions to that shown for the Sacramento River Hydrologic Region in Figure 5-5.

**Figure 5-6 Change in future statewide water demand by scenario**




## Looking to the Future—Statewide Scenario Water Demands

Through the use of scenarios, the Water Plan quantified three different, but plausible estimates of future water demands. Future urban water demand was estimated individually for the residential, commercial, industrial, and public sectors. Irrigated agricultural water demand was estimated by using different plausible estimates of future irrigated crop acreage. Environmental water demand for each scenario was assumed to equal water dedicated to the ecosystem under current conditions plus an additional scenario-specific amount. See Chapter 6 Integrated Data and Analysis for a more detailed description of the analytical methods used to estimate future water demands for each California region.

*The change in water demand shown by the solid bar assumes a repeat of historical hydrology while the hatched bar shows the change in water demand when considering 12 different climate change scenarios.*

Figure 5-6 shows the statewide change in water demand for each sector (urban, agricultural, and environmental) by scenario and summed across all sectors. The change in water demand shown is the difference between the average demands for 2043–2050 (projected future) and 1998–2005 (historical). The change in water demand shown by the solid bar assumes a repeat of historical hydrology while the hatched bar shows

the change in water demand when considering 12 different climate change scenarios. These climate scenarios are based on recent scientific studies of future trends in precipitation and temperature as described in the previous section. Both of these factors heavily influence water demand for outdoor landscaping and irrigated agriculture.

Across the three scenarios, there is a wide potential range in future annual combined statewide water demands depending on the specific scenario assumptions of future population growth, acres of irrigated farmland, development densities, and background water conservation (like plumbing code changes, natural replacement, actions water users implement on their own, etc.). Without considering climate change, annual combined *statewide water demand* shows a decrease of about 2.5 million acre-feet under the Slow & Strategic Growth scenario to an increase of about 6 million acre-feet per year under the Expansive Growth scenario. The Current Trends scenario falls in between these with an increase of about 2 million acre-feet per year. When climate change is factored in, all scenarios show higher annual water demands than under a repeat of historical climate. For example, with climate change the range of annual water demand for the Expansive Growth scenario was from about 6.5 million to above 9 million acre-feet per year, between 0.5 and 3 million acre-feet higher than when considering a repeat of historical climate. This reflects changes in water demand for future climate scenarios that are either warmer or drier or both warmer and drier.

*Without considering climate change, annual combined statewide water demand shows a decrease of about 2.5 million acre-feet under the Slow & Strategic Growth scenario to an increase of about 6 million acre-feet per year under the Expansive Growth scenario. The Current Trends scenario falls in between these with an increase of about 2 million acre-feet per year. When climate change is factored in, all scenarios show higher annual water demands than under a repeat of historical climate.*

The change in statewide annual *urban water demands* ranges from an increase of under 1.5 million acre-feet per year for the Slow & Strategic Growth scenario to an increase of about 10 million acre-feet per year under the Expansive Growth scenario. The Current Trend scenario falls in between with an increase of 6 million acre-feet per year. The demands for each scenario are heavily influenced by assumptions about future population growth shown in Figure 5-1 and background water conservation water savings assumed to be 5 percent, 10 percent, and 15 percent by 2050 for the Expansive Growth, Current Trends, and Slow & Strategic Growth scenarios, respectively. Climate change has a smaller impact on future annual urban water demands compared to the effects of future population growth, but could still result in increased annual water demands of up to 750 thousand acre-feet per year.

*Climate change has a smaller impact on future annual urban water demands compared to the effects of future population growth.*

All scenarios show a decrease in *agricultural water demand* associated primarily with loss of farmland to development and increases in background water conservation. Similar to the urban sector, background water conservation savings by 2050 are assumed to be 5 percent, 10 percent, and 15 percent for the Expansive Growth, Current Trends, and Slow & Strategic Growth scenarios, respectively. Climate change may have significant effects on future agricultural water demands due to assumptions of future precipitation and temperature under different climate change scenarios. The observed effect of climate change is to dampen the reduction in future agricultural annual water demands (i.e., agricultural water demands would be higher). For example, in the Current Trends scenario statewide annual water demands for agriculture decline by about 5 million acre-feet per year without climate change. With climate change this decline ranges from 3 million to 4.5 million acre-feet per year.

*The observed effect of climate change is to dampen the reduction in future agricultural annual water demands.*

As described in the previous section, the Water Plan scenarios use currently unmet environmental objectives as a surrogate to estimate new requirements that may be enacted in the future to protect the environment. The change in environmental water demand results are very coarse estimates and are not based on detailed hydrologic modeling of future instream flows. Under the three scenarios, the increase in annual water dedicated to environmental purposes is shown to increase between 0.5 million and 1.5 million acre-feet per year. Climate change may increase these amounts by approximately 10 percent in the drier climate scenarios.

*Under the three scenarios, the increase in annual water dedicated to environmental purposes is shown to increase between 0.5 million and 1.5 million acre-feet per year. Climate change may increase these amounts by approximately 10 percent in the drier climate scenarios.*

The three baseline scenarios for 2050 would play out differently in various hydrologic regions. This regional variability is illustrated in Figure 5-7, showing the combined urban, agriculture, and environmental water demand changes for each scenario in each region. The way scenario water demands change in each region reflects a number of things—the relative amount of water demand in the region for cities, farms, and environment; how the scenario factors (population, irrigated crop acreage, and water dedicated to the environment) increase or decrease in each area of the state; and how temperature and precipitation changed in the 12 climate change scenarios that were examined.

*The three baseline scenarios for 2050 would play out differently in various hydrologic regions.*

Hydrologic regions expecting higher population growth under the Current Trends and Expansive Growth scenarios, like the South Coast and the Sacramento River, show higher changes in water demands. Population growth also tends to drive urbanization of agricultural lands, reducing irrigated crop acreage. Precipitation and temperature heavily influence water demand for outdoor landscaping and irrigated agriculture. Less precipitation falling during the growing season increases the need to apply more irrigation water. Warmer temperatures increase crop evapotranspiration, which increases water demand.

*Hydrologic regions expecting higher population growth show higher changes in water demands. Precipitation and temperature heavily influence water demand for outdoor landscaping and irrigated agriculture. Water demand changes in Central Valley agricultural areas were most sensitive to the warmer and drier climate change scenarios.*

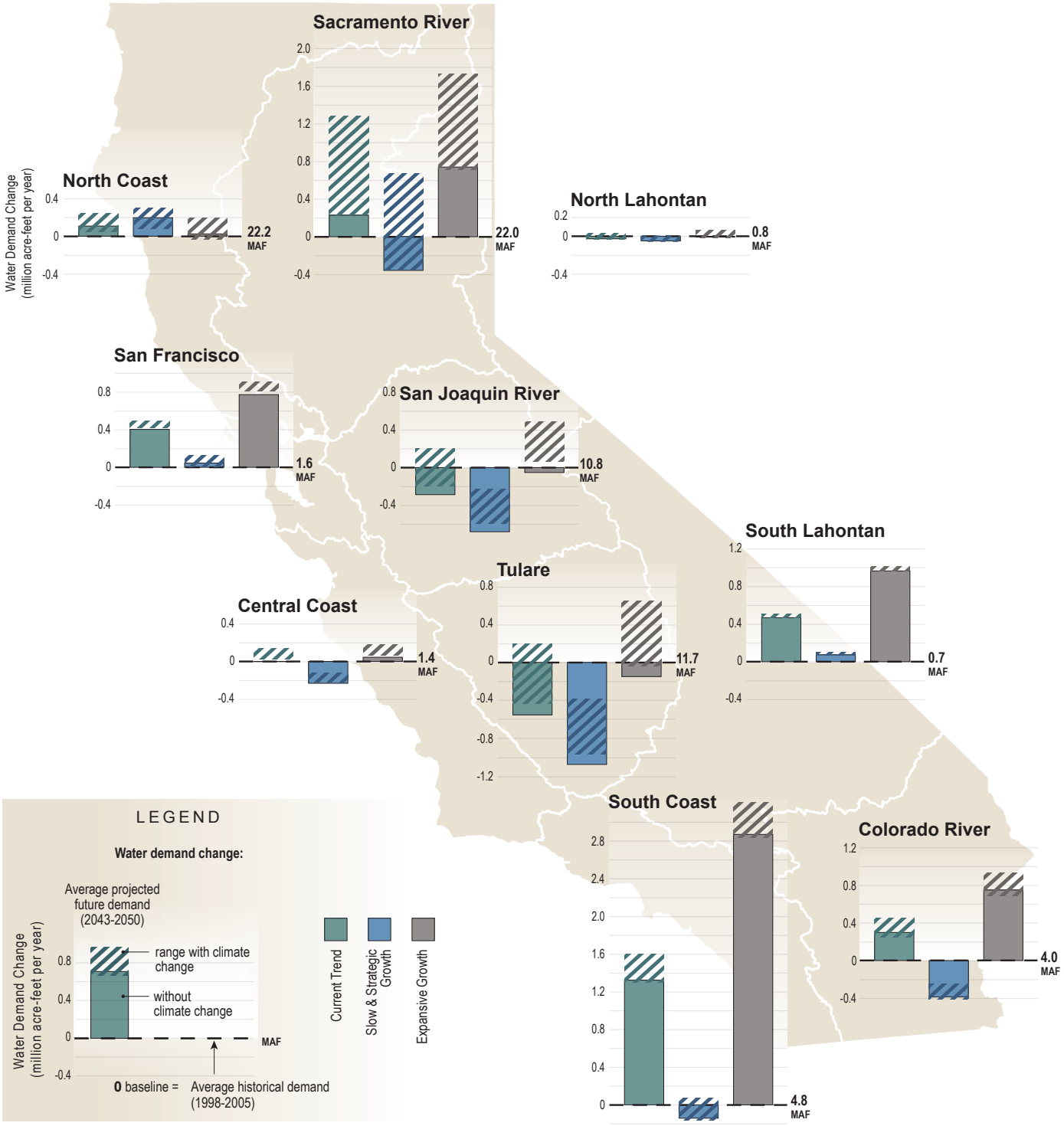
Water demand stays the same or decreases in the San Joaquin River and Tulare Lake regions when climate change was not considered because of less irrigated crop area from urbanization and more background water conservation. Water demand changes in Central Valley agricultural areas were most sensitive to the warmer and drier climate change scenarios. This is particularly evident in the Sacramento River Region where the variation in potential change in water demand is quite large across the 12 climate change scenarios.

### Regional Responses

Each future scenario describes a different baseline for 2050 to which the water community would need to respond. A response package is a mix of resource management strategies from Volume 2 designed to provide benefits for a given future scenario. The performance of several different response packages can be compared for each scenario to determine high-performing packages. Having response packages for multiple future scenarios can help identify management responses that perform well across the array of possible future conditions.

## Figure 5-7 Change in future regional water demand by scenario

Hydrologic regions expecting higher population growth show higher changes in water demands. Water demand changes in Central Valley agricultural areas were most sensitive to the warmer and drier climate change scenarios.



No single response package will work for all areas of California as each region has its own needs, constraints, and opportunities. Facing an uncertain future, regions need to invest in an appropriate mix of strategies based on integrated regional water management plans that are diversified, satisfy regional and state needs, meet multiple resource objectives, include public input, address environmental justice, mitigate impacts, protect public trust assets, and are affordable. (See Chapter 4 California Water Today in this volume or chapters in Volume 3 Regional Reports for examples of regional water projects throughout the state.)

*Each future scenario describes a different baseline for 2050 to which the water community would need to respond. Having response packages for multiple future scenarios can help identify management responses that perform well across the array of possible future conditions. No single response package will work for all areas of California as each region has its own needs, constraints, and opportunities.*

## Summary

Integrated water management is becoming the basis for California's water planning. This umbrella approach comprises the principles and actions of integrated regional water management and integrated flood management (see Volume 1 Chapter 2 Imperative to Act for further discussion). It undertakes water and flood management at all fronts and on many levels—regionally and statewide; for multiple uses and benefits; for sustainable watersheds, water uses, and water and flood systems; and while weighing the risks of uncertain futures.

The California Water Plan recommends reducing uncertainty through improved data collection, data management, and development of analytical tools for integrated water management. DWR and other entities are conducting various risk assessments so risks can be better balanced with the rewards for improved management. Update 2009 used three different scenarios of future water demand based on alternative but plausible assumptions of future population growth, land use changes, background water conservation and other factors affecting water demands. These scenarios also considered the effect future climate change might have on future water demands. Future updates will test different response packages, or combinations of resource management strategies, for each future scenario. These response packages help decision-makers, water managers, and planners develop integrated water management plans, including integrated flood management plans, that provide for resources sustainability and investments in actions with more sustainable outcomes.

*The California Water Plan recommends reducing uncertainty through improved data collection, data management, and development of analytical tools for integrated water management.*

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# Integrated Data and Analysis

***Chapter photo.*** CIMIS station. The California Irrigation Management Information System is a program in the California Department of Water Resources that manages a network of over 120 automated weather stations in the state of California.

# Contents

**Chapter 6. Integrated Data and Analysis ..... 6-5**
About this Chapter ..... 6-5
Purpose and Motivation ..... 6-5
Improving Technical Support for Decision-making in Light of Uncertainties .. 6-5
Improving Technical Support for Integrated Regional Water Management ..... 6-6
Specific Water Management Information and Analytical Needs ..... 6-7
Information Gaps and Limitations ..... 6-7
Technical Challenges of Integrated Water Management ..... 6-8
Recent Studies and Forums for Improving Water Management Information and Analysis ..... 6-10
Update 2005, Volume 1, Chapter 4 ..... 6-10
CWEMF (California Water and Environmental Modeling Forum) Strategic Analysis Framework ..... 6-10
San Francisco Estuary & Watershed Science ..... 6-11
DWR Climate Change Adaptation White Paper ..... 6-11
DWR Climate Science White Paper ..... 6-11
SWAN (Statewide Water Analysis Network) ..... 6-11
Implementing Long-term Technical Improvements through Shared Vision Planning ..... 6-12
Critical Near-term and Long-term Activities ..... 6-13
Implementing Analytical Improvements for Water Plan Update 2009 ..... 6-20
Approach for Quantifying Future Scenarios for Update 2009 ..... 6-20
Regional Drivers of Water Demand and Available Supply ..... 6-23
Quantification of Scenarios and Resource Management Responses ..... 6-27
Statewide Water Demands ..... 6-27
Quantifying Resource Management Responses ..... 6-28
Summary ..... 6-30
References ..... 6-30

## Figures

Figure 6-1 Conceptual model of water management system ..... 6-17
Figure 6-2 Sample schematic of water management system ..... 6-18
Figure 6-3 Example diagram using Unified Modeling Language standard notation .. 6-18
Figure 6-4 Statewide annual water demand under 12 future climate scenarios ..... 6-26

## Boxes

Box 6-1 Shared Vision Planning Workshop ..... 6-12
Box 6-2 Entities Engaged in Long-term Technical Improvements for Statewide Water Management ..... 6-14
Box 6-3 Integrated Water Resources Information Systems – A Working Information System ..... 6-16
Box 6-4 Quantitative Deliverables for the California Water Plan ..... 6-20
Box 6-5 DWR Scenario-related Workshops ..... 6-23
Box 6-6 Abbreviations and Acronyms Used in this Chapter ..... 6-24

# Chapter 6. Integrated Data and Analysis

## About this Chapter

Chapter 6 Integrated Data and Analysis describes a roadmap and key actions needed to improve water resources information and analysis for integrated water management by State government, particularly the Department of Water Resources (DWR), and by the many other research institutions, and federal, Tribal, regional, and local water management entities. This chapter is organized into the following sections.

- Purpose and Motivation
- Specific Water Management Information and Analytical Needs
- Recent Studies and Forums for Improving Water Management Information and Analysis
- Implementing Long-term Technical Improvements through Shared Vision Planning
- Implementing Analytical Improvements for Water Plan Update 2009
- Quantification of Scenarios and Resource Management Responses

## Purpose and Motivation

Investment in our analytical capabilities lags far behind the growing challenges facing water managers and resource planners. We need significant new investment in our technical capabilities to advance integrated water management, to improve sustainable management of the Sacramento-San Joaquin River Delta (the Delta), and to prepare for future impacts of climate change, extended droughts, and flood events. Improving communication between technical experts and decision-makers goes hand in hand with improving our technical capabilities because sound technical information is critical to making difficult and robust policy decisions and making decisions for sustainable outcomes in light of uncertainty. Needed technical improvements are described for two essential capabilities:

*Improving communication between technical experts and decision-makers goes hand in hand with improving our technical capabilities.*

- Decision-making in light of uncertainties
- Supporting integrated water management, including integrated flood management, regionally and statewide

### Improving Technical Support for Decision-making in Light of Uncertainties

Decision-makers often take action on issues that affect water management even 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, today scientists 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 that decision-makers have enacted 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.*

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. As discussed later, Shared Vision Planning is a collaborative approach for using technical information with decision support tools to seek informed and consensus-based solutions.

## Improving Technical Support for Integrated Regional Water Management

Integrated water management is becoming a foundation of water planning in California and is the theme of this California Water Plan update. This is a multi-objective approach that encourages using a mix of resource management strategies to provide broad benefits particularly to regions. 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. Update 2009 (Volume 2) identifies 27 strategies to help meet regional and statewide water management objectives. Communities can plan, invest, and diversify their water portfolios using these management strategies to become more self-sufficient with local supplies and minimize conflicts with other resource management efforts and other regions.

Unfortunately, many Integrated Regional Water Management Plans are only integrated conceptually and not quantitatively. California needs better water management information and analytical tools to produce useful and more integrated information on water quality, environmental objectives, economic performance, social equity objectives, and surface water and groundwater interaction. Today, it is difficult to compare, much less integrate, information from different local entities to understand and resolve regional water management issues, and even more difficult to understand the statewide linkages.

*California needs to create a new water information exchange and management system and more integrated analytical tools that can be used to document and share knowledge.*

To make significant progress toward a more comprehensive scientific understanding, California needs to create a new water information exchange and management system and more integrated analytical tools that can be used to document and share knowledge as it is developed. Investments in information exchange and integrated analytical tools will help facilitate consensus-based decision-making that is a key part of integrated water management.

# Specific Water Management Information and Analytical Needs

*California lacks a consistent framework and standards for collecting, managing, and providing access to information on water and environmental resources.*

Several factors have led DWR to rethink how it evaluates California's future water conditions. Policy-makers and the public need more 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. Finally, California lacks a consistent framework and standards for collecting, managing, and providing access to information on water and environmental resources essential for integrated water management. For example, four separate statewide surveys of urban water use by different entities result in duplicative efforts by those reporting the information and often with inconsistent responses. More accurate water resources information and analytical tools and better information management 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 we can adapt our water systems to reduce controversy and conflicts.

