

# RESERVOIR ADAPTIVE MANAGEMENT: WHAT WEATHER FORECAST ENHANCEMENTS ARE NEEDED IN TEXAS?

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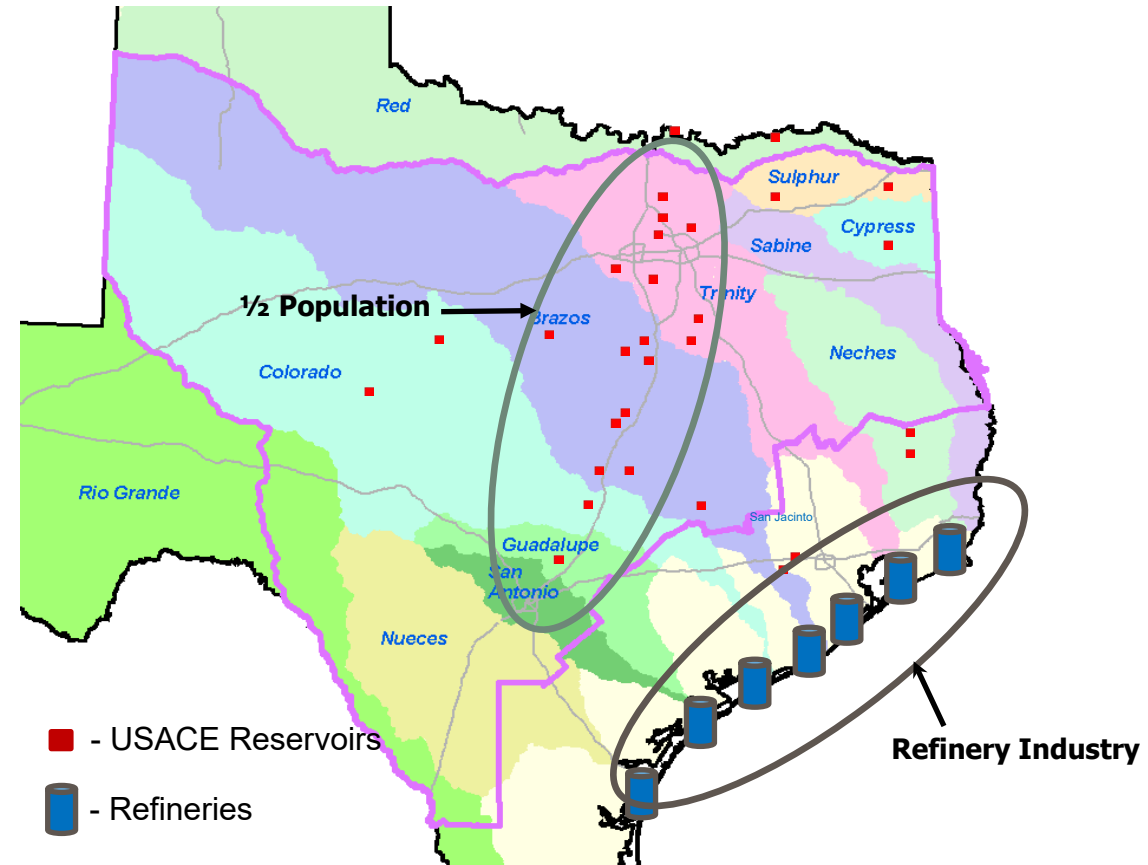
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# INCREASING RESILIENCY - STATEWIDE FEDERAL RESERVOIR DEVELOPMENT



- Multi-purpose reservoirs, 400+ nationally, 32 statewide, \$8B investment
- WS storage 6.5 M ac-ft contracted, 1/3 TX surface water. Nationally 10M ac-ft supplies 85M people, 115 communities
- Population growth, 1100/day, 30M to 54M 2050
- 1/2 population along I35
- Texas is 2<sup>nd</sup> in GDP, 3<sup>rd</sup> in Ag. production
- 32% of refinery capacity
- Significant drought vulnerabilities
- Current WS deficit 3M ac-ft
- 2070 WS deficit 7M ac-ft
- \$80B projected cost including 23 new reservoirs
- Pumping
- **What about adaptive management?**
- **Flood storage 13.4 M ac-ft**
  - 5% - 20% FIRO



