

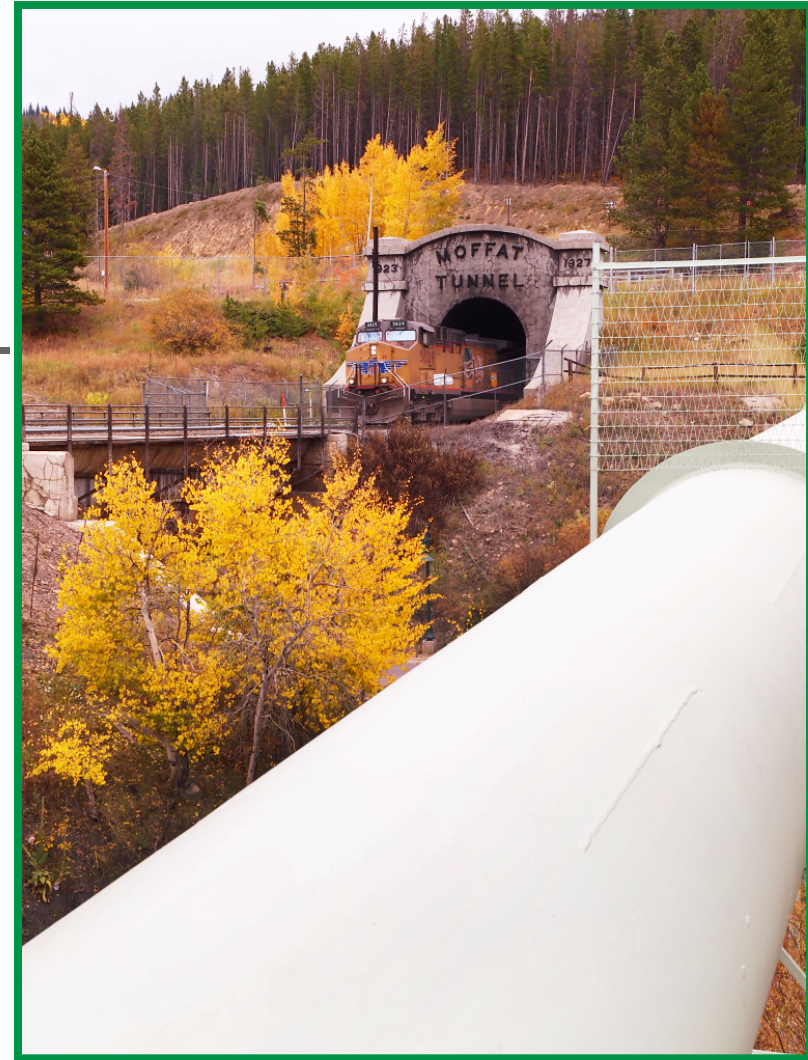
# Application Barriers: Using High Res Data at Denver Water



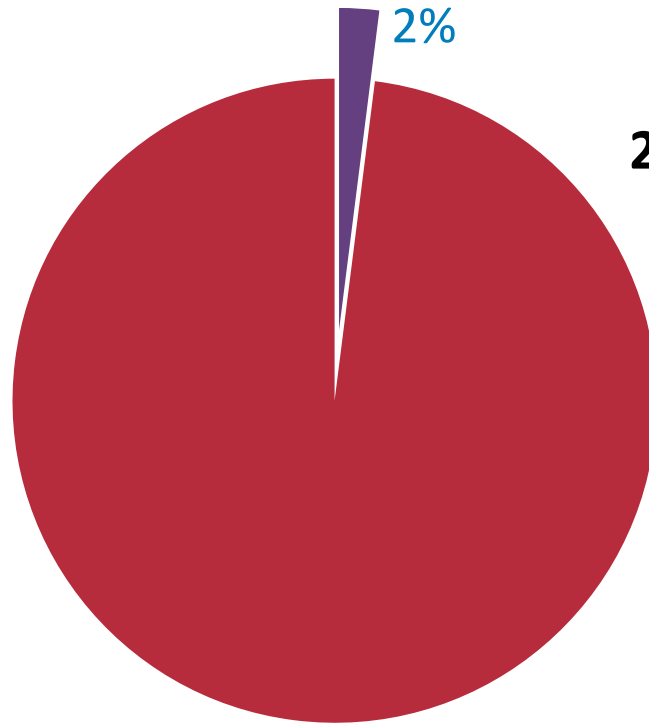
*August 4, 2015 - AGCI High Resolution Climate Modeling and Data  
Laurina Kaatz - Climate Program Manager, Denver Water*