## Information Gaps and Limitations

*Completing regional flow diagrams and water balances requires more detailed land and water use data, the ability to differentiate between applied and consumptive water uses, and better surface water and groundwater data.*

Today's water resources problems are much more complex than in the past. A large amount of information is needed not only to analyze water demands and supplies, but also to evaluate ecosystem restoration options, adapt to long-term climate change, and implement integrated regional water and flood management solutions. The Water Plan describes much of the current water resource information requirements in regional waterflow figures (see Volume 3 Regional Reports and Volume 5 Technical Guide). Flow diagrams characterize a region's hydrologic cycle. Completing regional flow diagrams and water balances requires more detailed land and water use data, the ability to differentiate between applied and consumptive water uses, and better surface water and groundwater data. The following categories of information are not available or are very expensive to compile.

- Statewide land use—native vegetation, urban footprints, nonirrigated and irrigated agriculture
- Groundwater[1]—total natural recharge, subsurface inflow and outflow, recharge of applied water, extractions, groundwater levels, pumping-induced land subsidence, and water quality
- Surface water—natural and incidental runoff, local diversions[2], return flows, total streamflows, conveyance seepage and evaporation, runoff to salt sinks, and water quality

1 Senate Bill 6, enacted in November 2009, provides a significant improvement in access to groundwater information by requiring local agencies to monitor groundwater levels.

2 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 and water requirements
- Land elevations and channel bathymetry
- Current and future price of water by supply source

Information is available for some regions and not others. For example, methods and data to estimate natural runoff are available for regions like the Sacramento Valley where the Delta is a central outflow measurement. In areas like the South Coast Hydrologic Region, with no central point for outflow measurement and substantial groundwater, the natural runoff is more difficult to estimate. In addition to natural obstacles, existing data are not easily gathered or split apart to provide convenient access for all areas of interest. And budget constraints limit the data collection and management necessary to quantify and track all the water in the state.

*Much of the new water management projects and activities over the last 20 years have been developed and funded by local and regional water agencies. And new State laws have been passed to encourage California regions to become more self-sufficient with their water supplies.*

## Technical Challenges of Integrated Water Management

Update 2005 highlighted and encouraged California's regions to take a leadership role in solving many of California's water management challenges. This is a reflection of what has been happening for many years. Much of the new water management projects and activities over the last 20 years have been developed and funded by local and regional water agencies. These include water conservation programs, new surface water and groundwater storage, and water recycling projects. California voters have passed several statewide bond measures during this time providing billions of dollars to support local and regional water management activities. And new State laws have been passed to encourage California regions to become more self-sufficient with their water supplies.

*New tools must be developed that allow for inclusion of economic, environmental, and social (equity) benefits and impacts using project life-cycle analysis.*

Integrated regional water management is a multi-objective approach that encourages using a mix of resource management strategies to provide broad benefits to regions. Technical analysis performed for multi-objective planning often seeks to minimize total economic costs or maximize the total economic benefits for the entire region when implementing a set of resource management strategies. This analysis requires a detailed and dynamic representation of the water management system. However, water managers often lack detailed information or analytical tools to represent groundwater pumping, dynamic relationships between surface water and groundwater, ecosystem benefits and stressors, and ambient water quality. In addition, it is difficult to represent many of these factors in economic terms and to characterize uncertainty. New tools must be developed that allow for inclusion of economic, environmental, and social (equity) benefits and impacts using project life-cycle analysis. The following highlights three examples of analysis performed for integrated regional water management that have significantly increased the need for improved water management information with robust and transparent technical analysis.

### Integrated Flood Management

Integrated flood management seeks to include both structural and nonstructural methods to manage high water events and seeks to enhance the ability of undeveloped floodplains and open spaces to reduce the incidence 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. 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, and existing and future land uses in floodplains.

### Ecosystem Restoration

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 our 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. Scientists often only qualitatively estimate environmental benefits of restoration projects because of scientific uncertainty about the effects of proposed projects and how species respond to different environmental factors such as waterflow and water temperature. In addition, usually only limited historical data are available on ecosystems and their relative health.

### Adapting to Climate Change

As a result of climate change, California's future hydrologic conditions are changing from patterns observed over 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 extent and timing of the changes remain uncertain. These changes could have major implications for water supply, flood management, and ecosystem health. (See the climate change adaptation white paper and the climate science white paper in Volume 4 for a discussion of these changes.)

Scientists and engineers require significant improvements in water management information and analytical tools to effectively examine how California's water infrastructure and natural systems can be managed to accommodate or adapt to climate change. An article in the San Francisco Estuary & Watershed Science (Dettinger and Culberson 2008) recommends a series of strategic responses to address challenges

*An article in the San Francisco Estuary & Watershed Science recommends a series of strategic responses to address climate change challenges facing water managers.*

facing water managers. The following are some of the strategic responses associated with improving the basic science and analysis:

- Additional emphasis on long-term monitoring of restoration and resource management activities
- Support multidisciplinary, integrated science
- Encourage multivariate climate monitoring and modeling
- Ensure consistency of observational and analytical methods
- Develop and maintain integrated models that include important subsystems

*The need for concerted improvements in our water management information and analysis is not a new revelation.*

## Recent Studies and Forums for Improving Water Management Information and Analysis

*The Shared Vision Planning approach can transcend the individual efforts to provide long-term improvements to our technical infrastructure.*

This section highlights a few of the studies and forums closely associated with the California Water Plan that recommend specific new investments in our technical capabilities. Numerous related efforts by federal, State, and local entities have developed similar recommendations. The need for concerted improvements in our water management information and analysis is not a new revelation. Scientists and engineers involved in water resources planning and management agree that investments in collecting reliable water resources information and developing improved analytical procedures has not kept pace with the need. Information from the following studies and forums are the basis of the Shared Vision Planning approach proposed later in this chapter that can transcend the individual efforts to provide long-term improvements to our technical infrastructure.

### Update 2005, Volume 1, Chapter 4

California Water Plan Update 2005 (DWR 2005) introduced several new concepts within the analytical approach for evaluating statewide and regional water conditions (as compared to previous water plan updates). They included the development of multiple scenarios of the future, the shift from using average or normalized data when describing current water management conditions, and the development of specific criteria to evaluate the expected performance of potential water management strategies. Although not fully implemented in Update 2005, these new concepts helped define the long-term direction for the Water Plan. DWR worked extensively with the Water Plan Advisory Committee to outline the improved quantitative deliverables that are at the core of the analysis performed for the California Water Plan.

***CWEMF.*** *California Water and Environmental Modeling Forum is a nonprofit, nonpartisan organization whose mission is to increase the usefulness of models for analyzing California's water-related problems with emphasis in the San Francisco Bay, Sacramento-San Joaquin Delta, and Central Valley system (Bay-Delta Watershed).*

### CWEMF (California Water and Environmental Modeling Forum) Strategic Analysis Framework

The California Water and Environmental Modeling Forum developed a Strategic Analysis Framework (CWEMF 2005) for the long-term development of data and models to manage water in California (see it in Volume 4 Reference Guide). The CWEMF framework describes the important water management challenges that California faces and promotes the development of better integrated and modular analytical tools to

evaluate alternative solutions to these challenges. CWEMF considered several efforts within the United States and abroad when it developed the framework. The framework also describes several potential institutional and funding options that California should explore to improve the technical foundation for the state's water planning and management studies. Several of these options include an important role for DWR.

## San Francisco Estuary & Watershed Science

The paper "Internalizing Climate Change - Scientific Resource Management and the Climate Change Challenges" (Dettinger and Culberson 2008) includes recommendations for strategic improvements in scientific research and collaboration needed to respond to climate change. In particular, the paper identifies seven important climate change-related challenges and a number of strategic responses that should be undertaken by the technical community. These strategic responses include improving monitoring commitments, supporting multidisciplinary science, and better integrating our water resources information and analysis. (Read the article in Volume 4 Reference Guide.)

*Many of the recommended strategies call for more integrated management of state and local water supply and flood systems and are incorporated in Update 2009 objectives and related actions.*

## DWR Climate Change Adaptation White Paper

In October 2008, DWR published Managing an Uncertain Future: Climate Change Adaptation Strategies for California's Water. The primary purpose of this white paper is to identify some of the important challenges of long-term climate change that California faces and to recommend water management adaptation strategies to respond to the effects of climate change. Many of the recommended strategies call for more integrated management of state and local water supply and flood systems, and are incorporated in Update 2009 objectives and related actions (see Chapter 7 Implementation Plan). The white paper also identifies the need for additional investment in scientific information used to support decisions about adaptation strategies.

*This climate science paper includes specific recommendations for research and improvements to analytical tools and data for evaluating climate impacts.*

## DWR Climate Science White Paper

DWR with input from the Climate Change Technical Advisory Group developed (2009) a white paper on the state of climate-related science. "The State of Climate Change Science for Water Resources Operations, Planning, and Management" describes the current understanding of potential climate-related impacts to our water supply, water use, and water management infrastructure and makes a series of recommendations to advance the science. (Read the paper in Volume 4 Reference Guide.) This paper includes specific recommendations for research and improvements to analytical tools and data for evaluating climate impacts.

*DWR convened the Statewide Water Analysis Network, a standing technical advisory group known as SWAN, to assist with formulating recommendations on technical improvements needed to support the Water Plan.*

## SWAN (Statewide Water Analysis Network)

Water Plan Update 2005 recommended that DWR and other State agencies improve data, analytical tools, and the exchange of information needed to support regional integrated resource plans. In response, DWR convened the Statewide Water Analysis Network, a standing technical advisory group known as SWAN, to assist with

**Box 6-1 Shared Vision Planning Workshop**

On April 22, 2008, the California Department of Water Resources and the California Water and Environmental Modeling Forum, in collaboration with the US Army Corps of Engineers' Institute for Water Resources, sponsored a one-day workshop to introduce the topic of Shared Vision Planning to an audience of natural resource planners, scientists, and engineers.

Stakeholders identified the opportunities for use of Shared Vision Planning concepts that have the greatest potential for improving the utility of, and confidence in, the analytic tools used to study water management problems. By developing higher level, transparent screening tools, developing common planning scenarios, and sharing data and data collection efforts, the Water Plan process will build long-term relationships, increase awareness and support for collaborative planning processes, and build trust in the planning process. Additional near-term steps include a communications plan for Update 2009 that includes Shared Vision Planning and touches on the many competing programs that deal with water.

Participants identified the need for two levels of detail in analytical tools used for water planning: detailed analytical tools and simpler Shared Vision Planning tools. Detailed analytical tools are needed to capture the complex system dynamics as realistically as possible. These more complex tools are used to ground truth the simpler Shared Vision Planning tools. Proponents of Shared Vision Planning need to show a bridge to the development of the detailed analytical tools that support the Shared Vision Planning tools to justify long-term funding commitments.

A workshop summary can be found in Volume 4 Reference Guide.

formulating recommendations on technical improvements needed to support the Water Plan. SWAN is a voluntary collection of scientists and engineers and met several times during development of Water Plan Update 2009 to provide advice on the quantitative deliverables for the Water Plan including the recommendations contained in this chapter. See http://www.waterplan.water.ca.gov/swan for additional information about the activities of SWAN.

## Implementing Long-term Technical Improvements through Shared Vision Planning

*Shared Vision Planning integrates tried-and-true planning principles, systems modeling, and collaboration into a practical forum for making water resources management decisions.*

DWR is pursuing the approach and methods of Shared Vision Planning (SVP) in the Water Plan 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 Water Plan information

SVP integrates tried-and-true planning principles, systems modeling, and collaboration into a practical forum for making water resources management decisions. The term is most closely associated with the US Army Corps of Engineers, Institute for Water Resources which has been implementing the approach and methods since the National Drought Study in the 1990s (See www.SharedVisionPlanning.us for additional information).

SVP addresses the need for broad involvement of stakeholders by actively involving them in the technical analysis. Aside from the intensive and continuous collaboration, what defines SVP is the use of collaboratively developed decision-support models that serve as the primary tools for plan formulation and evaluation. These SVP models are designed to be transparent and easy-to-use and integrate hydrologic simulations with economic, environmental, and other considerations relevant to understanding the system. Benefits of SVP are a shared understanding and vision of the system, identification of alternatives that are both technically and politically feasible, and reduced resistance to implementation of any decisions.

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DWR working with SWAN 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 our 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 analytic tools so that they are more relevant to current and future problems. Current data and analytical tools are not sufficient to provide answers to important questions from decision-makers, water managers, and resource planners. DWR working through SWAN applied SVP in preparing this Water Plan (See Box 6-1 Shared Vision Planning Workshop). DWR, CWEMF, the CALFED Science Program, and others have proposed specific activities to ensure that California continues to improve our water management information and analysis for making crucial decisions about water resource investments. Achieving these advances requires significant investments in better information management systems; additional data collection; and more sophisticated, transparent, and accessible analytical tools.

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## Critical Near-term and Long-term Activities

Several agencies and institutions are engaged in long-term efforts to improve California's water management information and analytical capabilities (See Box 6-2 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. Development of simpler SVP or decision support tools ultimately must be verified against these detailed models. Each of the entities in Box 6-2 has long-term strategic plans for technical improvements for their particular area of responsibility.

Missing are the crosscutting actions that transcend the individual efforts to provide widespread integration of water resources information and analysis. This section describes five of these currently unmet crosscutting actions that are critical for the long-term improvement of our technical capabilities.

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DWR working with SWAN recommends these critical activities to support a long-term vision for integrated water management information and analysis (e.g., the Strategic Analysis Framework envisioned by CWEMF in its 2005 report).

- Develop a Strategic Plan to Improve Water Management Information

**Box 6-2 Entities Engaged in Long-term Technical Improvements for Statewide Water Management**

- The US 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 US 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 US Bureau of Reclamation jointly maintain an analytical tool of the Central Valley Water Management System.
- Researchers of the University of California develop and maintain numerous analytical tools as part of specific research projects.

- Improve Integration of Water Management Information
- Develop Common Schematics of the Water Management System
- Develop a Common Conceptual Understanding of the Water Management System
- Establish Modeling Protocols and Standards

Involvement of stakeholders in these five technical activities will support an SVP approach to the Water Plan. These activities were determined to be priority, based on advice received at SWAN workshops and the recommendations of key studies mentioned earlier in this chapter. Although significant resources are needed to implement them, these activities would greatly enhance the ability of scientists and engineers to support integrated water management and decision-making in light of uncertainties. They must be viewed as long-term commitments to our technical infrastructure.

## Develop a Strategic Plan to Improve Water Management Information

The limitations and gaps in water management information under our current institutional arrangements are described in an earlier section. California water and resource managers and planners have a critical need for a strategic plan describing the specific information needed to support water management activities and the institutional arrangements for collecting and maintaining the information. A strategic plan for improving water management information would identify the range of different program needs to respond to flood and drought management, climate change, ecosystem restoration, water quality improvement, and integrated management objectives. Based on program needs the strategic plan would:

*The Water Plan does not have a fully transparent linkage between the information collected from local entities and reported at the hydrologic region.*

- establish standards and protocols to ensure the widest utility and efficient use of resources,
- identify the optimal location of monitoring stations,
- prioritize long-term improvements in the monitoring network, and
- ensure long-term maintenance and accessibility to water management information.

## Improve Integration of Water Management Information

Water management information is collected and maintained by a multitude of local, regional, State, federal, and Tribal governments, agencies, and organizations. Some entities like the Metropolitan Water District of Southern California have made inroads into effective integration of information from its water retailers. However, development of the Water Plan requires a labor-intensive process of collecting relevant information and converting it into a useful format for the Water Plan. The Water Plan does not have a fully transparent linkage between the information collected from local entities and reported at the hydrologic region. DWR has proposed three activities to improve integration of water management information; they are described below. Some initial planning and pilot studies for these activities have occurred, but DWR does not currently have the resources to implement them as proposed.

### *Integrating Data from Urban Water Management Plans, Integrated Regional Water Management Plans, and the California Water Plan*

Local agency Urban Water Management Plans and the California Water Plan are required by State 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 and how much to invest in our local and statewide water management systems. Better integration is needed to ensure that both plans are using the best available and consistent information so that decision-makers can have confidence in water policy decisions and the public can have confidence in their investments.

DWR is leading a collaborative effort to explore how information can more effectively be integrated among local, regional, and statewide water planning and management activities. The initial focus of this effort is to improve how information produced for Urban Water Management Plans can be used more effectively to support Integrated Regional Water Management Plans and the California Water Plan while streamlining reporting requirements. This initial focus will require looking beyond these plans to consider related activities that collect urban water planning and management information.

*DWR is building, and plans to maintain, an online information exchange system—called the Water Planning Information Exchange (Water PIE).*

### *Water Planning Information Exchange*

DWR is building, and plans to maintain, an online information exchange system—called the Water Planning Information Exchange (Water PIE)—to share water management information between State, regional, and local agencies and governments. 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 of Integrated Regional Water Management Plans by providing a common vocabulary and basic information needed to develop an effective plan. 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

*A prototype system called the Integrated Water Resources Information System (IWRIS) is operational as the first step for Water PIE.*

**Box 6-3 Integrated Water Resources Information Systems – 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 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 (CDEC), USGS streamflow, Local Groundwater Assistance Grants (AB303), as well as data from local agencies. IWRIS can be accessed at http://www.water.ca.gov/iwris/.

most current information throughout the state. A prototype system called the Integrated Water Resources Information System (IWRIS) is operational as the first step for Water PIE (see Box 6-3 Integrated Water Resources Information System—A Working Information System).

### *Regional Synthesis of Water Management Information*

Preparation of the Water Plan scenarios, regional reports, and regional water portfolios requires a significant amount of research and analysis to develop quantitative estimates of current and future water management conditions. For the Water Plan, information obtained from local water planning entities is aggregated up to 10 hydrologic regions, the Mountain Counties area, and the Delta region. DWR staff cannot now fully review and evaluate every statewide and regional planning document with useful water planning information.