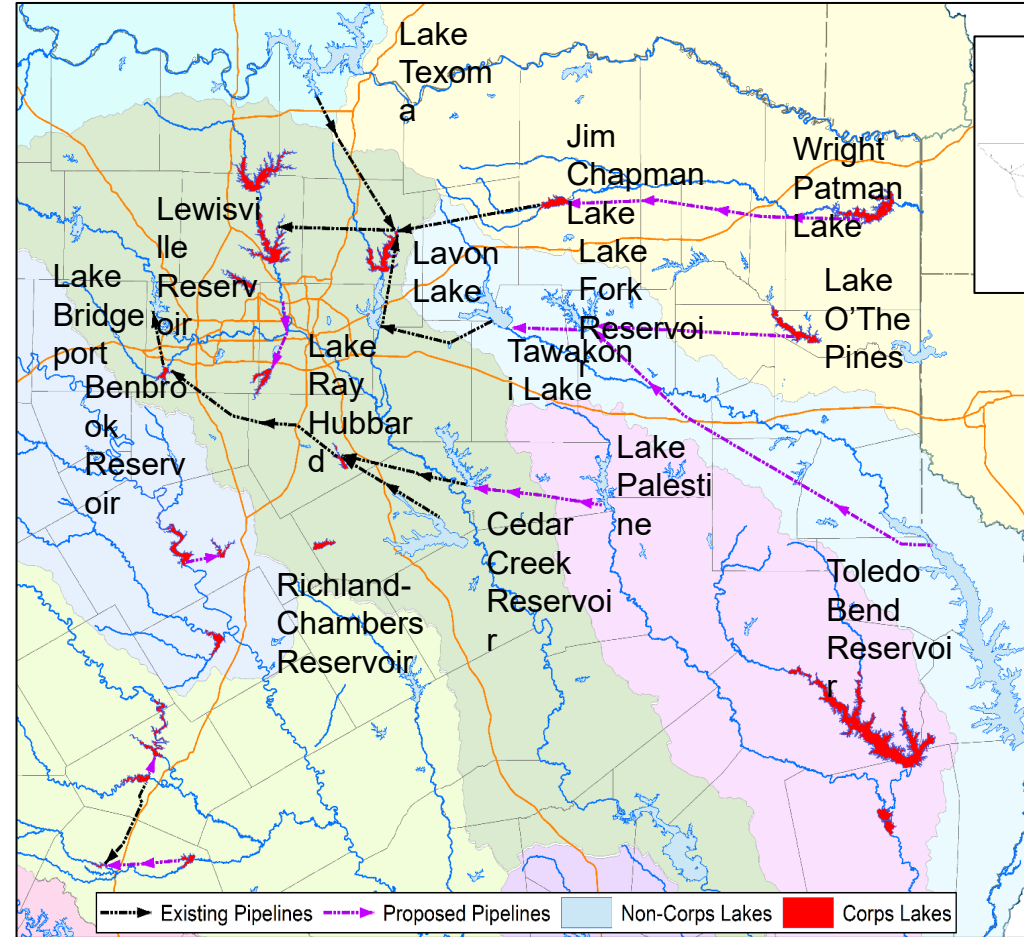


# FUTURE CHALLENGES EXISTING AND PROPOSED PIPELINES



## Water Supply Community

- ~1500 miles of constructed or planned pipelines
- Transport of water to population centers
- Can be seasonal or shortage driven
- Population will continue to increase
- Conservation will be needed

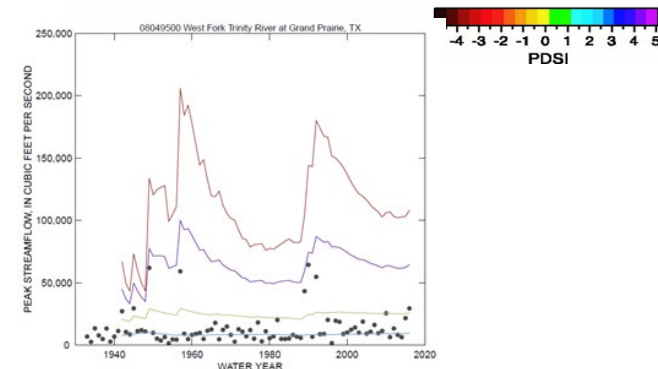
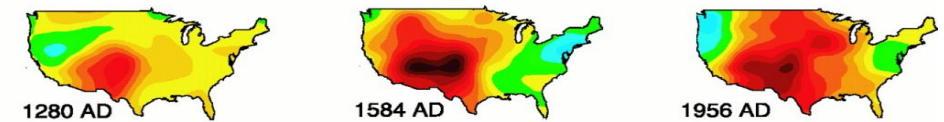
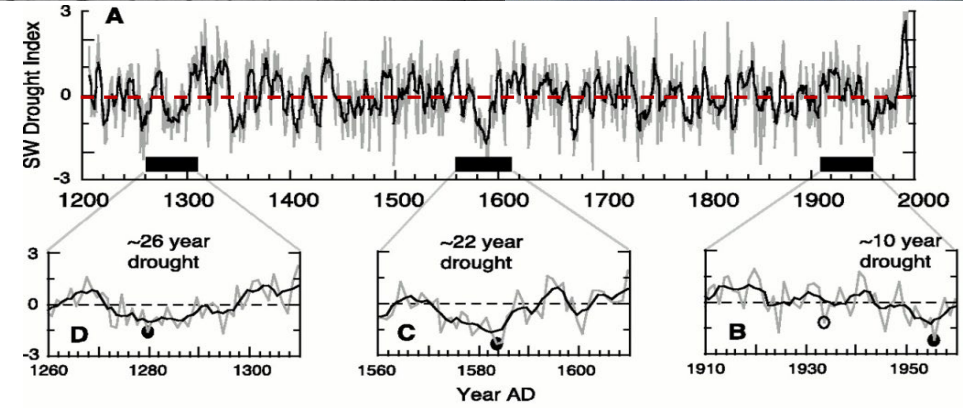
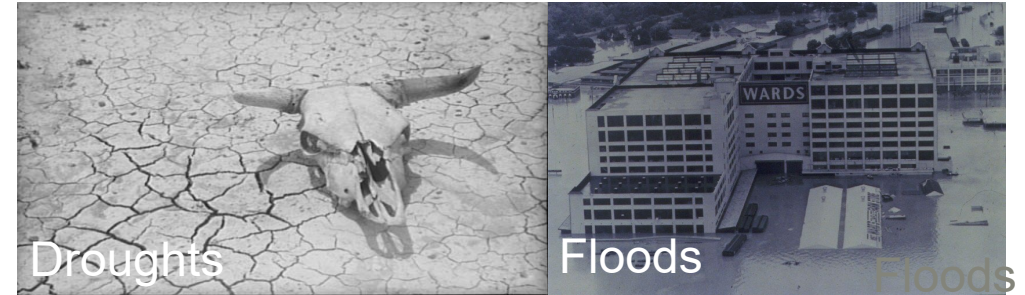