# 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



# Water use in Colorado



**Denver Water serves  
25% of Colorado's population  
with only  
2% of the state's water.**



Wyoming

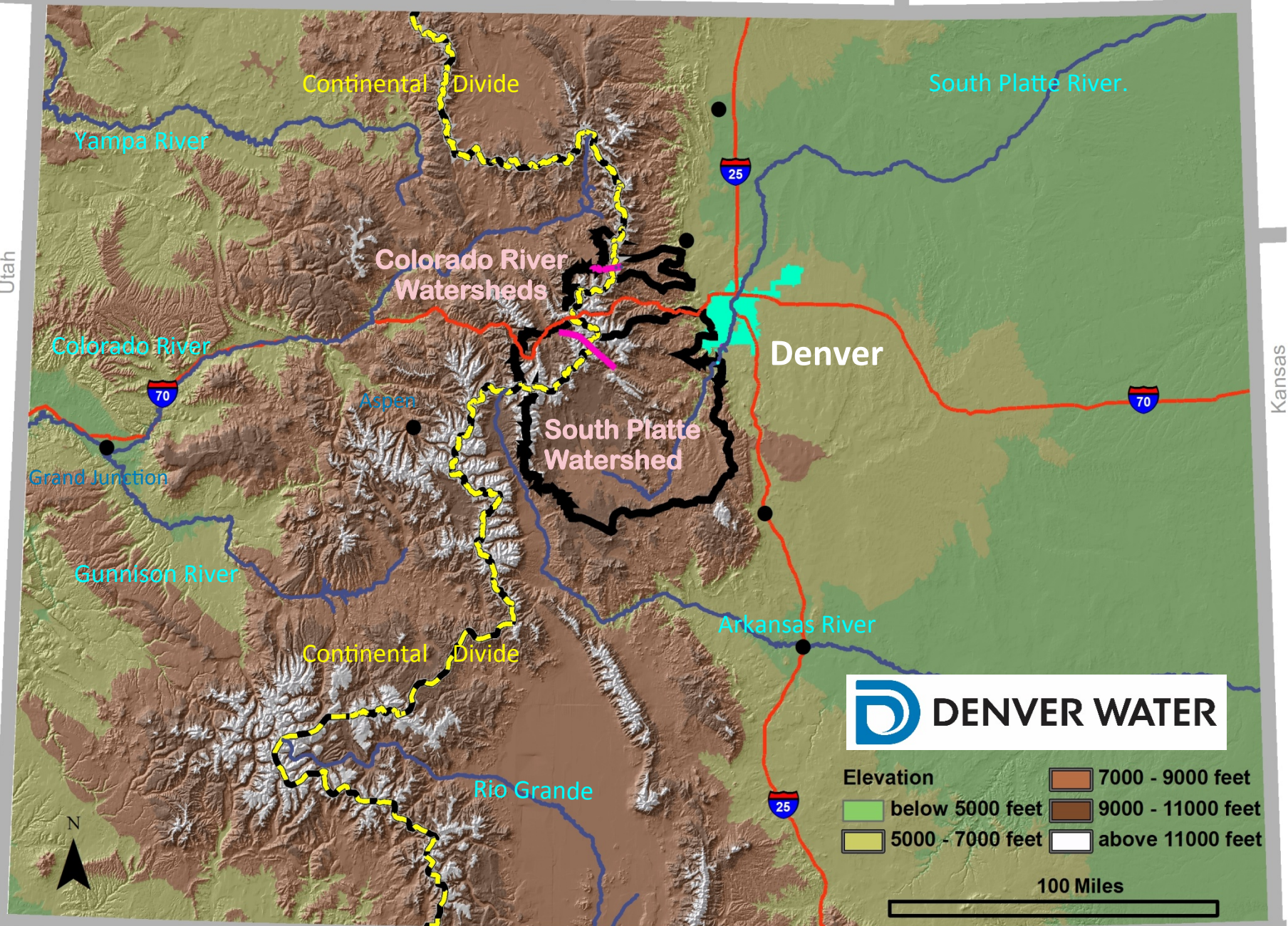
Nebraska

Utah

Kansas

New Mexico

Oklahoma

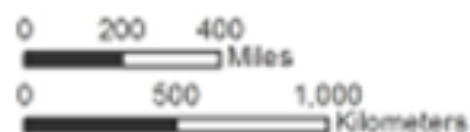




## Colorado River Basin



# Major rivers of the U.S.



Average Flow in cubic feet per second (cfs):  
1,000 2,500 10,000 50,000 250,000 650,000





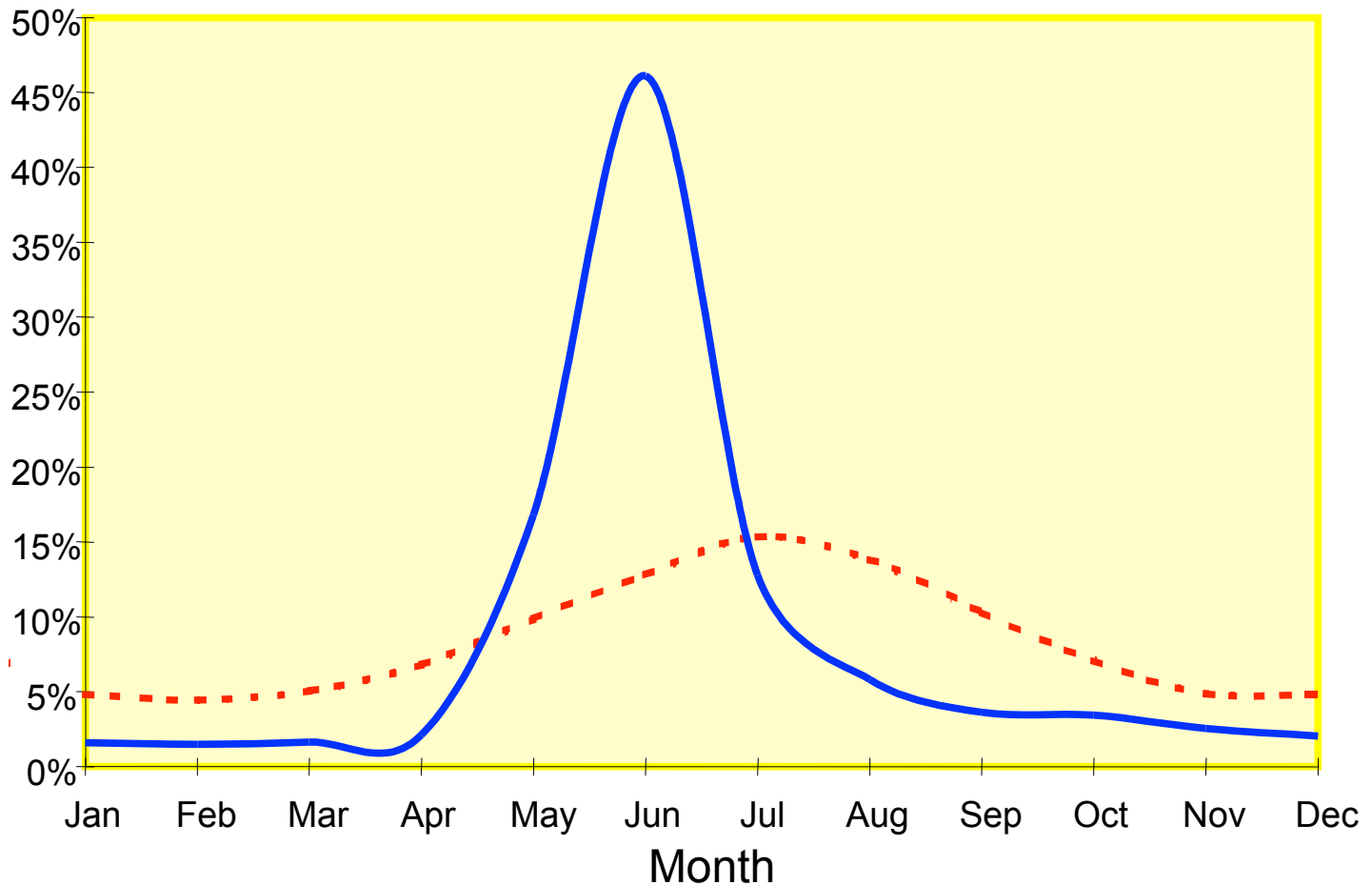
# Issues facing Denver's water supply



- 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)