However, DWR, SWAN members, and other Water Plan stakeholders are interested in exploring ways of more effectively using this wealth of information in the Water Plan. Example studies include:

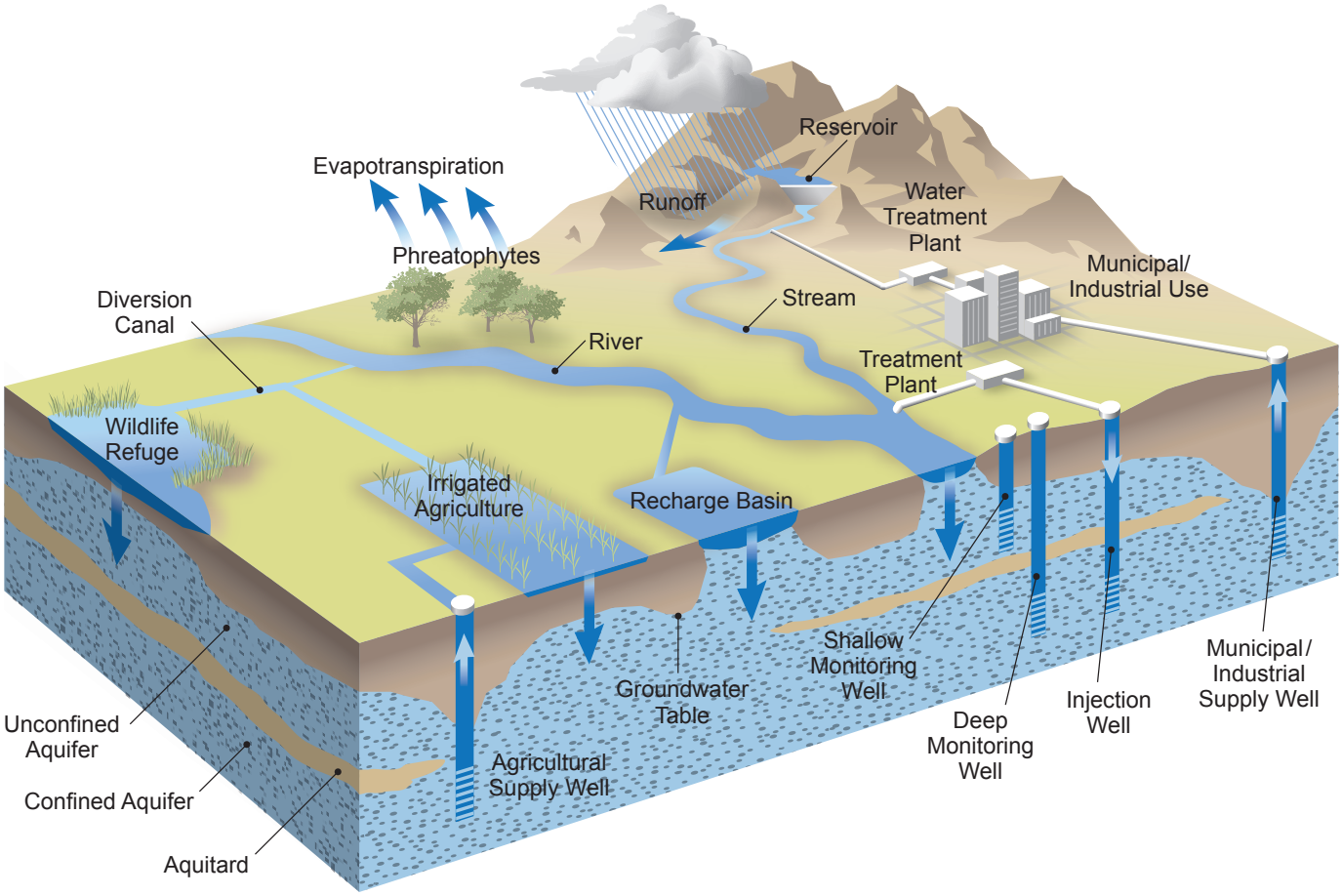
- local and regional agency water planning and policy studies;
- DWR and US Bureau of Reclamation modeling studies of the State-federal Central Valley water management system operations, the Delta, climate change, and additional surface storage;
- DWR water portfolios and water supply, demand, and modeling studies; and
- California Energy Commission-sponsored studies of climate change.

### Develop Common Schematics of the Water Management System

*Development of common schematics will allow integration with other models and sources of information.*

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 CALSIM, CALVIN, Water Evaluation and Planning System (WEAP), and Statewide Agricultural Production Model (SWAP) represent water management in portions of the Central Valley, but it is difficult to share data between them and determine whether they use information consistently. These models often

**Figure 6-1** **Conceptual model of water management system**




represent the water management system at a coarse level and do not always provide information at the scale needed for planning by a local water agency.

*Figure 6-1 shows a conceptual model of the water management system with relationships between its components.*

Development of common schematics will allow integration with other models and sources of information on water quality, ecosystem functions, flood management, climate change and other parts of integrated regional water management. DWR will take the lead in developing common water management system schematics at different spatial scales by coordinating with other technical experts and the wide array of local, regional, and statewide water planning entities.

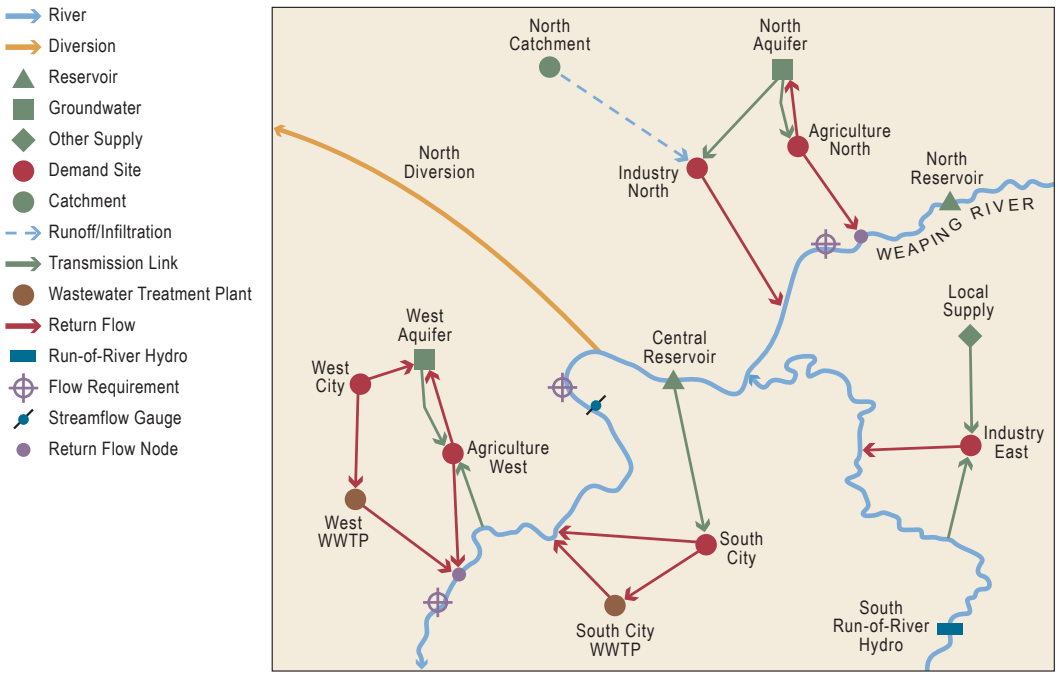
*What is needed is a common and consistent way to conceptually describe the different pieces of the water management system and how the pieces interact with each other. DWR is promoting the use of an iterative development process used widely in the software development industry.*

## 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 way to clearly and in a concise manner describe the water management system and its complexities. The result is that technical experts, decision-makers, and stakeholders have an extremely difficult time communicating how to include critical details of the water management system. On one hand, the detailed

*Figure 6-2 represents a sample schematic of the water management system from the Water Evaluation and Planning System model. This figure and Figure 6-1 on previous page represent alternative views of the water management system.*

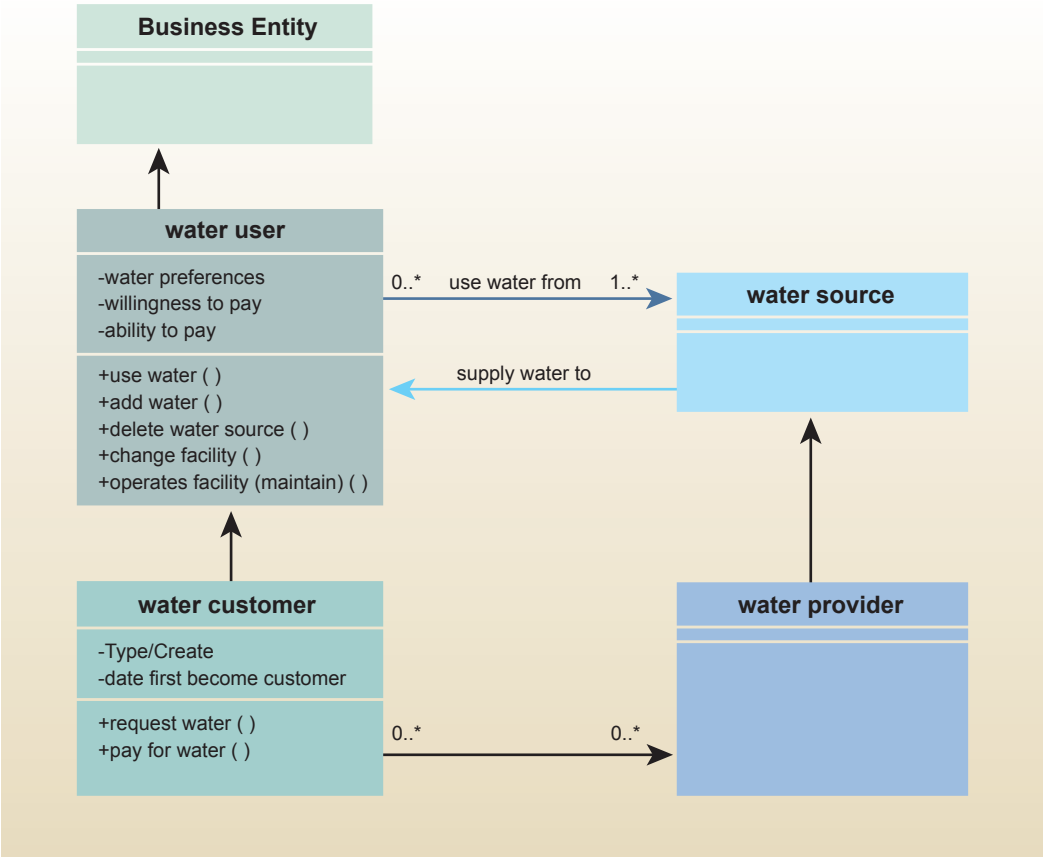
## Figure 6-2 Sample schematic of water management system




Source: WEAP (Water Evaluation And Planning system)
http://www.weap21.org

*Figure 6-3 shows an example describing the relationships between water users and water providers using Unified Modeling Language standard notation.*

## Figure 6-3 Example diagram using Unified Modeling Language standard notation



analytical tools are too obscure for nontechnical people. On the other hand, decision-makers and stakeholders often have a general understanding of only parts of the water management system.

What is needed is a common and consistent way to conceptually describe the different pieces of the water management system and how the pieces interact with each other. DWR is promoting the use of an iterative development process used widely 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 6-1 shows a conceptual model of the water management system with relationships between its components. Figure 6-2 represents a sample schematic of the water management system from the Water Evaluation and Planning System model (see 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.*

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 6-3 shows an example describing the relationships between water users and water providers using Unified Modeling Language standard notation.

*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.*

### Establish Modeling Protocols and Standards

The movement toward integrated water management 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 very similar to the need for standards and protocols for information exchange as described in a previous section. CWEMF developed modeling protocols (CWEMF 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 and decision-makers, and their technical staff as models 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.

**Box 6-4 Quantitative Deliverables for the California Water Plan**

- **Water portfolios** that describe annual, regional water balances for 1998-2005.
- **Future scenarios** that describe alternative, plausible base conditions of future water use and water supply throughout California. Scenarios are distinguished from each other by different assumptions used for key factors over which water managers have little control, like population growth, land use changes, and climate conditions.
- **Response packages** of resource management strategies that are designed to improve performance of the water management system with regard to management objectives. The expected system performance of alternative response packages are analyzed under each future scenario using evaluation criteria.

## Implementing Analytical Improvements for Water Plan Update 2009

*Update 2009 has built upon Update 2005 by including additional years in the water portfolios, refining the representation of future scenarios, including hydrologic variability and climate uncertainty, and more fully describing water management response packages.*

Update 2005 introduced several new concepts within the analytical approach for evaluating statewide and regional water conditions. These new concepts help define the long-term direction for the update process. DWR worked extensively with the Water Plan Update 2005 Advisory Committee to outline three groups of quantitative deliverables (described in Box 6-4 Quantitative Deliverables for the California Water Plan) that are the core of the analysis performed for the California Water Plan. Due to resource and schedule constraints, Update 2005 did not fully implement all three of these quantitative deliverables. However, with each successive Update, DWR will move to this more comprehensive analysis. Update 2009 has built upon Update 2005 by including additional years in the water portfolios, refining the representation of future scenarios, including hydrologic variability and climate uncertainty, and more fully describing water management response packages.

### Approach for Quantifying Future Scenarios for Update 2009

*The ultimate goal is to quantitatively integrate the Water Plan with Integrated Regional Water Management Plans to provide consistency in the information used to guide both regional and statewide water management decisions.*

In this volume, Chapter 5 Managing an Uncertain Future describes the basics behind the development of future scenarios for Update 2009 and some of the statewide drivers and presents three narrative scenarios for conditions through 2050. This section describes the analytical approach used to quantify the scenarios including regional drivers of demand, regional water management response packages, and the performance of these response packages. In the long run, the five activities (described under the earlier section Critical Near-term and Long-term Activities) for improving technical capabilities will also support the continued refinement of scenario analysis used in the Water Plan. The ultimate goal is to quantitatively integrate the Water Plan with Integrated Regional Water Management Plans to provide consistency in the information used to guide both regional and statewide water management decisions.

## Using the Water Evaluation and Planning System (WEAP) to Quantify Future Scenarios

For Update 2009, DWR with input from SWAN chose to apply WEAP as a tool to help quantify different future scenarios and alternative water management responses. (See www.weap21.org for additional information about the WEAP tool.) During and after the completion of Update 2005, DWR evaluated several possible approaches to quantify future scenarios for Update 2009, including the Analytica tool used for Update 2005. In 2005, DWR participated in a study with the Stockholm Environment Institute (SEI) funded by the US Environmental Protection Agency to apply the WEAP tool to understand the potential effects of climate change on the Sacramento Valley. DWR chose the WEAP tool for Update 2009 because WEAP:

- has a friendly graphical user interface that supports collaboration,
- requires a shorter learning curve than alternatives,
- was successfully applied by the RAND Corporation to evaluate climate scenarios for the Inland Empire Utilities Agency, and
- received positive feedback from SWAN and other Water Plan stakeholders.

### *Summary of Update 2009 Proposal*

At the September 2007 SWAN meeting, SEI presented how the WEAP tool could support scenario analysis for the Water Plan. Following positive feedback and suggestions for implementation by both stakeholders and DWR staff, MWH, SEI, and RAND Corporation in fall 2007 provided DWR a proposal for developing a quantitative scenario analysis tool of water management responses under uncertainty for Update 2009. As described later, the WEAP proposal was presented at several public forums, including two technical workshops of the SWAN in December 2007 and June 2008. The WEAP proposal has undergone several revisions in response to stakeholder comments and was accepted and funded by DWR.

The WEAP proposal completes and builds on work begun in Update 2005 and other studies by employing the WEAP modeling tool to simulate and evaluate more refined integrated water management scenarios for Update 2009. The WEAP proposal both quantifies a small set of hand-crafted narrative scenarios developed by the Water Plan update staff and Water Plan Advisory Committee and generates a larger ensemble of plausible scenarios to systematically evaluate the performance of various regional water management response packages in the face of a number of critical uncertainties, including climate change. Work is under way in pursuit of the following specific objectives:

- Develop an integrated scenario analysis modeling framework
- Use this framework to assess the full spectrum of uncertainties that confront water planning in California, including global climate change, land use and demographic changes, hydrologic variability, and others
- Evaluate the results of these analyses against an appropriate set of performance metrics, introducing the notions of robustness and risk as part of the evaluation process

*DWR used WEAP to develop a low-resolution regional demand representation for each of the 10 hydrologic regions in California.*

- Develop a strategy to evaluate the most promising regional water management responses

### *Update 2009 Scenario Analysis Performed at Two Scales*

*A pilot study used WEAP at a smaller spatial scale suitable to capture the major hydrologic flows, represent major demographic and land use trends, and to evaluate the effects of water management responses.*

For Update 2009, most of the scenario analysis was performed at the hydrologic region scale. DWR used WEAP to develop a low-resolution regional demand representation for each of the 10 hydrologic regions in California. For this analysis, indoor urban demand is represented in a manner similar to that used for Update 2005. The representation of outdoor urban and agricultural water demand is improved using evapotranspiration (ET) requirements and irrigation patterns, and variable monthly scenarios of precipitation and temperature based on 12 available scenarios representing future climate change.

As a pilot study, Update 2009 also presents a more detailed analysis of scenarios and water management response packages for the Sacramento River and San Joaquin River hydrologic regions. The pilot study used WEAP at a smaller spatial scale suitable to capture the major hydrologic flows, represent major demographic and land use trends, and to evaluate the effects of water management responses. In general, the model is organized by DWR Planning Areas—there are 11 PAs in the Sacramento River Hydrologic Region and 10 in the San Joaquin River Hydrologic Region. For the four PAs covering the southern Cascade and northern and central Sierra Nevada ranges, the PAs are further disaggregated along watershed boundaries and elevation bands to reflect major reservoir operations and elevation-dependent hydrologic processes. For the remaining 17 PAs, located primarily on the floor of the Central Valley, water demands and water supplies are specified at the PA level, and only disaggregated when necessary to properly reflect usage of different supplies or to evaluate scenarios and response packages of greater interest. See Volume 4 for the article describing this WEAP pilot study.

### *Review of WEAP Proposal by SWAN and Other Water Plan Stakeholders*

*The key factors of uncertainty affecting future water demand are future land use patterns, future population and other demographic patterns, level of background water conservation, and future climate (precipitation and temperature).*

The Water Plan provided significant opportunities for stakeholders to participate in reviewing and refining the WEAP proposal. Box 6-5 (DWR Scenario-related Workshops) lists workshops and meetings conducted by DWR to obtain feedback on the development of scenarios and on the WEAP proposal. At the June 2008 SWAN workshop, information was presented on how the Water Plan might quantify climate change, flood management, environmental water, and water quality as part of the scenario analysis. Workshop participants identified several strengths and limitations associated with the WEAP proposal. Some of the identified weaknesses are the inability to properly track floodflows and operations because of the coarse monthly time step used and limited representation of water quality. All feedback helps DWR identify where to focus future investments in the scenario analysis. See Volume 4 for a copy of the WEAP proposal and see www.waterplan.water.ca.gov/swan for the comments received. Meeting summaries for the workshops in Box 6-5 are posted at www.waterplan.water.ca.gov/calendar/calendar.cfm.

**Box 6-5 DWR Scenario-related Workshops**

| Date | Workshop Purpose and Scenario Content |
|---|---|
| 9/17/2007 | SWAN – Case studies in implementing scenarios for regional planning |
| 10/22/2007 | Plenary – Role and themes of scenarios |
| 11/29/2007 | General - Narrative themes for future baseline scenarios |
| 12/10/2007 | SWAN - Quantification of scenarios for California Water Plan Update 2009 |
| 12/19/2007 | Advisory Committee - Quantification of scenarios for Update 2009 |
| 4/22/2008 | SWAN – Shared Vision Planning |
| 6/3/2008 | All Regions Forum – Quantifying scenarios and response packages |
| 6/19/2008 | SWAN – Quantifying climate change, flood management, environmental water, and water quality for Water Plan Update 2009 and beyond |
| 2/11/2009 | SWAN – Preliminary scenario demands |
| 6/16/2009 | General – Graphics for Water Portfolios and Future Scenarios |
| 10/08/2009 | SWAN — Regional and Statewide Water Management Responses to an Uncertain Future |

## Regional Drivers of Water Demand and Available Supply

Chapter 5 Managing an Uncertain Future describes three narrative scenarios developed for Water Plan Update 2009 and some of the high level statewide and regional results. Here, we describe the underlying methods for quantifying factors of uncertainty that can drive future water demand and available supply. The key factors of uncertainty affecting future water demand are future land use patterns, future population and other demographic patterns, level of background water conservation, and future climate (precipitation and temperature). Future land use patterns affect how much land is devoted to irrigated agriculture or landscaping. Higher density urban development or water-wise landscaping practices can result in less water applied to landscape irrigation. Future population growth also has a significant effect on future water requirements. Future climate including occurrence of drought and wet years will affect the availability of supply and the additional water required to grow crops and maintain plants used in landscaping.

