

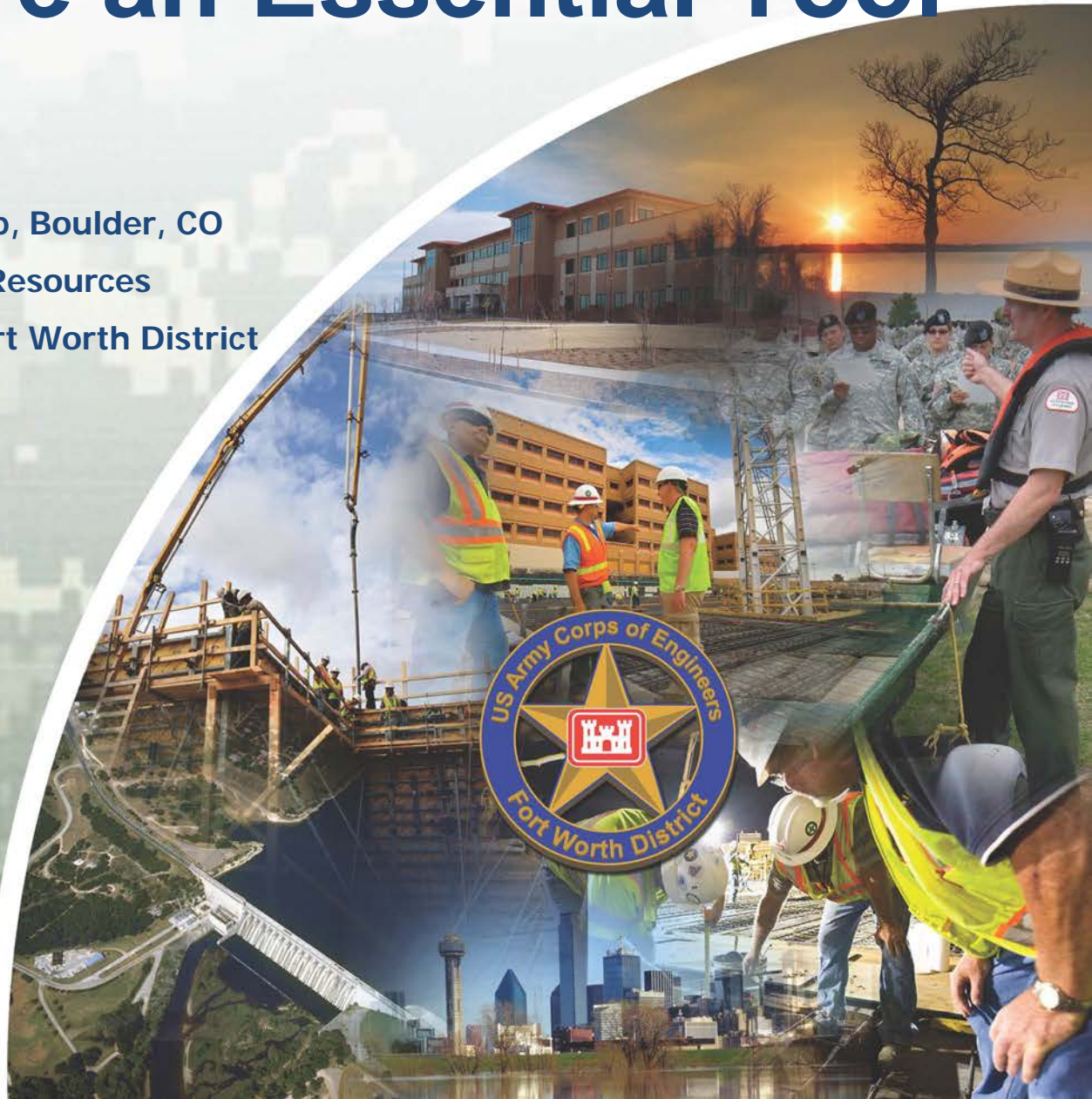
# RiverWare an Essential Tool

Date: 01 February 2018

Audience: RiverWare Users Group, Boulder, CO

Jerry L. Cotter P.E., Chief Water Resources

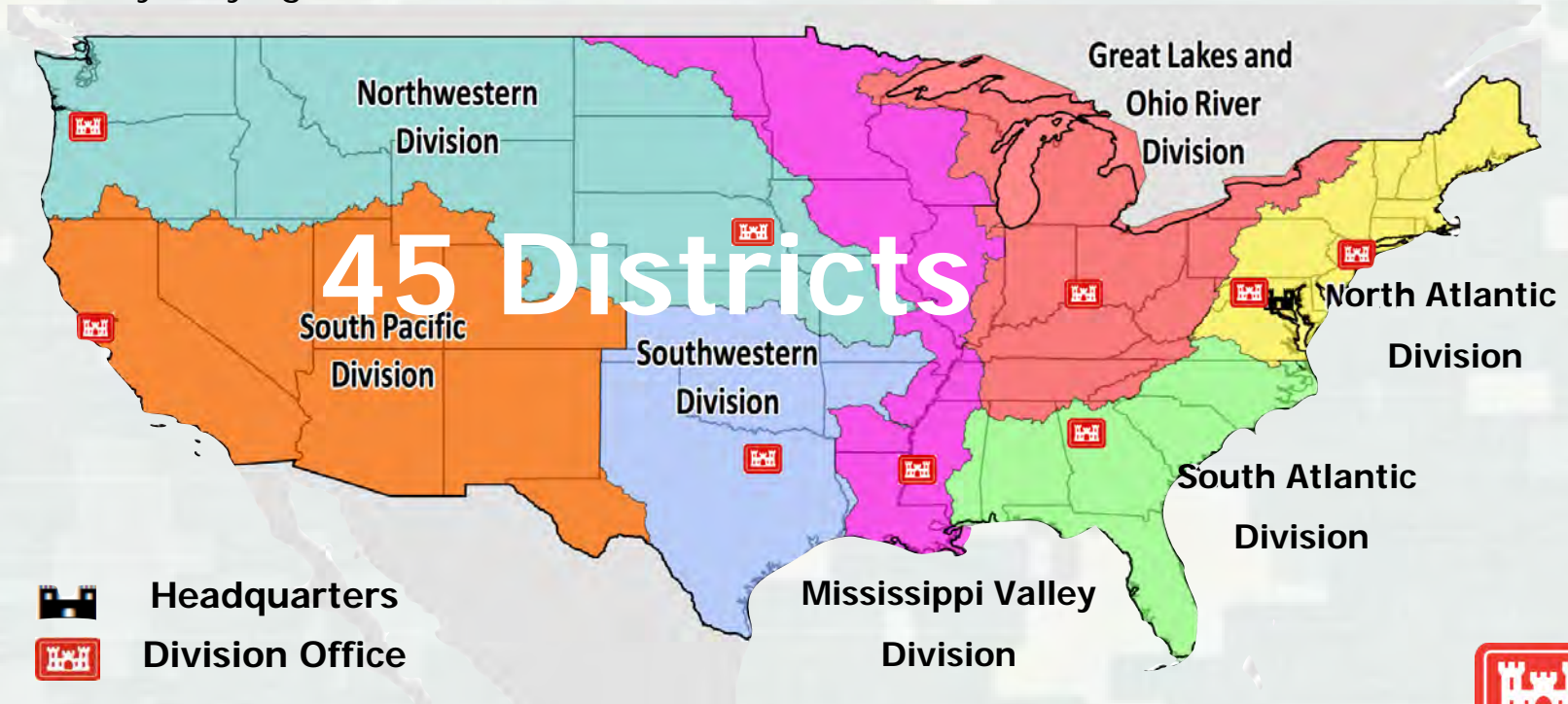
U.S. Army Corps of Engineers, Fort Worth District



# USACE Divisions

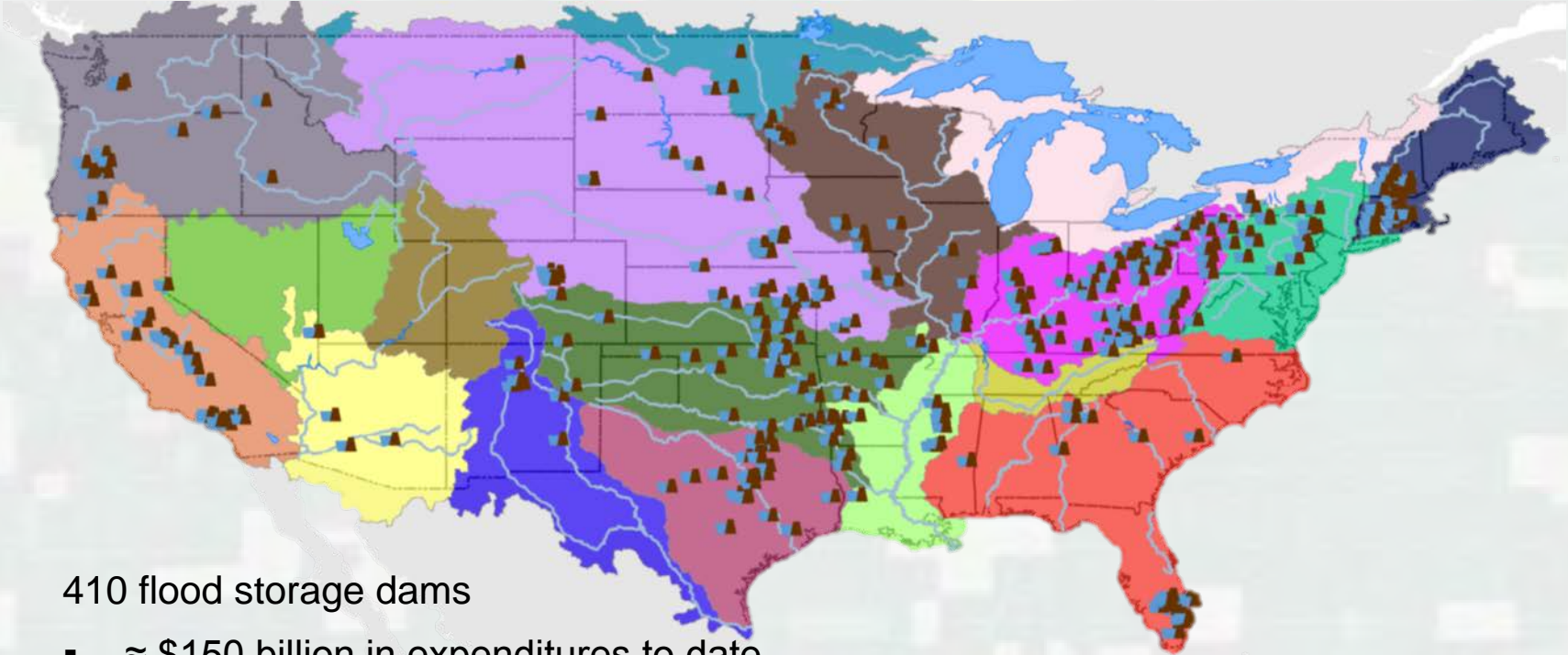
- 9 divisions
- Employees **37,000**
- Countries **130 of 196 total**
- \$5+ billion in civil works projects
- Decentralize organization
- Widely varying missions