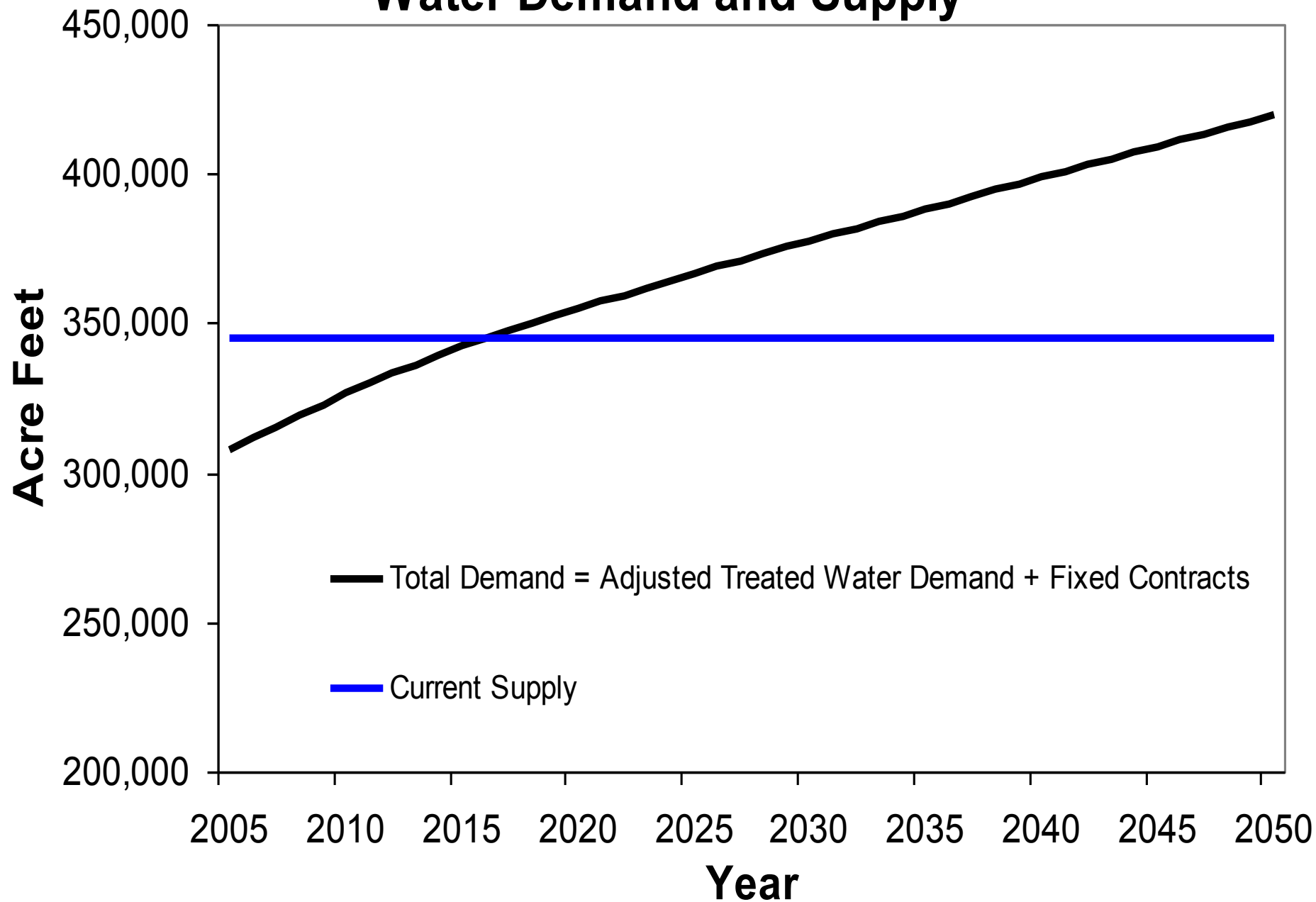
# Factors Affecting Water Supply

Objective: Fill Reservoirs and Balance System

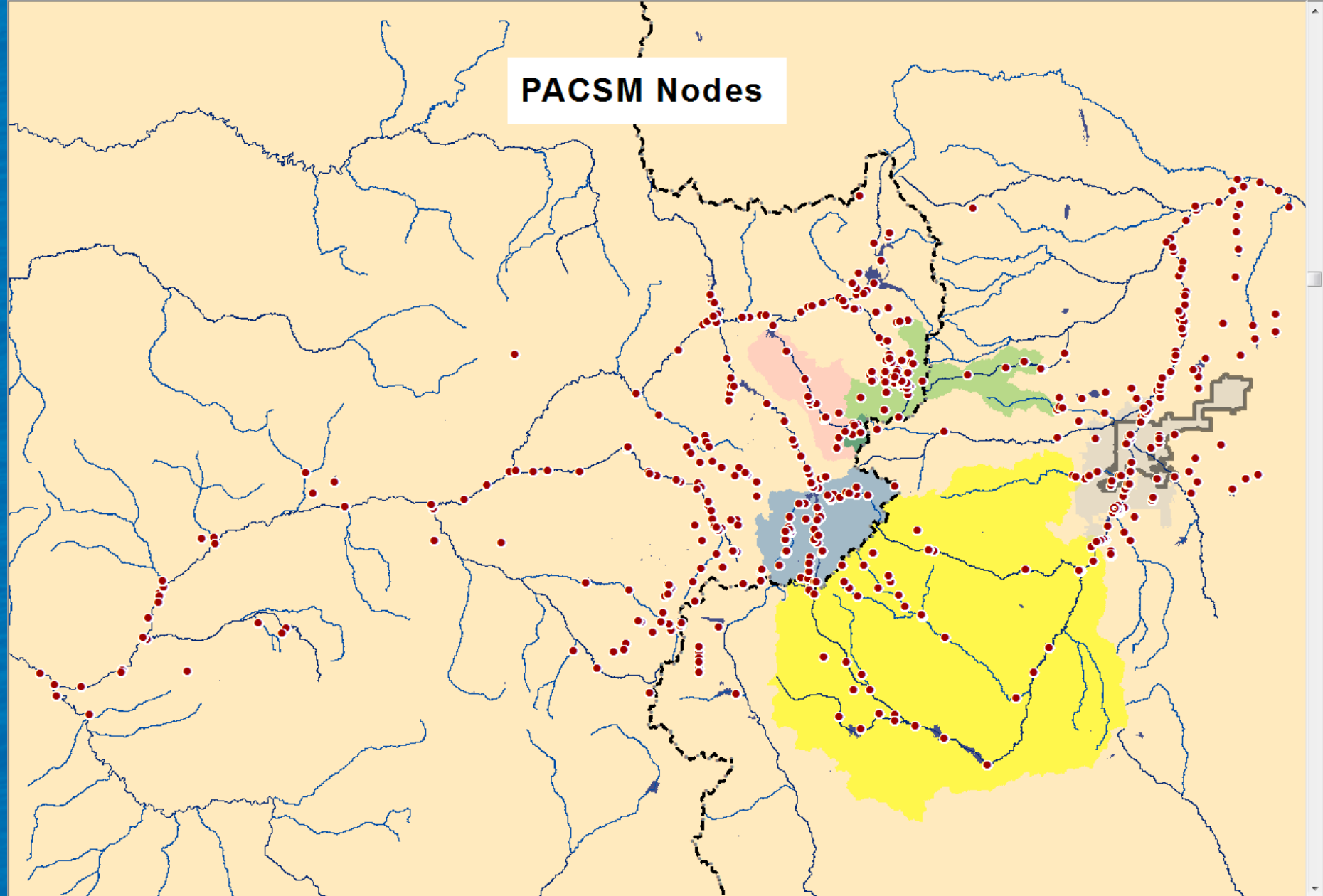
- Available Flow (natural flows)
  - Variations in annual, seasonal and daily weather patterns and runoff
  - System losses (evaporation, carriage losses)
- System Constraints
  - Tunnels, canals, reservoirs
  - Stream channels
  - Treatment plants and distribution
  - Water quality
- Water Rights and 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