*The irrigated agricultural land use estimates are based on potential urbanization of agricultural land, changes in crop mix, and changes in multicropping.*

### *Agricultural Land Use*

For Update 2009, three different scenarios of irrigated agricultural land use were developed corresponding to the Current Trend, Slow & Strategic Growth, and Expansive Growth scenarios described in Chapter 5. The irrigated agricultural land use estimates are based on potential urbanization of agricultural land, changes in crop mix, and changes in multicropping. The reduction in irrigated land area was based partially on the 2003 study, "How We Will Grow: Baseline Projections of the Growth of California's Urban Footprint through the Year 2100", conducted for the Natural Resources Agency (Landis and Reilly 2003). The Landis study ties future population growth with future

**Box 6-6 Abbreviations and Acronyms Used in this Chapter**

| | |
|---|---|
| CAT | Climate Action Team |
| CWEMF | California Water and Environmental Modeling Forum |
| DOF | California Department of Finance |
| DWR | California Department of Water Resources |
| PPIC | Public Policy Institute of California |
| SEI | Stockholm Environment Institute |
| SVP | Shared Vision Planning |
| SWAN | Statewide Water Analysis Network |
| SWAP | Statewide Agricultural Production model |
| Water PIE | Water Planning Information Exchange |
| WEAP | Water Evaluation and Planning system |

urban development for the years 2020 and 2050. Landis developed a GIS urbanization model and created spatial urban footprints starting from the California Department of Conservation 1998 urban footprint. These urban footprints were used with the current irrigated agricultural land footprint to estimate irrigated land in the future.

The level of future multicropping area assumed for each of the three scenarios was developed using trends of historical multicropping area, irrigated land area, and results from the Landis study for 2020 and 2050. For Update 2009, relationships were developed between the Landis study and three recent estimates of projected 2050 population corresponding to Water Plan scenarios to quantify irrigated land area and multicropped area for each scenario by decade from 2010 to 2050. Land use was interpolated between decades.

### *Demographic Information*

- **Population.** Three different estimates of future population growth to 2050 were developed for the three Water Plan scenarios. The Current Trends scenario follows population projections by the California Department of Finance (DOF). Population for the Slow & Strategic Growth and Expansive Growth scenarios are respectively based on low and high population growth scenarios developed by the Public Policy Institute of California as described in "Population projections for California climate change scenarios" (article in Volume 4 Reference Guide). The PPIC study was conducted for the Governor's Climate Action Team 2008 Biennial Climate Assessment Report. Some minor changes were made to the PPIC high population growth to distinguish it from the DOF projections.
- **Housing and housing density.** The three estimates of future population growth described above were used to develop estimates of future housing and housing density for the three Water Plan scenarios. Future population was used with demographic information from Woods and Poole (2007) to develop estimates of future single- and multiple-family households and household size. Estimates of future single- and multiple-family households and household size for the Current

Trends, Slow & Strategic Growth, and Expansive Growth scenarios are consistent with the DOF, PPIC Low, and PPIC High population projections, respectively.

- **Commercial and Industrial employment.** Similar to the housing factors, commercial and industrial employment for the Current Trends, Slow & Strategic Growth, and Expansive Growth scenarios are consistent with the DOF, PPIC Low, and PPIC High population projections, respectively, and are based on demographic information from Woods and Poole (2007).

*Unmet objectives are objectives that have been identified by regulatory agencies or court decisions, but are not yet required by law.*

### *Unmet Environmental Water Objectives*

*This information was updated for Update 2009 to include information from 1998 to 2007 and to consider additional objectives.*

The three Water Plan scenarios include additional water needed in the future to meet currently unmet objectives for additional instream flow needs and deliveries for managed wetlands. Unmet objectives are objectives that have been identified by regulatory agencies or court decisions, but are not yet required by law. The first step of the analysis was to evaluate unmet objectives for existing streams and managed wetlands based on recent historical information following the methods described in the Volume 4 Reference Guide article by Environmental Defense, "Recommendations Regarding Scenarios and Application of Environmental Water 'Demands' in the State Water Plan Update & Quantification of Unmet Environmental Objectives in State Water Plan 2003 Using Actual Flow Data for 1998, 2000, and 2001." This information was updated for Update 2009 to include information from 1998 to 2007 and to consider additional objectives from the May 2008 report by the California Department of Fish and Game, "Flow Recommendations to the State Water Resources Control Board," which also can be found in Volume 4.

*The Water Plan team coordinated efforts to quantify future climate with the ongoing work of the Climate Action Team (CAT). The result is 12 different time scenarios of future climate that the Water Plan applied for each of the three Water Plan scenarios.*

The second step in the analysis was to estimate future unmet environmental water objectives. For each hydrologic region, unmet objectives vary from year to year based on future precipitation projections from each of the 12 climate scenarios used by the Climate Action Team as described in the next section. The values for each year are derived from the historical unmet objectives and vary between scenarios. For example, for a future "wet" year type, the Current Trends scenario uses the average of the historical "wet" years; the Slow & Strategic Growth scenario uses the maximum of the historical "wet" years, and the Expansive Growth uses the minimum of the historical "wet" years. See Table 5-3 in Chapter 5 for the historical and scenario values for unmet environmental water objectives.

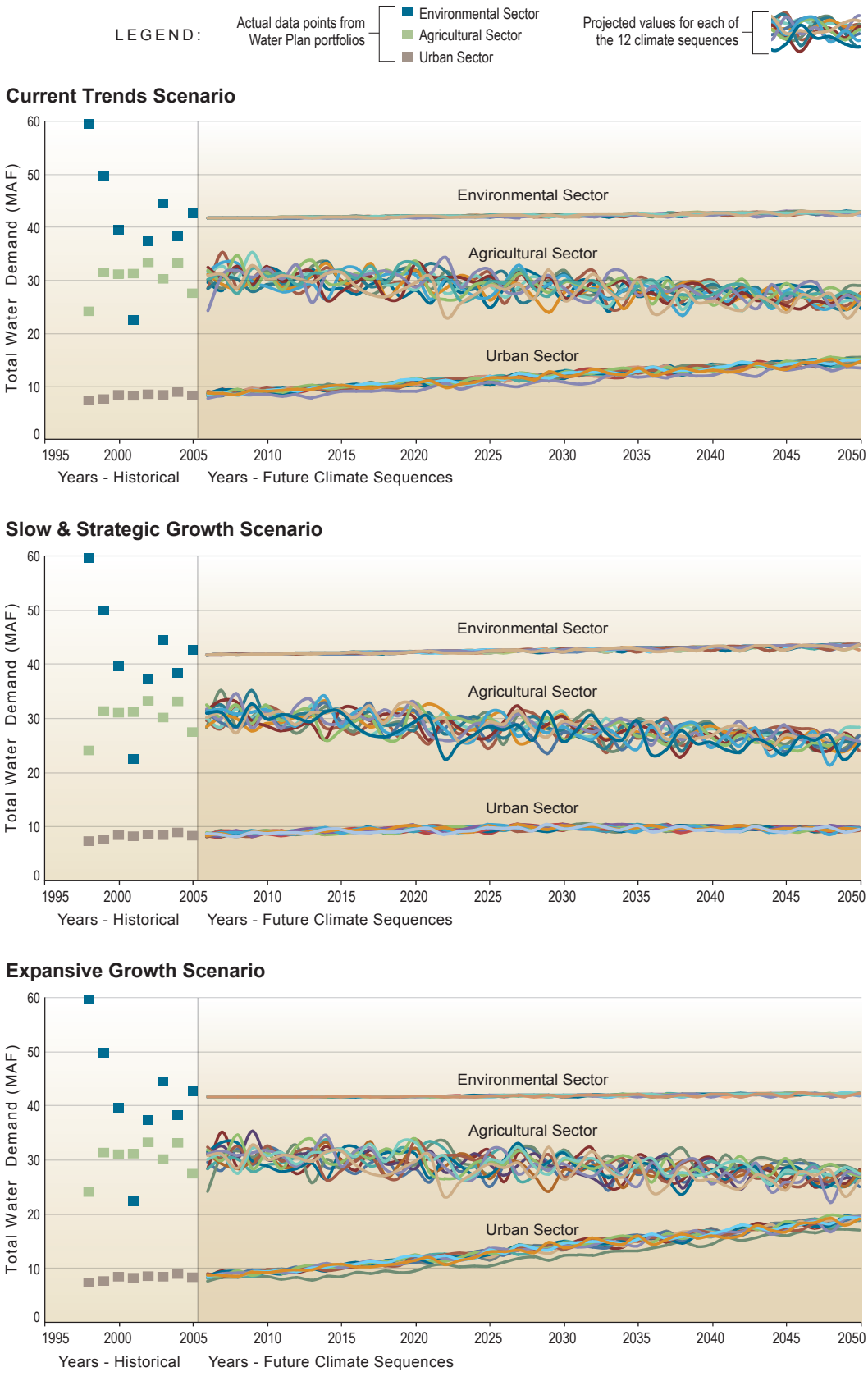
### *Future Climate*

The Water Plan team coordinated efforts to quantify future climate with the ongoing work of the Climate Action Team (CAT) initiated by the Governor. The CAT completed a second biennial assessment of potential climate change impacts in the state. At the core of this effort is climate-change scenarios derived from six global climate models:

- From France: CNRM CM3
- From USA: GFDL CM2.1
- From Japan: MIROC3.2 (med)
- From Germany: MPI ECHAM5

*Figure 6-4 shows annual statewide water demands for all sectors. The left side of each chart shows historical water use information for 1998 through 2005 from the Water Plan Water Portfolios. The right side of each chart shows 12 plausible scenarios for future water demand from 2005 to 2050 for 12 different scenarios of future climate superimposed on a single baseline growth scenario considering the effects of future population growth, land use changes, and background water conservation.*

## Figure 6-4 Statewide annual water demand under 12 future climate scenarios



- From USA: NCAR CCSM3
- From USA: NCAR PCM1

These models were chosen on the basis of the availability of detailed outputs for use in various parts of the assessment process and upon consideration of certain aspects of their performance. The CAT used each of the six global climate models with two separate greenhouse gas emission scenarios developed by the Intergovernmental Panel on Climate Change. The result is 12 different time scenarios of future climate (temperature, precipitation, and relative humidity) that the Water Plan applied for each of the three Water Plan scenarios. Please refer to Volume 4 Reference Guide article "Overview of Climate-change Scenarios being Analyzed" for additional information on the CAT climate scenarios.

## Quantification of Scenarios and Resource Management Responses

### Statewide Water Demands

Chapter 5 describes the statewide change in total water demands by 2050 under 3 scenarios and by each sector (urban, agriculture, and environmental). Here we provide more detailed results showing the aggregate impact of the regional drivers described in previous section on future water demands over time. Figure 6-4 shows the relative magnitude of water demands for each sector by showing historical information from the Water Plan water portfolios (Volume 5 Technical Guide) and annual statewide water demand results generated for 2005 to 2050 using the WEAP analytical tool.

In Figure 6-4, the left side of each line chart shows historical water use information for 1998 through 2005 from the Water Plan water portfolios. The right side of each chart shows 12 plausible scenarios for future water demand from 2005 to 2050 for 12 different scenarios of future climate superimposed on a single baseline growth scenario considering the effects of future population growth, land use changes, and background water conservation. Each line chart, one for each scenario, presents environmental, agricultural, and urban water demand separately. Total environmental demands are assumed to ramp up gradually over time from the 1998-2005 average, but vary from year to year depending on the climate. For each scenario, statewide agricultural water use varies considerably from year to year based on the climate for that year, and declines generally over time due to decreases in irrigated crop area associated with urbanization as well as additional background water conservation. Urban demands also show the influence of future climate, but are more dampened by indoor demands, which are not assumed to be influenced by climate. However, the impact of future population growth on increasing water demand is particularly evident under the Current Trends and Expansive Growth scenarios.

*The long-term goal for the California Water Plan is to allow for an integrated quantification and evaluation of regional resource management responses.*

## Quantifying Resource Management Responses

*To help bridge the technical gap in Update 2009, DWR held a SWAN workshop to solicit feedback on recent studies exploring the effectiveness of regional and statewide water management responses to uncertainties facing California water managers.*

The long-term goal for the California Water Plan is to allow for an integrated quantification and evaluation of regional resource management responses. This is to be implemented as part of the quantitative deliverables described in Box 6-4 that includes water portfolios, future scenarios, and response packages. Building on Update 2005, Update 2009 applied the WEAP model to quantify future scenarios of water demand at two levels of detail. In addition, Volume 2 describes and, where possible, quantifies benefits from 27 resource management strategies that should be considered by water managers as part of integrated resource planning. This work will be expanded during preparation of Update 2013 to begin quantifying and evaluating regional water management strategies.

*These studies highlight our current technical capabilities and limitations for describing future uncertainties and providing decision-makers with insights into the challenges and opportunities facing water managers.*

To help bridge the technical gap in Update 2009, DWR held a SWAN workshop on October 8, 2009, to solicit feedback on recent studies exploring the effectiveness of regional and statewide water management responses to uncertainties facing California water managers. Studies were presented that offer different perspectives on how climate change, population growth, droughts, and other uncertainties may impact regional water management systems and operations of the Central Valley Project and State Water Project. These studies highlight our current technical capabilities and limitations for describing future uncertainties and providing decision-makers with insights into the challenges and opportunities facing water managers. See Volume 4, Data and Analytical Tools category, for the workshop summary.

The following is a summary of the three studies presented at the workshop:

- **Water Management Lessons for California from State-wide Hydro-economic Modeling (Lund et al. 2009, University of California, Davis)**
  Researchers at the University of California, Davis presented the results of a decade of quantification and analysis of California's water management system from a hydro-economic perspective. The study focused on the general approach, management and policy insights, and promising directions that consistently emerge from these analyses. Limitations and suggestions were presented for improving hydro-economic modeling for providing insights into contemporary and future water management problems in California. Listed below are the study's key conclusions.
  1. It is possible to significantly improve statewide integrated water management and policy studies in California using hydro-economic modeling.
  2. Most water management entities in California benefit from being connected to a wide variety of water sources and other water users, facilitating more adaptable water management and water markets.
  3. The Delta is the weakest link in California's water supply system.
  4. There is rarely a shortage of water, only a shortage of cheap water.
  5. Integrated portfolio solutions of traditional and new options tend to be the most cost effective and robust.
  6. Of traditional infrastructure, expansions of selected conveyance and aquifer recharge are typically much more beneficial if water operations are well managed.

7. We have fragmented our technical and scientific capabilities and understanding of the system. Better integration and flexibility is needed for our water management system to adapt in coming decades to changed population, land use, climate and ecosystem threats.

*The study provides a preliminary assessment of the future performance of the Central Valley Project and State Water Project systems and describes and quantifies challenges related to Delta health, climate change, and drought.*

- **CalSim-II Modeling Efforts on Water Resources Challenges and Potential Management Responses and Uncertainties Facing Management of the Central Valley Project and State Water Project (DWR 2009)**
  DWR staff conducted a preliminary analysis of current water resources challenges facing the State and potential management responses using existing data and analytical tools. The study provides a preliminary assessment of the future performance of the Central Valley Project and State Water Project systems and describes and quantifies challenges related to Delta health, climate change, and drought. This evaluation is ongoing, and recommendations are included for completing the assessment and providing comprehensive information for decision makers and the public. Listed below are the study's key conclusions.
  1. New conveyance provides greatest benefits during average hydrologic conditions.
  2. New storage provides the greatest supply reliability benefits under drought or climate-induced conditions.
  3. New groundwater storage performs similarly, with even greater drought year performance and with climate change.
  4. A range of integrated regional water management actions in the South Coast Hydrologic Region do not appear to significantly affect Delta operations or deliveries.
  5. The relative frequency of dead storage conditions in upstream reservoirs indicate that significantly modified operations will be required with climate-induced conditions.

*Metropolitan is using IRPSIM to assist in its current integrated resources planning efforts ... to estimate the region's future water demands and to evaluate different water supply development scenarios ... additional uncertainties in its analytical studies such as demographics and climate change.*

- **Regional Water Management Responses using IRPSIM**
  Staff from the Metropolitan Water District of Southern California presented information from over a decade of studies conducted for their integrated water resource plan, which began in 1996 and was updated in 2003. IRPSIM is Metropolitan's primary tool for evaluating regional reliability, storage operations, and resource opportunities. Metropolitan is using IRPSIM to assist in its current integrated resources planning efforts. The presentation covered how IRPSIM is used to estimate the region's future water demands, and to evaluate different water supply development scenarios. It also provided an overview of Metropolitan's efforts to incorporate additional uncertainties in its analytical studies such as demographics and climate change. IRPSIM uses a modeling method known as sequentially indexed Monte-Carlo simulation. In short, the model integrates projections of Metropolitan's demands and imported water supplies for each forecast year and adjusts each independent projection up or down, based on an assumed pattern of future weather drawn from the historical record.

## Summary

California needs significant improvements in its analytical tools and data to effectively evaluate the costs, benefits, and trade-offs of alternative water management strategies and support decision-making. These improvements must be done in a way that promotes integrated water planning and fosters collaboration. A tremendous amount of work needs to be done to provide the desired quantitative deliverables for future Water Plan 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. Achieving these advances requires significant investments in better information management systems; additional data collection; and more sophisticated, transparent, and accessible analytical tools.
This chapter describes some of the critical activities undertaken recently to improve our technical information and identifies several critical activities that must be conducted for the next Water Plan update to continue progress.
It concludes with a summary of the technical accomplishments from Water Plan Update 2009 and summarizes other recently completed studies that highlight our current technical capabilities and limitations for describing future uncertainties and to provide decision-makers with insight into the challenges and opportunities facing water managers.

