

Integrated Scenario Analysis for the California Water Plan Update 2009

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California **Water Plan** Highlights

INTEGRATED WATER MANAGEMENT



Update 2009 - Department of Water Resources

Pre-Final Draft
October 16, 2009

Presentation Overview

- ◆ Water Plan Highlights and climate change
- ◆ Scenario concepts used in California Water Plan
- ◆ Application of scenarios to statewide Hydrologic Regions
- ◆ Summary of climate information in Water Plan Update 2009



Climate Change: Stressing Our Water System (1)

California Water Plan (2009) | Washington

Climate Change: Stressing Our Water System

Bad news: California's reservoir and water delivery systems were designed and operating under more benign hydrological conditions of light and during the winter with higher elevations requiring less ground storage.

What Has Already Happened?

Looking over the past century, the following changes are evident:

- California's temperature has risen one degree Fahrenheit, mostly at night and during the winter, with higher elevations requiring less ground storage.
- Average early spring snowpack in the Sierra Nevada has decreased by about 15 percent, a reduction of 1.5 million acre feet of water storage (one acre foot of water is enough for one to two families for one year). Reduced snowpack at the Sierra Nevada is California's largest surface water storage.
- Sea level along California's coast has risen 7 inches.
- Flood peaks in the state's rivers have increased.
- Climate patterns are more variable.

Average Annual Runoff

Runoff at streamheads may cause some of our reservoirs to spill their water to sea. The amount that is captured in the amount of snowpack, an important indicator for storing water in the winter and for supplying the water supply in spring and summer. Climate change projects a decline in the spring and the amount of snowpack and may cause water supply shortages in the winter. People could then experience water shortages in the winter and in the summer.

Decreasing California Reservoir

Decreasing California Reservoir

What More is Expected?

Looking forward to year 2050 and the end of the century, more changes can be expected:

- California's mean temperature may rise 2.5 degrees to 5.0 degrees Fahrenheit by 2050 and 3.0 degrees to 5.0 degrees by the end of the century.
- Sierra Nevada snowpack may decrease by 25 to 40 percent by mid-century, a storage reduction of about 2.0 million acre feet to 8 million acre feet. Snow a little less in a 1000 more than the capacity of California's largest reservoir (surface reservoir).
- Average annual precipitation may show little change, but more intense wet and dry periods can be expected - more floods and more droughts.
- Flood peaks will become higher and earlier spring snowmelt runoff will become longer.
- Studies show a possible sea level rise of 4 to 10 inches by mid-century and 7 to 10 inches by the end of the century, with the potential for higher rates.
- Higher sea levels will increase salinity up the Delta.

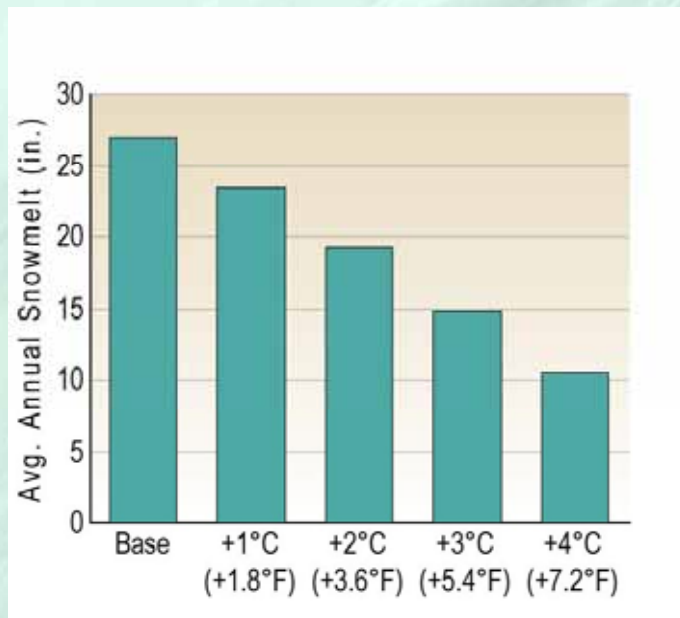
Water and Projected Sea Level at Golden Gate