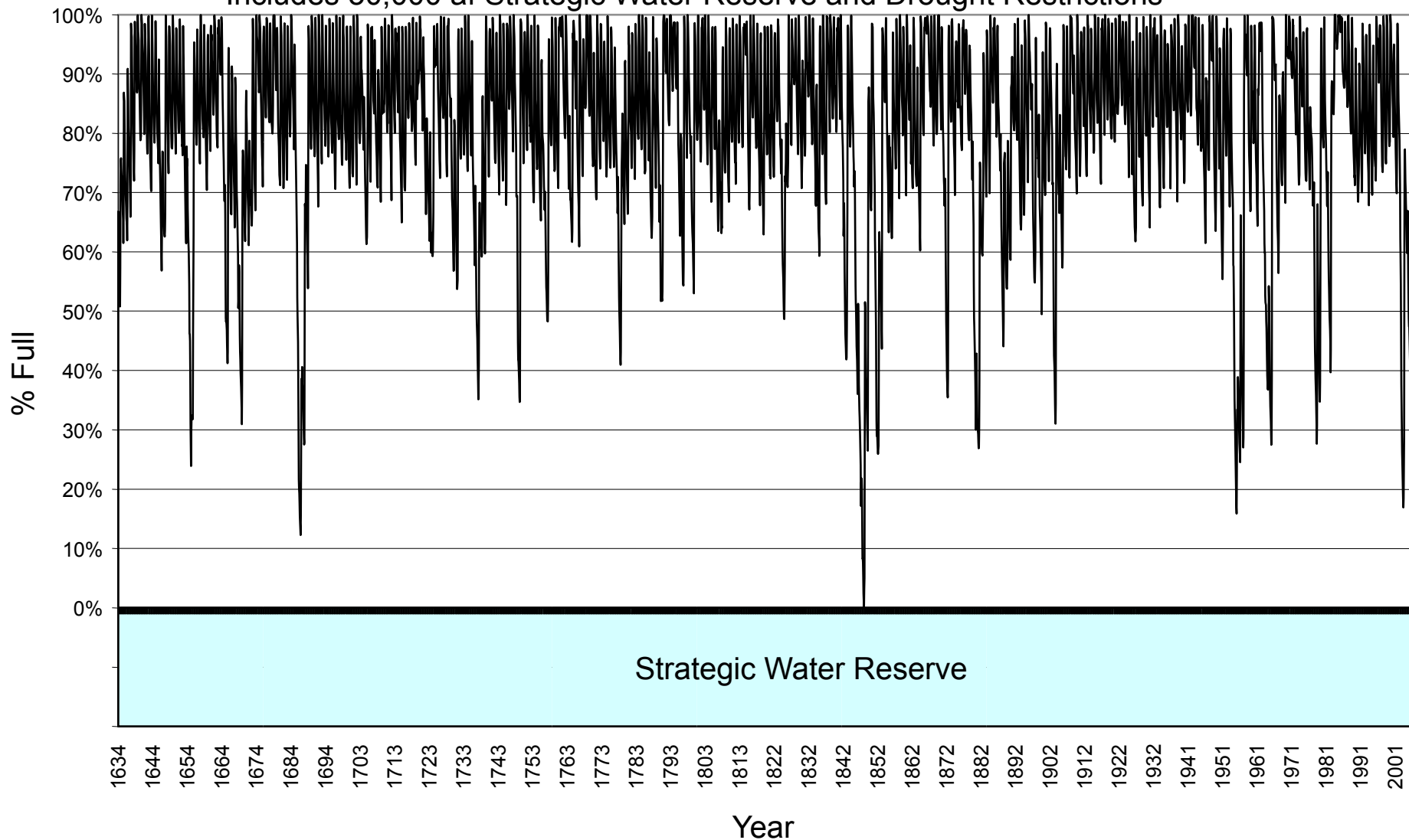


# Denver Water Reservoir Contents

(1634-2005)