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# Implementation Plan

***Chapter photo.*** *Pelicans*

# Contents

**Chapter 7. Implementation Plan ..... 7-5**
About this Chapter ..... 7-5
Implementation Plan Organization ..... 7-5
Objectives and Related Actions ..... 7-6
Objective 1 – Expand Integrated Regional Water Management ..... 7-8
Objective 2 – Use and Reuse Water More Efficiently ..... 7-11
Objective 3 – Expand Conjunctive Management of Multiple Supplies ..... 7-14
Objective 4 – Protect Surface Water and Groundwater Quality ..... 7-18
Objective 5 – Expand Environmental Stewardship ..... 7-21
Objective 6 – Practice Integrated Flood Management ..... 7-23
Objective 7 – Manage a Sustainable California Delta ..... 7-26
Objective 8 – Prepare Prevention, Response, and Recovery Plans ..... 7-32
Objective 9 – Reduce Energy Consumption of Water Systems and Uses ..... 7-33
Objective 10 – Improve Data & Analysis for Decision-making ..... 7-35
Objective 11 – Invest in New Water Technology ..... 7-38
Objective 12 – Improve Tribal Water and Natural Resources ..... 7-39
Objective 13 – Ensure Equitable Distribution of Benefits ..... 7-41

## Tables

Table 7-1 Elements of the strategic plan ..... 7-6

## Boxes

Box 7-1 Required Elements of Integrated Regional Water Management ..... 7-9

# Chapter 7. Implementation Plan

## About this Chapter

Chapter 7 lays out the implementation plan for California Water Plan Update 2009 by presenting 13 objectives and their 115-plus related actions.

By statute the California Water Plan cannot mandate actions nor authorize spending for its recommendations. Update 2009 makes neither project-specific nor site-specific recommendations; therefore, it does not include environmental review and documentation as required by the California Environmental Quality Act. Consequently, policy-makers and lawmakers must take further action to adopt the recommendations and actions in this Water Plan and develop funding methods to help in their implementation. This underscores the need to have broad public participation and support for the Water Plan in order to have its objectives and recommendations realized.

*Policy-makers and lawmakers must take further action to adopt the recommendations and objectives in this Water Plan and develop funding methods to help in their implementation.*

## Implementation Plan Organization

California Water Plan Update 2009 identifies the most pressing water management issues and challenges faced by the state and regions. The Water Plan is a strategic guide toward meeting statewide and regional water challenges and leveraging opportunities. As a strategic plan, it contains a vision, mission, guiding principles, goals, objectives, related actions, and performance measures (Table 7-1 Strategic plan elements). While the objectives and related actions appear here in Chapter 7 Implementation Plan, the vision, mission, goals, and guiding principles are discussed in Chapter 2 Imperative to Act.

In addition, the Water Plan has nine crosscutting recommendations for changes needed to reduce or eliminate constraints and impediments, or to harness opportunities, to help achieve the strategic plan's vision, goals, objectives, and actions. These recommendations are directed at decision-makers throughout California, the executive and legislative branches of State government, and the Department of Water Resources (DWR) and other State agencies. The recommendations are as varied as the constraints they are intended to change—institutional, legal, knowledge, information, skills/capacity, resources, funding, schedule, public awareness, etc. For details and discussion of these Update 2009 recommendations, go to Chapter 2 Imperative to Act.

*The recommendations are as varied as the constraints they are intended to change—institutional, legal, knowledge, information, skills/capacity, resources, funding, schedule, public awareness, etc.*

The resource management strategy narratives in Volume 2 include recommendations on how each strategy could be implemented over the next 30 to 40 years to minimize its trade-offs and challenges, as well as how to promote additional implementation. Many of these recommendations are for State government to enact technical support to help regional groups make better decisions on the use of the strategies. The narratives do not

**Table 7-1 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. It identifies what it should do and why, and for whom it does it. |
| **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 State, federal, 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 will describe how to make decisions and do business. |
| **Objectives** | Objectives tell what we will do and why we are doing it in order to accomplish one or more goals. |
| **Related Actions** | Related actions tell how an objective will be carried out. They describe specific actions in measurable, time-based statements of intent. They emphasize the results of actions at the end of a specific time. Some related actions must be undertaken by State government or communities over which DWR has no authority. In these cases, measure and time must be part of the entities' own strategic plans. |
| **Performance Measures** | Performance measures describe what to measure and the method by which to measure in order 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 to compare how well an action has met a desired goal or objective. |

*Related actions may be directed at specific government department and agencies. Capitalized State refers to California's State government.*

include specific recommendations for funding of individual strategies since local and regional efforts will need to complete additional analysis before deciding to proceed with strategies.

## Objectives and Related Actions

*The objectives and related actions presented in this strategic plan are taken in part from DWR's climate change white paper as well as from companion State plans and Tribal Communication Plan.*

The objectives and related actions presented in this strategic plan are taken in part from DWR's climate change white paper (Managing an Uncertain Future: Climate Change Adaptation Strategies for California's Water, October 2008) as well as from companion State plans and Tribal Communication Plan. As part of the Water Plan strategic plan, these 13 objectives will help us achieve the Water Plan goals. Meeting these 13 objectives, and planning and investing in their more than 115 related actions, will provide greater system diversity and resilience to future uncertainties and risk, and help California deal with climate conditions and other future uncertainties and risks. Numbering of the objectives and related actions is for ease of identification and does not represent priority.

*Objectives and Related Actions*

Many objectives derived from the Climate Change white paper were initially developed as adaptation strategies to reduce climate change impacts. Many objectives derived from companion State plans were developed to meet various resource management and communication goals. Some of the companion State plans considered in preparing the objectives and actions are listed here. (See further discussion in this volume, Chapter 3 Companion State Plans.)

- 2007 Integrated Energy Policy Report (California Energy Commission 2007)
- 2009 California Climate Adaptation Strategy (California Natural Resources Agency)
- California Department of Public Health Strategic Plan 2008-2010 (CDPH 2008)
- California Drought, An Update (DWR Apr 2008)
- California Outdoor Recreation Plan 2008: An Element of the California Outdoor Recreation Planning Program (CORP) (State Parks 2009)
- California Transportation Plan 2025 (April 2006) and 2030 (Caltrans Oct 2007)
- California Water Plan Update 2009 Draft Tribal Communication Plan (Tribal Communication Committee, Summer 2008)
- California Wildlife Action Plan (DFG 2007)
- Climate Change Scoping Plan: A Framework for Change (California Air Resources Board Dec 2008)
- Critical Water Shortage Contingency Plan (Governor's Advisory Drought Panel 2000)
- Delta Vision Committee Implementation Report (31 Dec 2008)
- Delta Vision Strategic Plan-Final (Governor's Delta Vision Blue Ribbon Task Force, Oct 2008)
- Delta Vision: Our Vision for the California Delta (Governor's Delta Vision Blue Ribbon Task Force, 19 Jan 2008)
- FloodSAFE Strategic Plan (DWR May 28, 2008 public review draft)
- General Plan Guidelines (Office of Planning and Research 2003)
- Managing an Uncertain Future; Climate Change Adaptation Strategies for California's Water (DWR Oct 2008)
- Preparing for California's Next Drought – Changes Since 1987–1992 (DWR 2000)
- Regional Water Quality Control Plans (Basin Plans) (Water Boards)
- State of California Multi-Hazard Mitigation Plan (Governor's Office of Emergency Services 2007)
- Strategic Workplan for Activities in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (State Water Boards July 2008)
- Water Action Plan (CPUC Nov 2005)
- Water Boards Strategic Plan 2008-2012 (Water Boards 2008)
- Water-Energy Climate Change Mitigation Strategies-Draft (WETCAT Mar 2008 Draft)

*Objective 1 Expand Integrated Regional Water Management*

## Objective 1 – Expand Integrated Regional Water Management

Promote, improve, and expand Integrated Regional Water Management to create and build on partnerships that are essential for California water resources planning, sustainable watershed and floodplain management, and increasing regional self-sufficiency.

*For related information, see in this volume: Chapter 2 Imperative to Act section on Integrated Water Management*

The broad purpose of Integrated Regional Water Management (IRWM) is to promote a regional planning and implementation framework to comprehensively address water supply, quality, flood, and ecosystem challenges and to implement integrated solutions through a collaborative multi-partner process that includes water managers, Tribes, non-governmental organizations, State, federal, and local governments, and disadvantaged communities. Over the past decade, California has improved its understanding of the value of regional planning and made significant steps in implementing IRWM.

IRWM is a portfolio approach for determining the appropriate mix of water-related resource management strategies, water quality actions, and steps to enhance environmental stewardship. The goal is to provide long-term, reliable water supplies for all users at lowest reasonable cost and with highest possible benefits for economic development, environmental quality, and other societal objectives. Moreover, if appropriately developed and implemented, IRWM plans—in combination with other regional and watershed planning efforts for land use and transportation—can serve as the basis for broader community and regional plans for adapting to climate change impacts and increasing regional self-sufficiency.

California lies within multiple climate zones, therefore each region of the state will experience unique impacts from climate change. For some regions, improving watershed health will be the chief concern. Other areas will be affected by saltwater intrusion. In particular, regions that depend heavily upon water imports will need strategies to cope with greater uncertainty in supply. Because economic and environmental effects depend on location, climate adaptation strategies need to be regionally appropriate and preferably at a watershed scale.

California government is working to ensure funds for certain IRWM efforts. As part of the 2009 Comprehensive Water Package, Senate Bill 8 Water Diversion and Use/ Funding (from Seventh Extraordinary Session) appropriates funds from Proposition 84 for IRWM grants and expenditures for projects to reduce dependence on the Delta and to local agencies to develop or implement Natural Community Conservation Plans. The Safe, Clean, and Reliable Drinking Water Supply Act of 2010, if approved by voters, will provide $11.14 billion in funding for local, regional, and statewide programs and projects that address ecosystem and water supply issues. Of this, $1.4 billion funds would be in addition to prior funding provided by Proposition 50 and Proposition 84 and would support the existing IRWM program. Its seven funding categories are drought relief, water supply reliability, Delta sustainability, statewide water system operational improvement, conservation and watershed protection, groundwater protection and water quality, and water recycling and water conservation.

*Objective 1 Expand Integrated Regional Water Management (continued)*

**Related Actions:**

1. State government should encourage—through both financial and technical assistance—IRWM planning and implementation throughout California with greater emphasis on adapting to effects of changing climate including possible increases in drought frequency and duration and possible increases in flood events.
   - State government should promote and provide incentives to regional partnerships to move toward water and flood planning at a watershed-scale or IRWM plan-scale and to consider using watershed and groundwater basin boundaries when determining IRWM planning region boundaries.
   - State government should closely coordinate its participation in the IRWM Program, State Watershed Program, Regional Blueprint Planning Program, and other regional planning efforts to prevent duplication, leverage resources, and provide clear and consistent guidance to stakeholders.
   - State government should prioritize funding and technical assistance to support the development of IRWM plans where none exist to ensure that all regions have access to funding. State government should ensure plans are developed across the entire state to achieve the recommended planning and actions within the California Water Plan.
   - State government should acknowledge that additional assistance is warranted to IRWM plans and regions with significant rural areas and/or higher percentages of disadvantaged communities to address critical water needs and to enable them to be competitive for IRWM plan funding.
   - State government should provide incentives to encourage IRWM plans to address multiple issues and involve and provide benefits to multiple interest groups. When evaluating grant proposals, State government should award higher scores for projects that address multiple issues with a collaborative project team that includes representatives from different sectors.

2. IRWM plans must address the following objectives and issues and the plan elements listed in Box 7-1 Required Elements of Integrated Regional Water Management.
   - Protection and improvement of water supply reliability, including identification of feasible agricultural and urban water use efficiency strategies.
   - Identification and consideration of the drinking water quality of communities within the area of the plan.
   - Protection and improvement of water quality within the area of the plan, consistent with the relevant regional basin plan.
   - Identification of significant threats to groundwater resources from overdrafting.
   - Protection, restoration, and improvement of stewardship of aquatic, riparian, and watershed resources within the region.
   - Protection of groundwater resources from contamination.
   - Identification and consideration of the water-related needs of disadvantaged communities in the area within the boundaries of the plan.

*Objective 1 Expand Integrated Regional Water Management (continued)*

**Box 7-1 Required Elements of Integrated Regional Water Management**

- Consideration of all the resource management strategies identified in the California Water Plan, as updated in 2009 and future updates.
- Consideration of objectives in the appropriate regional basin plan or plans and strategies to meet applicable water quality standards.
- Description of major water-related objectives and conflicts within an IRWM planning region.
- Measurable regional objectives and criteria for developing regional project priorities.
- An integrated, collaborative, multi-benefit approach to select and design projects and programs.
- Identification and consideration of the water-related needs of disadvantaged communities in the area within the boundaries of the plan.
- Performance measures and monitoring program to demonstrate progress toward meeting regional objectives.
- A plan for implementation and financing of projects and programs.
- Consideration of greenhouse gas emissions of identified projects and programs.
- Evaluation of adaptability to climate change of water management systems in the region.
- Documentation of data and technical analyses used in the development of the plan.
- A communication process to disseminate data and information related to the development and implementation of the plan.
- A facilitation process to engage and coordinate water management projects and activities of participating local agencies and governments, local stakeholders and Tribes to avoid conflicts and take advantage of efficiencies.
- Other matters as identified by DWR.

DWR will provide financial incentives, technical assistance, and other guidance to support regions in developing and improving their IRWM plans, including standards, quantitative tools, monitoring program, and other guidance for evaluating energy intensity and resulting GHG emissions, and as well as developing adaptive responses to climate change. DWR will focus technical and financial assistance on medium and small water utilities that may lack resources to address climate change in their planning processes.

3. By 2011, all IRWM plans should include the following elements to help their region adapt to a changing climate using the IRWM partnership's best available information:
   - An assessment of the region's vulnerability to the long-term increased risk and uncertainty associated with climate change.
   - Strategies for substantial water conservation and higher use efficiency (see Objective 2).
   - Conjunctive water management strategies (see Objective 3).
   - An integrated flood management element (see Objective 6).
   - A drought contingency element that describes how entities within a region can share supplies and infrastructure during droughts and emergencies.

- Strategies for improving coordination with land use policies and planning that:
  - help restore natural processes in watersheds to increase infiltration, slow runoff, improve water quality, and augment the natural storage of water (see Objectives 5);
  - encourage Low Impact Development that reduces water demand and increases water supply reliability (see Objective 2).
- Counties and cities in general plans and other planning tools should identify areas at risk of increased wildfires and flooding and other catastrophic events due to climate change.

*Objective 1 Expand Integrated Regional Water Management (continued)*

## 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.

*For related information, see in Volume 2, Resource Management Strategies: Chapter 2 Agricultural Water Use Efficiency, Chapter 3 Urban Water Use Efficiency, and Chapter 11 Recycled Municipal Water*

Urban and agricultural water use efficiency will continue to be a primary way that we meet future water demands and Update 2009 goals. To minimize the impacts of water management on California's natural environment and ensure that our state continues to meet its water demands, our cities and farms must use water more efficiently to get maximum utility from existing and future supplies. Californians have been leaders in water use efficiency measures such as conservation and recycling. However, because competition for California's limited water resources is growing, we must continue to aggressively promote and invest in water use efficiency efforts and be innovative in our pursuit of efficiency.

The California Constitution explicitly prohibits the waste and unreasonable use of the state's water. Therefore, in the future, we must broaden our definition of efficient water use to include other ways of getting the most utility out of our groundwater and surface water resources and water management systems. Related management strategies are noted in this and other Update 2009 objectives and described in Volume 2.

As part of the 2009 Comprehensive Water Package, Senate Bill 7 Statewide Water Conservation creates a framework for future planning and actions by urban and agricultural water supplies to reduce California's water use. SB 7[1] 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 establishes multiple pathways for urban water supplies to achieve the statewide goal in urban water use. SB 7 also requires agricultural water suppliers to measure water deliveries and adopt a pricing structure for water customers based at least in part on quantity delivered, and, where technically and economically feasible, implement additional measures to improve efficiency. It also requires agricultural water supplies to submit agricultural water management plans

1 Chaptered by Secretary of State as Chapter 4, Statutes of 2009-10 Seventh Extraordinary Session. An act to amend and repeal Section 10631.5 of, to add Part 2.55 (commencing with Section 10608) to Division 6 of, and to repeal and add Part 2.8 (commencing with Section 10800) of Division 6 of, the Water Code, relating to water.

*Objective 2 Use and Reuse Water More Efficiently (continued)*

beginning December 31, 2012, and include in those plans information relating to the water efficiency measures they have undertaken and are planning to undertake.

Water use efficiency must be a key part of the water portfolio of every water agency, city, county, farm, and business—as well as State and federal government agencies. Using water efficiently must be a foundational action of every water plan—one that also serves to mitigate and adapt to climate change. Further, water use efficiency and conservation reduce not only water demand but wastewater loads as well, and can reduce energy demand and greenhouse gas (GHG) emissions. Efficient water use can help communities cope with reduced water supply reliability that may be induced by climate change, thus reducing economic and environmental impacts of water scarcity.

### Related actions:

1. DWR will work cooperatively with the California Urban Water Conservation Council to establish a task force that will identify best management practices to assist the commercial, industrial, and institutional sector in meeting the water conservation goal.

2. DWR, the State Water Resources Control Board (State Water Board), and other State agencies will develop a standardized water information reporting system to streamline water reporting required under the law.

3. Governor Schwarzenegger directed DWR to collaborate with the State Water Board and its nine Regional Water Quality Control Boards (Regional Boards), the California Energy Commission, the California Public Utilities Commission, the California Department of Public Health, and other agencies to implement strategies to increase regional water supply self-sufficiency and achieve a statewide 20 percent reduction in per capita urban water use by 2020.
   - Effective January 2009, all terms of water management loans and grants to an urban water supplier administered by DWR, the State Water Boards, and California Bay Delta Authority is conditioned on implementation of the water demand management measures described in Urban Water Management Plans.
   - By 2010, all Urban Water Management Plans should include provisions to implement all cost-effective, feasible, and urban best management practices established by the California Urban Water Conservation Council and should identify conservation actions for disadvantaged communities within the service area.
   - Local and regional water use efficiency programs—residential, commercial, industrial, institutional, and agricultural—should emphasize those measures that reduce both water and energy consumption, notwithstanding other water management objectives.
   - By December 31, 2010, DWR will identify and develop through a public process a method to identify per capita targets that cumulatively result in a statewide 20-percent reduction in urban daily per capita water use by

*Objective 2 Use and Reuse Water More Efficiently (continued)*

December 31, 2020. In developing urban daily per capita water use targets, DWR will follow the provisions set forth in SB 7 Statewide Water Conservation.
   - By 2010, local governments should initiate and pursue water conservation programs to reduce water use on existing and new landscapes. All local governments are now required by statute to adopt the State Model Water Efficient Landscape Ordinance or an ordinance that is as effective as the State model ordinance in water conservation.

4. Agricultural water agencies should fully implement Efficient Water Management Practices, in accordance with the memorandum of understanding regarding Agricultural Efficient Water Management Practices, to reduce net unit water use, improve the quality of drainage water and return flows, and to report on EWMP implementation in their agricultural water management plans.
   - DWR and other State agencies will provide technical assistance and financial incentives to agricultural water agencies and growers to increase the percentage of California agricultural lands that are irrigated with highly efficient irrigation systems and management practices.
   - Agricultural water suppliers will measure water deliveries and adopt a pricing structure for water customers based at least on quantity delivered, and where technically and economically feasible, implement additional measures to improve efficiency.
   - Beginning December 31, 2012, agricultural water suppliers will submit Agricultural Water Management Plans and include in those plans information relating to the water efficiency measures they have undertaken and are planning to undertake.
   - In 2013, 2016, and 2021, DWR will report to the Legislature the agricultural efficient water management practices being undertaken and reported in agricultural water management plans.