# CLIMATE VARIABILITY?



- Annual rainfall totals in DFW from 20" – 60"
- Paleohydrology indicates more severe droughts have occurred historically
- Flood-flow-frequency analysis using historical data shows significant variability
- Brazos and Colorado River Basins show significant downward trends in runoff

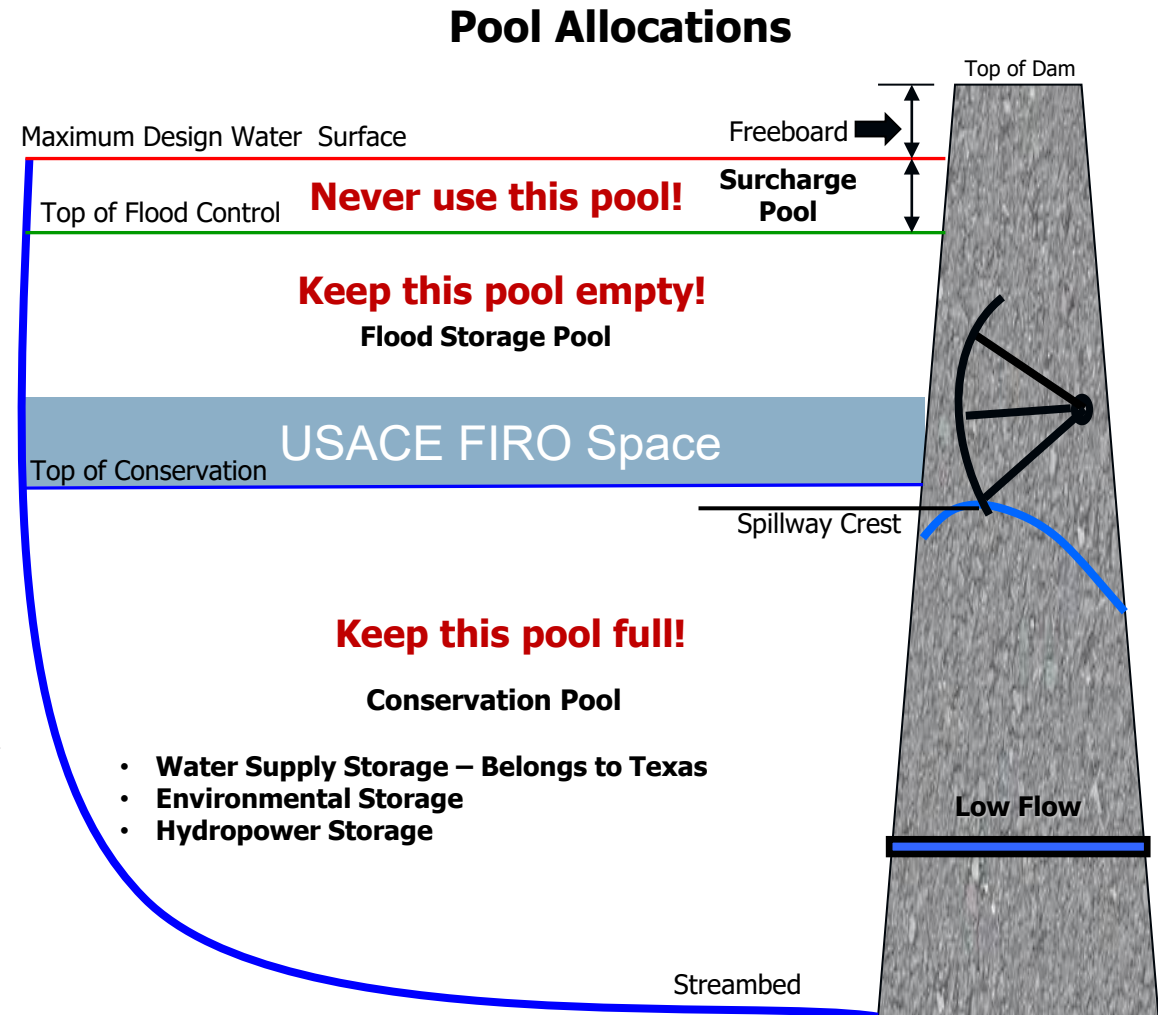




# USACE OPERATIONS – WHAT ARE FIRO OPERATIONS

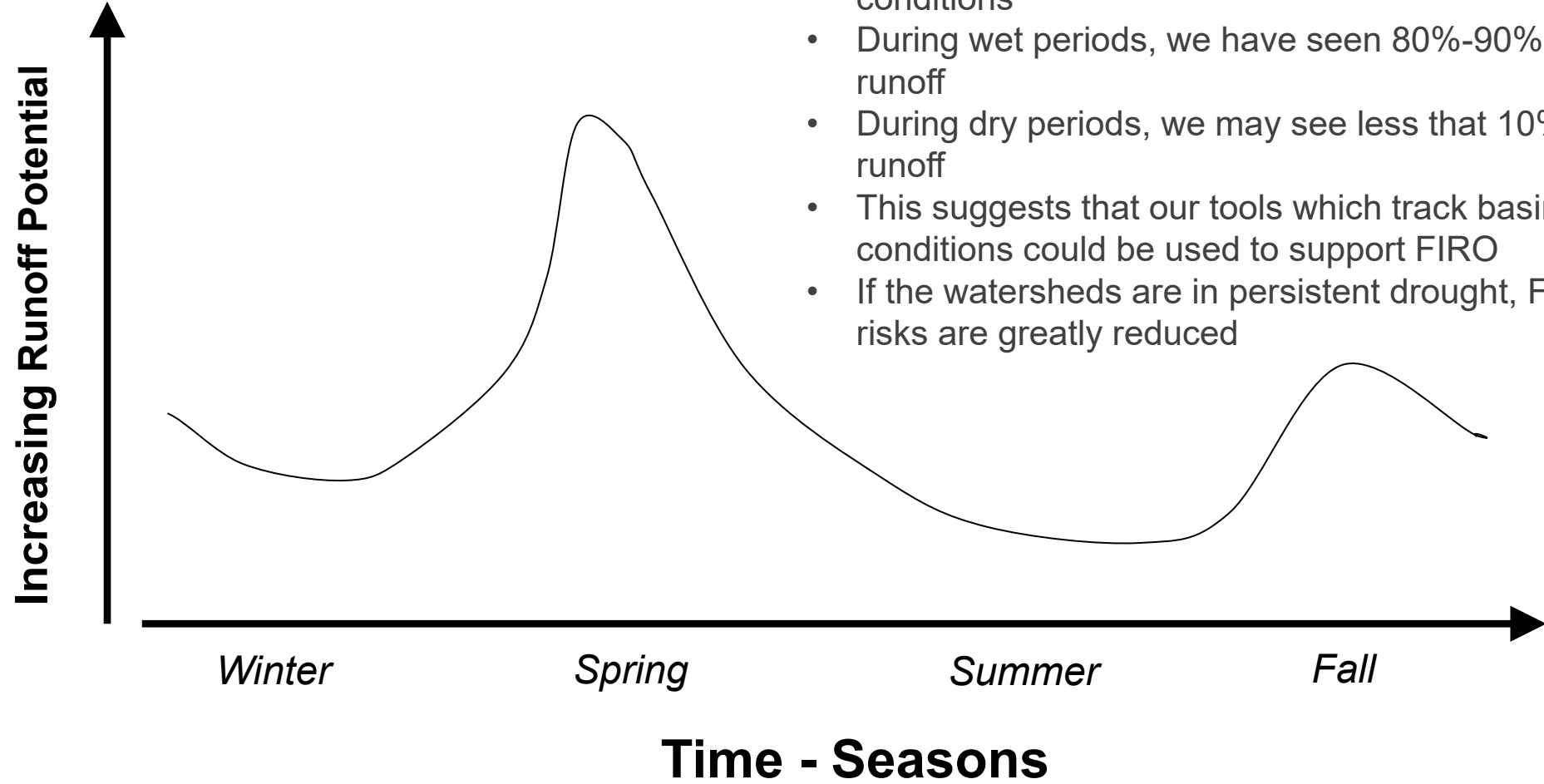


- Reservoir Operations
  - Follow WCM "Plan of Operation" for reservoir system
  - Store water in conservation pools
  - Temporarily store flood inflow to maintain safe DS conditions
  - Safely release water into DS river reaches
  - **By utilizing NWS products**
- USACE FIRO (adaptive management)
  - Technology driven flexibilities
  - Targets lower 5% - 20% of flood pool
  - Requires improvements in short-term and mid-range forecasts
  - Integrate forecast improvements into NWS products (ESP & HEFS)
  - Reservoir operational analysis
  - Initially supported thru deviations
  - Codified within a WCP
- Broad national and regional support