American River Runoff Annual Maximum 3-Day Flow

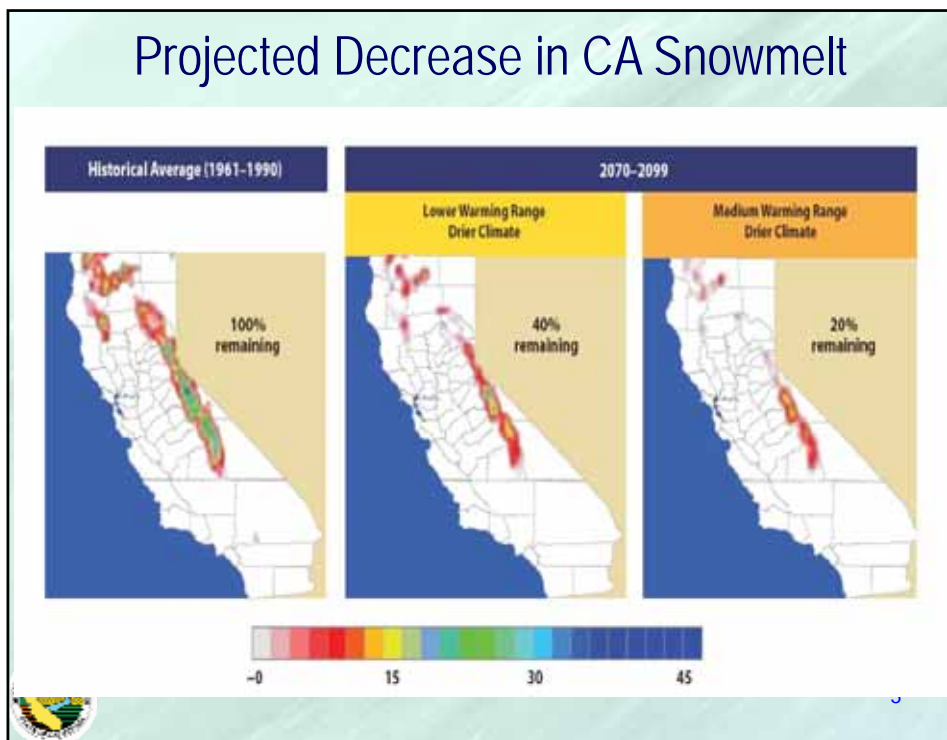
The five highest flows of runoff at the American River have occurred since 1990.

Source: California Climate Change Center | Chapter 2: Adapting Our Water System to a Changing Climate | The National Academies Press | 2009

