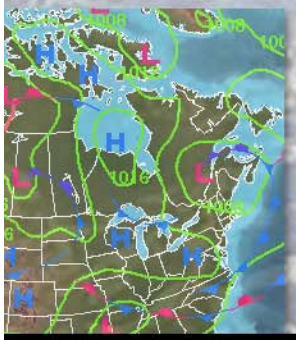

Climate Change and Drought Operations Planning in Water Supply

Presented by:

- **Steven M. Thurin, P.E.,** *HDR Engineering*

AWRA Spring Specialty Conference – May 6, 2009



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CENTRAL UTAH WATER CONSERVANCY DISTRICT

Outline of Presentation

- Supply Planning - Needs and Concerns
- CUWCD Water Supply System
- Meteorology, Climate, and Water Supply
- Climate Change Scenarios and Impacts
- Conclusions and Recommendations
- Questions

A Two Part Study

- Part One – Climate Change Issues
- Part Two – Operational Improvements

CUWCD Operates and Maintains

- 8 Dams / Reservoirs – 1.6 million AF of Storage
- 3 Major and 6 Minor Diversion Dams
- 89 Miles of Large-Diameter Tunnels and Pipelines
- 3 Water Treatment Plants
  - Utah Valley WTP 80 MGD
  - Duchesne Valley WTP 4 MGD
  - Ashley Valley WTP 15 MGD

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CUWCD Operates and Maintains

- Multiple Federal Projects
- Large (and small) reservoirs in Colorado River and Great Basin
- Transbasin diversions, complex water rights
- Endangered species recovery and minimum instream flows

CUWCD Operates and Maintains

- Multiple Federal Projects
- Large (and small) reservoirs in Colorado River and Great Basin
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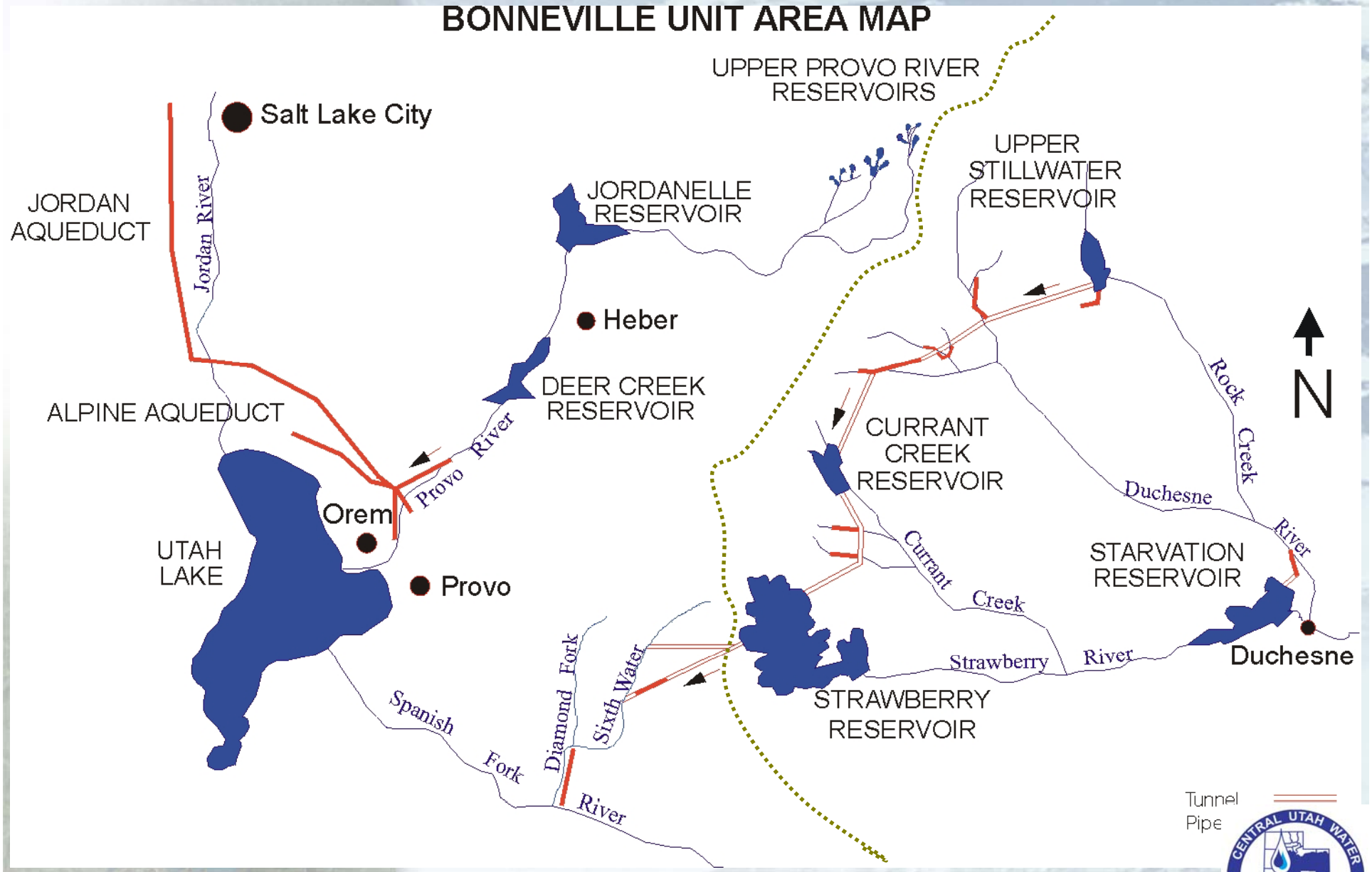
CUWCD Needs to Know How Climate Change may Affect the Reliability of its Water Supply

