Denver Water

- Established in 1918
- Separate from City
- Serve 1.3 million people - 25% of Colorado
- Total watershed area: 4,000 square miles (2.5 million acres)
- 19 raw water reservoirs
Denver Water serves 25% of Colorado’s population with only 2% of the state’s water.
Grand Junction

Aspen

Arkansas River

South Platte River.

Yampa River

Rio Grande

Gunnison River

Colorado River

Conterminous Divide

South Platte Watershed

Colorado River Watersheds

Denver

Continental Divide

Grand Junction

Gunnison River

Rio Grande

Continental Divide

Arkansas River
Major rivers of the U.S.
Issues facing Denver’s water supply

- Climate change
- Drought
- Wildfires
- Consumer risk tolerance
- Economic uncertainties
- Growth
- Colorado River Compact call
Comparison of Water Supply and Demand Patterns

- **DW Service Area Average Demand Pattern**
- **Average Supply Pattern** (S.F. Williams Fork)
Factors Affecting Water Supply

Objective: Fill Reservoirs and Balance System

- **Available Flow (natural flows)**
  - Variations in annual, seasonal and daily weather patterns and runoff
  - System losses (evaporation, carriage losses)

- **System Constraints**
  - Tunnels, canals, reservoirs
  - Stream channels
  - Treatment plants and distribution
  - Water quality

- **Water Rights and Agreements**
  - Colorado water law
  - Contracts & agreements
  - Minimum, maximum flows
  - Environmental factors

- **Demand**
  - Existing vs. Future
  - Variations in annual, seasonal and daily demands
  - Indoor versus outdoor demand
  - Future conservation savings
  - Demands of other entities
  - Social values
Water Demand and Supply

Total Demand = Adjusted Treated Water Demand + Fixed Contracts

Current Supply
Denver Water Reservoir Contents
(1634-2005)
Water Supply: 345,000 af
Includes 30,000 af Strategic Water Reserve and Drought Restrictions

% Full

Strategic Water Reserve

Year

Projected Changes for North Central Colorado

![Graph showing projected changes in precipitation and temperature for North Central Colorado. The graph plots precipitation change (%) on the Y-axis against temperature change (°F) on the X-axis. Points are scattered across different temperatures and precipitation changes, indicating variability in projected changes over the 2040 and 2070 timeframes.]
## Denver Water’s Simple Assessments

<table>
<thead>
<tr>
<th></th>
<th>2° F</th>
<th>5° F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Colorado</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Platte</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td><strong>Additional</strong></td>
<td>5%</td>
<td>8%</td>
</tr>
<tr>
<td>precipitation to</td>
<td></td>
<td>12%</td>
</tr>
<tr>
<td>offset warming</td>
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### 5° F

<table>
<thead>
<tr>
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<th>% Change</th>
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<tbody>
<tr>
<td>Yield</td>
<td>-22%</td>
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<tr>
<td>Demand</td>
<td>7%</td>
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</table>
Scenario Planning

The Cone of Uncertainty

Near-term strategy

Today

Decision Points

2050
Conclusions

• High res in operations
• New planning model???
• Science need: streamflow???
• Increase system diversity and flexibility
• Maintain reliability
• Plan for multiple futures
• Identify and preserve options
High Resolution Data

Spatial and Temporal Distribution

Streamflow

- Rain
- Snow
- Soil Moisture
- Watershed
- Transpiration
- Evaporation
- Temperature
- Wind
- Ground water
- Droughts
- Flooding

Special and Temporal Distribution
### A Front Range of 5 million people?

<table>
<thead>
<tr>
<th>City</th>
<th>People per Square Mile</th>
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<tbody>
<tr>
<td><strong>2010 Census</strong></td>
<td><strong>People per Square Mile</strong></td>
</tr>
<tr>
<td>New York</td>
<td>27,000</td>
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<td>26,000</td>
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<td>25,000</td>
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<td>Baltimore</td>
<td>8,000</td>
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<td>7,000</td>
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<tr>
<td><strong>Denver Water Service Area 2050</strong></td>
<td>6,000</td>
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<td><strong>St. Louis</strong></td>
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<td><strong>Denver Water Service Area 2010</strong></td>
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<td></td>
<td>2,000</td>
</tr>
<tr>
<td>Nashville</td>
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</tbody>
</table>
“All I’m saying is *now* is the time to develop a plan to deflect an asteroid.”
Water Planning Challenges

Drought

Population Growth

Endangered Species

Water Quality

Colorado River Compact Call

Climate Change
Planning Futures

• **Traditional future** - The future is extrapolated from past trends.

• **Water quality rules** - Contaminant removal and other drinking water requirements are extremely stringent.

• **Hot water** - A warmer climate accompanied by more frequent and more severe droughts.

• **Economic woes** - An ongoing energy crisis and deep economic downturn.

• **Green revolution** - Environmental values and sustainable living become dominant social norms.
Supply Gap in 2050

Planning Futures

Water Demand

Gap
Existing Supply

DENVER WATER
Short-Term Planning Goals

Annual Objectives
– Fill Reservoirs
– Maximize Runoff Capture
– Maintain System Balance

Common Questions Along the Way…
– How much water should be released this week?
– How should we balance our system?
– Should we make power, recreation, environment, flood, etc. releases?
– Do any parts of the system need to be serviced?
– Do we need to prepare for drought?
– Should we run Robert’s tunnel over winter?
What is the State of Science of Climate Adaptation???

**DW Challenges**
- Sophisticated water system model
- Responsibility to customers
- Regulatory paralysis
- Organizational buy-in and risked loss of trust
- Preparation vs stranded assets

**Science Questions**
- Accurat
- What do we actually know?
- What do we need to know to act?
- Research
  - ESP Forecasts
  - Diagnostic work
Colorado Water

**West Slope**
- Population: 562,000
- Irrigated Acres: 918,000

**East Slope**
- Population: 4,490,000
- Irrigated Acres: 2,548,000