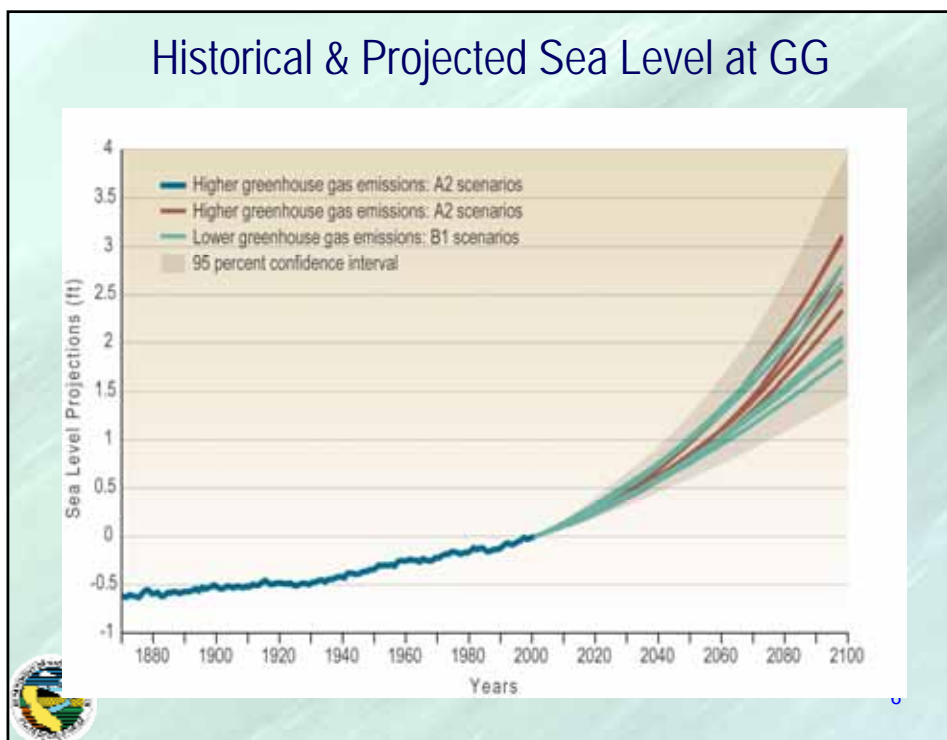
Average Annual Snowmelt Projections



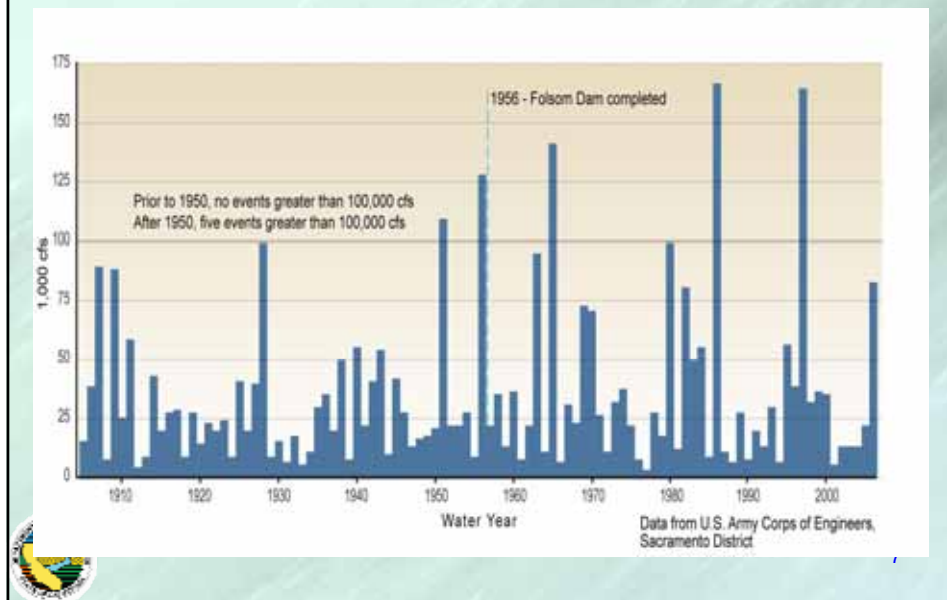
Projected Decrease in CA Snowmelt



Historical & Projected Sea Level at GG



American River Runoff Annual Maximum 3-Day Flow



Scenario Concepts



Water Plan Scenarios Used To Consider Future Uncertainty

- ◆ Three plausible yet very different conditions during 2050 planning horizon
- ◆ Explore key uncertainties facing water community
- ◆ Factors water community has little control over
- ◆ Not predictions ---- used to evaluate water management responses



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Scenarios Organized Around Uncertainty