- Commander - General
- Deputy Commander - Colonel
- 3 year terms





# USACE Flood Control Dams

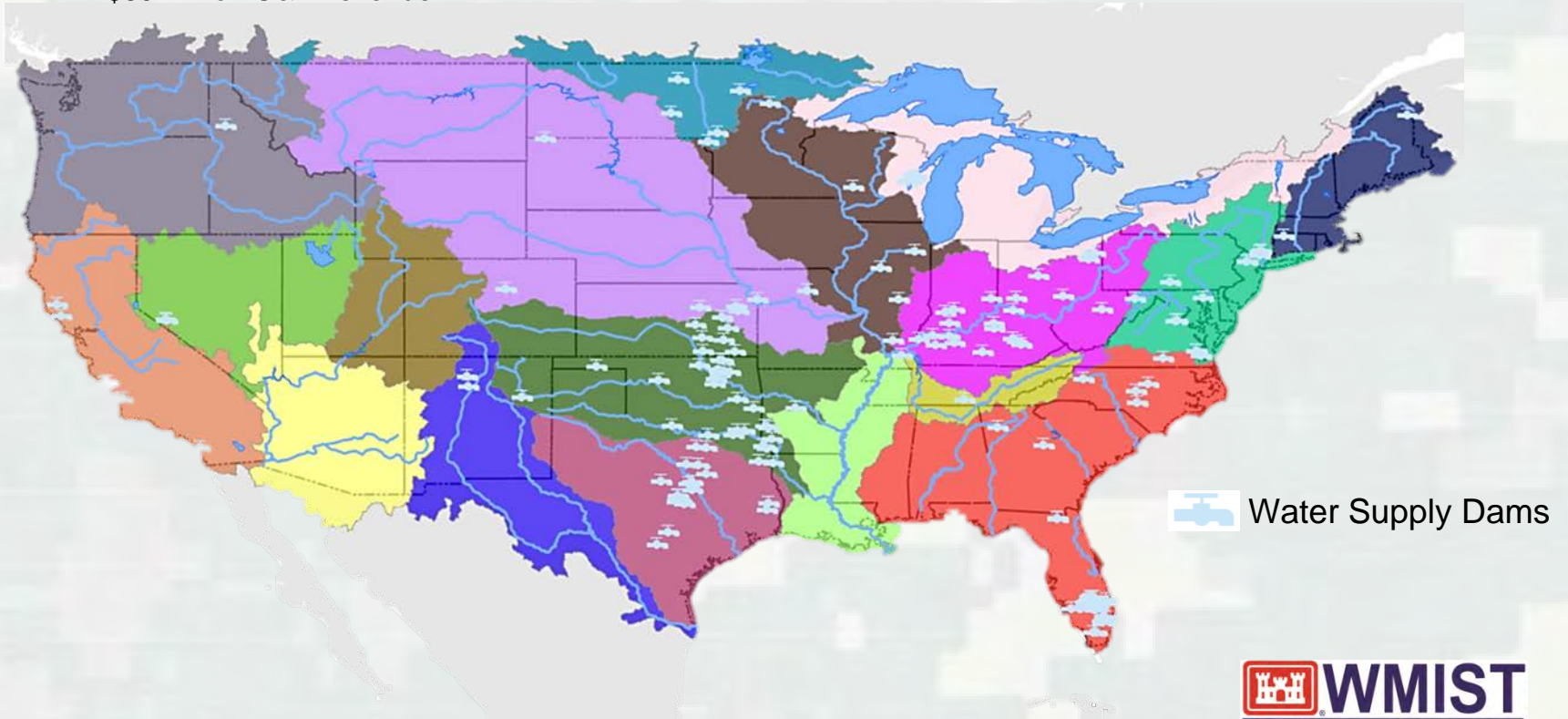


- 410 flood storage dams
  - ≈ \$150 billion in expenditures to date
  - ≈ \$1.2 trillion total damages prevented (1928-2014)
  - 8:1 B/C ratio
  - \$18 billion in damages prevented in Texas (2015)
- Maintain the national inventory of dams.

 Flood Control Dams

# USACE Water Supply Dams

- 12 billion cubic meters (10 million acre-feet) of water supply storage
  - 85 million people supplied in 115 cities
  - Over 2.5 million acres irrigated
- Estimated Benefit = \$9 billion
  - \$60 million O&M revenue



# What About RiverWare

- 18 year involvement
- Federal agencies have invested over \$100 M
  - ▶ Fund most improvements
  - ▶ Based on member and your input
- Federal steering committee?
  - ▶ Protect the federal investment





# Steps to Protecting Investment

Legalize cloning



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# Weather and Climate

- Climate variability?  
Real? Not Real?



- Climate change?  
Real? Not Real?





# Is Climate Change a Hoax or an Opportunity? Why Waste Our Time Creating a Better World?

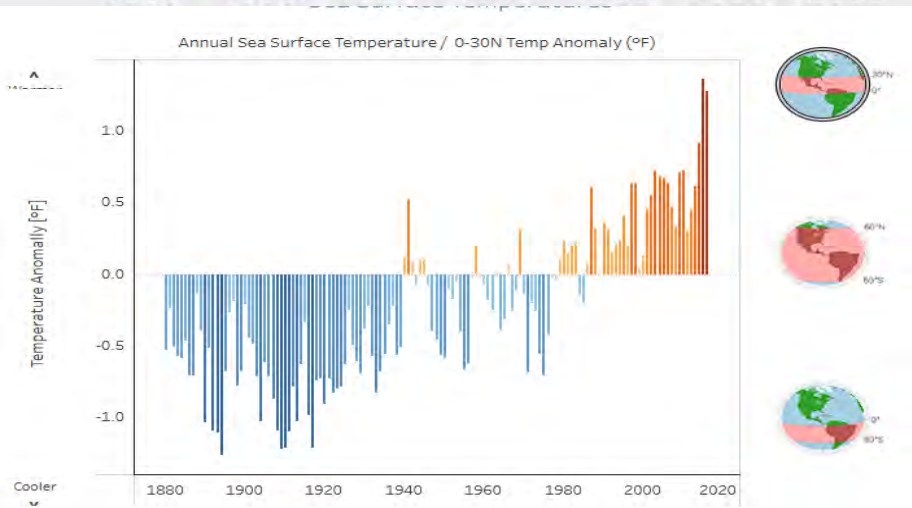
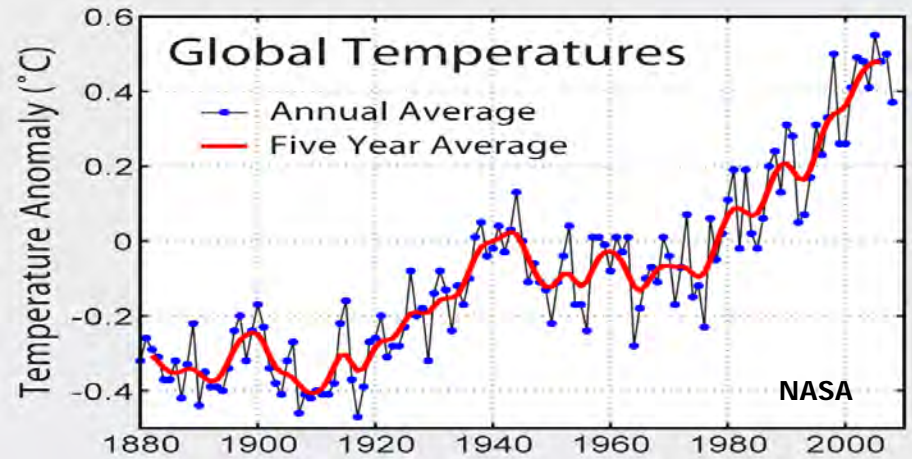
- More efficient dam operations
- Conservation of resources, e.g. **WATER**
- New industries
- Jobs
- Improved health
- Sustainability