5. State government should authorize and fund new incentive-based programs to promote the widespread and mainstream adoption of substantial and aggressive water conservation, recycling and reuse, and related water use and reuse monitoring programs, by urban and agricultural water systems and their users. These programs should include a monitoring plan that will allow agencies to track the effectiveness of the programs and the extent to which they provide equitable benefits to disadvantaged communities.

6. Municipal recycled water may represent a relatively energy-efficient water management strategy in some areas of the state.
   - State government should provide policies and incentives to promote and accelerate the use of municipal recycled water statewide.
   - The State Water Board will (a) implement its Recycled Water Policy to encourage the use of recycled water while protecting beneficial uses of water resources and the environment, and (b) require the use of recycled water where the use of potable water would be considered a waste or an unreasonable use of water.

*Objective 2 Use and Reuse Water More Efficiently (continued)*

- Water and wastewater agencies should adopt policies by 2015 that promote the use of recycled water for all appropriate, cost-effective uses while protecting public health, the beneficial uses of surface water and groundwater quality and the environment.
- Local government and wastewater entities, together with local salt nutrient contributing stakeholders as identified by the Association of California Water Agencies (ACWA), the California Association of Sanitation Agencies (CASA), and the WateReuse Association (together "the Associations") together with the Regional Water Boards will increase the use of recycled water from municipal wastewater sources in a manner that implements State and federal water quality laws, prepare consistent salt/nutrient management plans for every groundwater basin/subbasin in California by 2016. These salt/nutrient management plans shall be prepared as outlined in the State Water Board's Water Quality Control Policy for Recycled Water adopted May 14, 2009.

7. 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 storm water runoff, such as percolation to usable aquifers, underground storage beneath parks, small surface basins in drainages, or the creation of catch basins or sumps downhill of development. Depending on the source and application, captured storm water may be suitable for use without additional treatment, or it may be blended to augment local supplies. (Action also appears in Objective 9).

8. The Water Board and Regional Boards and the California Public Utility Commission will exercise their authority to require water conservation measures in permitting and other proceedings. Additional State legislation may be needed to further ensure attainment of these conservation efforts. Prior to any new measures, State government will evaluate the impacts on housing costs, including affordability to low and moderate income families and workers.

## 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.

*For related information, see in Volume 2, Resource Management Strategies: chapters 8 through 13 for strategies to increase water supplies and storage*

California can prepare for future droughts, flood, and climate change, and 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 existing and new surface storage and other water supply sources when available, including but not limited to recycled municipal water, surface runoff and floodflows, urban runoff and storm water, imported water, water transfers, and desalination of brackish water and sea water.

*Objective 3 – Expand Conjunctive Management of Multiple Supplies (continued)*

Surface and groundwater resources must be managed much more conjunctively 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 between regions.

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

Better regional and system-wide 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. System-wide operational coordination and cooperation needs to occur in advance of responding to extreme hydrologic events that may become larger and more frequent with climate change.

### Related actions:

1. By 2013, State and federal government, Tribes, and local agencies should develop conjunctive water management plans as part of their existing water planning efforts to identify strategies that can improve the coordination of local groundwater storage with State, federal, Tribal, and local surface storage and other water supply sources when available, and to facilitate re-operation of the Central Valley flood management system for multiple benefits.

2. By 2011, all Integrated Regional Water Management (IRWM) plans should identify strategies that can improve the coordination of local groundwater storage and banking with local surface storage and other water supply sources when available. The IRWM partnerships should utilize and build on their existing conjunctive water management plans. Supply sources include but are not limited to recycled municipal water, surface runoff and floodflows, urban runoff and storm water, imported water, water transfers, and desalination of brackish water and sea water.

*Objective 3 Expand Conjunctive Management of Multiple Supplies (continued)*

3. Streamline the State Water Resources Control Board water rights permitting process to facilitate water transfers associated with the development of statewide and basin-wide conjunctive water management strategies.

4. Local agencies should develop and implement AB 3030 Groundwater Management Plans with basin management objectives, or groundwater management plans prepared in accordance with other provisions of law, as a fundamental component of IRWM plans. Local agencies must have such groundwater management plans in order to:
   - reduce and eliminate groundwater overdraft;
   - effectively recharge and use aquifers as water banks;
   - protect and improve water quality;
   - prevent seawater intrusion of coastal aquifers caused by sea level rise;
   - monitor withdrawals and levels;
   - coordinate with other regional planning efforts to identify and pursue opportunities for interregional conjunctive management;
   - avert otherwise inevitable conflicts in water supply; and
   - provide for sustainable groundwater use.

5. Local land use agencies should adopt ordinances that protect the natural functioning of groundwater recharge areas.

6. State and local governments should increase funding incentives to protect groundwater basins from pollution or contamination, and to remediate pollution or contamination when either occurs.

7. State government should provide funding to implement monitoring, assessment, and maintenance of baseline groundwater levels, including the fractured rock hydrologeology. As the next step to achieve this, the State has enacted Senate Bill 6 Groundwater Monitoring of the 2009 Comprehensive Water Package (adds to and amends parts of Division 6 of the Water Code, specifically Part 2.11 Groundwater Monitoring). SB 6[2] requires that local agencies monitor and report the elevation of their groundwater basins to help better manage the resource during average water years and drought conditions. Specifically, this bill requires the following:
   - DWR will establish a priority schedule for monitoring groundwater basins and the review of groundwater elevation reports and make recommendations to local entities to improve the monitoring system.
   - DWR will assist local monitoring entities with compliance with this statute.
   - Local entities are allowed to determine regionally how best to set up groundwater monitoring program, crafting the program to meet their local circumstances.

2 Chaptered by Secretary of State as Chapter 1, Statutes of 2009-10 Seventh Extraordinary Session. An act to add Part 2.11 (commencing with Section 10920) to Division 6 of, and to repeal and add Section 12924 of, the Water Code, relating to groundwater.

*Objective 3 Expand Conjunctive Management of Multiple Supplies (continued)*

- DWR will implement groundwater monitoring programs in regions where local agencies fail to implement a monitoring program or fail to provide the required reports.
- By January 2, 2012, DWR in conjunction with public agencies will report to the Governor and Legislature findings of investigations of the state's groundwater basins that include geological and hydrological conditions and general patterns of groundwater pumping and recharge; findings will reported to the Governor and Legislature thereafter in years ending in 5 and 0.

8. In addition to the provisions required by SB 6, groundwater monitoring programs should be required to provide additional information needed to adequately characterize a groundwater basin or subbasin. State and local governments and local water management agencies should work to establish the following:
   - A water budget that quantifies the amount of water flowing into and flowing out of the basin, subbasin, aquifers or aquifers, using the groundwater monitoring data, streamflow data, and groundwater extraction data that are collected by the local agency(ies).
   - State government should require electronic submittal of monitoring data by local groundwater monitoring entities.
   - Guidelines and protocols developed by DWR for the collection and reporting of groundwater monitoring data by local water management agencies.
   - A system developed by DWR in cooperation with others for electronic reporting, storage, and retrieval of groundwater monitoring data in useful formats.

9. State government should establish a System Reoperation Task Force composed of state personnel, federal agency, and Tribal representatives, and regional and local governments, agencies, and organizations to:
   - quantify the potential costs, benefits and impacts of system reoperation for water supply reliability, flood management, conjunctive water management, hydropower, water quality, fish passage, cold-water management for fisheries, and other ecosystem needs;
   - support the update of US Army Corps of Engineers operations guidelines ("rule curves") for Central Valley reservoirs;
   - support the update of flood frequency analyses on all major rivers and streams;
   - evaluate the need to amend flow objectives;
   - expand the study of forecast-based operations for incorporation into reservoir operations guidelines;
   - include watershed level analyses that detail localized costs and benefits;
   - identify key institutional obstacles that limit system reoperation benefits;
   - communicate and promote demonstration project results to encourage broader participation in system re-operation analyses; and
   - identify dam safety issues.

*Objective 3 Expand Conjunctive Management of Multiple Supplies (continued)*

10. As part of completing the CALFED surface storage investigations, feasibility study reports, and associated environmental review and documentation, DWR and the US Bureau of Reclamation will:
    - Consider implementation of other strategies, including, but not limited to system reoperation and agricultural water use efficiency, recycling, desalination, conjunctive use of groundwater, conveyance, transfers and implementation of local Integrated Regional Water Management actions;
    - Consider climate change and its potential effects as it works to complete surface storage feasibility studies and environmental documentation for the North of Delta and Upper San Joaquin River Basin Storage Investigations;
    - DWR will make climate change recommendations as it works cooperatively with Contra Costa Water District on the Los Vaqueros Reservoir Expansion Investigation; and \
    - DWR will advise Reclamation on climate change considerations for Reclamation's Shasta Lake Water Resources Investigation.

## Objective 4 – Protect 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.

*For related information, see in Volume 2, Resource Management Strategies: chapters 14 through 19 for strategies to improve water quality*

The State Water Resources Control Board and nine Regional Water Quality Control Boards (Water Boards) adopted their draft Strategic Plan Update 2008-2012 on September 2, 2008, which includes environmental, planning, and organizational priorities. The environmental and planning priority objectives and actions from the Water Boards Strategic Plan are presented below as related actions 1, 2, 3, and 4. Related actions 5 and 6 are from California Water Plan Update 2005. The objectives from the Water Boards Strategic Plan for promoting sustainable water supplies are covered in Objective 2—Use and reuse water more efficiently.

The Water Boards Strategic Plan considers climate change and other future drivers for trends. It also notes that most of the actions in its strategic plan will be implemented in a watershed framework because healthy watersheds, or drainage basins, provide clean and adequate surface water and groundwater and support healthy riparian and wetland habitat. They are essential to support the state's resources and economic future. A watershed approach is hydrologically focused, recognizes the degree to which groundwater and surface water bodies are connected physically, recognizes 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 alone cannot support a comprehensive watershed protection approach. Success depends on the integration of State, federal, Tribal, and local programs, most importantly local land use decisions made by local officials, stakeholder involvement, and the actions of millions of individuals, who together can make enormous impacts.

*Objective 4 Protect Surface Water and Groundwater Quality (continued)*

**Related Actions:**

11. Implement strategies to fully protect the past, present, and probable future beneficial uses for all 2006-listed [CWA section 303(d)] water bodies by 2030.
    - 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 2006-listed water bodies by 2019.
    - 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 by 2012 and, where applicable, explore opportunities for using management techniques to promote sustainable water supplies.
    - Take appropriate enforcement actions and innovative approaches as needed to protect and restore the beneficial uses of all surface waters.

12. Improve and protect groundwater quality in high priority use basins by 2030.
    - Implement an integrated groundwater protection approach by 2012 to improve and protect groundwater in high-use basins that
        - evaluates and regulates activities that impact or have the potential to impact beneficial uses,
        - recognizes the effects of groundwater and surface water interactions on groundwater quality and quantity, and
        - encourages and facilitates local management of groundwater resources.
    - Identify strategies to ensure that communities that rely on contaminated groundwater will have a reliable drinking water supply, which may include remediation of polluted or contaminated groundwater, surface water replacement, and groundwater treatment.
    - Maintain high quality groundwater basins through application of the antidegradation directives of the State Water Board via waste discharge requirements (WDRs) and the remediation of polluted or contaminated groundwater.
    - Prepare consistent salt/nutrient management plans for every groundwater basin/subbasin in California by 2016. These salt/nutrient management plans should be prepared as outlined in the State Water Board's Water Quality Control Policy for Recycled Water adopted May 14, 2009, the purpose of which is to increase the use of recycled water from municipal wastewater sources that meets the definition in Water Code section 13050(n), in a manner that implements state and federal water quality laws.

13. Increase sustainable local water supplies available for meeting existing and future beneficial uses by 1,725,000 acre-feet per year (725,000 acre-feet per year through water recycling and 1 million acre-feet per year through water conservation), in excess of 2002 levels, by 2015, and ensure adequate flows for fish and wildlife habitat.
    - Promote implementation of best management practices, and improve compliance with requirements, for water conservation consistent with the

*Objective 4 Protect Surface Water and Groundwater Quality (continued)*

Strategic Workplan for Activities in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary and other relevant State and regional efforts.

- Increase the public acceptance and promote the use of recycled water and the reuse of storm water and gray water as locally available, sustainable water supplies consistent with the Climate Change Draft Scoping Plan developed pursuant to the California Global Warming Solutions Act of 2006 (AB 32) and other relevant State and regional efforts.
- Ensure that adequate stream flows are available for the protection of fish and wildlife habitat while meeting the need for diversions of water for other uses. (See Objective 5)

14. Comprehensively address 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.
    - Prepare, as a part of the California Water Plan, a comprehensive California Water Quality Plan to help 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.
    - Basin Plans are consistently organized 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.
    - Adopt Basin Plan amendments by collaborating in third-party initiated processes that incorporate Water Board requirements and stakeholder interests. An example is the Santa Ana Regional Water Board's Basin Plan amendment initiated with funding assistance from stakeholders as required in the State Water Board's Recycled Water Policy.

15. State government should lead an effort with local agencies and governments to remediate the causes and effects of pollution and contamination on surface water and groundwater quality. An evaluation should be completed by 2015 to inventory, evaluate, and examine the effect of contaminants on public health, ecosystem health, long-term sustainability of water resources and treatment costs, and should identify cost-effective ways and propose management strategies to improve water quality.
    - State government should work with State and federal agencies, Tribes, local Integrated Regional Water Management partnerships, and other third parties to assess, prioritize, fund, and remediate private, State, federal, and Tribal lands with abandoned mines or other mining toxin problems.

16. To safeguard water quality for all beneficial uses, State government will adopt preventive programs that integrate source water protection, pollution prevention, matching water quality to use, salt and salinity management, urban runoff management, groundwater/aquifer remediation, and water treatment and distribution.

*Objective 4 Protect Surface Water and Groundwater Quality (continued)*

## Objective 5 – Expand Environmental Stewardship

Practice, promote, improve, and expand environmental stewardship to protect and enhance the environment by improving watershed, floodplain, and instream functions and to sustain water and flood management systems.

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

*For related information, see in Volume 2, Resource Management Strategies: Chapter 20 Agricultural Land Stewardship, Chapter 22 Ecosystem Restoration, Chapter 23 Forest Management, and Chapter 27 Watershed Management*

Native riparian floodplain habitat has multiple resource, flood protection, and water supply benefits. Hydrologically connected floodplains retain and slowly release floodwater, facilitate groundwater recharge, provide seasonal aquatic and wetland habitat, support corridors of native riparian forests used as migration/movement corridors for plant and animal species related to rivers and riparian or wetland ecosystems, and create shaded riverine and terrestrial habitats. Setback levees and bypasses are approaches that can facilitate meeting these multiple benefit objectives. These objectives will also help meet AB 32 statewide mandates of greenhouse gas (GHG) emission reduction targets.

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

> ***Resilience*** *is the capacity of resource/natural systems to adapt to and recover from changed conditions after a disturbance.*

*Objective 5 Expand Environmental Stewardship (continued)*

**Related Actions:**

1. State, federal, Tribal, regional and local governments and agencies that own and operate water management systems and flood management systems, as well as public and private organizations, should include actions in their respective land use, water, flood, and natural resource management plans that would contribute to a statewide goal to protect and re-establish native riparian floodplain corridor habitat by 2020. The combined and coordinated activities of local planning activities including Integrated Regional Water Management (IRWM), Urban Water Management Plans, Natural Community Conservation Plans, Habitat Conservation Plans as well as other water resource or riparian floodplain focused efforts should include objectives to meet these environmental stewardship goals.
   - By 2020, re-establish 1 million acres of contiguous natural riparian and floodplain habitat and its hydrologic connectivity between rivers/streams and their historical floodplains for at least 50 percent of the river miles in the regions.
   - Contribute to AB 32 GHG reduction goals related to water and flood systems operations through enhancing carbon sequestration mechanisms by re-establishing 500,000 acres of historic vegetated floodplain corridors and restoring 500,000 acres of upper watershed forests.
   - IRWM and regional flood management plans that incorporate corridor connectivity and restoration of native aquatic and terrestrial habitats to support increased biodiversity and resilience for adapting to a changing climate should receive additional credits in State government water and flood grant programs. (See objectives 1, 2, and 6)

2. State government should work with dam owners/operators, federal resource management agencies, Tribes, and other stakeholders to evaluate opportunities to introduce or reintroduce anadromous fish to upper watersheds. Re-establishing anadromous fish upstream of dams may provide flexibility in providing cold water conditions downstream, and thereby inform with system re-operation. Candidate watersheds should have sufficient habitat to support spawning and rearing of self-sustaining populations. (See Objectives 1, 3, and 6)

3. By 2015, State government should identify and prioritize for protection lands at the boundaries of the San Francisco Bay and Sacramento-San Joaquin Delta that will provide the habitat range for tidal wetlands to adapt to and shift with sea level rise. Such lands can help maintain estuarine ecosystem functions and create natural land features that act as storm buffers, protecting people and property from flood damages related to sea level rise and storm surges. (See Objectives 6 and 7)

4. By 2015, State government should prioritize and expand Delta island and Suisun Marsh subsidence reversal and land accretion projects to create equilibrium between land and estuary elevations along select Delta fringes and islands. Sediment-soil accretion is a cost-effective, natural process that can help sustain the Delta and Suisun Marsh ecosystem and protect communities from inundation, and sequester carbon. (See Objectives 6 and 7)

5. By 2030, State government will encourage, prioritize, and financially support actions to protect, enhance, and restore at least 1 million acres of upper watershed forests and meadow systems that act as natural water and snow storage. This measure not only improves water supply reliability and protects water quality, but also safeguards significant high elevation habitats and migratory corridors. (See objectives 1, 3, and 4)

*Objective 5 Expand Environmental Stewardship (continued)*

6. State government, including the Department of Fish and Game, should lead an effort to identify streamflows that will protect public trust uses, including fish and wildlife. This effort should include completion of studies that relate instream water flows and fish habitat and development of flow recommendations to protect sustainable fisheries.

7. State government should acknowledge where California's water comes from when deciding how state money is regionally allocated and should weigh both the needs of population centers and the upper watersheds that must meet those needs. When administering grant programs, State government should increase funding to headwaters regions including the Sierra Nevada for local projects that will benefit downstream users.

## Objective 6 – Practice Integrated Flood Management

Promote and practice integrated flood management to provide multiple benefits including better emergency preparedness and response, higher flood protection, more sustainable flood and water management systems, and enhanced floodplain ecosystems.

Integrated flood management is a comprehensive approach to flood management that considers land and water resources at a watershed scale within the context of integrated water management; employs both structural and nonstructural measures to maximize the benefits of floodplains and minimize loss of life and damage to property from flooding; and recognizes the benefits to ecosystems from periodic flooding. This approach recognizes the:

- interconnection of flood management actions within broader water resources management and land use planning,
- value of coordinating across geographic and agency boundaries,
- need to evaluate opportunities and potential impacts from a system perspective,
- opportunity for multiple uses of floodplains, and
- importance of environmental stewardship and sustainability and the fundamental role of flood events to the vitality of California ecosystems.

