Climate Change
and California Water Management Challenges

Climate Change Conference
Austin, Texas
May 12, 2006
Topics for Today’s Briefing

- California Water Plan Update 2005
- Overview of California Water Resources
- Potential Climate Change Impacts
- Meeting the Challenge / Next Steps
The California Water Plan

- Comprehensive plan to guide water management
- First published 1957
- Updated every 5 years
- Eighth update 2005
“This is not just another update of the California Water Plan. Update 2005 represents a fundamental transition in how we look at water resource management in California. It also represents a fundamental transition in the way state government needs to be involved with local entities and interest groups to deal with water issues in the state.”

Lester Snow
April 14, 2005
New Process

- **Open & transparent public process**
- **Collaborative recommendations**
  - 65 on Advisory Committee
  - 350 in Extended Review Forum
  - 2000 Participants
- **Prepared a strategic plan**

<table>
<thead>
<tr>
<th>Meeting</th>
<th>Number</th>
<th>Person Hours</th>
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<tbody>
<tr>
<td>Advisory committee</td>
<td>43</td>
<td>12,681</td>
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<td>Extended review forum &amp; organizational briefings</td>
<td>43</td>
<td>1,558</td>
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<td>Workshops</td>
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<td>3,161</td>
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<td>2005 Public comment workshops</td>
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<td>Work groups</td>
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<td>4,271</td>
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<td>Tribal outreach</td>
<td>7</td>
<td>69</td>
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<tr>
<td><strong>Totals</strong></td>
<td>197</td>
<td><strong>23,252</strong></td>
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</table>
New Features

- **Water Portfolios**

- **Regional Reports**
  - For 10 hydrologic regions, the Delta, and Mountain Counties

- **Multiple Future Scenarios**
  - Plausible yet different base conditions to plan for uncertainties

- **25 Resource Management Strategies**
  - Tools for water managers & resource planners to …

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The many rivers and streams that are tributary to the Sacramento River provide important riparian habitat that is critical for many aquatic and terrestrial species including the spring-run Chinook salmon (Oncorhynchus tshawytscha), winter-run Chinook salmon (Oncorhynchus tshawytscha) and Central Valley steelhead (Oncorhynchus mykiss). This region is the only known area for the winter-run Chinook. The valley floor region section adjoining the river, provide some of the most important wintering areas for the species. The cold, wet winters with large amounts of snow providing runoff for summer water supplies. The Sacramento Valley floor has mild winters with less precipitation and hot dry summers. Overall annual precipitation in the region generally increases as you move from south to north and west to east. The heavy snow and rain that falls in this region contributes to the overall water supply for the entire state.

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Historical vs Current Trends

- **Less Resource Intensive**
- **More Resource Intensive**

Stewardship

1960 1980 2000 2020 2040
Water Plan Update Organization

- Introductory Video (8-minutes)
- Water Plan Highlights (with CD & DVD)
- Vol. 1 > Strategic Plan
- Vol. 2 > 25 Resource Management Strategies
- Vol. 3 > 12 Regional Reports
- Vol. 4 > Reference Guide (60+ online articles)
- Vol. 5 > Technical Guide (Online documentation)
Strategic Plan Overview

- Vision
- Mission
- Goals
- Recommendations
- Implementation Plan
Framework for Action
Sustainable & Reliable Water in 2030

Vision

2 Initiatives
Ensure Reliable Water Supplies

3 Foundational Actions
Ensure Sustainable Water Uses

Vital Economy
Healthy Environment
High Standard of Living

Implement Integrated Regional Water Management

Improve Statewide Water Management Systems

Use Water Efficiently

Protect Water Quality

Support Environmental Stewardship

Vital Economy
Healthy Environment
High Standard of Living
Diversifying Water Portfolios
Resource Management Strategies

Reduce Water Demand
- Agricultural Water Use Efficiency
- Urban Water Use Efficiency

Improve Operational Efficiency & Transfers
- Conveyance
- System Reoperation
- Water Transfers