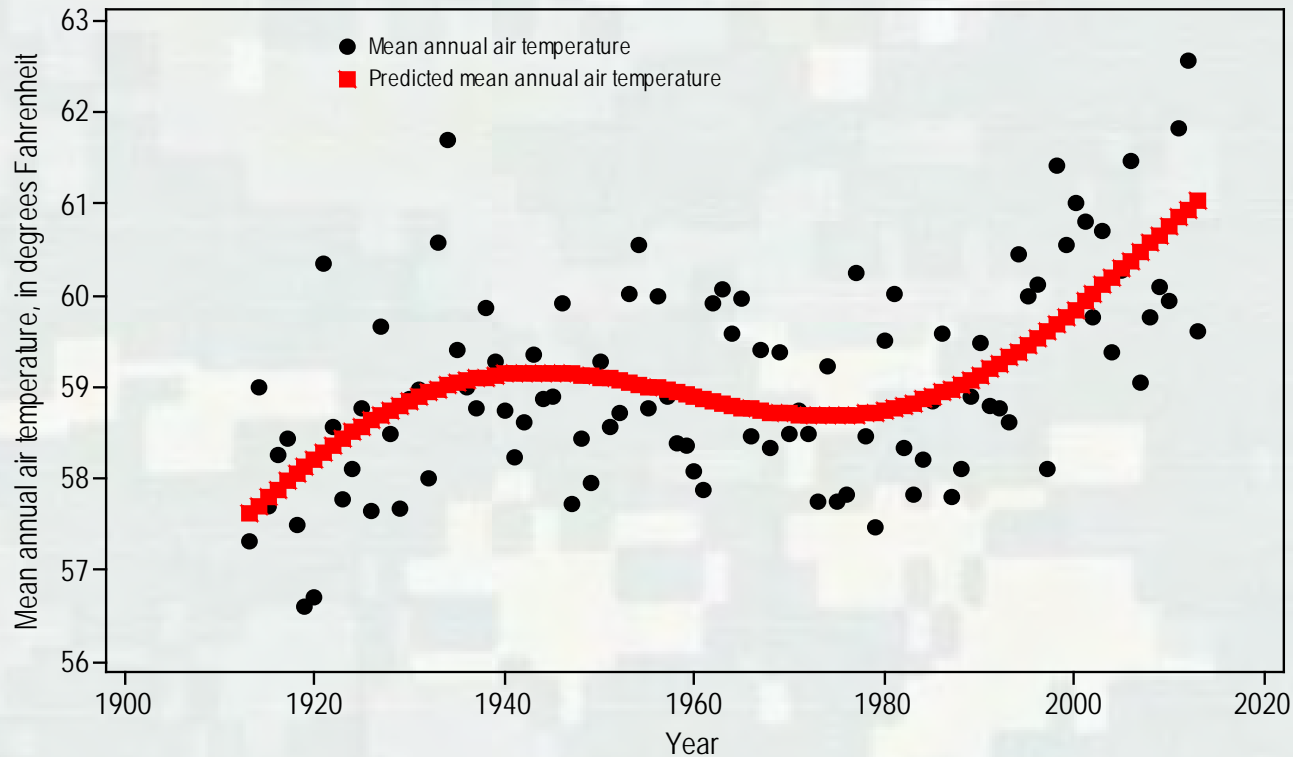
# Is Climate Change Real?

- 2015, 2016 and 2017 were the hottest 3 years on record, *NASA*
- During 2017 ocean temperatures were the warmest on record, *Institute of Atmospheric Physics, Chinese Academy of Science*



# Double Mountain Fork Brazos River near Aspermont, Tex. streamflow-gaging station (08080500) from 1913-2013

Dr. Glen Harwell, USGS

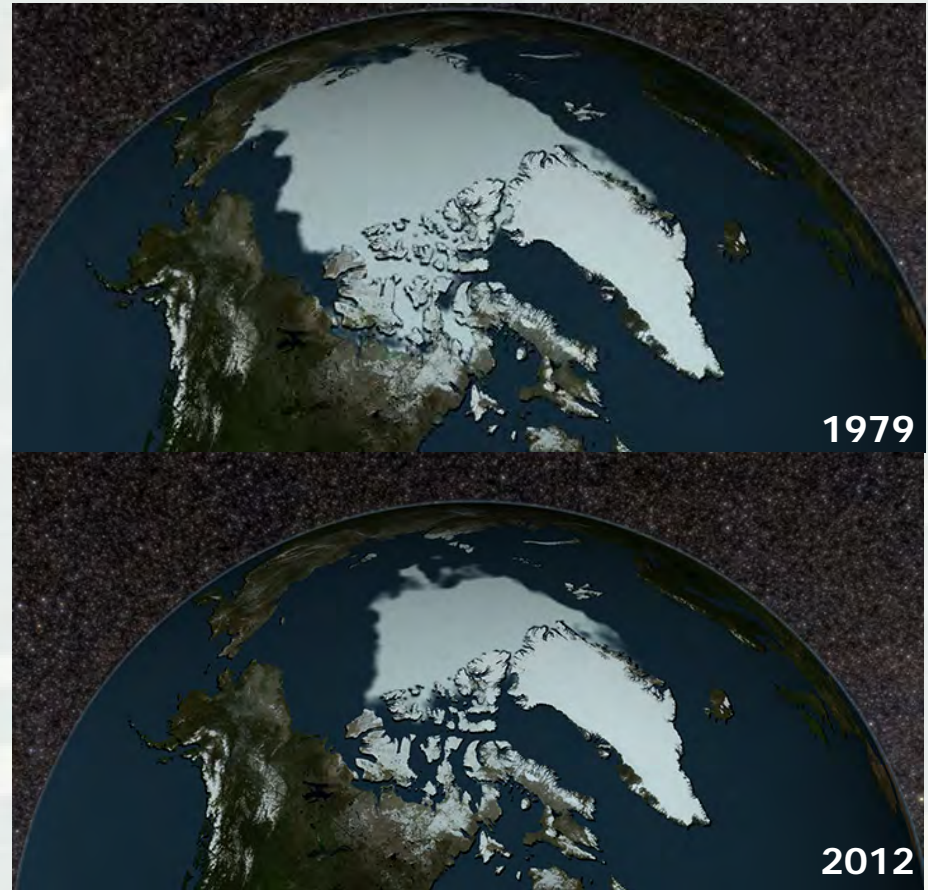


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# Is Climate Change Real?

- Minimum each September, *NASA*
- 13.2% rate of decline, *NASA*
- 2012 lowest arctic sea ice in satellite record, *NASA*



# Climate Change

- *NASA* - “A broad range of global phenomena created predominantly by burning fossil fuels.” The increasing average temperature of the Earth — that is, global warming — is one key result. Others are rising sea levels and a **growing trend toward extreme weather and weather anomalies**.
- Climate change may impact food supplies
- Climate change may impact **water supplies**