**Economic
and Financial**

**Institutional
and Political**

**Natural
Systems**

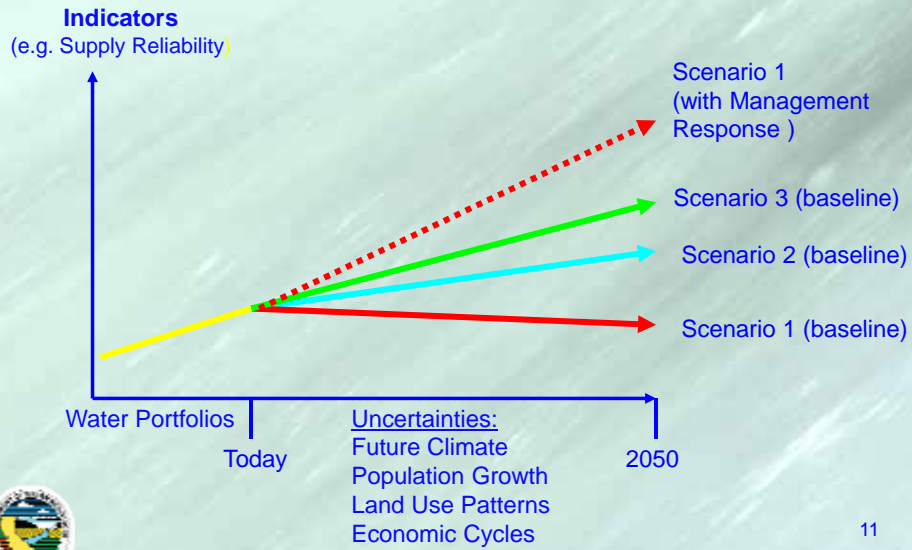
Technology

**Social
Practices**



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Evaluating Uncertainty Using Scenarios



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3 Baseline Scenarios for 2050 Plausible Yet Different Futures

💧 Current Trends

- ✓ Recent trends continue into the future for population, agricultural production, environmental water, and background water conservation

💧 Strategic Growth

- ✓ More coordinated planning & infill
- ✓ Lower population growth
- ✓ Lower reduction in agricultural production
- ✓ New environment water -- High
- ✓ More background water conservation

💧 Expansive Growth

- ✓ Less coordinated planning, sprawl
- ✓ Higher population growth
- ✓ Higher reduction in agricultural production
- ✓ New environment water -- Low
- ✓ Less background water conservation



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Technical Outreach for Scenarios

- ◆ December 2007 – Scenario proposal
- ◆ April 2008 – Shared Vision Planning
- ◆ June 2008 – Refinement of scenario proposal
 - Climate change
 - Environmental water
 - Flood management
 - Water quality
- ◆ February 2009 – Review of preliminary demands
- ◆ June 2009 – Review of revised results & graphics
- ◆ July 2009 – Climate TAG



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Quantifying Future Scenarios for Update 2009

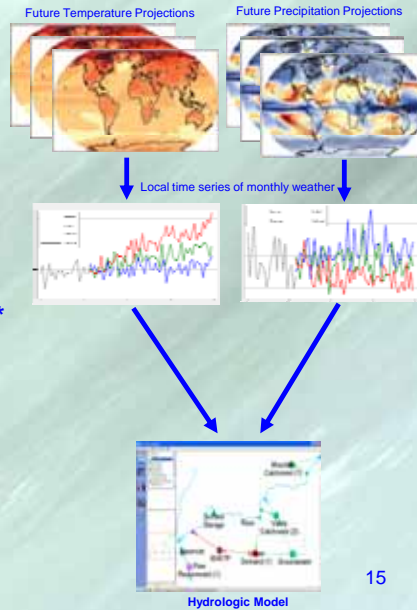
- ◆ Using WEAP analytical tool to quantify water demand and supplies for future scenarios and water management responses
- ◆ WEAP Hydrologic Region analysis being done for all regions --- high level, coarse representation
- ◆ WEAP Planning Area analysis for Sacramento and San Joaquin regions --- more physically based
- ◆ Each scenario evaluated with 12 climate sequences (climate change, multiple year droughts, wet years)



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Analysis Considers Possible Climate Change Impacts

- **Global circulation models produce numerous projections of future temperature and precipitation patterns**
 - Six GCMs
 - Two global emissions scenarios
- **Statistical downscaling methods produce local weather sequences***
- **Weather sequences drive hydrologic models to calculate:**
 - irrigation demand (HR and PA)
 - hydrologic flows (PA analysis, only)



Using the World Climate Research Programme's (WCRP's) Coupled Model Intercomparison Project phase 3 (CMIP3) multi-model dataset

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Hydrologic Region Scale Analysis



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Hydrologic Region Analysis

- ◆ Monthly, climate-driven demands to 2050
 - reflect global climate change projections
 - Agriculture, Urban, and Environmental sectors
- ◆ Simple representation of supplies possible

All 10 Hydrologic Regions



Framework for Statewide Scenarios

Uncertain Factors (X) and Scenarios	Management Actions (L) & Response Packages
Population Household factors Employment factors Irrigated Crop Area } 3 Growth Scenarios	Current management (no response) Response packages evaluated using Planning Area model for select Hydrologic Regions
Temperature Precipitation } 12 climate sequences + historical ★ New!	
Model (R)	Performance Measures (M)
WEAP model by Hydrologic Region ★ New!	Demand (historical climate) Demand (projected climate) Supply and environmental flows addressed using Planning Area model