Improve Water Quality
- Drinking Water Treatment and Distribution
- Groundwater/Aquifer Remediation
- Matching Quality to Use
- Pollution Prevention
- Urban Runoff Management

Practice Resource Stewardship
- Agricultural Lands Stewardship
- Economic Incentives (Loans, Grants, and Water Pricing)
- Ecosystem Restoration
- Floodplain Management
- Recharge Areas Protection
- Urban Land Use Management
- Water-Dependent Recreation
- Watershed Management

Increase Water Supply
- Conjunctive Management & Groundwater Storage
- Desalination – Brackish & Seawater
- Precipitation Enhancement
- Recycled Municipal Water
- Surface Storage – CALFED
- Surface Storage - Regional/Local
Range of Additional Water for Eight Resource Management Choices

<table>
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<tr>
<th>Resource Management Choice</th>
<th>Low Estimate</th>
<th>High Estimate</th>
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<tr>
<td>Precipitation Enhancement</td>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Conveyance</td>
<td>0.3</td>
<td>0.4</td>
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<tr>
<td>Ocean &amp; Brackish Desalination</td>
<td>0.5</td>
<td>0.8</td>
</tr>
<tr>
<td>Agricultural Water Use Efficiency (Net)</td>
<td>0.2</td>
<td>0.8</td>
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<tr>
<td>Surface Storage - CALFED</td>
<td>0.1</td>
<td>0.8</td>
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<tr>
<td>Recycled Municipal Water</td>
<td>0.9</td>
<td>1.4</td>
</tr>
<tr>
<td>Conjunctive Mgmt &amp; GW Storage</td>
<td>0.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Urban Water Use Efficiency (Applied)</td>
<td>1.2</td>
<td>3.1</td>
</tr>
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</table>

Additional Annual Water (million acre-feet per year)
California’s Water Resources
California’s Major River Systems

Average Annual Runoff (70.8 MAF)
15 MAF (~20%)

56 MAF (~80%)

Distribution of Annual Average Runoff In California
Statewide Water Management Systems

- Groundwater
- Colorado River
- Local Projects
- Federal Projects
- State Proj.
San Francisco Bay - and - Sacramento and San Joaquin River Delta

The Delta is critical to farms, cities, and the environment.

San Francisco Bay

The "Delta"

Suisin Marsh and Bay
What risks does climate change pose for the management of California’s water resources?
Potential Impacts of Climate Change

- Air temperature
- Precipitation amount, timing and type
- Runoff timing and quantity
- Sea level rise
Potential Water Resources Impacts

- Flood Management
- Water Supplies
- Water Quality
- Water Demands
- System Operations
- Ecosystems
Increased Temperatures

Projections

From: Dettinger, 2005
Expected Water Resource Impacts from Increased Temperatures

- Less precipitation falling in the form of snow
- Earlier snowmelt
- Changes in water demand
- Increased evaporation losses
- Changes in watershed vegetation and runoff
- Increased water temperatures
Changes in the Amount of Precipitation

Projections

From: Dettinger, 2005
Changes in Runoff Timing

Historical Evidence

Sacramento River Runoff
April - July Runoff in Percent of Water Year Runoff

Linear Regression (least squares) line showing historical trend

3-year running average

From: Roos, 2003
Less precipitation as snow
Earlier snowmelt
Changes in watershed runoff
Increased water temperatures
Let’s compare…….

- **13.5 MAF** ~ Approx. total reservoir capacity for the Sacramento Valley
- **11 MAF** ~ Approx. total reservoir capacity for the San Joaquin Valley
- **14 MAF** ~ Average annual Sierra snow pack for the Central Valley
- **5 MAF** ~ Estimated loss of Sierra snow pack from a 3 degree C rise in temperature over the next century ("moderate” projection)

This would increase the snow elevation about 1,500 feet.
Operational Challenges
- Reservoirs -

Climate Change

Winter/Early Spring
Operational Challenges for Multi-use Reservoirs

- Higher Inflow During Winter & Early Spring
  - Need to Maintain Greater Flood Reservation
  - Need to Accommodate Higher Flows