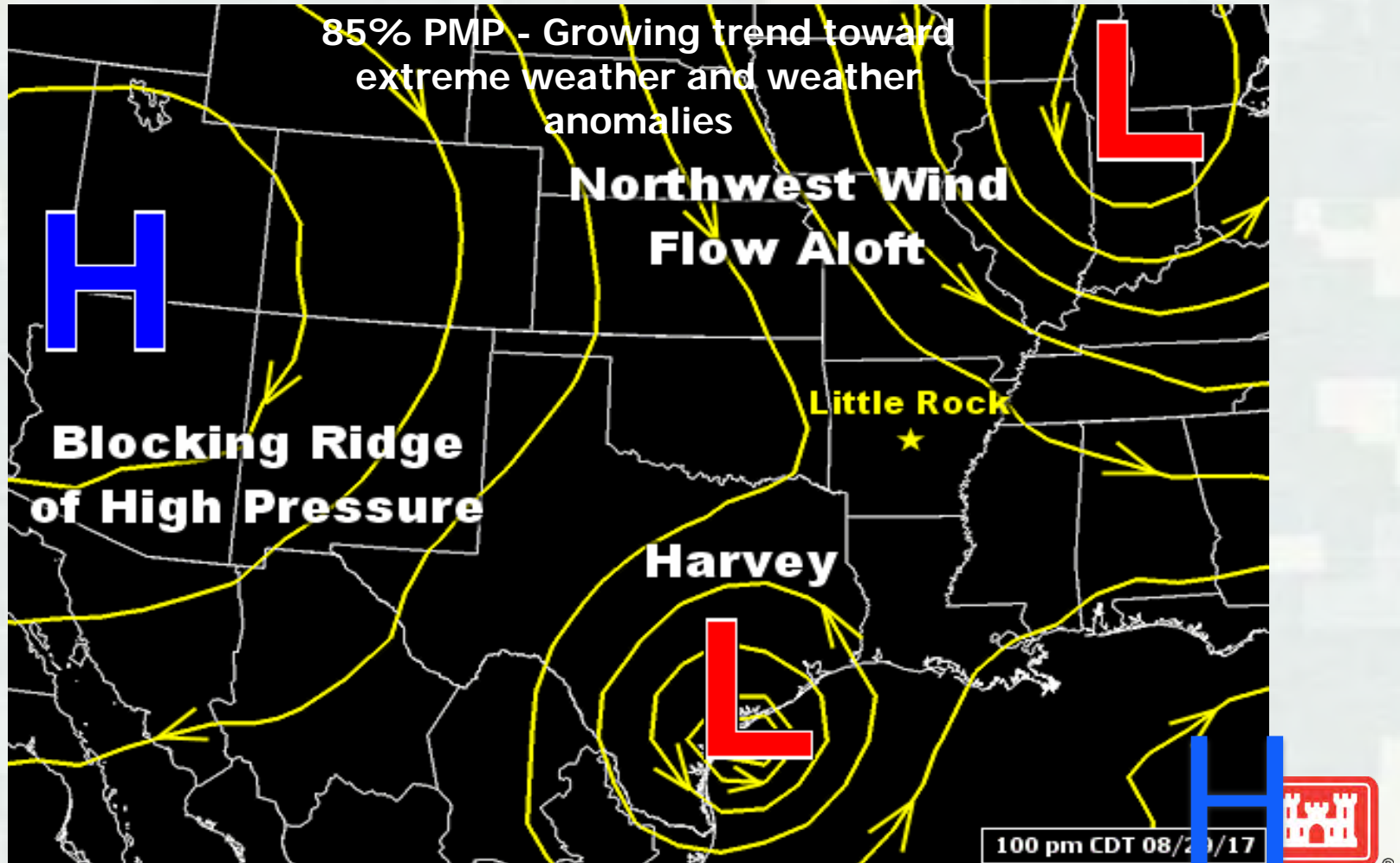
# Hurricane Harvey



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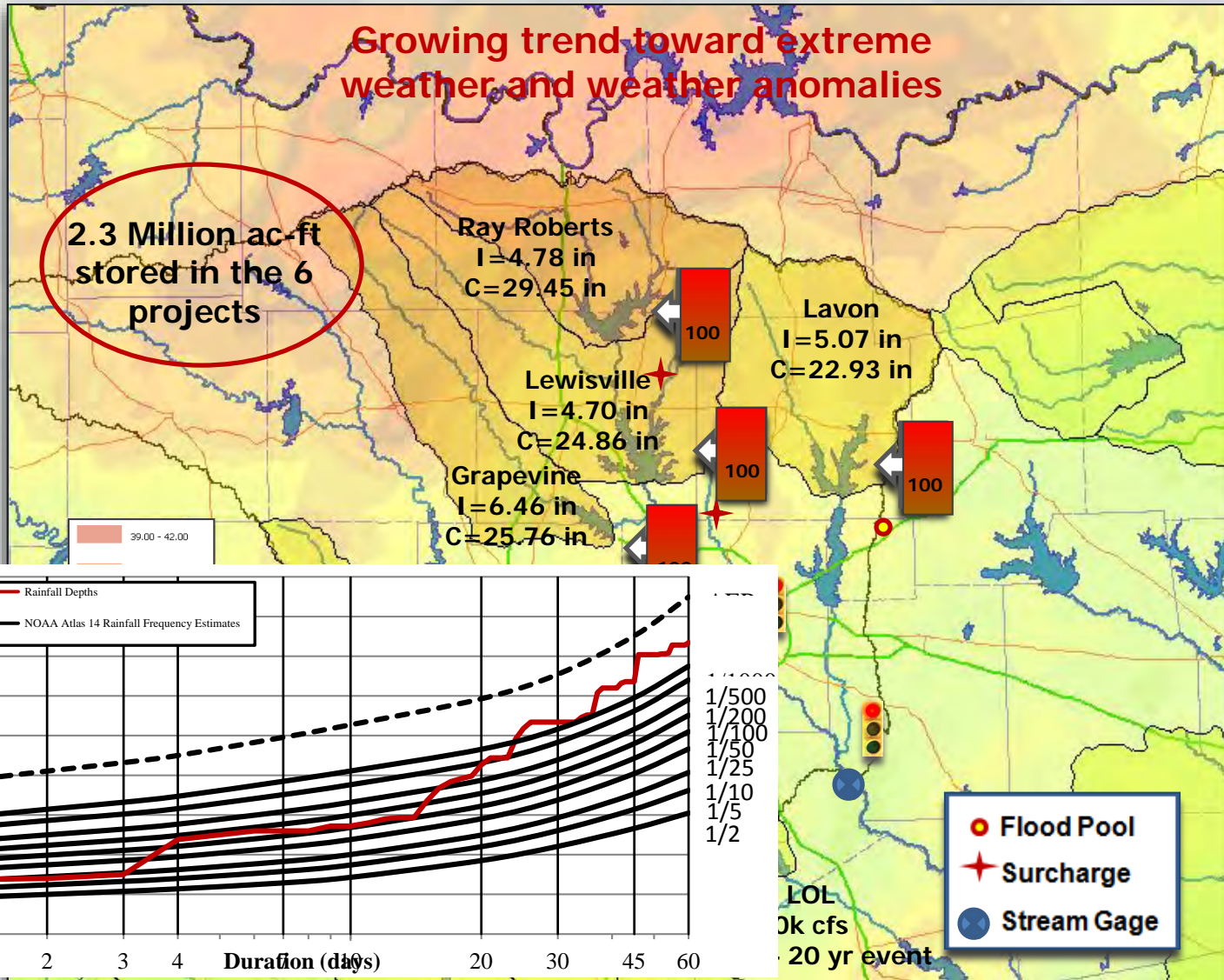
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# Harvey Weather Patterns