BONNEVILLE UNIT AREA MAP



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Climate Change Analysis Methods – Two Ways to Go

- **# 1** - The BIG Study
  - 1) Collect all the data
  - 2) Develop all the tools
  - 3) Model everything (snow, runoff, operations)
  - 4) Understand the system?
  - 5) Run GCMs (many?)
  - 6) Downscale the results (difficult)
  - 7) Model everything (many more times)
  - 8) Assemble and interpret results (which is "right"?)
  - 9) Conclusions and recommendations
  - 10) Change operating procedures?

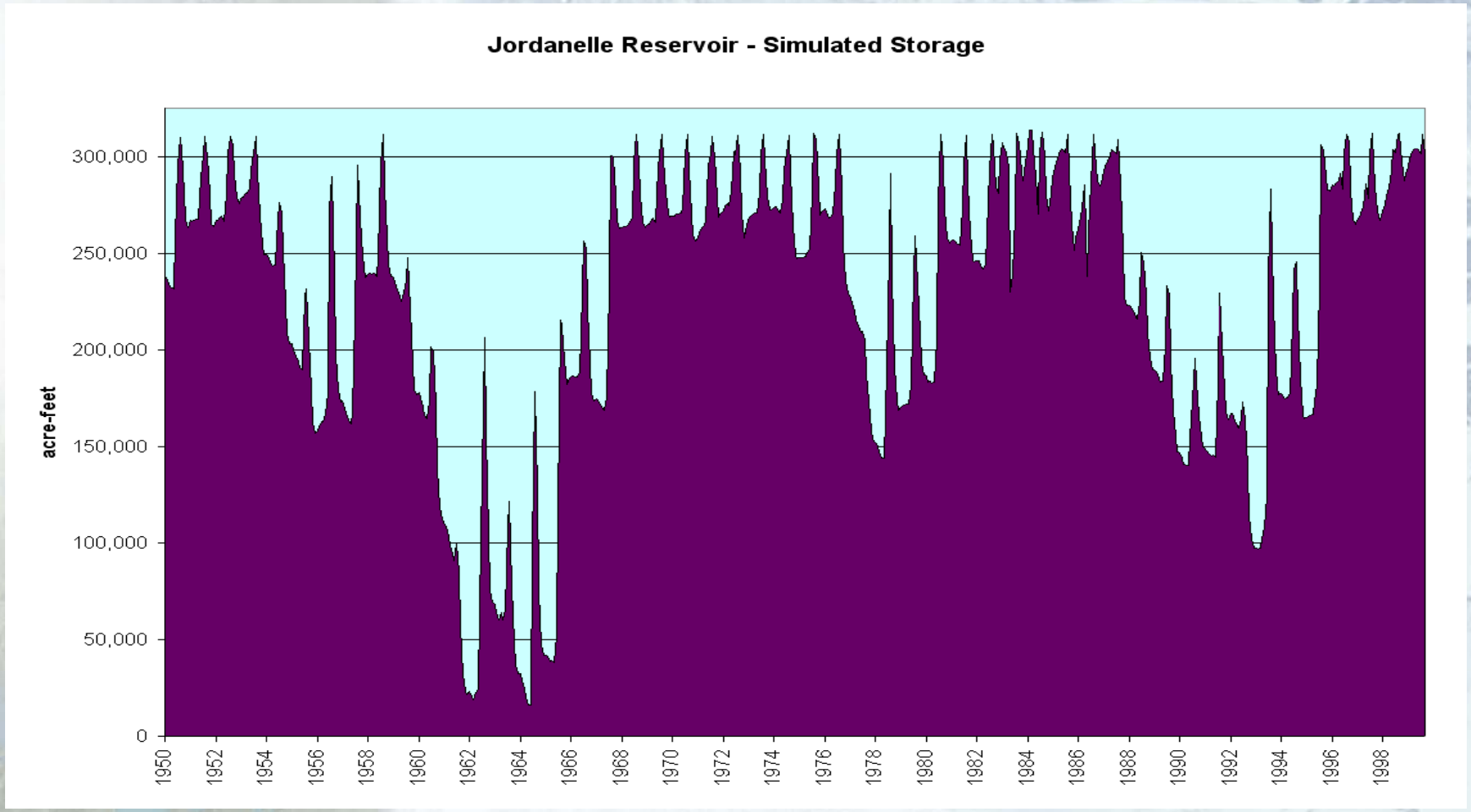
Climate Change Analysis Methods – Two Ways to Go

- **# 2** - The FOCUSED Study
  - 1) Understand needs & critical system factors
  - 2) Collect relevant data & develop simple relationships
  - 3) Utilize available climate impact conclusions
  - 4) "Model" the effects of the changes
  - 5) Conclusions and recommendations
  - 6) Change operating procedures?

CUWCD Water Supply System – Critical Supply Factors

- Runoff into Jordanelle Reservoir
- Storable Volume in Jordanelle Reservoir
- Inflow into Strawberry Reservoir
- Inflow into Utah Lake

CUWCD Water Supply System – Critical Water Supply Factors



Climate Scenarios Evaluated

- Scenario 1 assumes an increase in annual temperature of 2.0° to 3.5°C (3.6° to 6.3° F) and a 10 percent decrease in precipitation throughout the year.