# WATERSHED RUNOFF POTENTIAL



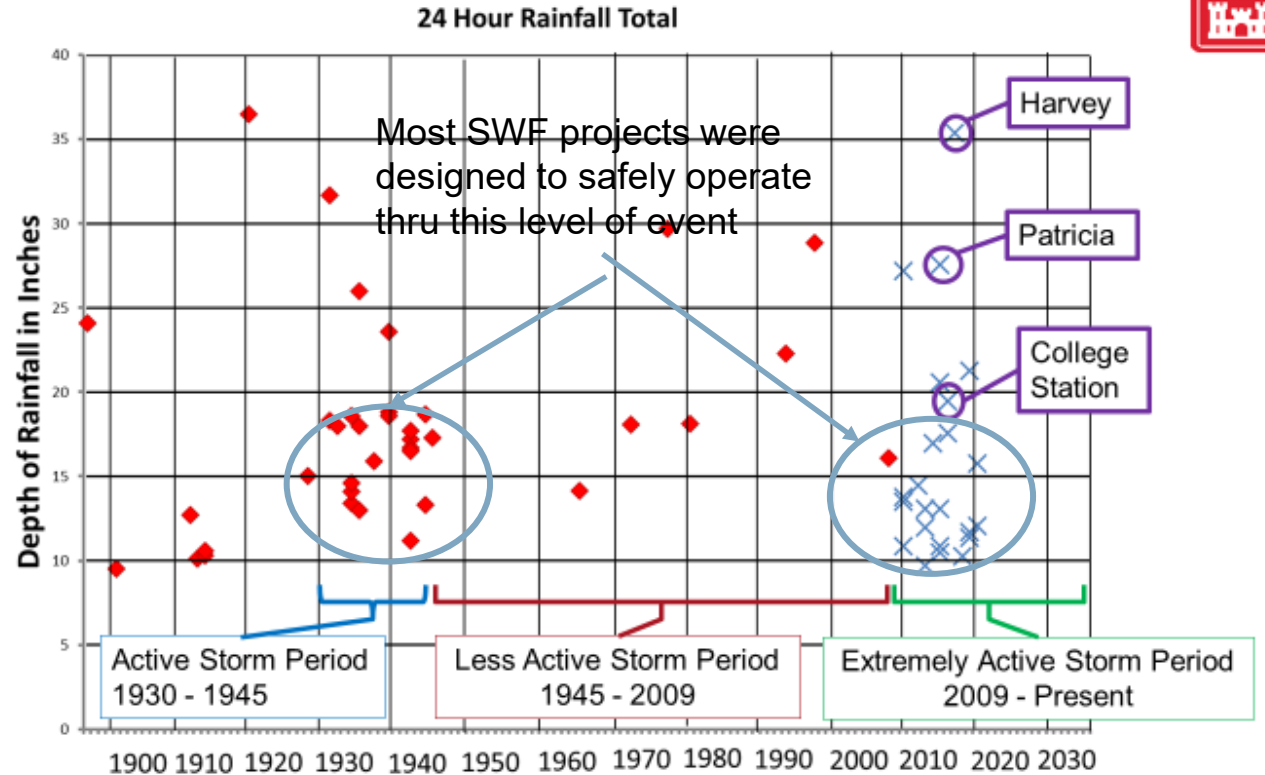
- Runoff potential for watersheds in Texas vary greatly due to persistent drought or wet conditions
- During wet periods, we have seen 80%-90% runoff
- During dry periods, we may see less than 10% runoff
- This suggests that our tools which track basin conditions could be used to support FIRO
- If the watersheds are in persistent drought, FIRO risks are greatly reduced



# MOST SWF PROJECTS CAN OPERATE SAFELY THRU A 16"-18" EVENT



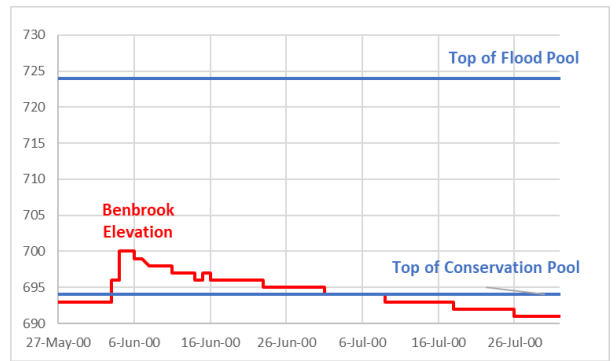
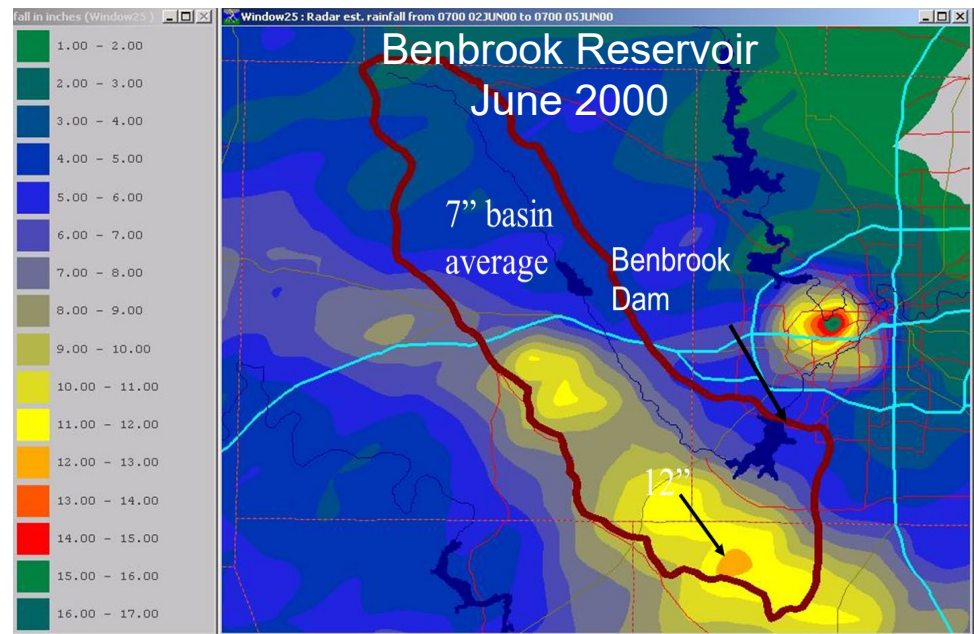
- Those that designed the SWF projects saw the active storm period that previously occurred from 1930-1945 and ensured the projects could be operated safely under this type of loading.
- This means the 100-yr events (10 inches in 24 hours for DFW area) are not significant events, especially in dry conditions
- This capacity may provide operational flexibilities that could be leveraged for FIRO