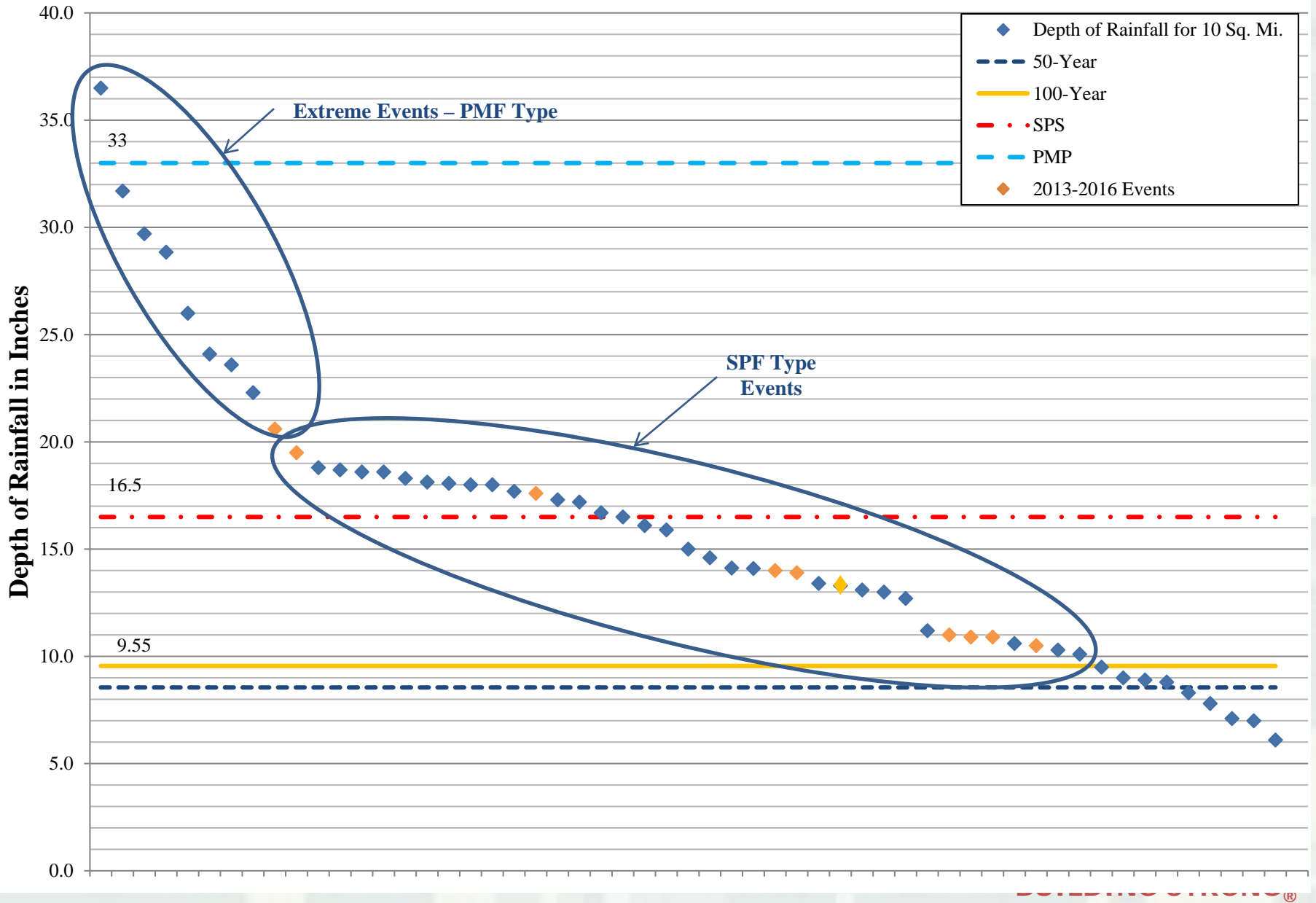


# May-June 2015 Flooding



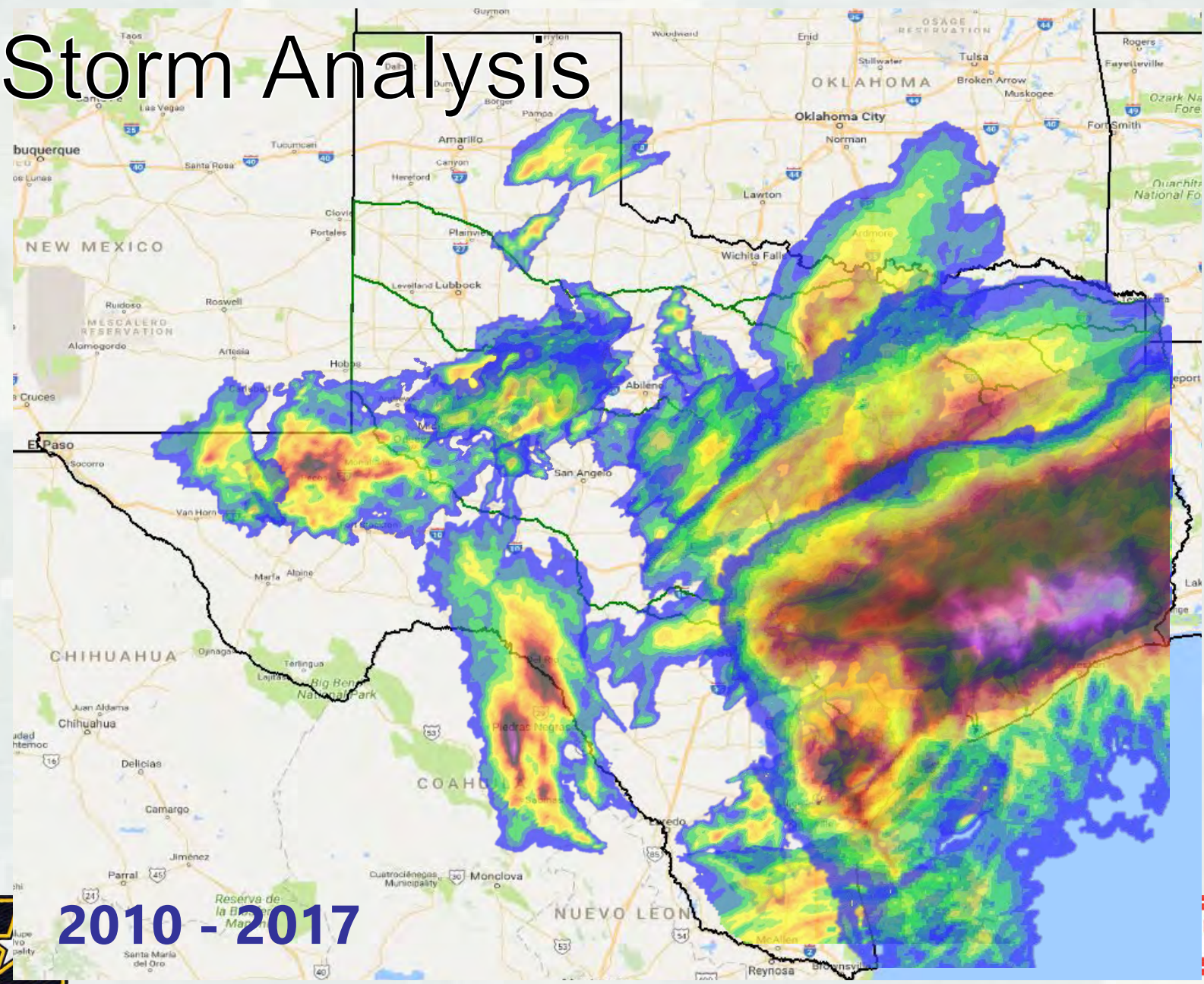
\*Pool percent taken on the last day

# 24 Hour Rainfall for 10 Sq. Mi.

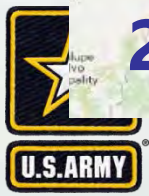




# Storm Analysis



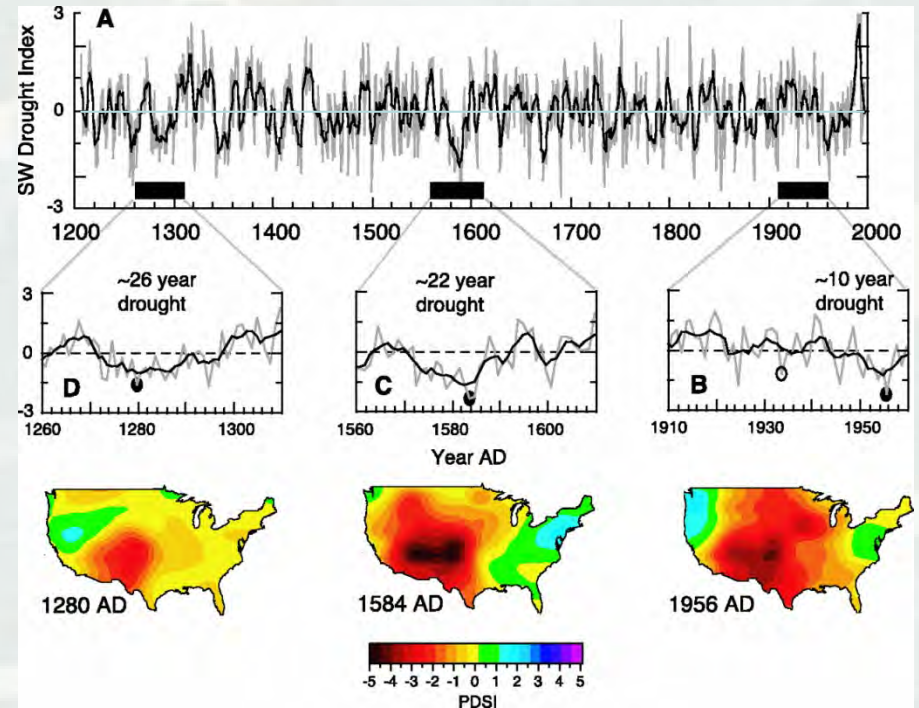
**2010 - 2017**



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# Climate Variability - Historical Perspective

- Significant Historical Droughts
  - ▶ 1271-1297 (26 years)
  - ▶ 1570-1592 (22 years)
  - ▶ 1947-1957 (10 years)
- WS yields determined based on the 1947-1957 drought period
- Greater risk on WS



What major civilization shift occurred as a result of the 1271-1297 drought?



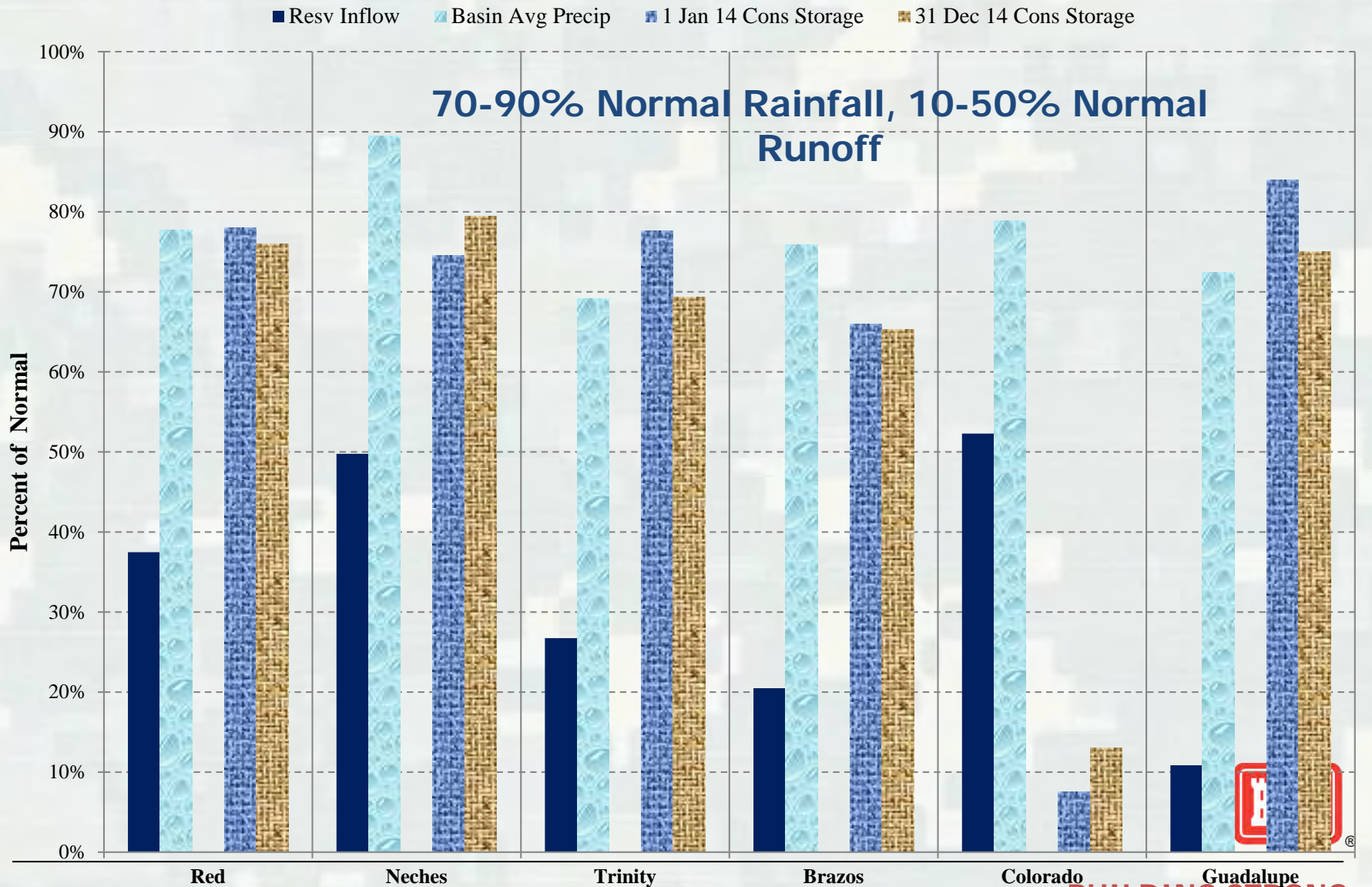
The Anasazi civilization fled their homeland south and east toward the Rio Grande and Colorado River to find better water sources.



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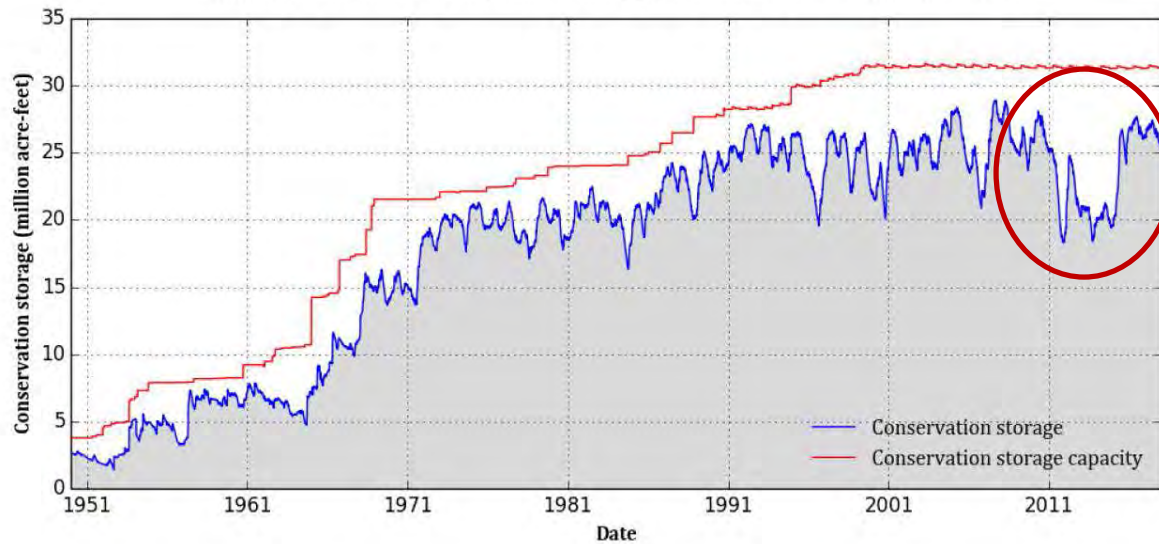
## Summary of Projects Averages for CY2014 Reservoir Inflow & Basin Average Precip