- Scenario 2 assumes more severe and longer drought periods. It applies the reduced runoff results from Scenario 1 to the most severe droughts experienced in the 1950-1999 historical period. For each drought, the volume is reduced using the slope of the correlation results, multiplied by ten percent of the average precipitation for the drought years.

Meteorology and Water Supply – Three Issues

- Temperature versus Streamflow
- Precipitation versus Streamflow
- Historical Trends in Runoff Timing

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Meteorology and Water Supply – Three Issues

Pop Quiz!!!

- Temperature versus Streamflow
- Precipitation versus Streamflow
- Historical Trends in Runoff Timing

Meteorology and Water Supply - Three Issues

Pop Quiz!!!

- Temperature versus Streamflow
  - How well does runoff correlate with average temperature?
- Precipitation versus Streamflow
- Historical Trends in Runoff Timing

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Meteorology and Water Supply – Three Issues

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- Temperature versus Streamflow
  - How well does runoff correlate with average temperature?
- Precipitation versus Streamflow
  - How well does runoff correlate with average precipitation?
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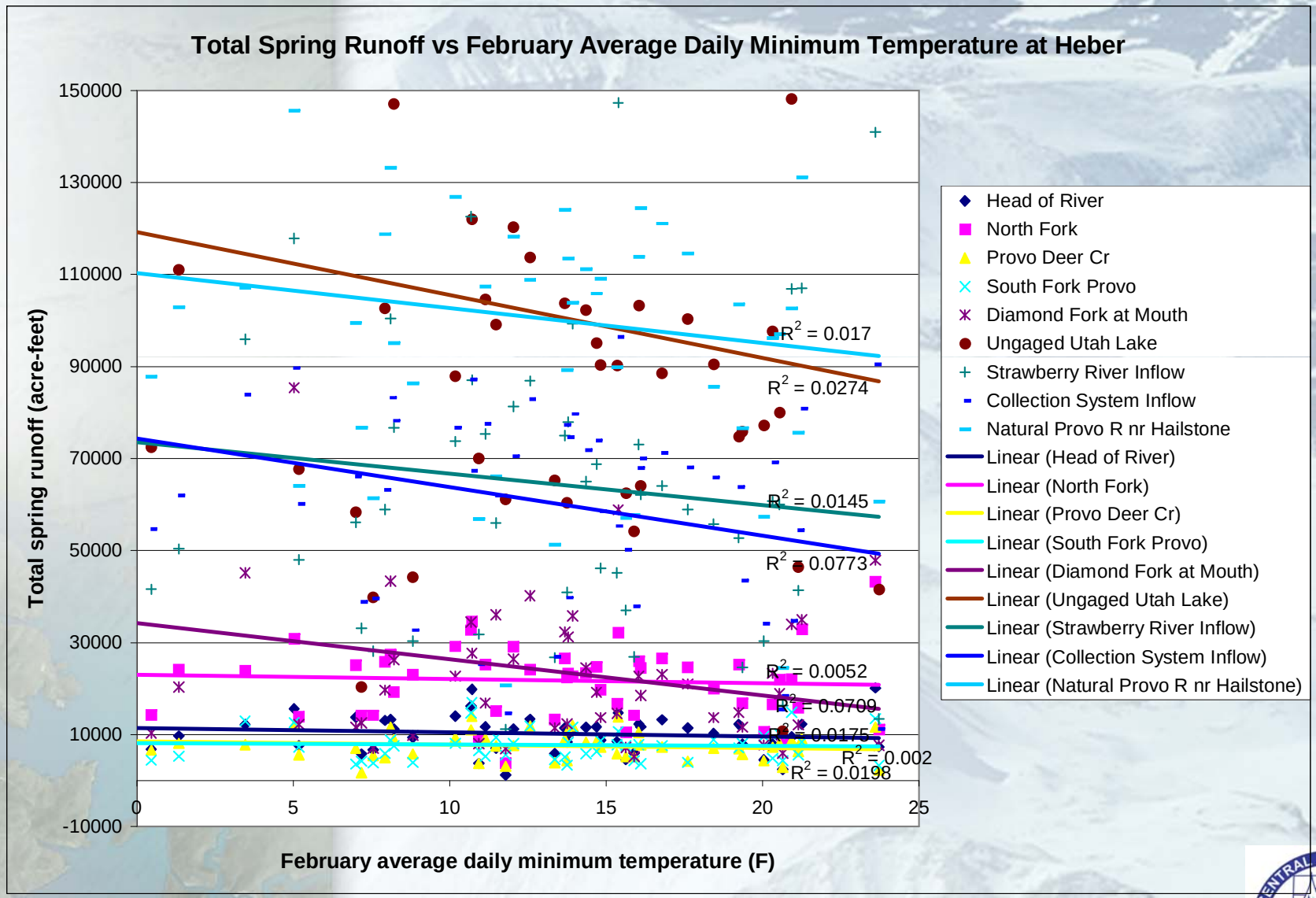
Meteorology and Water Supply – Three Issues

Pop Quiz!!!

- Temperature versus Streamflow
  - How well does runoff correlate with average temperature?
- Precipitation versus Streamflow
  - How well does runoff correlate with average precipitation?
- Historical Trends in Runoff Timing
  - How much earlier is runoff occurring compared with 40 years ago?