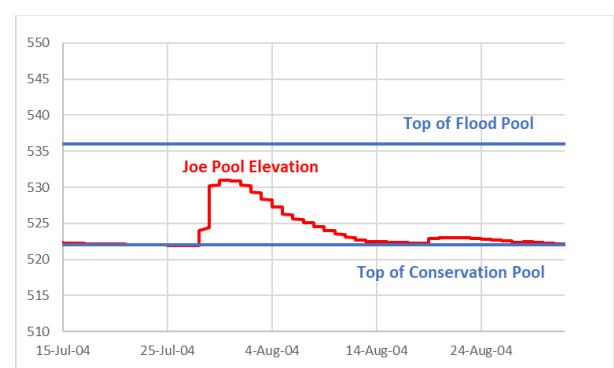
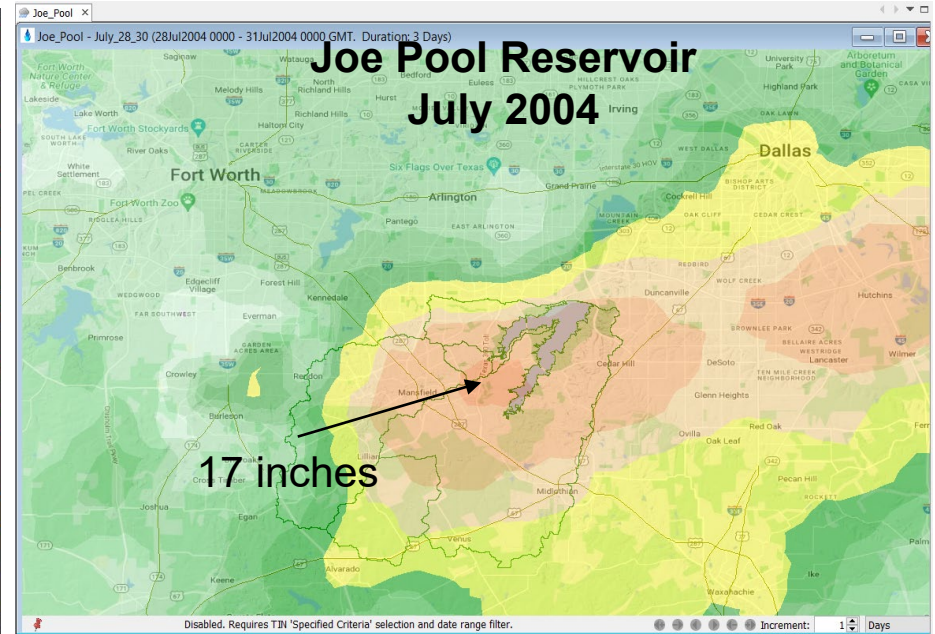


# EXTREME EVENTS – SMALLER EVENTS WITH DRY ANTECEDENT CONDITIONS

- Reservoirs are designed to operate thru extreme events
- June 2000 and July 2004 dry WS events suggest:
  - Projects operate through 12" & 17" events
  - 15% storage in Benbrook
  - 50% storage in Joe Pool
  - Ok for FIRO 5% - 20 % retention in flood pool



Benbrook Lake rose 6'



Joe Pool Lake rose 12'

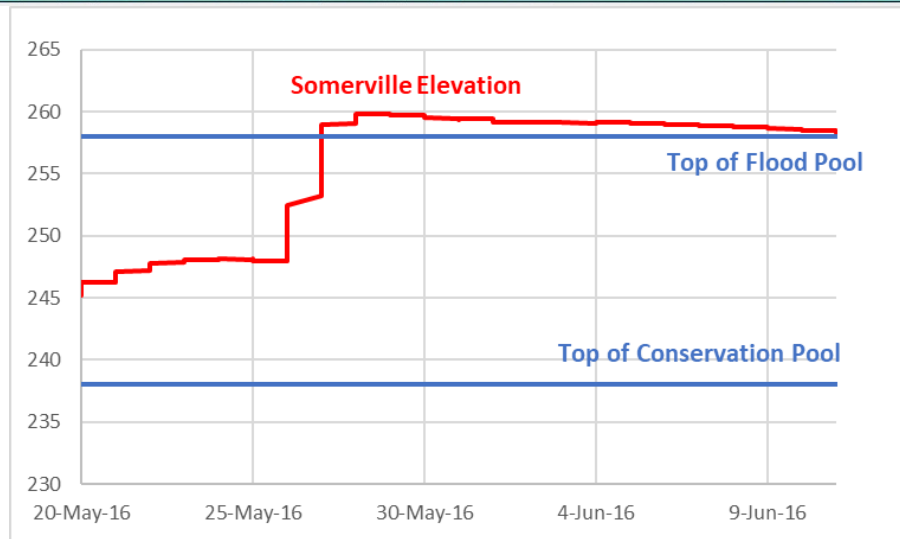
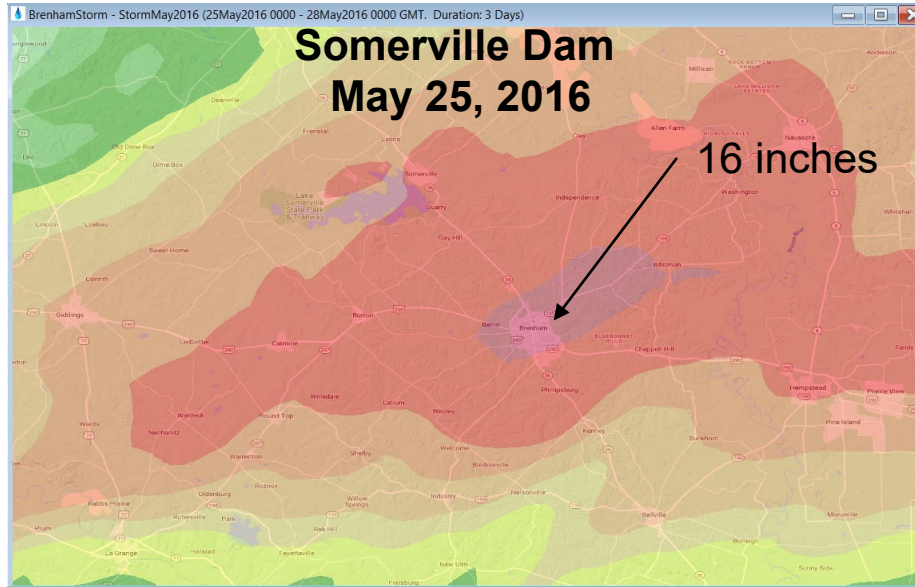