# Statewide Reservoir Storage

Statewide monitored major water supply reservoir conservation storage



Texas Water  
Development Board



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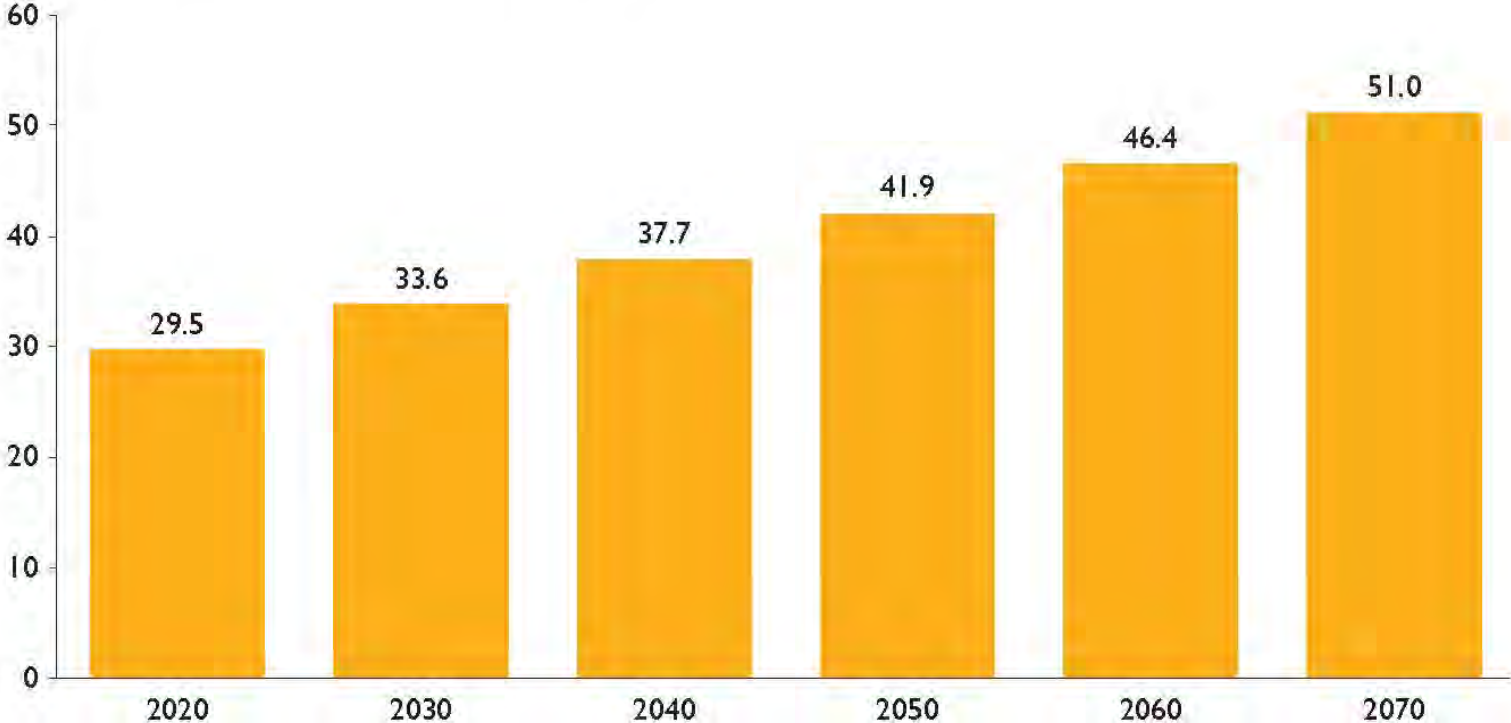
# Drought Reservoir Conditions



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# Population Growth In Texas

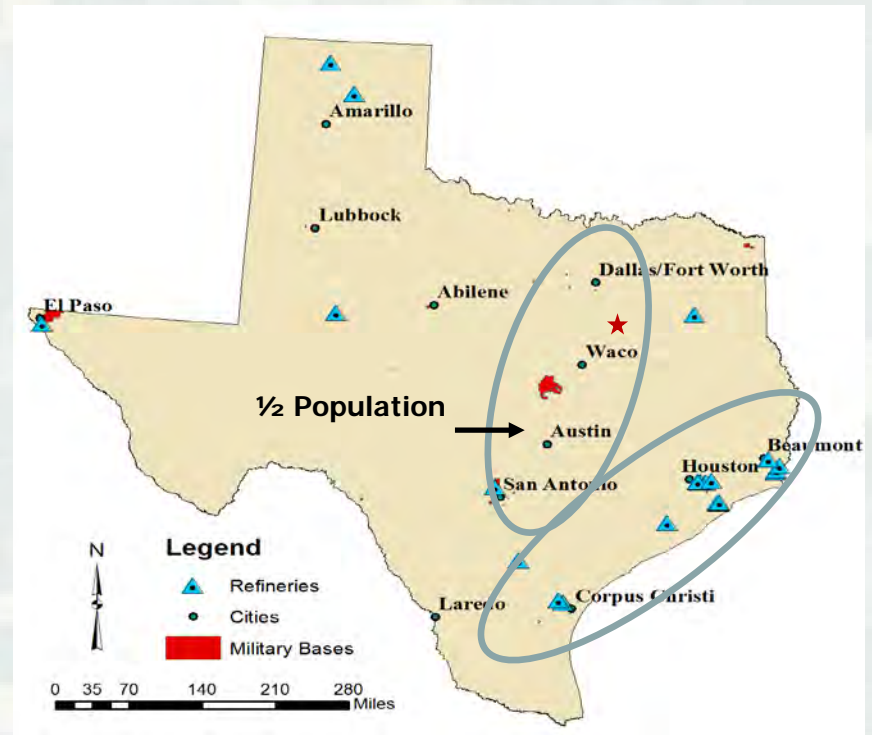
Figure ES.2 - Projected population in Texas (millions)





# Importance of Water Supply

- Population growth
  - ▶ 25+ M current
  - ▶ 51 M projected (2070)
- ½ Texas population lives along I35 corridor
- Significant refinery industry
- Military installations and supporting industry
- Climate variability



# Non-Stationary Trends in Some Texas Watersheds

- Basin runoff characteristic changes
- Climate change/shifts
- Trends in for USACE assets
  - ▶ Upper Colorado River Basin
    - Brush management (spraying)
  - ▶ Brazos River Basin
    - Declining flow volumes in upper watershed

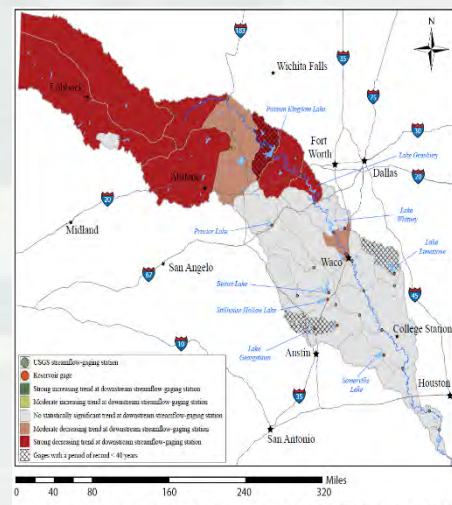
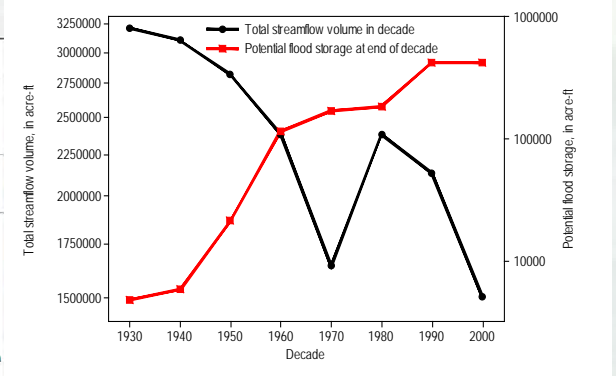
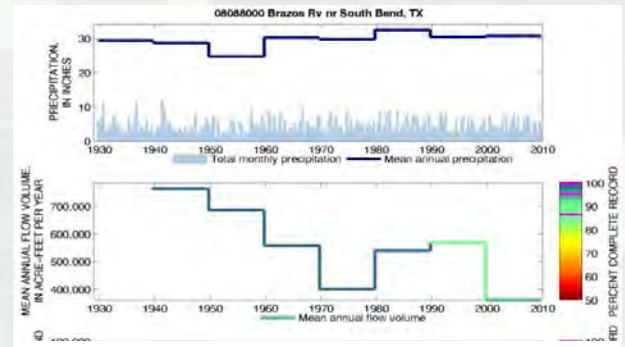
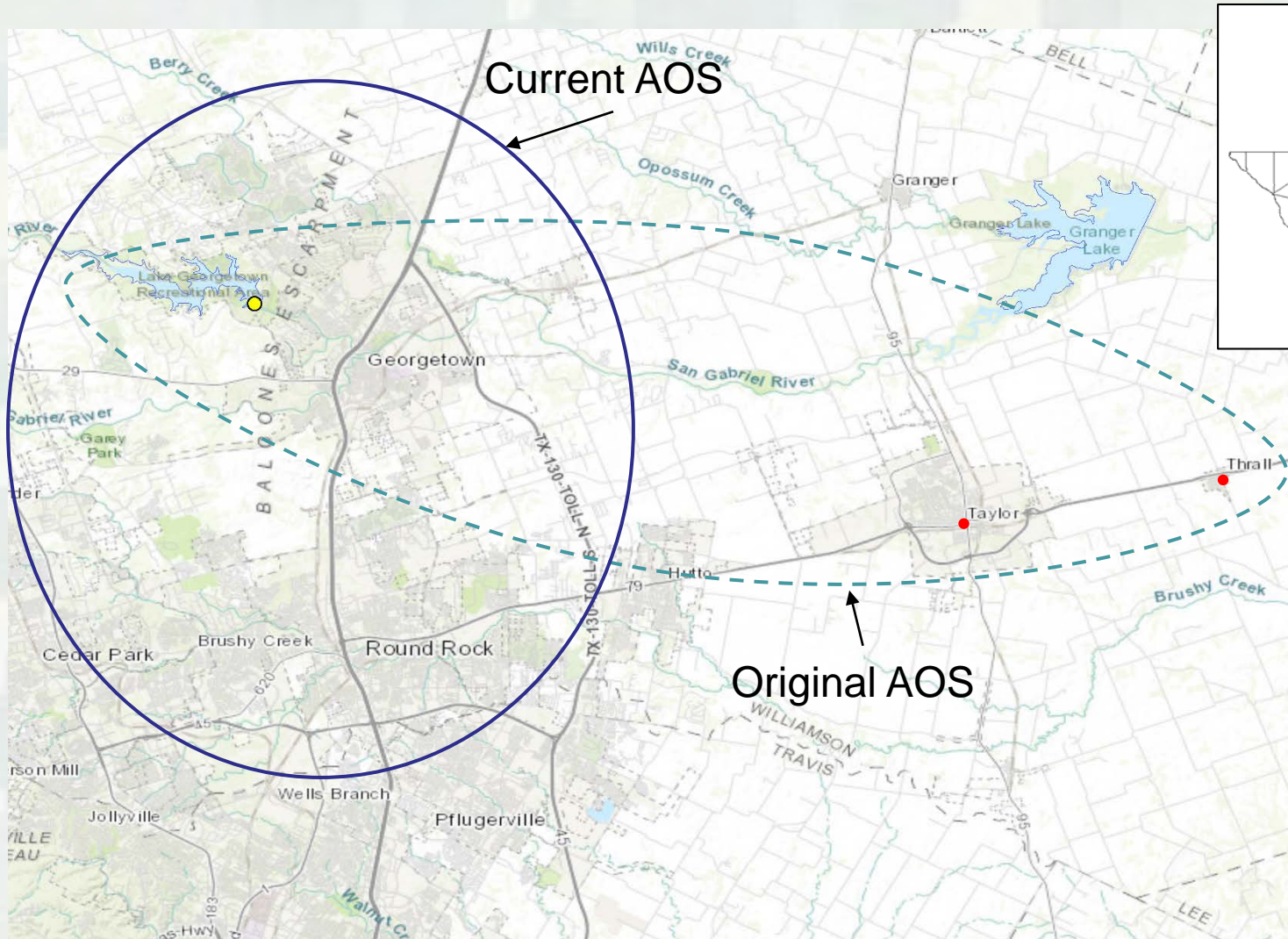