Temperature versus Streamflow



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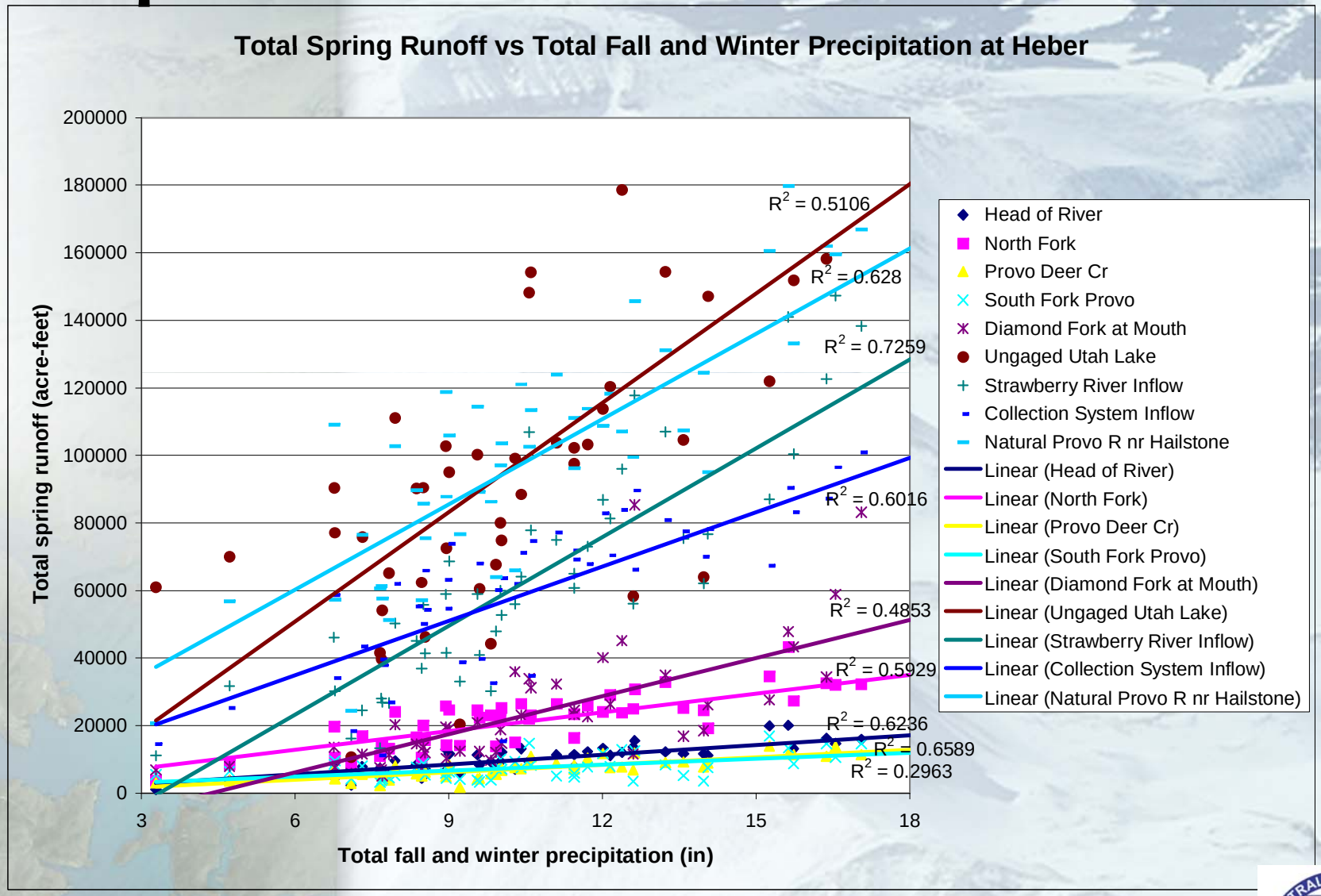
Precipitation versus Streamflow