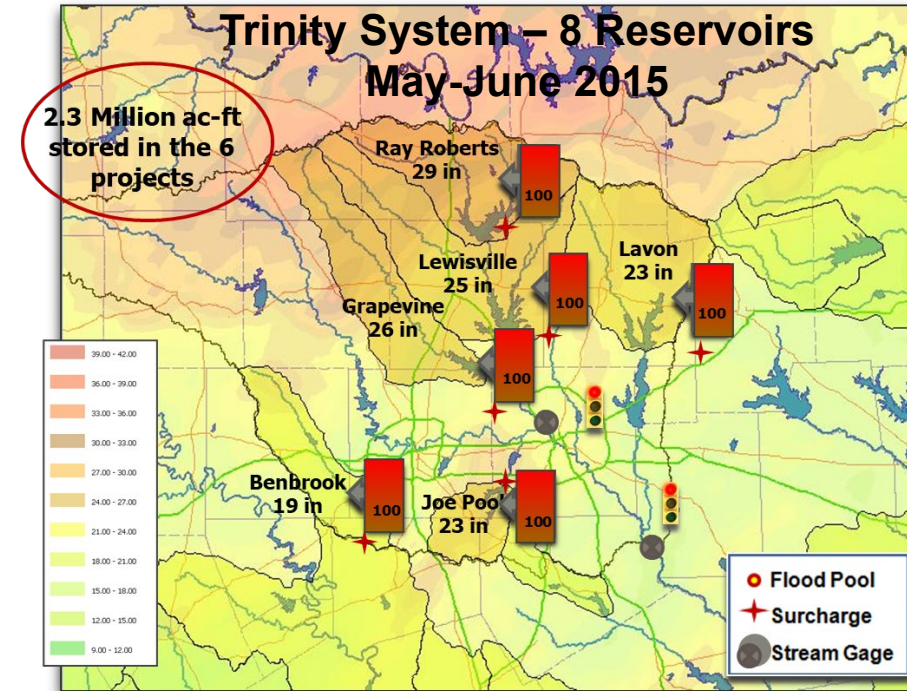
# EXTREME EVENTS – FIRO ADVERSE



- Larger extreme events with wet antecedent conditions may cause problems
- Larger 16” May 2016 Somerville event triggered a surcharge release
- May – June 2015 training storms, 6 weeks, triggered surcharge releases in all 8 USACE Trinity River reservoirs
- No FIRO operations suggested



Somerville Lake rose 14'

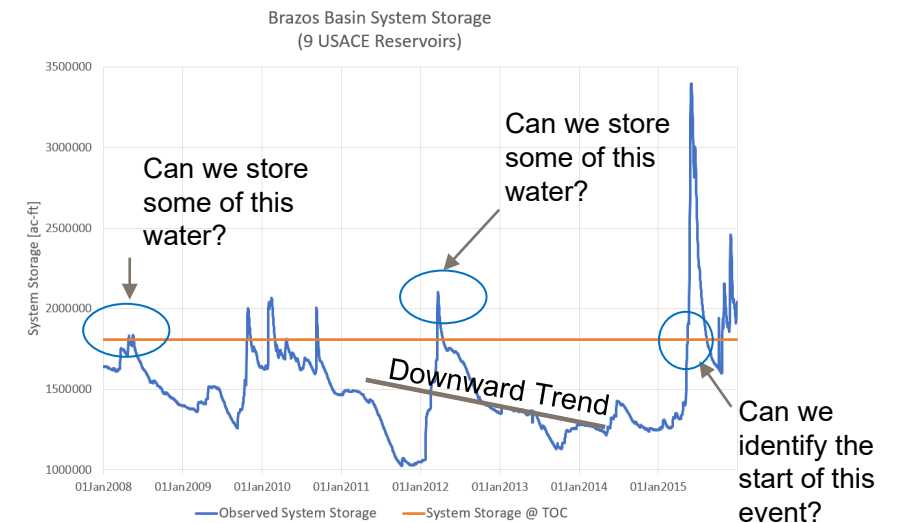
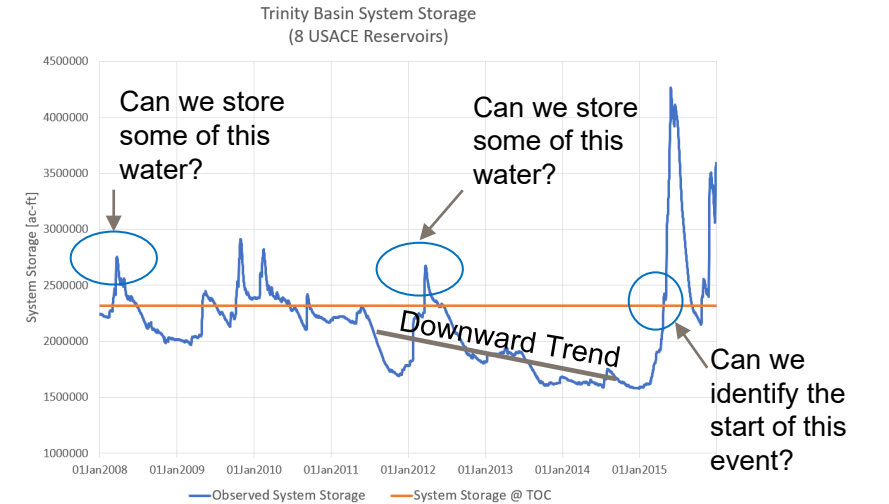