Figure 3. Temporal trends in annual streamflow at 31 streamflow-gaging stations within the Brazos River Basin, 1938–2014. Subbasins with statistically significant trends (p values less than 0.05) are shaded. Strong trends are those with a Kendall's tau > 0.75 or < -0.75; moderate trends are those with a Kendall's tau from 0.50 to 0.75 or from -0.75 to -0.50; and no trend when Kendall's tau is between -0.50 and 0.50.



# Area of Service Comparison



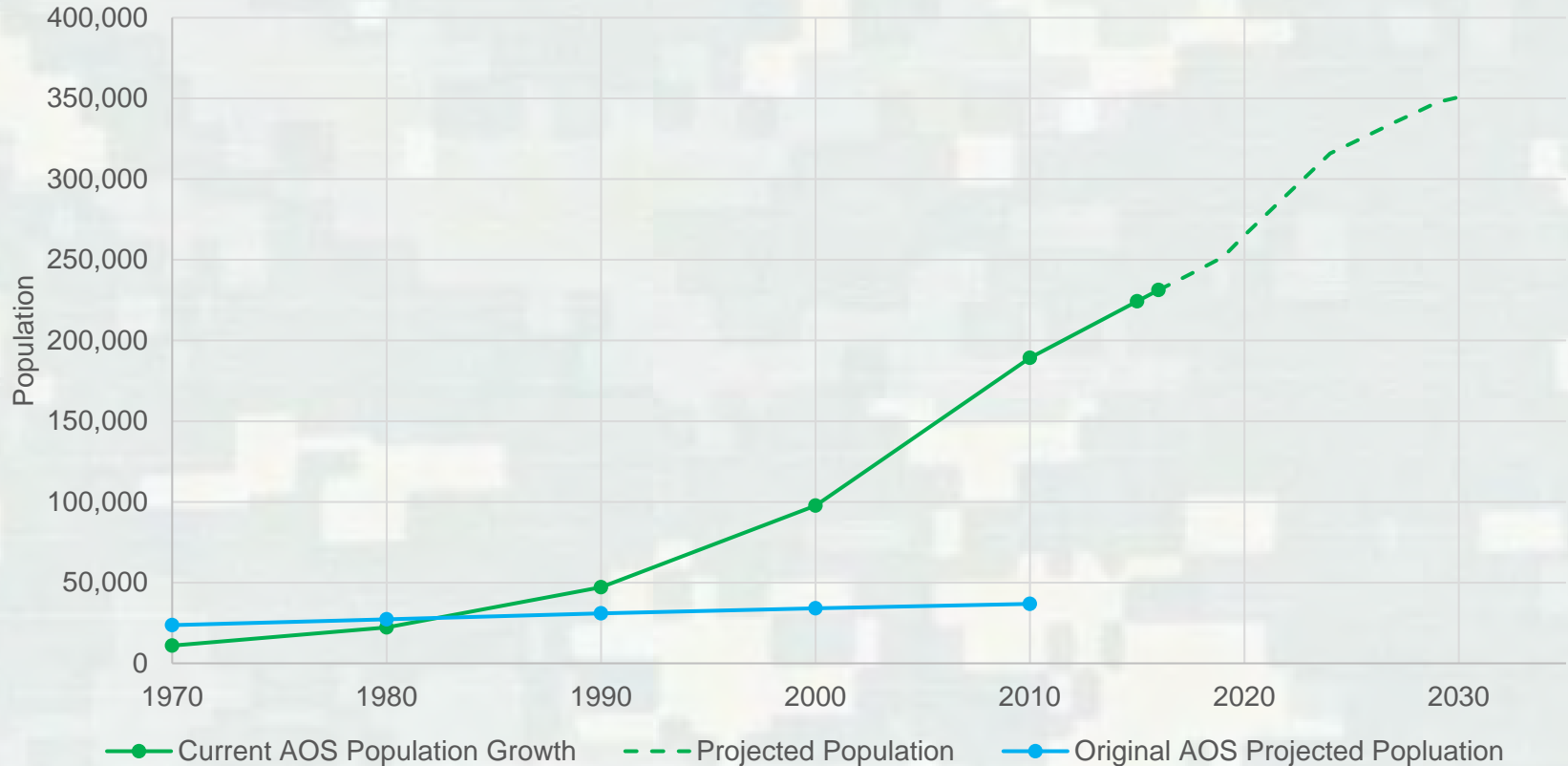
- Current AOS:**
- Georgetown
  - Round Rock
  - Brushy Creek MUD





# Projected Population Growth of Current AOS

Current AOS Population Growth



# Statewide Summary

## Existing Pipelines



780 Miles of Pipeline

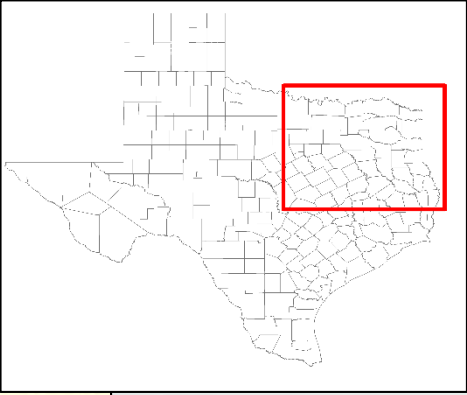
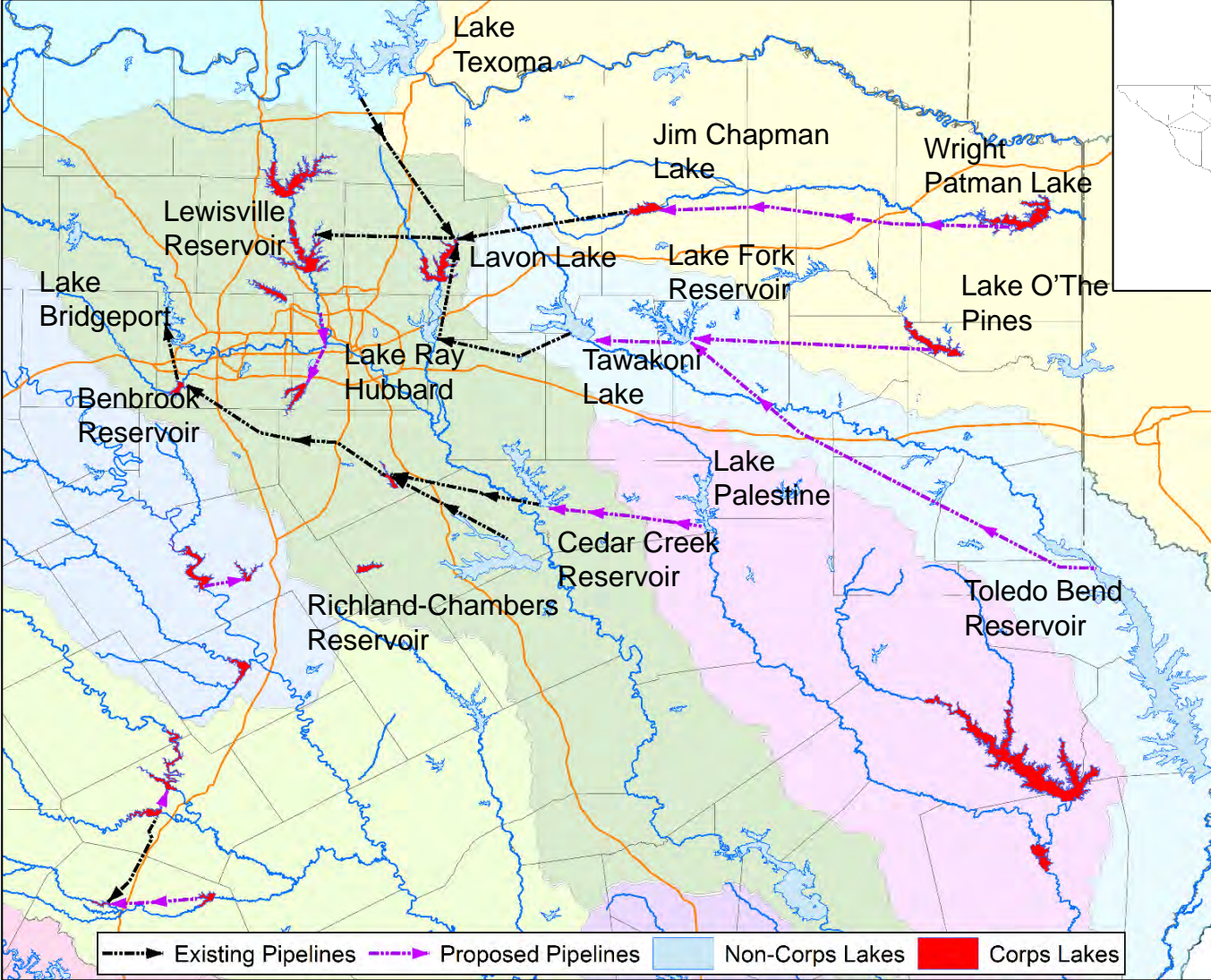