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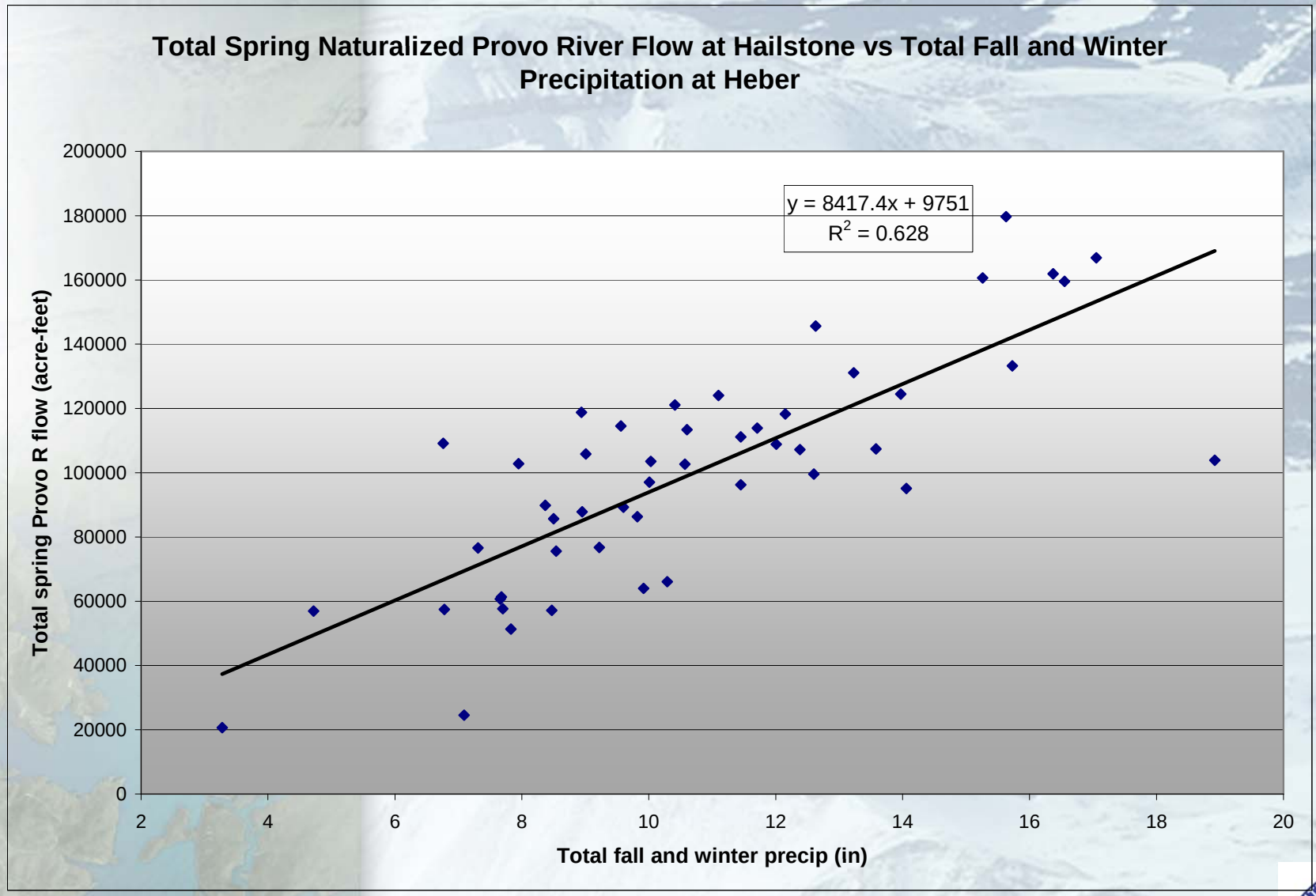
Precipitation versus Jordanelle Inflow



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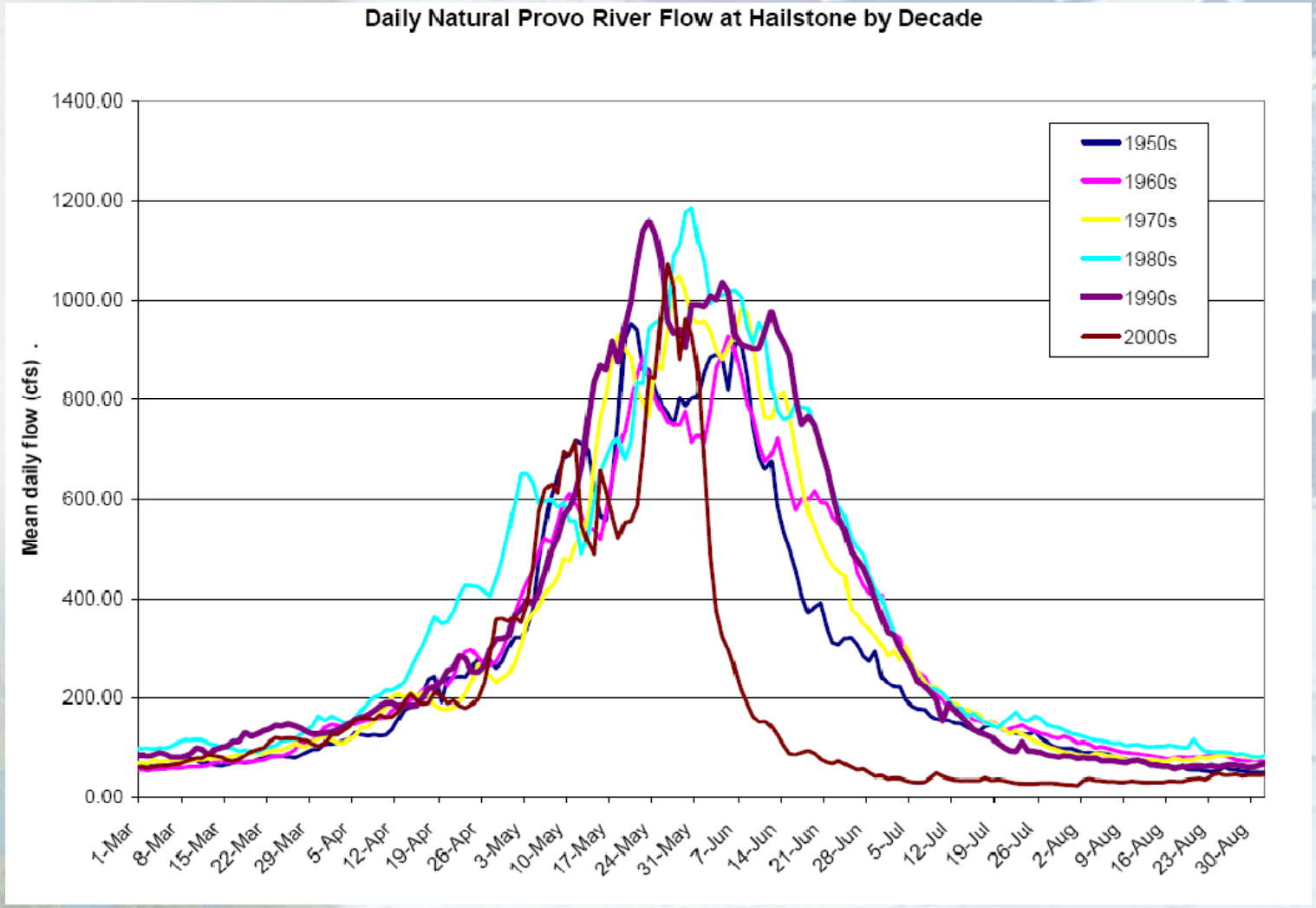
Climate Change Scenarios and Impacts