- Lower Inflows During Late Spring & Summer
  - Flood Management versus Water Supply
  - Salinity Intrusion in the Delta
  - Warmer Water
Sea Level Rise

Historical Evidence

Golden Gate Annual Average and 19-Year Mean Tide Levels

Source: Roos, 2003
Sea Level Rise

Projections

Source: IPCC, 2001
Impacts of Sea level Rise

- Effects on estuaries and tidal marshes
- Backwater effects and related flooding
- Sea water intrusion into coastal aquifers
What Happens to Bay-Delta Estuary?
Levee Overtopping

Photo by Rob Duvall Jan 1, 2006
Implications of Sea Level Rise for the Bay-Delta Estuary

- Ocean salinity intrusion
- Levee failures & inundation of property
- Disrupted transportation corridors & utility lines
- Interrupted water supply conveyance
- Habitat changes, conversion or loss in natural ecosystems and restoration projects
Meeting the Challenge
What We Know

- Climate change is real
- Climate change has significant challenges for California water management
- We need to plan for it
Governor Arnold Schwarzenegger says on Global Warming:

“I say the debate is over. We know the science. We see the threat. And we know the time for action is now.”
Governor’s Executive Order S-3-05

- Recognizes global climate change and its impacts on California.
- Establishes aggressive greenhouse gas emission reduction targets for the State.
- Requires biennial assessments of climate change impacts and the development of impact mitigation & adaptation plans.
- Requires the formation of an interagency team to implement the Executive Order.
Climate Change Work Team Goals

1. Build Coalitions with Climate Change Researchers
2. Support Mandates Related to Climate Change
3. Estimate Climate Projection Uncertainty
4. Conduct Impacts Assessment
5. Coordinate with State and Federal Agencies

Probabilistic Risk Assessment
Building Coalitions

- SCRIPPS Institute of Oceanography
- Lawrence Livermore Lab
- Lawrence Berkeley Lab
- California Energy Commission
- U.S. Geological Survey
- Santa Clara University
- UC Davis
- UC Berkeley
CAT Assessment

Water Appendix
Coming soon

1 Introduction
2 Background
3 DWR Studies
4 SWP-CVP Impacts
5 Delta Impacts
6 Flood Management
7 Evapotranspiration
8 Future Directions
State of knowledge on water resource impacts

- Discussion in Strategic Plan (Vol 1 – Ch 4)
- Reference articles & literature review (Vol 4)

Recommendation - Adapt for Global Climate Change Impacts

State government must help predict and prepare for the effects of global climate change on our water resources and water management systems. (Vol 1 – Ch 5)
Climate Change Action Items in Update 2005 Implementation Plan

- DWR work with CAT to prepare biennial assessments and adaptation plan
- Help reduce GHG emissions by identifying means of energy savings for the storage, conveyance, distribution, and use of water
- Evaluate responses to potential impacts on the SWP and California’s hydrology
- Develop alternative flow data indicative of climate change conditions to help State and regional planners
- Dedicate more staff and resources to climate change analysis and response planning
Some Strategies to Cope with Climate Change

- Observe, understand, and adapt
- Increase monitoring of climatologic & water resource conditions
- Promote Integrated Regional Water Management to use water efficiently, protect quality, support environmental stewardship
- Diversify regional water portfolios with appropriate mix of 25 management strategies in Water Plan 2005
- Develop long-term strategic plan for Delta and Suisun Marsh
- Implement strategies to improve Delta levee management
- Change operation strategy & rules for reservoirs & facilities
- Install additional cold-water release facilities from reservoirs
- Adapt strategies for aquatic and wetland habitat restoration
- Review water rights – amount, timing & location of diversions
Future Direction

- Expand quantitative climate change information and scenarios in future California Water Plan Updates
- Improve and link flood and supply forecasting to climate change model projections
- Evaluate reservoir re-operation scenarios for SWP, CVP & local
- Assess impacts on hydropower
- Improve and develop analytical tools
- Expand collaboration
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