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# Statewide Summary

## Proposed Pipelines



~1500 miles of proposed Pipeline

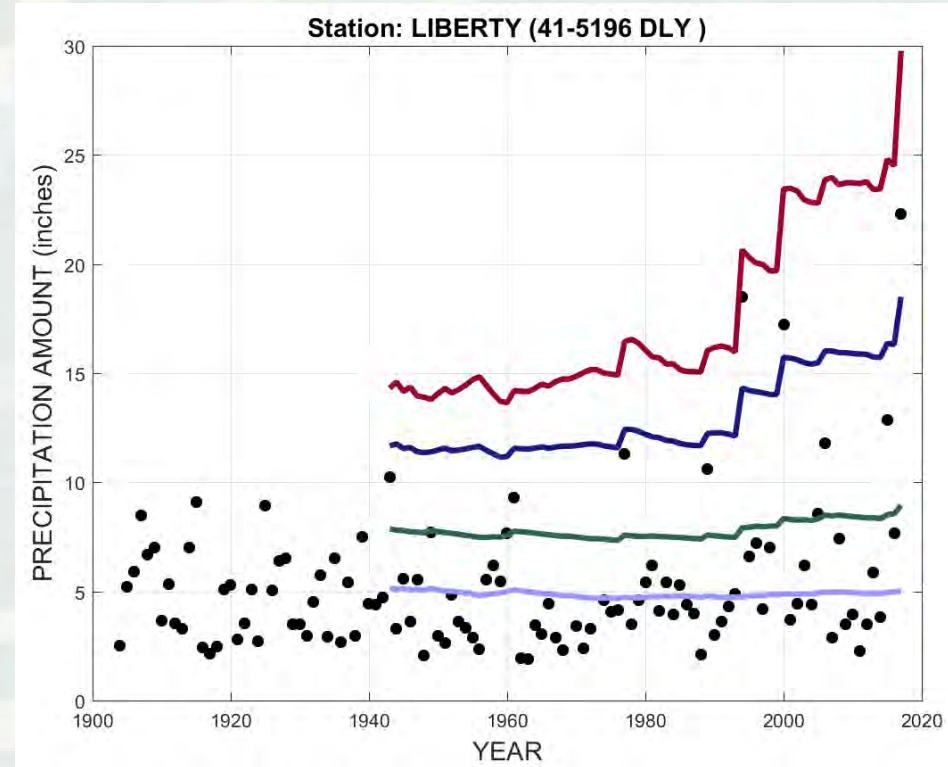


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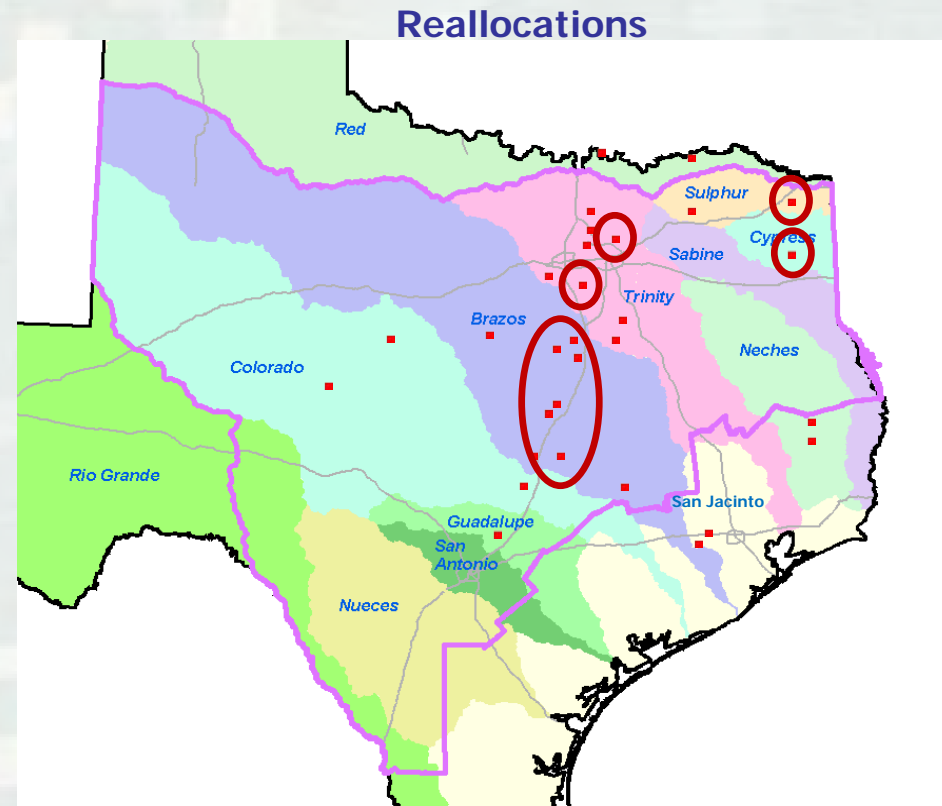
# Impacts

- Project operations
- Environmental
- Socioeconomic
- Panic
- Pressure to reallocate flood storage
- Increased uncertainty associated with flood risk



# RiverWare is a Critical Analysis Tool for USACE

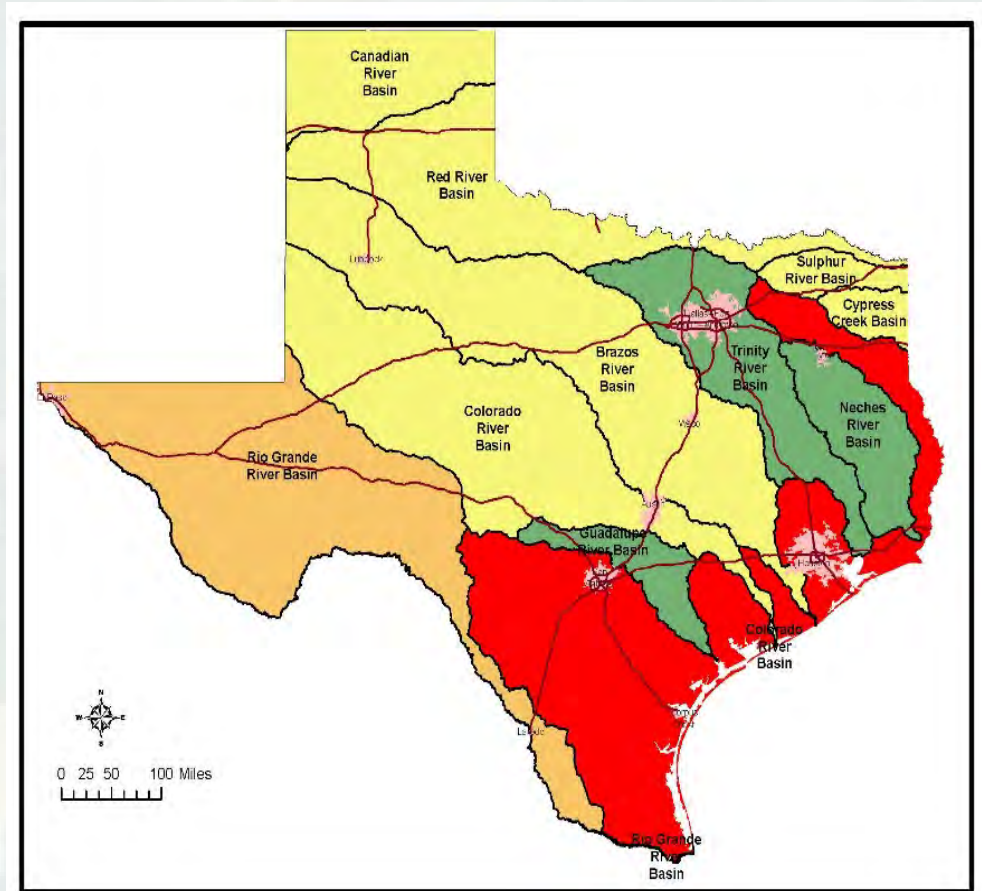
- Reallocation studies
  - ▶ 11 projects - 7 Brazos, 2 Trinity, 1 Cypress, 1 Red
  - ▶ Yield
  - ▶ Flood impacts & DS
- Operational studies
- Flood risk studies (WHA)
  - ▶ Reg. vs unreg.
- Environmental permitting
- Real-time - CWMS
- USACE users group



# Watershed Hydrology Assessments

FEMA Region 6

- Infrastructure design and NFIP discharges
  - 2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr, 250-yr, 500-yr
- Existing conditions
- Future conditions
- Climate change impacts (DOD funded)
- \$2.5 million investment





# Questions?



**US Army Corps  
of Engineers**

U.S. Army Corps of Engineers  
Fort Worth District (SWF)  
819 Taylor Street  
Fort Worth, TX 76102

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