*For related information, see in this volume Chapter 2 Imperative to Act section on Integrated Flood Management and Emergency Response and also in Volume 2 Resource Management Strategies, Chapter 28 Flood Risk Management*

Balancing the benefits of living in floodplains against the benefits of flooding is at the heart of integrated flood management. Flooding is a necessary characteristic of many California ecosystems. Yet floodplains are among the most valuable lands we have, providing the richest agricultural soils, desirable home sites, recreational opportunities, ready sources of water, and great ecological potential. Natural systems that evolved with

*Objective 6 Practice Integrated Flood Management (continued)*

floods are dependent on the periodic disturbance of flood waters to maintain the quality of the ecosystem. Floods provide renewed soils and nutrients, move plant and animals around, rearrange spatial organizations of natural communities, and convey sands, gravels, and sediments. These factors contribute to the great benefit people experience from living on floodplains while simultaneously posing risks to people.

Today in the Central Valley of California, more than 1.8 million people live behind nearly 6,000 miles of levees, with populations continuing to grow. Traditionally, Californians have altered the risk of flooding by building dams and levees that constrain floodwaters and diminish the natural benefits of floods, while providing protection to people from the harmful aspects of flooding. However, across the nation we have seen levee protection fall short of our needs. At the same time climate change may worsen the state's flood risk by producing higher peak flows, a shift toward more intense winter precipitation, and sea level rise.

The financial liability to State government of repairing our communities following a flood event is an additional concern. A collection of recent laws has refocused attention on flooding and the risks it poses. These laws require in significant areas of the state an analysis of our existing system of protection, plans for improving these systems, means of sharing financial and operational responsibilities, and a mandate to seek broad arrays of benefits from the manner in which we manage our floodplains and water systems. These laws are intended to promote a new perspective of managing floods, at least in part, for recovery from disturbance and with a greater acknowledgement of the natural cycles of flooding.

System reoperation is an important element of better integrating California's water and flood management systems. Current water resources infrastructure is already strained to meet existing, competing objectives for water supply, flood management, environmental protection, water quality, hydropower, and recreation. With a changing climate, the conflicts between competing interests will be even greater if supplies become less reliable. Because the prediction of climate change impacts will never be exact, flexibility and adaptability must be a fundamental tactic, especially with respect to water and flood system operations and management (see Objective 3).

### Related Actions:

1. To facilitate coordinated operations, State and federal agencies collaboratively established a Joint Operations Center (JOC) that has served California's water supply and flood management needs. In order to successfully meet the potential threats posed by climate change, though, the capacity of the JOC should be expanded and enhanced to:
    - Improve tools and observations to better support decision-making for individual events and seasonal and inter-annual operations, including water transfers and stream gage data.
    - Improve communications and coordination during emergencies, such as floods and droughts.

*Objective 6 Practice Integrated Flood Management (continued)*

- Develop an operational information clearinghouse related to the major water systems in California, which would facilitate coordination with planning and research endeavors to ensure that climate change impacts related to operations are addressed.

2. Flood management systems must better utilize natural floodplain processes. Flood management should be approached from a watershed perspective. The basic physical properties of water and sediment flow, and water storage in groundwater basins and reservoirs should be evaluated considering the ecology of watersheds. Agricultural, urban, and recreational activities and regulations should be considered and planned on this basis to identify integrated water management needs and opportunities.

3. 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.
   - State government should assist disadvantaged communities located in floodplains to prepare for and recover from flood emergencies.

4. By January 1, 2012, DWR will collaboratively develop a multi-objective *Central Valley Flood Protection Plan* that includes actions to improve integrated flood management in the Central Valley and accounts for the expected impacts of climate change. The plan will provide strategies for greater flood protection and environmental resilience. It will address:
   - restoring the State/federal flood management system to refine definitions of floodplains and flood risks throughout the Central Valley to provide the design level of performance;
   - emergency preparedness, response, evacuation, and recovery actions;
   - expansion of the flood bypass system to reduce pressure on critical urban levees and provide for habitat, open space, recreation, and agricultural land preservation;
   - structural and nonstructural improvements to provide at least a historical 200-year level flood protection for all urban areas;
   - consideration of flood easements, zoning, set-back levees, and land acquisitions to provide greater public safety, floodplain storage, habitat, and system flexibility;
   - evaluation of dam modifications to pass potentially larger floods;
   - flood insurance requirements to address residual risk;
   - extensive, grassroots public outreach and education; and
   - integrate flood management with all aspects of water resources management and environmental stewardship.

5. DWR will complete a FloodSAFE report that identifies and characterizes significant flood risks throughout each of California's regions and documents needs and opportunities to improve integrated flood management statewide.

*Objective 6 Practice Integrated Flood Management (continued)*

6. Local governments should implement land use policies that consider flood risk.
   - Local land use agencies should update their General Plans in light of existing and future climate change impacts. For planning purposes, DWR recommends using a higher than historical peak reference flow.
   - Local governments should site new development where flood avoidance strategies are ensured. Flood management strategies should identify the relevant flood water elevations and describe how the public will avoid damage from this magnitude of flooding. These strategies should also account for the risks from floods of greater magnitude.
   - Local governments should utilize Low Impact Development techniques that store and infiltrate urban and storm water runoff while protecting groundwater.
   - Local governments should include flood-resistant design requirements in local building codes.

## Objective 7 – Manage a Sustainable California Delta

Set as co-equal goals a healthy Delta ecosystem and a reliable water supply for California and recognize the Delta as a unique and valued community and ecosystem to promote and practice management for a sustainable California Delta.

*For related information, see the Sacramento-San Joaquin Delta regional report in Volume 3*

The Delta ecosystem is experiencing a steep decline. This condition, in addition to increasing seismic risk, increased added year-round water demand, court-ordered pumping reductions, and the impacts of climate change have already caused severe reductions in the Delta-dependent water supply and in the reliability of that supply. These reductions impact our economy, our food security, and our quality of life. The stakes are high, and Californians must come together now to take fundamental actions to preserve and protect the many uses of the Delta.

By executive order the Governor in 2006 launched the Delta Vision process by establishing a Blue Ribbon Task Force, a Delta Vision Committee made up of cabinet secretaries, Delta science advisors, and a stakeholder coordination group. The task force presented Delta Vision: Our Vision for the California Delta in November 2007, and a year later published the Delta Vision Strategic Plan. In December 2008, the Delta Vision Committee presented to the Governor and Legislature an implementation plan. All urged strong action to stop the continued decline of water reliability and concurrent deterioration of the Delta ecosystem. The implementation report and other Delta Vision materials are available online at http://deltavision.ca.gov/.

A multi-part water legislation package was enacted in November 2009 that includes many of the recommendations from the implementation report and other Delta Vision materials. The water package is composed of four policy bills and an $11.14 billion bond. Most significantly, the water package establishes the co-equal goals of providing

*Objective 7 Manage a Sustainable California Delta (continued)*

a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem.

The new laws also establish the Delta Stewardship Council and Delta Conservancy. The Delta Stewardship Council is charged with developing a Delta Plan by 2012; the council also is charged with adopting an interim plan that includes recommendations for early actions and projects.

The bond, if passed by California voters in November 2010, will fund with local cost sharing programs for Delta sustainability, water supply reliability, drought relief, improvements to the statewide water system operations, conservation and watershed protection, groundwater protection, and water recycling and water conservation.

The new laws address the issues that the Delta Vision Committee recommended as near-term actions necessary to achieve Delta sustainability and avoid catastrophe. In its implementation report, the Delta Vision Committee asserted that priorities that form the foundation for a sustainable Delta should include the following "fundamental actions":

- A new system of dual water conveyance through and around the Delta to protect municipal, agricultural, environmental, and the other beneficial uses of water.
- An investment commitment and strategy to restore and sustain a vibrant and diverse Delta ecosystem including the protection and enhancement of agricultural lands that are compatible with Plan goals.
- Additional storage to allow greater system operational flexibility that will benefit water supplies for both humans and the environment and adapt to a changing climate.
- An economic investment plan to protect and enhance unique and important characteristics of the Delta region.
- A comprehensive Delta emergency preparedness strategy and a fully integrated Delta emergency response plan.
- A plan to significantly improve and provide incentives for water conservation – through both wise use and reuse – in both urban and agricultural sectors throughout the state.
- Strong incentives for local and regional efforts to make better use of new sources of water including brackish water cleanup and seawater desalination.
- An improved governance system with reliable funding, clear authority to determine priorities and strong performance measures to ensure accountability to the new governing doctrine of the Delta: operation for the coequal goals. Completion of this fundamental action is absolutely essential to the sustained operation and maintenance of all of these recommendations.

*Objective 7 Manage a Sustainable California Delta (continued)*

## Related Actions:

### *The Delta Ecosystem Must be Protected and Revitalized*

**Recommended actions that have authorization**

1. Complete the Bay Delta Conservation Plan and associated environmental assessments by the end of 2010.

2. Update Bay-Delta regulatory flow and water quality standards to protect beneficial uses of water by 2012. Fully implement these new standards as well as the existing standards.

3. Continue funding for implementation of the CALFED Ecosystem Restoration Program (ERP), including finalization of the ERP Conservation Strategy. Complete several ecosystem projects including Dutch Slough, Mein's Landing and Hill Slough tidal restoration projects and improved habitat in the Yolo Bypass.

4. Evaluate and begin construction on Delta gates and barriers that improve water quality, water supply reliability, and ecosystem function.

5. Develop and implement streamflow recommendations throughout the annual hydrograph for tributaries to the Delta. Direct the Department of Fish and Game to develop streamflow recommendations for tributaries in the Delta watershed, as specified in Public Resources Code Section 10000 – 10005. Direct the State Water Resources Control Board (State Water Boards) to undertake appropriate proceedings to consider and implement the flows.

6. Control aquatic invasive species within the Delta. Funding the Aquatic Invasives Management Plan developed by the Department of Fish and Game, a comprehensive effort to prevent new invasions and minimize impacts from established invaders, would aid the restoration of desirable habitat.

7. Require the State Water Boards and the Department of Fish and Game to immediately expand their evaluation of potential stressors of the aquatic habitat and continue to adopt long-term programs to regulate discharges from irrigated agriculture and urban areas.

8. By 2010 begin comprehensive monitoring of Delta water quality and fish and wildlife health and by 2012 develop and implement Total Maximum Daily Load programs for the Delta and its tributary areas to eliminate water quality impairments including, but not limited to, reduction of organic and inorganic mercury entering the Delta from tributary watersheds.

**Recommended actions addressed in legislation enacted in 2009**

9. Large-scale habitat restoration. Identify funding and direct restoration of large areas—on the order of 100,000 acres—of interconnected habitats in coordination with flood control planning and implementation within the Delta and adjacent areas.

10. Reduce effects of non-project in-Delta diversions. Secure additional funds from the Legislature for the Department of Fish and Game to evaluate the effects of in-Delta diversions on native fishes and to make recommendations to minimize their effects while respecting their water rights.

### *The State's Water Supply Must be More Reliable*

**Recommended actions that have authorization**

1. Near-term water conveyance improvements. Complete the Bay Delta Conservation Plan and associated environmental assessments by the end of 2010.

2. Water use reductions. Initiate the Governor's objective to reduce per capita urban water usage 20 percent by 2020. (Refer to Objective 2 and its related actions.)

3. Surface storage investigations. Complete CALFED surface storage feasibility studies and their environmental assessments by December 2010.

4. Financial and technical assistance. Immediately provide financial incentives and technical assistance through the Integrated Regional Water Management Plans and Local Groundwater Assistance Program to improve surface water and groundwater monitoring and data management.

**Recommended actions addressed in legislation enacted in 2009**

5. Long-term water conveyance improvements. Implement conveyance improvements and associated ecosystem restoration projects upon the completion of the BDCP evaluations.

6. Expand surface and groundwater storage. Complete analyses of surface storage, groundwater storage, flood control, and improved reservoir operations by 2012 and implement feasible and effective projects.

7. Water rights accountability. Enact legislation to enhance and expand the State Water Board's water rights administrative accountability. These recommendations are not intended to adversely affect the current water right priority system, including area-of-origin priorities but rather to strengthen the current administrative system. Appropriate enforcement will protect water rights.

*Objective 7 Manage a Sustainable California Delta (continued)*

8. Water use reporting. Ensure the sustainability of water supplies by improving water diversion and use reporting, strengthening water rights accountability, and increasing water use efficiency.

9. Integrated regional water management. Continue to improve water supply reliability by encouraging regional self-sufficiency, promoting alternative supplies, and by increasing local and regional water storage capacity.

### *The Delta is a Unique and Valued Place*

**Recommended actions that have authorization**

1. Improve flood protection and emergency response. Immediately increase emergency preparedness and response in the Delta by continuing to stockpile flood response materials. Complete by 2010 a Delta-wide regional emergency response plan that achieves legally binding regional coordination between local, State, and federal agencies, and by carrying out near-term emergency preparation actions such as those recommended in the Delta Vision Strategic Plan.

2. Strengthen the Delta levee system. Continue to fund and implement levee improvement projects especially in urban areas, while also expanding the levee special projects and subvention programs until a long-term levee strategy is formulated.

3. Create a Delta National Heritage Area. Achieve federal designation for portions of the Delta as a National Heritage Area and expand the State Recreation Area network in the Delta.

4. Develop a Delta economic plan. The Delta Protection Commission is to develop a Delta economic sustainability plan by July 2011 to support increased investment in agriculture, recreation, and tourism.

**Recommended actions addressed in legislation enacted in 2009**

5. Establish a Delta Investment Fund to implement the economic sustainability plan.

6. Plan for appropriate land uses for at-risk areas in the Delta.

7. Long-term levee planning. Prepare a comprehensive long-term levee investment strategy that matches the level of protection provided by Delta levees to the uses of land and water enabled by those levees.

### *Strengthen Delta Governance and Provide Reliable Funding*

*Objective 7 Manage a Sustainable California Delta (continued)*

**Recommended actions that have authorization**

1. Complete the Central Valley Flood Protection Plan.

2. Continue existing CALFED programs that support State and federal activities.

3. Continue a strong and consistent investment in science and engineering important to the Delta through a robust, well-coordinated Delta Science and Engineering Program with transparent oversight and review from a Delta Science and Engineering Board.

**Recommended actions addressed in legislation in 2009**

4. Establish the Delta Stewardship Council. The council will be composed of seven voting members, four appointed by the Governor and confirmed by the Senate, one appointed by the Senate Committee on Rules, one appointed by the Speaker of the Assembly, and the Chair of the Delta Protection Commission.

5. Enhance the Delta Protection Commission. The mission of the Delta Protection Commission was modified to focus its efforts in the areas of land use and economic development.

6. Establish a Delta Conservancy. The Delta Conservancy will be responsible for implementing ecosystem actions that are consistent with the Delta Plan.

7. By January 1, 2012, the Delta Stewardship Council will adopt a Delta Management Plan (Delta Plan) that will be informed by and incorporate information, actions and recommendations from Delta and Suisun planning efforts, including but not limited to:
   - Provisions of SB 1[3] Delta Governance/Delta Plan,
   - The Delta Vision Strategic Plan,
   - Delta Vision Committee's Implementation Report
   - Bay Delta Conservation Plan,
   - Suisun Marsh Management Plan,
   - Delta Protection Commission's Delta Management Plan and Economic Sustainability Plan,
   - Central Valley Flood Protection Plan,
   - State Water Boards' Delta Water Quality Control Plan,
   - CALFED Surface Storage Investigations Feasibility Study Reports, and
   - Other Delta planning studies.

3 Chaptered by Secretary of State as Chapter 5, Statutes of 2009-10 Seventh Extraordinary Session. Amends sections of the Public Resources Code and Water Code.

*Objective 8 Prepare Prevention, Response, and Recovery Plans*

## 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.

*For related information, see Volume 4 Reference Guide articles on droughts and floods and the Drought Contingency Plan*

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 by 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.

### Related Actions:

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).
   - State government should assist disadvantaged communities located in floodplains to prepare for and recover from flood emergencies.

2. By December 2010, the water shortage contingency plans prepared as part of Urban Water Management Plans and IRWM drought contingency plans should assume, until more accurate information is available, a 20 percent increase in the frequency and duration of future dry conditions.

*Objective 8 Prepare Prevention, Response, and Recovery Plans (continued)*

3. By February 2010, DWR will develop a long-term California Drought Contingency Plan (and update it on the same schedule as the California Water Plan) that includes:
   - articulation of a coordinated strategy for preparing for, responding to, and recovery from drought;
   - assessment of state drought contingency planning and preparedness;
   - description of State government's role and responsibilities for drought preparedness;
   - identification of needed improvements for drought monitoring and preparedness;
   - identification of measures to mitigate the economic, environmental, and social risks and consequences of drought events;
   - assessment of and adaptation to the impacts of drought under existing and future conditions including climate change;
   - identification of needed improvements to real-time surface water and groundwater monitoring programs;
   - identification of needed research in drought forecasting; and
   - identification of needed research of the indices and metrics for assessing the levels of drought.

4. DWR will work with the California Emergency Management Agency to develop preparedness plans to respond to other catastrophic events that would disrupt water resources and infrastructure; events like earthquakes, wildfires, chemical spills, facility malfunctions, and intentional disruption.

5. By December 2010, the California Emergency Management Agency, 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.

## Objective 9 – Reduce Energy Consumption of Water Systems and Uses

Reduce the energy consumption of water and wastewater management systems by implementing the water-related strategies in AB 32 Scoping Plan to mitigate greenhouse gas emissions.

*For related information, see Volume 4 Reference Guide articles on adapting water management to climate change impacts*

In December 2008, the California Air Resources Board approved the Proposed AB 32 Scoping Plan, which includes six measures for reducing the energy intensity and resulting greenhouse gas (GHG) emissions of water uses and water and wastewater management systems. These six measures are presented here as related actions. Three of the measures target reducing energy requirements associated with providing and using reliable water supplies, and two measures are aimed at reducing the amount of electricity associated with conveying and treating water as well as using more renewable energy. The final measure focuses on providing stable funding for implementing these actions. Three of the measures—water use efficiency, water recycling, and urban water reuse—

*Objective 9 Reduce Energy Consumption of Water Systems and Uses (continued)*

are also covered in objectives 1, 2, and 4. Many of these actions also have the co-benefit of improving water supply reliability.

Although water generates approximately one-fifth of the state's electricity, water conveyance, distribution, and use also consume significant amounts of energy. Approximately one-fifth of the electricity and a third of the non-power plant, natural gas (i.e., the natural gas not in turn used to generate electricity) consumed in the state are associated with water use. According to the California Energy Commission, end use of water is the most energy-intensive portion of the water use cycle in California. In addition to the many efficiency efforts throughout the state, DWR is implementing a directive from the Governor to develop a plan to reduce per capita urban water use by 20 percent by 2020 (described in Objective 2). Many measures to increase water use efficiency and reuse can also reduce electricity demand from the water sector, and in turn, reduce GHG emissions.