Water Scenarios 2050: Range of Considerations

Water Scenarios 2050: A Range of Considerations

Water will continue to be a critical resource for the future. The population growth being seen in recent years will continue to increase. The pace of climate change continues to increase, creating a global network of regulations. We have no way of predicting the future, but we can consider some plausible scenarios. Future resources can be used to help us better understand the implications of future conditions on water management. Update 2010 made significant improvements to the scenarios by considering the potential effect of long-term climate change on future water demands. The water use climate change is highlighted on pages 8 through 11.

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, water demand patterns, environmental conditions, the climate, and many other factors that affect water use and supply may change by 2050. To help plan for change, we approach water management and planning for the future with an uncertainty range of consideration.

Update 2010 has three future scenarios for the year 2050 to which the water management would need to respond: (1) by implementing a set of water management strategies that focus on water management strategies on highlighted pages 18 and 19 and strategies of strategies on highlighted pages 20 and 21. (2) The role of water conservation - Current Trends, Strategic Growth, and Expansive Growth - will be something about how different factors, like population or irrigated land, are expected to change over time. These are factors over which the water community has little control, yet many external factors affect future water demand. Water Plan Update 2010 provides several factors that together provide a description of future water demand for urban, agricultural, and environmental sectors.

Factors of Uncertainty

Factor	Current Trends	Strategic Growth	Expansive Growth
Population	60 million	45 million	70 million
Land Use	Continued development	Compact development	Sprawling development
Irrigated Crop Area	8.5 million acres	9 million acres	8.2 million acres
Environmental Water	1.0 additional MAF	1.5 additional MAF	0.6 additional MAF
Background Water Conservation	10% increase	15% increase	5% increase

2050 Water Demand Changes by Scenario

Combined Water Demand Change by Scenario

Water Demand Changes and Climate Change Variability

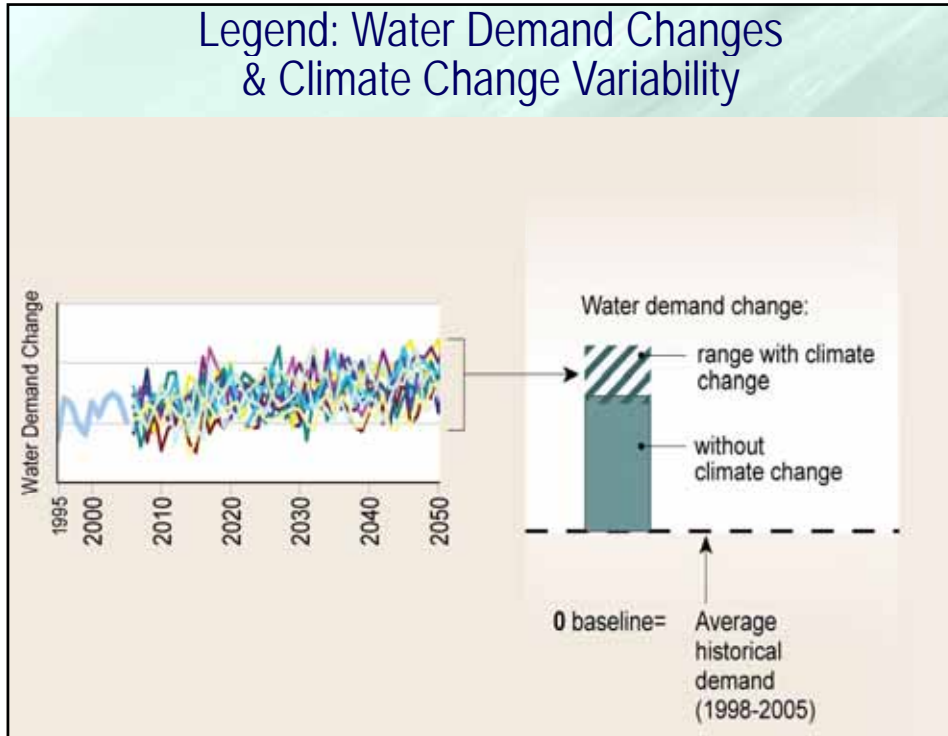
The water demand change is shown in the chart below. The chart shows the change in water demand from 2000 to 2050 for three scenarios: Current Trends, Strategic Growth, and Expansive Growth. The chart also shows the change in water demand from 2000 to 2050 for three scenarios: Current Trends, Strategic Growth, and Expansive Growth. The chart also shows the change in water demand from 2000 to 2050 for three scenarios: Current Trends, Strategic Growth, and Expansive Growth.