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Meteorology and Water Supply – Three Issues

Pop Quiz Results!!!

- Temperature versus Streamflow
  - How well does runoff correlate with average temperature? – **Not well!**
- Precipitation versus Streamflow
  - How well does runoff correlate with average precipitation? – **Fair!**
- Historical Trends in Runoff Timing
  - How much earlier is runoff occurring compared with 40 years ago? –**None!**

Climate Change Scenario #1 Impacts – (10% less winter precipitation)

Natural Provo River spring inflow to Jordanelle	A 10% decrease in fall and winter precip (average about 1.1 inch) could decrease inflow by 9,000 acre-feet
Annual storable flow in Jordanelle	A 10% decrease in fall and winter precipitation could decrease diversions to storage by 10,000 acre-feet
Strawberry Reservoir annual inflow	A 10% decrease in fall and winter precipitation could decrease Strawberry Reservoir inflow by 18,000 acre-feet
Utah Lake annual inflow	A 10% decrease in fall and winter precipitation could decrease annual inflow by 48,000 acre-feet[5]

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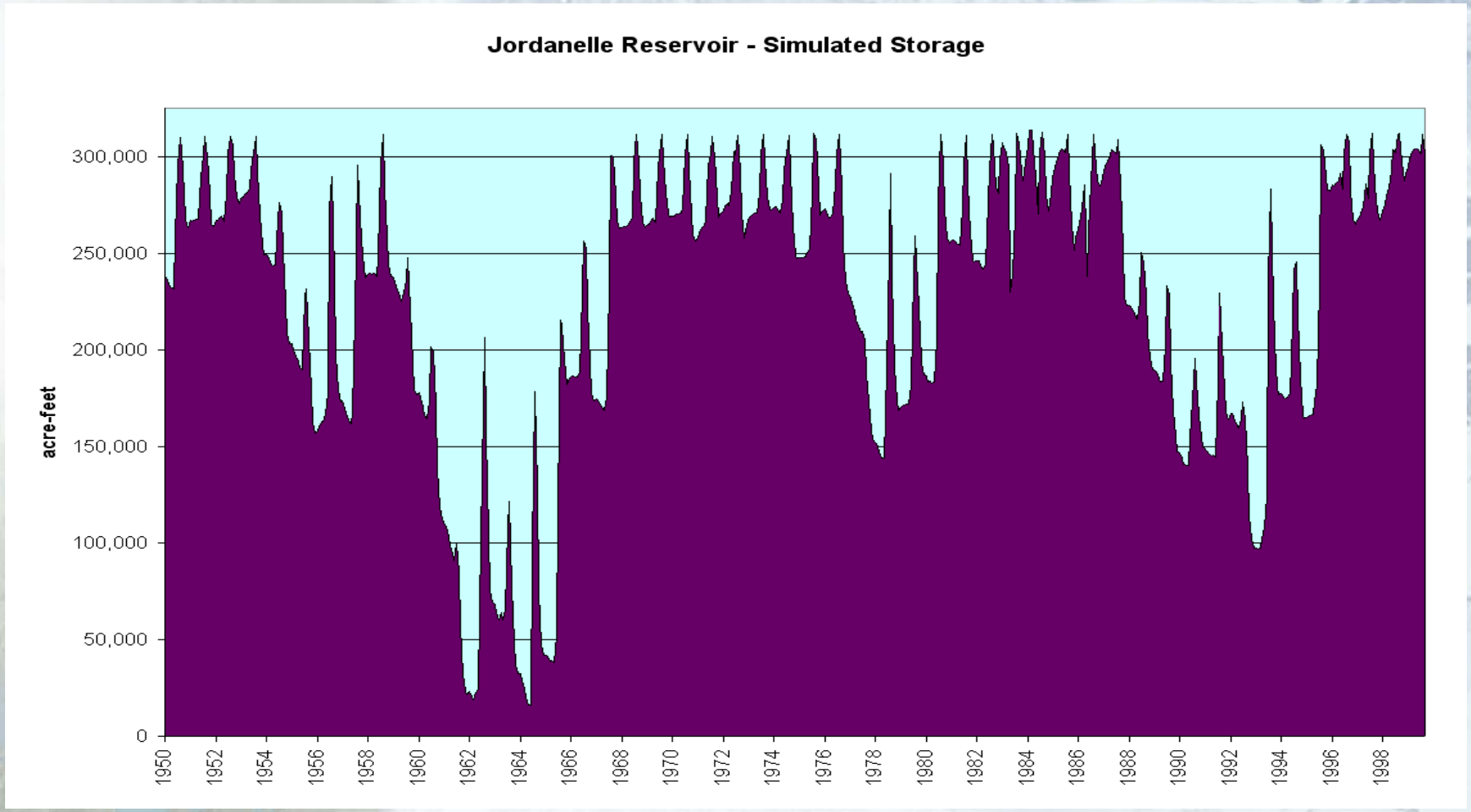
Climate Change Scenario #2 Impacts – (more severe/extended drought)