### Related Actions:

1. Water use efficiency reduces not only water demand but, in many instances, reduces energy demand as well, which in turn can lead to reductions in GHG emissions. (See Objective 2 for related actions).

2. Municipal recycled water may represent a relatively energy efficient water management strategy in some areas of the state (this action also appears in objectives 2 and 4).
   - Water agencies should adopt policies by 2015 that promote the use of recycled water for all appropriate, cost-effective uses while protecting public health, the beneficial uses of surface water and groundwater quality, and the environment.
   - The State Water Board will (a) implement its Recycled Water Policy to encourage the use of recycled water while protecting beneficial uses of water resources and the environment, and (b) require the use of recycled water where the use of potable water would be considered a waste or an unreasonable use of water.
   - By 2015, water and wastewater utilities should collaboratively develop water recycling plans as part of Integrated Regional Water Management plans.

3. Local agencies and governments should implement cost effective, energy efficiency measures in water system infrastructure projects.
   - Large water and wastewater utilities should conduct an assessment of their carbon footprint and consider implementation of strategies described in the AB 32 Scoping Plan to reduce GHG emissions. To take advantage of an existing framework and process for calculating their carbon footprint, these utilities should join The Climate Registry.
   - The Water-Energy Subgroup of the Governor's Climate Action Team (WETCAT) will conduct a study to assess reasonable energy efficiency and reduction targets for water and wastewater systems. Reduction in electricity

consumption could in turn reduce the GHG emission associated with this amount of electricity generation.

- The California Energy Commission, in collaboration with the WETCAT, will develop tools and protocols to evaluate, measure, and verify the energy impacts of water system and end use conservation and efficiency activities/programs.

*Objective 9 Reduce Energy Consumption of Water Systems and Uses (continued)*

4. Urban and, where feasible, rural communities should invest in facilities to capture, store, treat and use storm water runoff, such as percolation to usable aquifers, underground storage beneath parks, small surface basins in drainages, or the creation of catch basins or sumps downhill of development. Depending on the source and application, captured storm water may be suitable for use without additional treatment, or it may be blended or otherwise treated to augment local supplies. All levels of government should establish policies and provide incentives to promote better urban runoff management and reuse. (Action also appears in Objective 2).

5. Water and wastewater utilities should identify renewable generation projects that can be co-located with existing water system infrastructure, and where feasible begin their implementation. Examples of energy existing within water and wastewater systems include water moving through conduits, sunlight, wind, and gases emitted from decomposing organic wastes. Producing energy from these resources at water and wastewater facilities will reduce GHG emissions by offsetting the need for the facilities to consume electricity derived from natural gas and coal.
   - State government should remove impediments to implementing renewable energy projects.

6. State government will establish a public goods charge for funding investments in Integrated Regional Water Management strategies that will help mitigate and adapt to climate change.

## Objective 10 – Improve Data & Analysis for Decision-making

Improve and expand monitoring, data management, and analysis to support decision-making, especially in light of uncertainties, that support Integrated Regional Water Management and flood and water resources management systems

Investment in our analytical capabilities lags far behind the growing challenges facing water managers. Significant new investment in our technical capabilities is needed to support integrated regional water planning and management and integrated flood management, to improve management of the Sacramento-San Joaquin River Delta, and to prepare for the impacts of climate change, extended droughts, and flood events. Improving communication between technical experts and decision-makers goes hand in hand with improving our technical capabilities because sound technical information is critical to making robust policy decisions.

*For related information, see in this volume: Chapter 6 Integrated Data and Analysis*

*Objective 10 Improve Data and Analysis for Decision-making (continued)*

California needs better data and analytical tools to produce useful and more integrated information on water quality, environmental objectives, economic and equity issues, surface water and groundwater interaction, and flood protection. As part of the 2009 Comprehensive Water Package, Senate Bill 6 Groundwater Monitoring requires for the first time in California's history that local agencies monitor the elevation of their groundwater basins to help better manage the resource during both average water years and drought conditions. (See objective 3 for related actions as part of SB 6.)

## Related Actions:

### *Improve water management information*

1. By 2013, a DWR-convened technical task force of State, federal, Tribal, and local water and resource managers and planners should develop a strategic plan describing specific information needs to support Integrated Regional Water Management activities and the institutional arrangements for collecting and maintaining the information. The plan should identify the range of different program needs to respond to flood and drought management, climate change, ecosystem restoration, water quality improvement, and other integrated water management objectives. Based on program needs the strategic plan should:
   - establish standards and protocols to ensure the widest utility and efficient use of resources,
   - identify the optimal location of monitoring stations,
   - prioritize long-term improvements in the monitoring network, and
   - ensure long-term maintenance and accessibility to water management information.

2. DWR will participate with the National Oceanic and Atmospheric Administration and Scripps Institute of Oceanography in implementing the Hydrometeorological Test Bed program which enhances off-shore and land measurements of weather variables.

3. State government should establish an interim range of sea level rise projections for short-term planning purposes for local, regional, and statewide projects and activities.
   - The Natural Resources Agency, in coordination with other State agencies, will convene and support a scientific panel of the National Research Council (NRC) to provide expert guidance regarding long-range sea level rise estimates and their application to specific California planning issues. These estimates should be revisited and revised regularly to reflect updated science.
   - Based upon guidance from the NRC, DWR in collaboration with other State agencies should develop long-range sea level rise scenarios and response strategies to be included in California Water Plan Update 2013.
   - As part of the ongoing California Water Plan Update process, DWR will provide revised estimates of changes to sea level, droughts, and flooding that can be

*Objective 10 Improve Data and Analysis for Decision-making (continued)*

expected over the subsequent 25 years (or the planning horizon for each Water Plan update).

4. In association with research institutions such as the Regional Integrated Science and Assessment centers (of National Oceanic and Atmospheric Administration), Lawrence Livermore and Berkeley National Laboratories, and the University of California:
   - State agencies should identify focused research needs to provide guidance on activities to reduce California's vulnerability to climate change.
   - The University of California should establish a system-wide Climate Change Adaptation Research Center.
   - State government should also explore partnerships with the federal government, other Western states, and research institutions on climate change adaptation.

5. State government should sponsor science-based, watershed adaptation research pilot projects to address water management and ecosystem needs. Funding for pilot projects should only be granted in those regions that have adopted Integrated Regional Water Management plans that meet DWR's plan standards and have broad stakeholder support.

### *Improve integration of water management information*

6. By 2013 DWR will adopt Shared Vision Planning (SVP) in the California Water Plan to achieve better integration and consistency with other planning activities, to obtain consensus on quantitative deliverables, to build a common conceptual understanding of the water management system, and to improve transparency of Water Plan information. SVP integrates tried-and-true planning principles, systems modeling, and collaboration into a practical forum for making water resources management decisions.

7. By 2013 DWR will implement pilot studies in different areas of the state to explore how information can be more effectively integrated among local, regional, and statewide water planning and management activities. The initial focus of this effort will be to improve how information produced for urban water management plans can be used to more effectively support Integrated Regional Water Management plans and the California Water Plan while streamlining reporting requirements.

8. By 2011, DWR, the State Water Resources Control Board and Regional Water Boards, and other State agencies that collect water data will develop a water use measurement and reporting strategy and implementation plan. Accurate measurement of water use can facilitate better water planning and management, especially in the context of managing aquifers more sustainably, and is necessary for the development of more accurate hydrologic budgets.

9. DWR should participate in a pilot project to test the H2O, 2.0 Initiative—Adaptive Management for Water Storage and Flood Control Program. This program would

*Objective 10 Improve Data and Analysis for Decision-making (continued)*

establish a network of monitoring stations, use satellite imagery, and generate real-time data to inform water resource and flood management decisions.

10. In 2008, DWR completed the Integrated Water Resources Information System as a working prototype of the Water Planning Information Exchange (Water PIE). IWRIS facilitates sharing data and networking existing databases and Web sites, among State, federal, regional, and local agencies and governments and citizen monitoring efforts. This information exchange system will improve analytical capabilities and develop timely surveys of statewide land use, water use, and estimates of future implementation of resource management strategies.
    - By 2013, DWR will have an implementation and funding plan for Water PIE describing the long-term technical approach and strategy for increasing the number of linked partners.

11. By 2013, DWR will initiate a pilot project to develop a common schematic of California's water management system. Development of a common schematic will allow better integration with other analytical tools and models and sources of information on water quality, ecosystem functions, flood management, climate change and other parts of integrated water management.

12. In 2010, DWR will convene a workshop of the Statewide Water Analysis Network (SWAN) to provide advice on prioritizing technical improvements for Water Plan Update 2013, particularly to quantify future scenarios and evaluate regional water management strategies.

## Objective 11 – Invest in New Water Technology

Identify and fund applied research and pilot studies on emerging water technology to make them attainable and more cost effective.

*For related information, see in Volume 2 Resource Management Strategies discussions and recommendations regarding technology*

State government will work with California research and academic institutions—like 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.

### Related Actions:

1. State government will work with California research and academic institutions to identify, prioritize, and begin funding applied research projects as part of a broad and diverse scientific agenda to fill gaps in knowledge about California's water resources.

2. State government will invest in pilot projects to help local agencies and governments and regional partnerships implement promising water technologies—

*Objective 11 Invest in New Water Technology (continued)*

to improve water use efficiency, water recycling and reuse, water supplies and quality, water and wastewater treatment, storm water capture and reuse, desalination, and others—more cost effectively with knowledge and experience specific to each region.

3. The California Energy Commission through its PIER Program (Public Interest Energy Research) will conduct research and demonstration projects that explore ways to reduce the energy intensity of the water use cycle and to better manage the energy demand of water systems.

## Objective 12 – Improve Tribal Water and Natural Resources

Develop Tribal consultation, collaboration, and access to funding for water programs and projects to better sustain Tribal water and natural resources.

*For related information, see Volume 4 Reference Guide articles on Tribes and Tribal Water Summit*

Water Plan Update 2005 recommended that DWR and other State agencies invite, encourage, and assist Tribal government representatives to participate in statewide, regional, and local water planning processes and to access State funding for water projects. As part of Update 2009, a Tribal Communication Committee (TCC) prepared a comprehensive Tribal Communication Plan for the California Water Plan (presented in the Volume 4 Reference Guide). The Tribal Communication Plan includes definitions, goals, objectives, guiding principles, audience and venues, and a detailed implementation plan. The fifth goal of the Tribal Communication Plan calls for convening a Tribal Water Summit during Update 2009 and publishing the summit proceedings in the final Water Plan Update 2009. The summit was held in November 2009.

The 10 Tribal Communication Plan objectives are included as part of the related actions.

The Tribal Communication Committee included all California Native American Tribes in its communication planning efforts, and adopted the following definition:

***California Native American Tribe*** *is any federally recognized California Native American Tribe or a non-federally recognized California Native American Tribe that is on the contact list maintained by the Native American Heritage Commission (NAHC).*

### Related Actions:

1. Everyone involved in the California Water Plan (Water Plan) should share information with California Native American Tribes about how Tribal water issues intersect with water law, planning, and management in California. Intersections include, among other things, water rights, human life and health, fisheries management, water diversions, water storage and conveyance, flood management, water use efficiency, desalination, and climate change.

*Objective 12 Improve Tribal Water and Natural Resources (continued)*

2. Everyone involved in the Water Plan should share information with California Native American Tribes about how the water planning, management, and projects of State, local, and federal governments, as well as water purveyors, impact and affect California Native American Tribes.

3. Everyone involved in the Water Plan should share information with California Native American Tribes about State funding that is available for water projects, how California Native American Tribes can apply for the funding, what obstacles they may face in accessing these funds, and how they can influence future funding programs.

4. California Native American Tribes should use the Water Plan as a stepping stone to ensure their representation and genuine participation in water planning processes throughout California, including those linking water to public health, housing, economic development, and environmental justice.

5. California Native American Tribes should build a foundation of knowledge and relationships for developing their own long-term water management plans, as well as participating genuinely in regional and local water planning, including Integrated Regional Water Management plans.

6. California Native American Tribes should shape the content of the Water Plan through a variety of mechanisms, particularly the review of regional reports, resource management strategies, and other materials, and through Tribal and public meetings.

7. California Native American Tribes should build working relationships and partnerships with relevant State, local and, federal governments, and water purveyors that are based on mutual respect, fairness, honesty, responsibility, and mutual trust.

8. California Native American Tribes should educate State, local, and federal governments, and water purveyor executives and planners about the historical and ongoing relationships between California Native American Tribes and water, especially cultural and religious practices, including fishing.

9. California Native American Tribes should propose and clarify how DWR works with California Native American Tribes in State water planning efforts.

10. California Native American Tribes should build a foundation of knowledge and relationships for hosting a Tribal Water Summit in 2009 that includes the highest level of decision-makers from State, local, and federal governments, and water purveyors. DWR will place proceedings of this summit in the Water Plan's Volume 4, the Reference Guide.

11. Indigenous communities should be involved in climate change adaptation actions that will directly impact their people, waterways, cultural resources, or lands.

12. The Tribal Communication Committee, Tribal Summit Planning Team, or an equivalent Tribal forum should advise the 2013 Water Plan Steering Committee on ways to implement these related actions and the recommendations from the 2009 Tribal Water Summit, and should assist in the preparation of subsequent Tribal water summits.

*Objective 12 Improve Tribal Water and Natural Resources (continued)*

## Objective 13 – Ensure Equitable Distribution of Benefits

Increase the participation of small and disadvantaged communities in State processes and programs to achieve fair and equitable distribution of benefits. Consider mitigation of impacts from the implementation of State government programs and policies to provide safe drinking water and wastewater treatment to all California communities and to ensure that these programs and policies address the most critical public health threats in disadvantaged communities.

*For related information, see Volume 4 Reference Guide articles on Environmental Justice*

Water Plan 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 as a State planning priority 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 impacted communities must be identified and engaged.
- The water–related needs of these communities must be identified, 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.

One of the challenges that State agencies and water systems have expressed about trying to address the needs of disadvantaged communities is simply answering the questions, Who are they? Where are they? It is not difficult to address, but agencies are often hampered by their insistence on defining communities strictly through a water lens. In some cases, local colleges and universities, or the local public health agency may already have this information assembled in a useful format that takes into account pollution sources and health indicators in addition to income and race information.

*Objective 13 Ensure Equitable Distribution of Benefits (continued)*

The California Water Plan can provide guidance and tools for identifying disadvantaged and environmental justice communities. It is vitally important to identify community needs. Most water, wastewater, and flood projects are not developed for these communities; yet they can impact them. An important thing to understand is that even projects that convey "general" public benefit may not benefit environmental justice or disadvantaged communities proportionally. For example, conservation programs that are heavily dependent upon toilet and washing machine rebates will have greater penetration in middle and upper class communities than they will on poorer communities that purchase less frequently and cannot afford the initial outlay for the fixture. These problems are resolved by taking community concerns into account during the project design phase in order to ensure equitable benefits.

Another concept that plays into the measurement of impacts is the cumulative effects of a project. It is understandable that water agencies would look at other water projects in determining the impact of their project, but that ignores the reality of these communities –that they live with so many stressors that one more, from any source, is one more than they can handle.

Finally, it is recommended that planners develop multi-benefit projects with consideration of affected disadvantaged communities and vulnerable populations. This is particularly true in already impacted 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, habitat, or recreation for the disadvantaged communities and vulnerable populations.

### Related Actions:

1. Increase disadvantaged community participation in planning
   - DWR and the other Water Plan Steering Committee members should incorporate environmental justice issues of precautionary applications, cumulative health impact reductions, public participation, community capacity building and communication, and meaningful participation into current and future California Water Plan Update processes and other programs.
   - DWR should require that grant and loan recipients conduct outreach to disadvantaged communities and vulnerable populations and their advocates seeking their participation in water planning programs, including the California Water Plan Update and Integrated Regional Water Management plans and other local water planning processes.

2. Increase disadvantaged community access to funding
   - DWR and other State agencies should work with disadvantaged communities and vulnerable populations and their advocates to review State government funding programs and develop guidelines that make funding programs equally accessible to disadvantaged and environmental justice communities.

*Objective 13 Ensure Equitable Distribution of Benefits (continued)*

- DWR and other State agencies should work with disadvantaged communities and vulnerable populations and their advocates to develop a technical assistance program to provide resources, expertise, and information to disadvantaged and environmental justice communities to enable them to actively and equally participate in planning processes and access funding sources.

3. Collect and maintain data on environmental justice and disadvantaged communities
   - DWR, in coordination with the appropriate State and federal agencies, should review its current monitoring and regulatory programs to identify and address gaps in available data and monitoring programs that impact disadvantaged communities and vulnerable populations.

4. Develop Water Plan goals and objectives, in coordination with Integrated Regional Water Management partnerships, to resolve water-related public health issues in disadvantaged communities.
   - The Water Plan should include goals and objectives to ensure that all Californians have access to safe drinking water.
   - California Tribes, both recognized and unrecognized, should provide goals and objectives to protect Tribal uses of water, especially those that impact the health of Tribal members (see Objective 12).
   - DWR, the Department of Fish and Game, and other State agencies should develop statewide goals and objectives for the provision of safe fish for communities that rely on fish as part of their subsistence diet.
   - DWR, in consultation with other State agencies, including the Department of Conservation, Tribes, and community groups, should develop goals and objectives to restore and protect watersheds making use of existing community-based watershed councils and groups that are an under-utilized tool in maintaining and restoring California's water resources.

5. Assess environmental justice water-related concerns on a regional level
   - DWR and other State agencies should assess environmental justice water-related concerns on a regional level and incorporate this analysis into the Water Plan Update regional reports.
   - DWR should include provisions for environmental justice and disadvantaged communities in the guidelines for the Integrated Regional Water Management planning and grant program.

DWR should use its regional assessment, along with other applicable information such as the Department of Public Health and State Water Board's projects lists for the small community safe drinking water grant program and the small community wastewater system grant program respectively, to guide evaluation of Integrated Regional Water Management plans and whether they have met the environmental justice criteria for funding.

**The California Water Plan** provides a framework for resource managers, legislators, Tribes, other decision-makers, and the public to consider options and make decisions regarding California's water future. Our goal is that this document meet Water Code requirements, receive broad support among those participating in California's water planning, and be a useful document. With its partners, DWR completed the final Update 2009 volumes and *Highlights* in December 2009.

The first four volumes of the update and the *Highlights* booklet are contained on the CD attached below. All five volumes of the update and related materials are also available online at *www.waterplan.water.ca.gov*.

**Volume 1: The Strategic Plan**
**Volume 2: Resource Management Strategies**
**Volume 3: Regional Reports**
**Volume 4: Reference Guide**
**Volume 5: Technical Guide**

For printed copies of the Highlights, Volume 1, 2, or 3, call 1-916-653-1097.
If you need this publication in alternate form, contact the Public Affairs Office at 1-800-272-8869.

The accompanying CD holds proceedings and other materials from the 2009 California Tribal Water Summit, "Protect Our Sacred Water."


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