3 Future Scenarios: Key Factors of Uncertainty

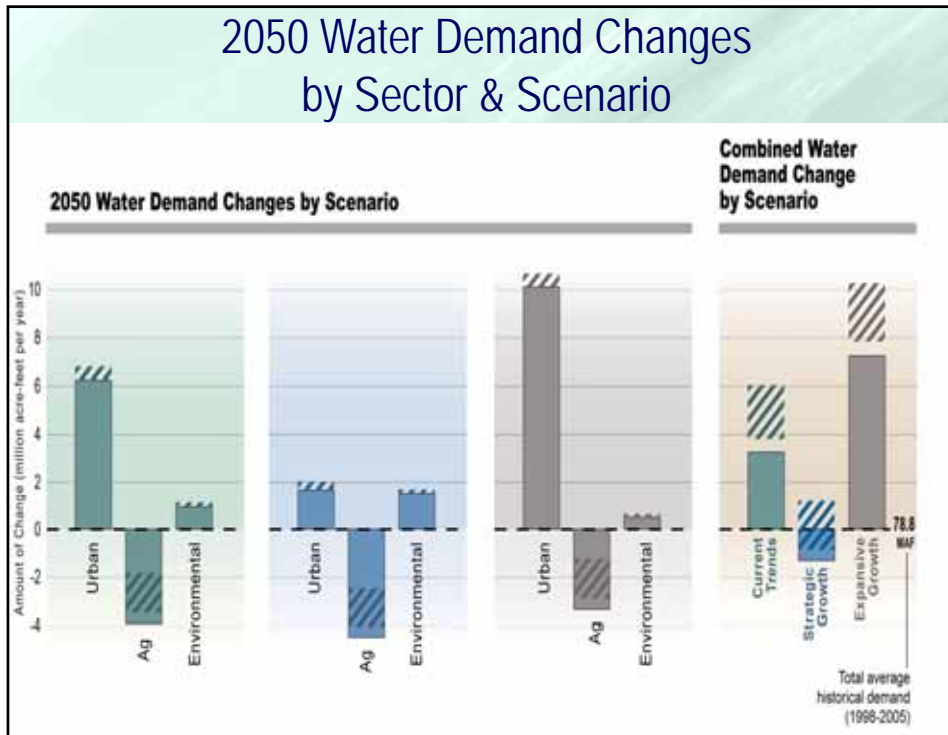
Factors of Uncertainty

Factor	Current Trends	Strategic Growth	Expansive Growth
Population	Recent trends are assumed to continue into the future. Initiated mostly by lawsuits, the state faces lawsuits on a regular basis: from flood damages to water quality and endangered species protections. Regulations are not coordinated or comprehensive, creating uncertainty for planners and water managers.	Private, public, and governmental institutions form alliances to provide for efficient planning and development that is less resource intensive than current conditions. State government implements comprehensive and coordinated regulatory programs to improve water quality, protect fish and wildlife, and protect communities from flooding.	Future conditions are more resource intensive than existing conditions. Protection of water quality and endangered species is driven mostly by lawsuits. State government has responded on a case-by-case basis, creating a patchwork of regulations and uncertainty for planners and water managers.
Population	60 million	45 million	70 million
Land Use	Continued development	Compact development	Sprawling development
Irrigated Crop Area	8.5 million acres	9 million acres	8.2 million acres
Environmental Water	1.0 additional MAF	1.5 additional MAF	0.6 additional MAF
Background Water Conservation	10% increase	15% increase	5% increase