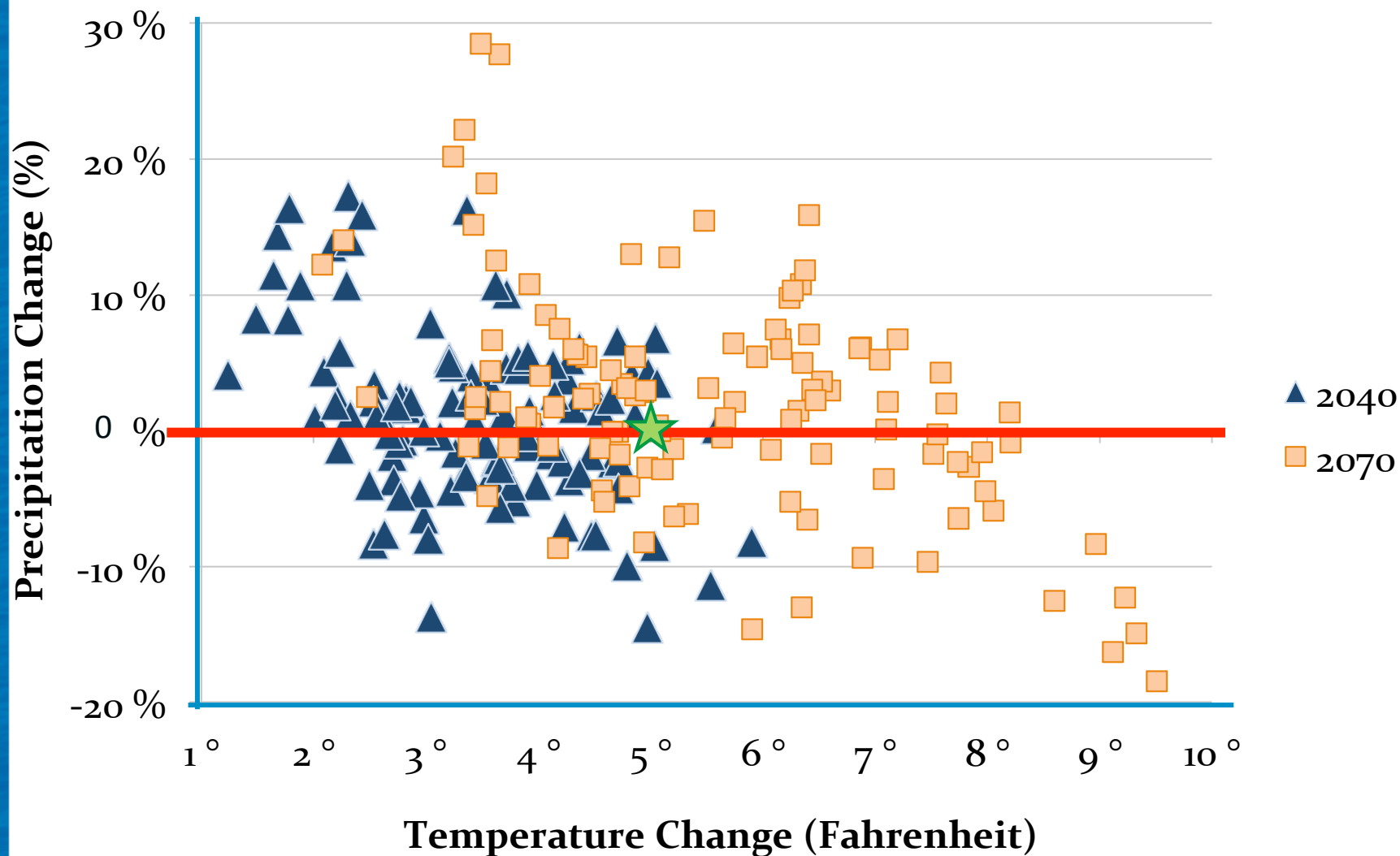
Water Supply: 345,000 af

Includes 30,000 af Strategic Water Reserve and Drought Restrictions





# Projected Changes for North Central Colorado



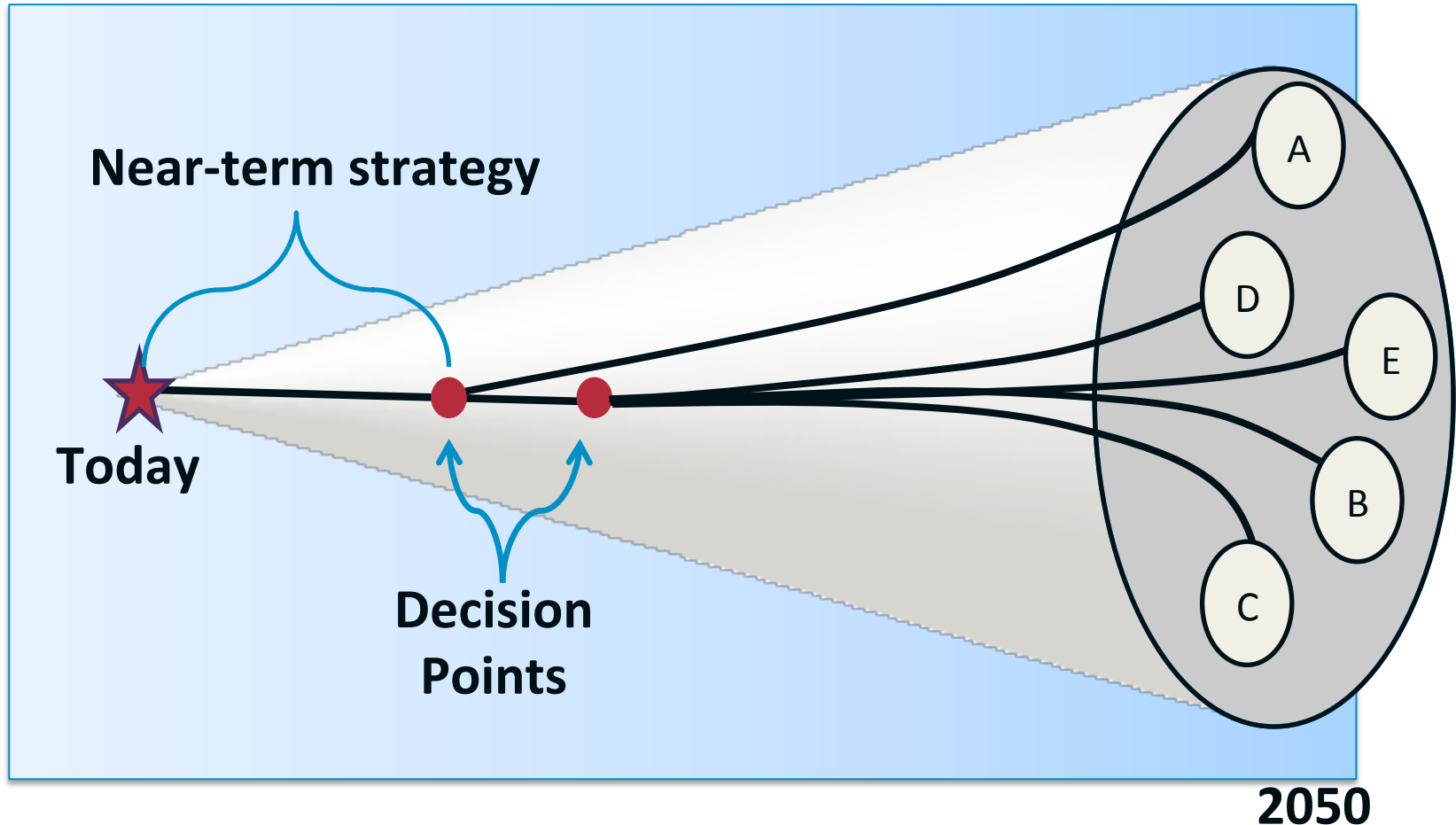
# Denver Water's Simple Assessments

|  | 2° F     |              | 5° F     |              |
|--|----------|--------------|----------|--------------|
|  | Colorado | South Platte | Colorado | South Platte |
| Additional precipitation to offset warming | 5%       | 5%           | 8%       | 12%          |

| 5° F     |      |
|----------|------|
| % Change |      |
| Yield    | -22% |
| Demand   | 7%   |