Time period of low water availability	Naturalized Provo River flow at Hailstone total spring runoff	Utah Lake total annual local inflows	Total Strawberry Reservoir annual inflow	Annual storable water in Jordanelle Reservoir
One-year	20,696	266,840	31,450	31,049
More Severe One-year	17,935	234,870	23,494	27,986
Two-year	42,937	300,850	32,100	56,042
More Severe Two-year	34,985	245,413	16,489	45,943
Three-year	47,857	317,680	43,617	59,173
More Severe Three-year	39,648	247,203	26,098	47,594
Four-year	59,960	322,606	57,495	70,973
More Severe Four-year	51,599	245,113	39,557	58,665
Five-year	68,734	336,700	56,706	81,069
More Severe Five-year	59,840	254,788	36,768	67,969

CUWCD Water Supply System – Critical Water Supply Factors



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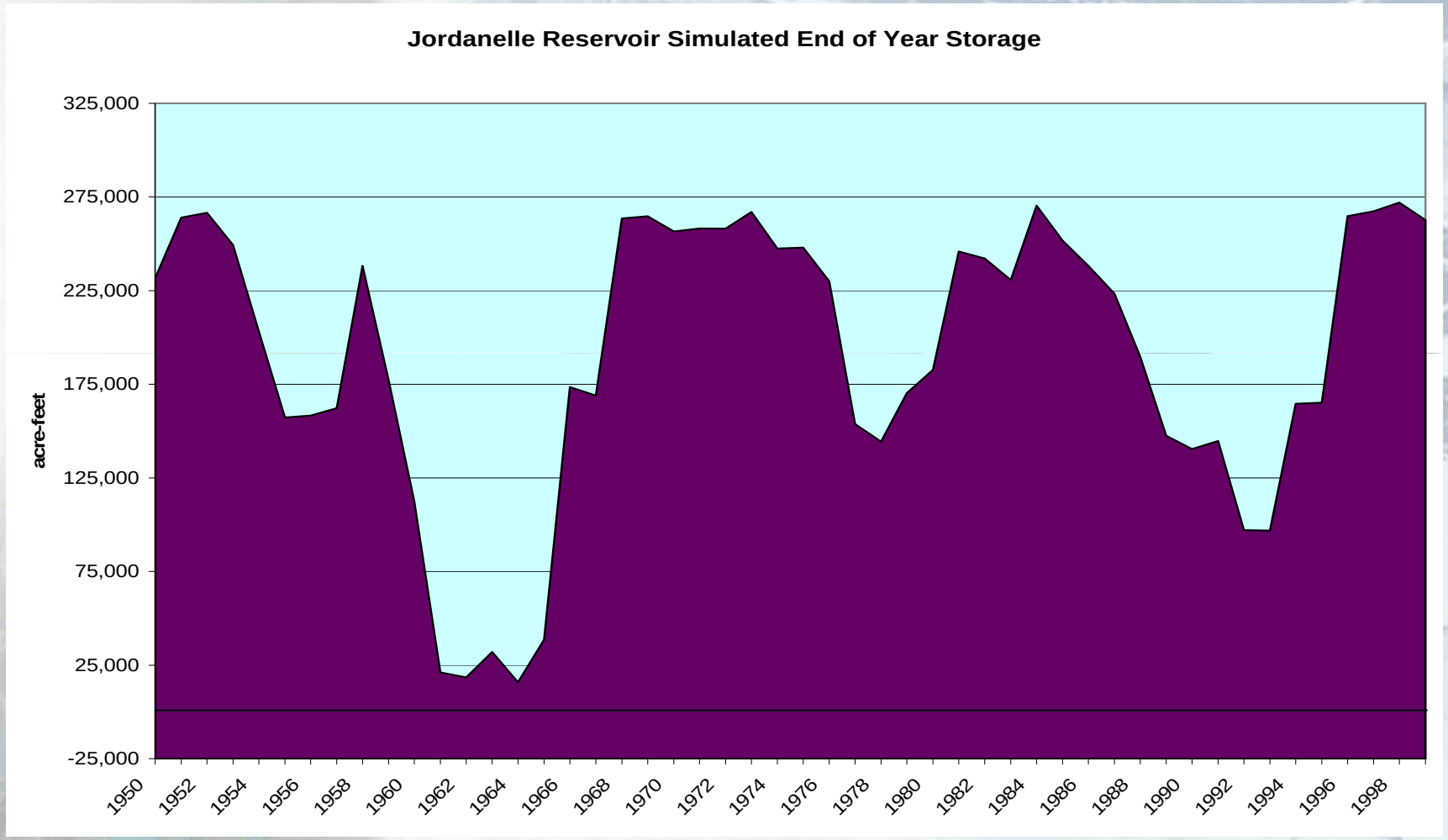