# FIRO FORECASTING TARGETS



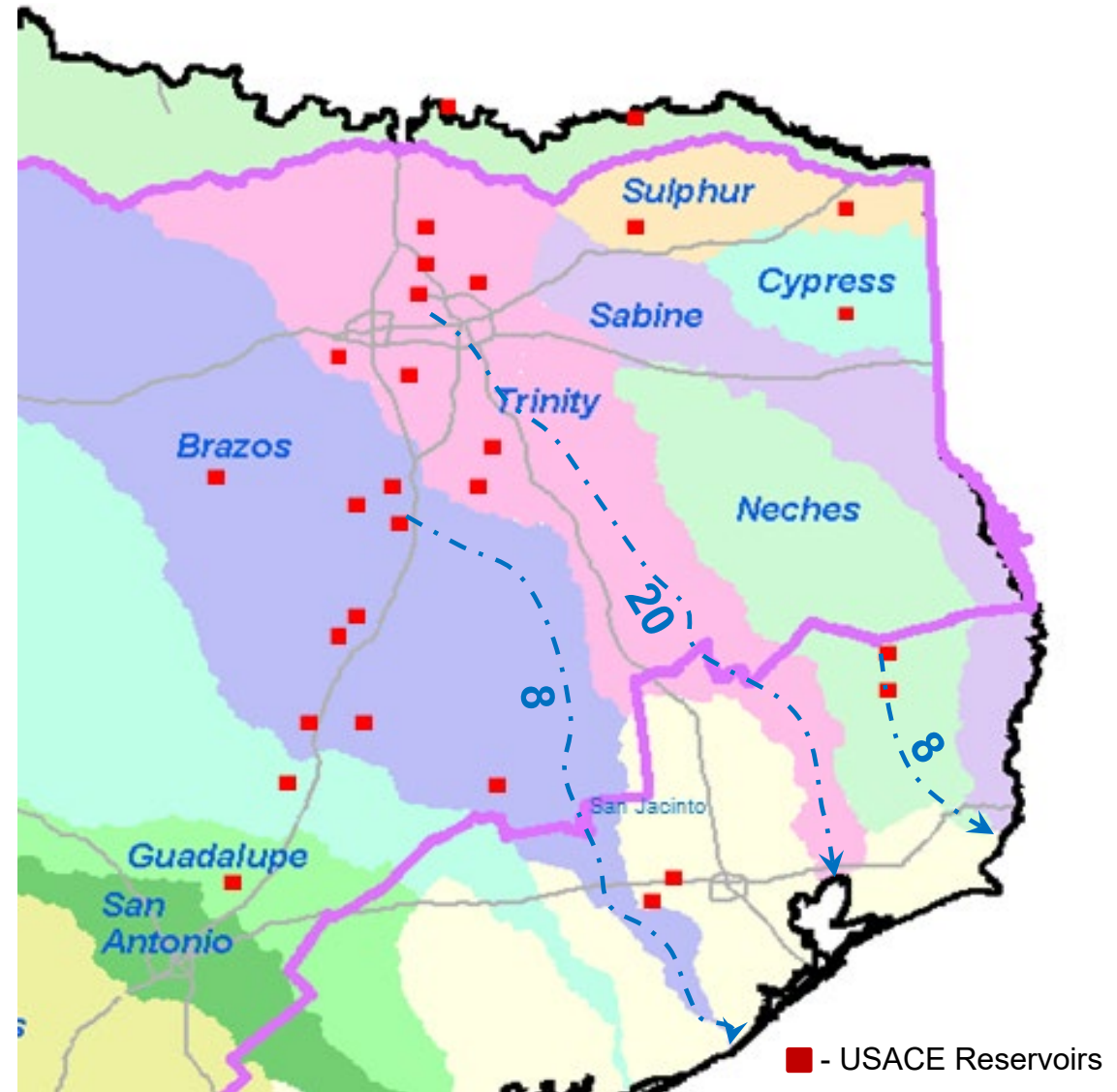
- More water available without costly infrastructure investments
- Storing flood water in late spring and early summer
  - Could reduce the need for pumping
- Storing runoff that may occur during sequential drought years
- Current forecast capability may not support any of these FIRO paradigms
- Forecast improvements need to target
  - The end of spring rains
  - Identification of persistent drought
  - Climate shifts from dry to wet and wet to dry





# FIRO CHALLENGES

- Long travel times
  - Neches ~ 8 days
  - Trinity ~ 14-20 days
  - Brazos ~ 8-14 days
- Time to empty flood storage
- Complexities in precipitation
  - Convective/Tropical
  - El Nino
  - La Nino
  - AMO
  - PDO
  - AR's
- To implement FIRO in TX in the same way in has been pursued in CA would require forecast lead times of 3 weeks+
- FIRO in TX will be different than CA FIRO
- Current products
  - HEFS & ESP





# QUESTIONS?



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