# Scenario Planning

## *The Cone of Uncertainty*





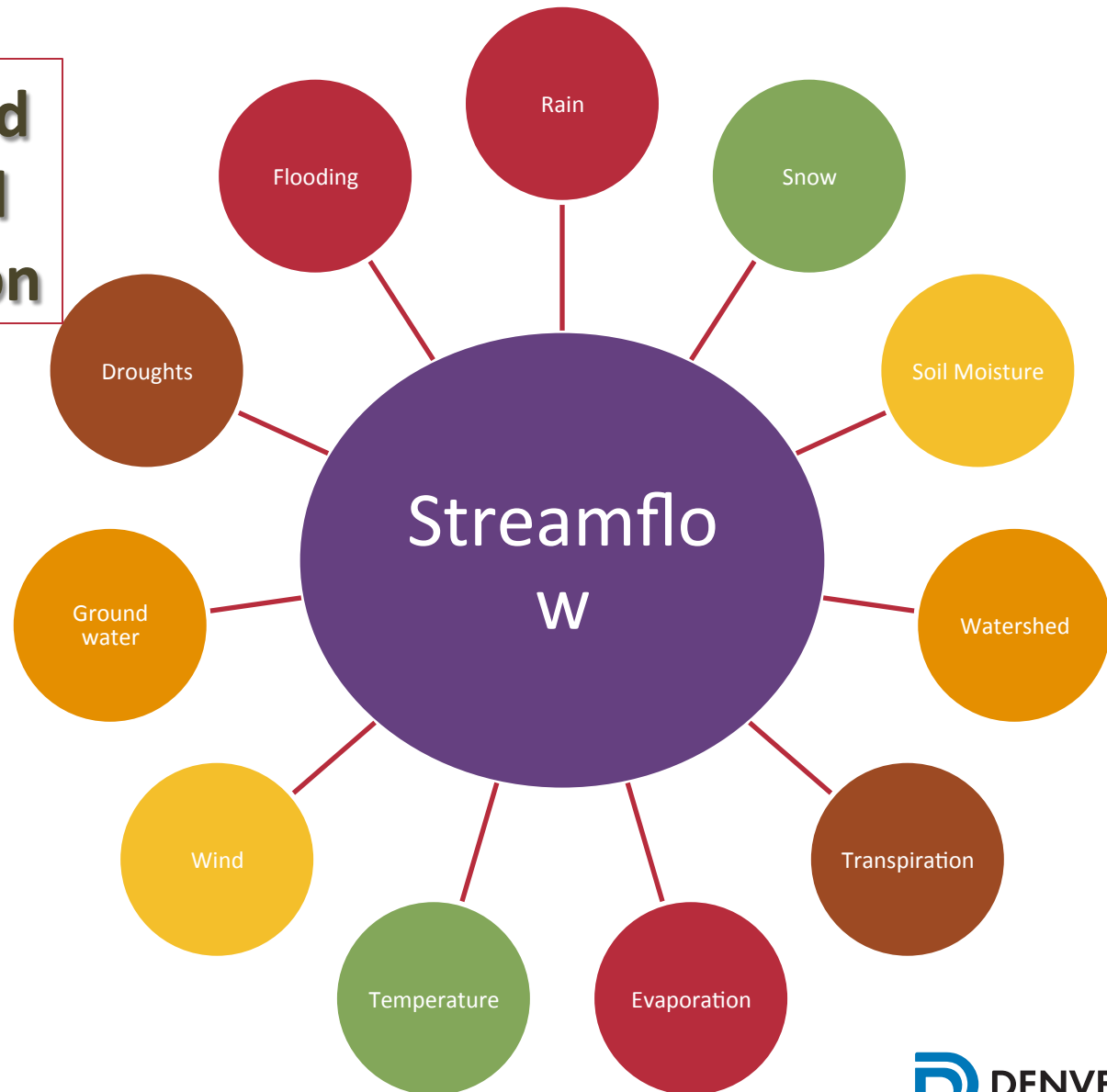
# Conclusions

- 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**



# EXTRA SLIDES



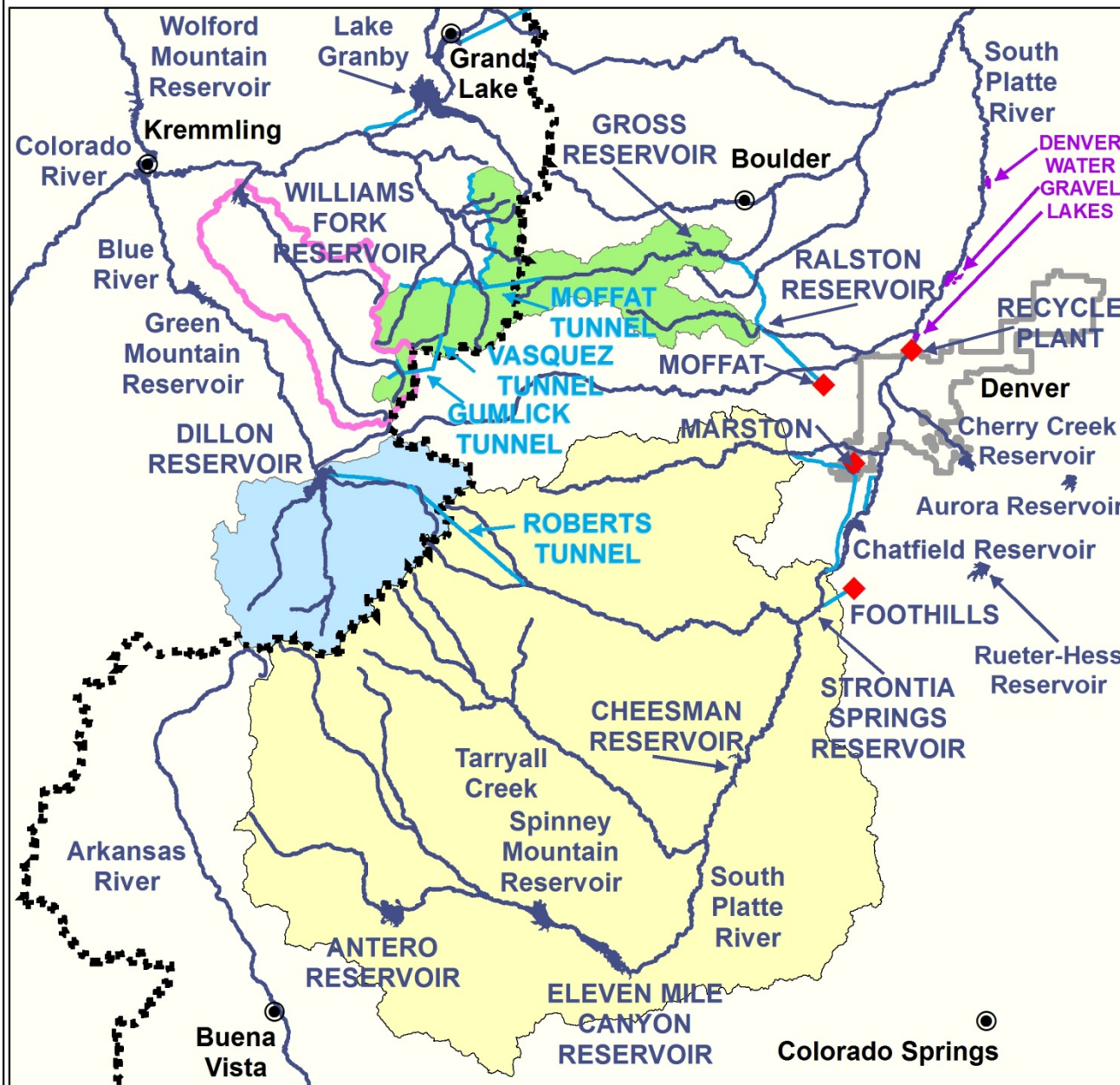
# A Front Range of 5 million people?

| <u>2010 Census</u>             | <u>People per<br/>Square Mile</u> |
|--------------------------------|-----------------------------------|
| New York                       | 27,000                            |
|                                | 26,000                            |
|                                | 25,000                            |
|                                | 24,000                            |
|                                | 23,000                            |
|                                | 22,000                            |
|                                | 21,000                            |
|                                | 20,000                            |
|                                | 19,000                            |
|                                | 18,000                            |
| San Francisco                  | 17,000                            |
|                                | 16,000                            |
|                                | 15,000                            |
|                                | 14,000                            |
|                                | 13,000                            |
| Chicago                        | 12,000                            |
|                                | 11,000                            |
|                                | 10,000                            |
|                                | 9,000                             |
| Baltimore                      | 8,000                             |
|                                | 7,000                             |
| Denver Water Service Area 2050 | 6,000                             |
| St. Louis                      | 5,000                             |
| Denver Water Service Area 2010 | 4,000                             |
|                                | 3,000                             |
|                                | 2,000                             |
| Nashville                      | 1,000                             |



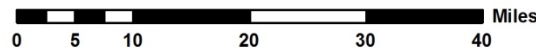
City and County  
of Denver  
Board of  
Water Commissioners

# Water Collection System



## LEGEND

- Town
- ◆ Denver Water Treatment Plant
- Continental Divide
- Major Canal or Tunnel
- Major Stream or River
- Major Lake or Reservoir
- Williams Fork Reservoir Watershed
- South Platte Collection System
- Roberts Tunnel Collection System
- Moffat Collection System



N



June 2012  
\\wrgis\projects\graphics\lochhead\_forests\_june2012\system-ppt-landscape-june2012.mxd