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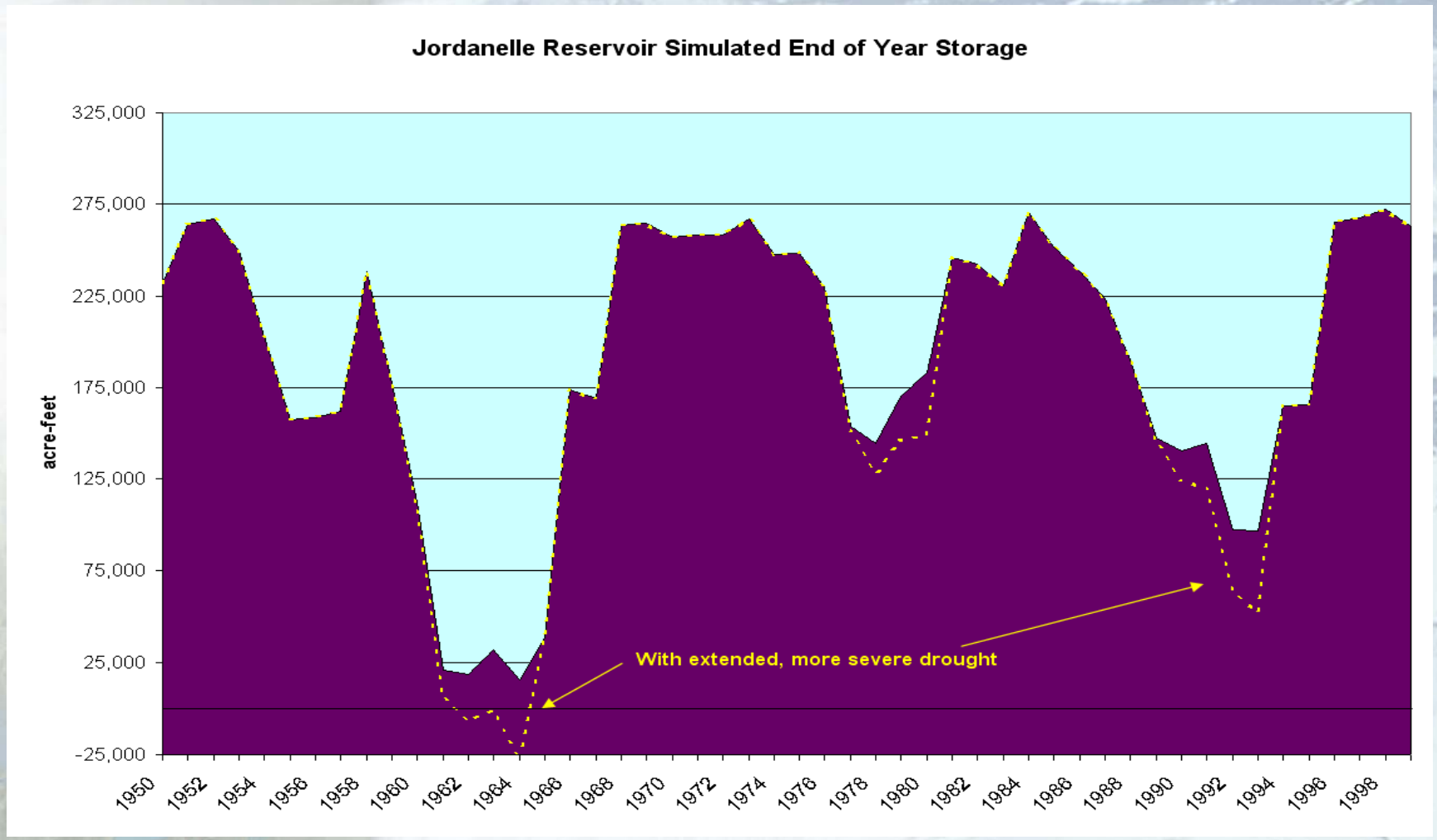

Climate Change Conclusions

- The climate changes assumed in the evaluated scenarios could impact CUWCD water supplies
- Extended or more severe droughts (whether or not associated with climate change) could put additional stress on CUWCD reservoirs and produce water supply shortages
- Climate change is likely to increase meteorological variability and therefore to contribute to increased water supply uncertainty
- CUWCD needs to continue to responsibly and efficiently plan, manage, and operate to protect its valuable water supplies

Climate Change Recommendations – Phase Two

- Develop an improved understanding of critical hydro-meteorological supply factors
- Develop hydro-meteorological forecast factors to improve forecasting and predict critical conditions early
- Link hydro-meteorological and runoff forecast results to an operational model
- Develop and test shortage criteria and drought operations plans and procedures

Questions



Climate Change and Drought Operations Planning in Utah Water Supply

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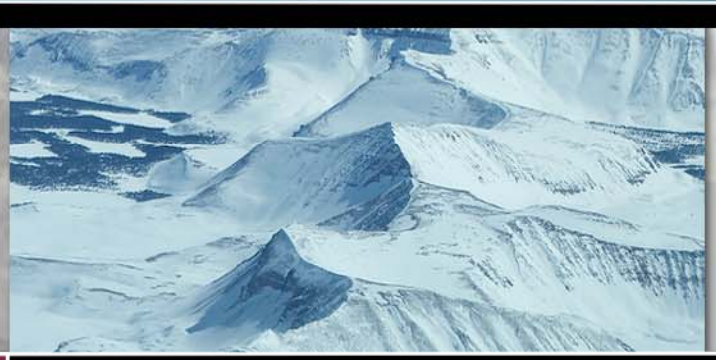


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