Legend: Water Demand Changes & Climate Change Variability

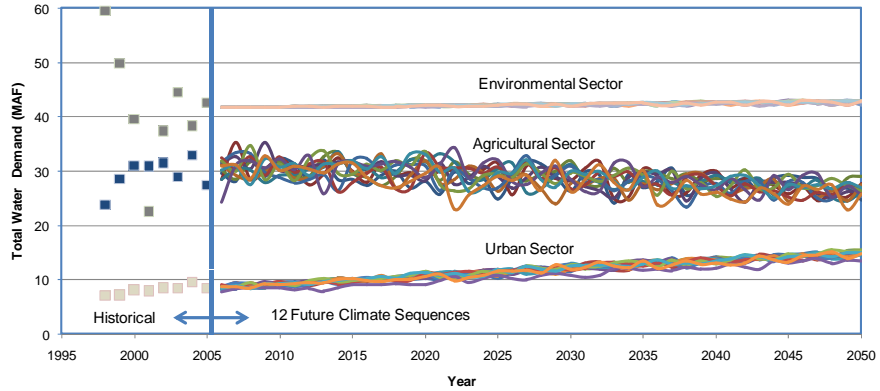


2050 Water Demand Changes by Sector & Scenario

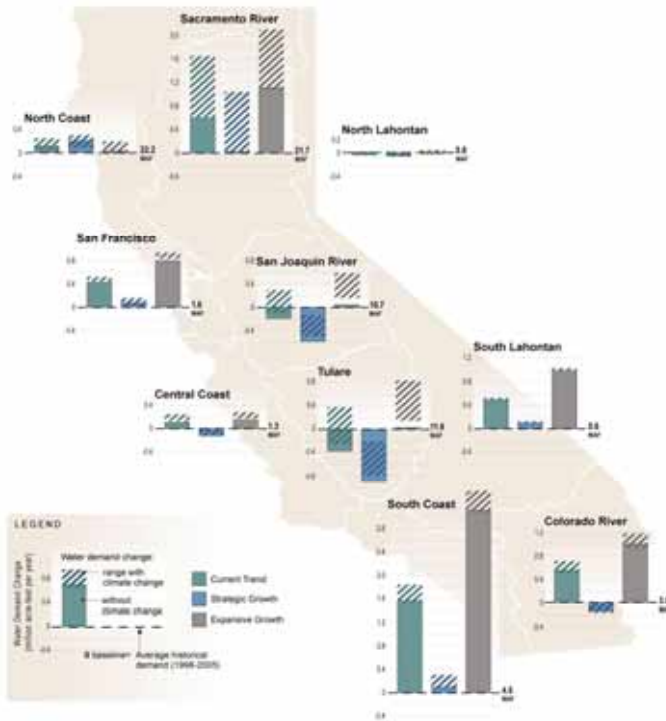


Climate change increases variability and range of future statewide water demands

Figure 6-4 Statewide Annual Water Demand Under 12 Future Climate Sequences (Current Trends Scenario)



Regional Water Demand Changes by Scenario



Planning Area Analysis

Sacramento and San Joaquin River Regions

- ◆ Hydrologically-based water system simulation by month to 2050

- reflect global climate change projections

- ◆ Estimate environmental flows, system operations, deliveries, and reliability

- ◆ More direct representation of response packages

Sacramento River & San Joaquin River Hydrologic Regions



Climate Information in Update 2009

- ◆ Highlights

- ◆ Volume 1

- Chapter 4 – California Water Today
- Chapter 5 – Managing an Uncertain Future
- Chapter 6 – Integrated Data and Analysis

- ◆ Volume 4 Reference guide

- Climate Adaptation Strategy
- Climate Science



Summary

- ◆ Water Plan uses scenarios to capture future uncertainties like population growth, land use changes, and climate change
- ◆ Water Plan shows water demands out to 2050 using 3 scenarios and 12 climate sequences
- ◆ As part of Update 2009 we have piloted finer detail analysis at Planning Area scale
- ◆ Pre-Final draft of Water Plan is available on-line and contains a wealth of information on California water management.



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Reference Information

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◆ Water Plan Update 2009

<http://www.waterplan.water.ca.gov/cwpu2009>

◆ SWAN

- <http://www.waterplan.water.ca.gov/swan>

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