**“All I’m saying is now is the time to develop  
a plan to deflect an asteroid.”**





# Water Planning Challenges

34

Drought

Population Growth

Endangered Species

Water Quality

Colorado River  
Compact Call

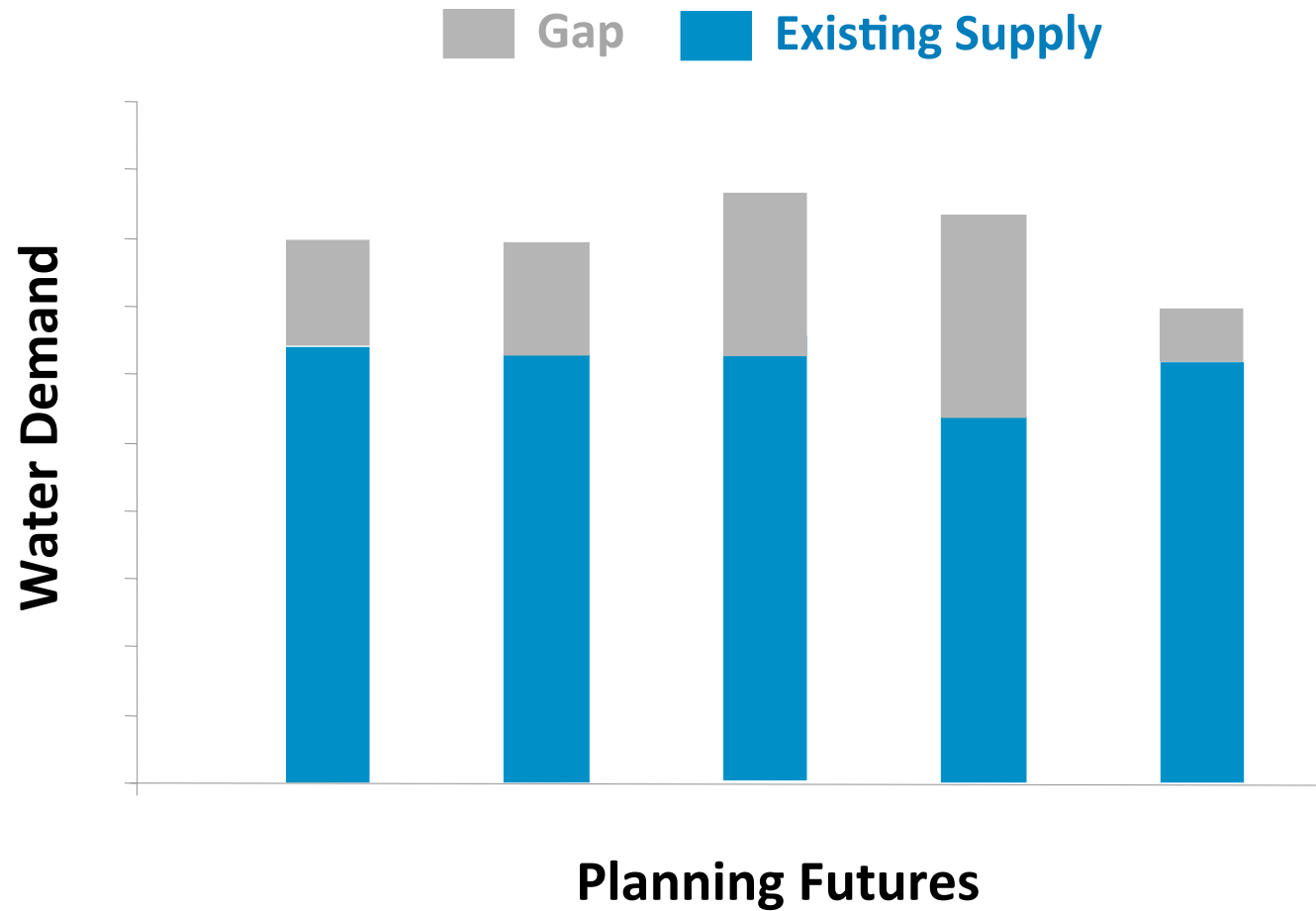
Climate  
Change



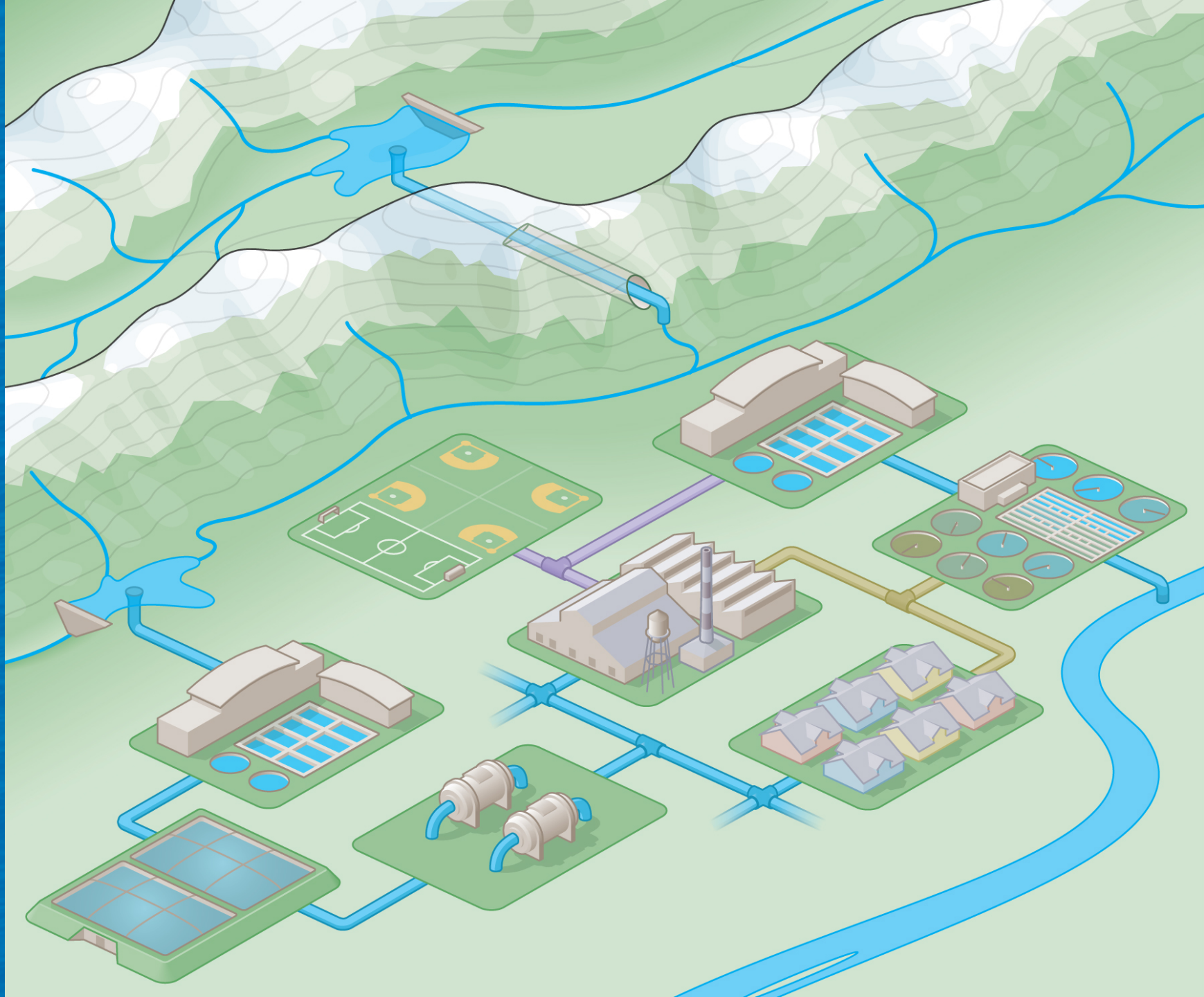
# Planning Futures

- **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







# 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

- Accurate
- What do we actually know?
- What do we need to know to act?
- Research
  - ESP Forecasts
  - Diagnostic work

# Colorado Water

