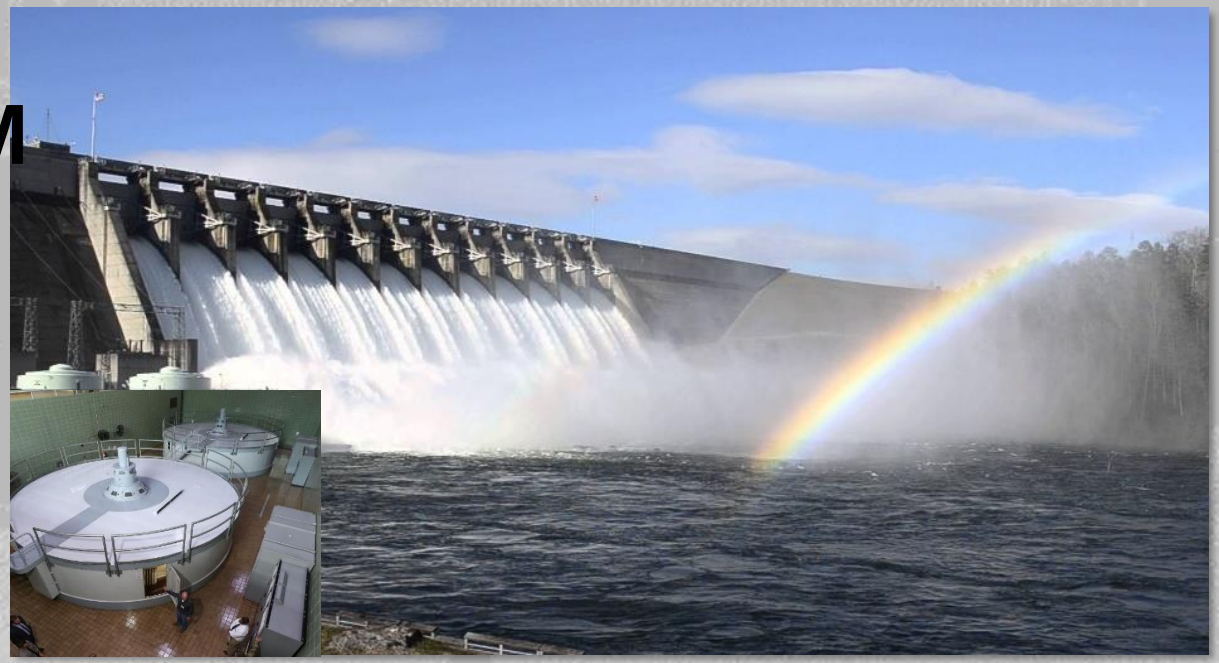
UPDATE ON USACE ACTIVITIES RELATED TO DAM OPERATIONS AND FLOOD SCIENCE



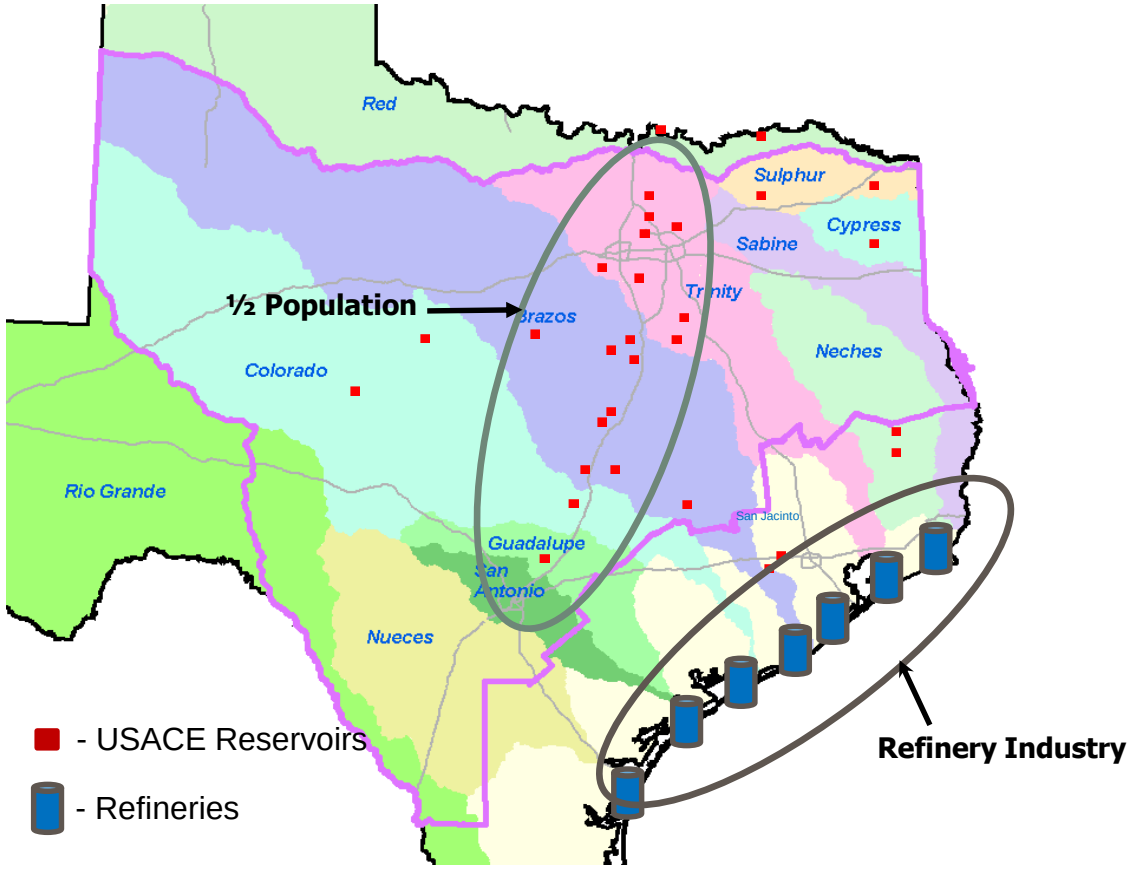
By: Jerry Cotter P.E.
Title: Chief Water Resources, Fort Worth District
Date: 09 February 2024

Audience: SAME Infrastructure Conference, Texas

US Army Corps of Engineers ®

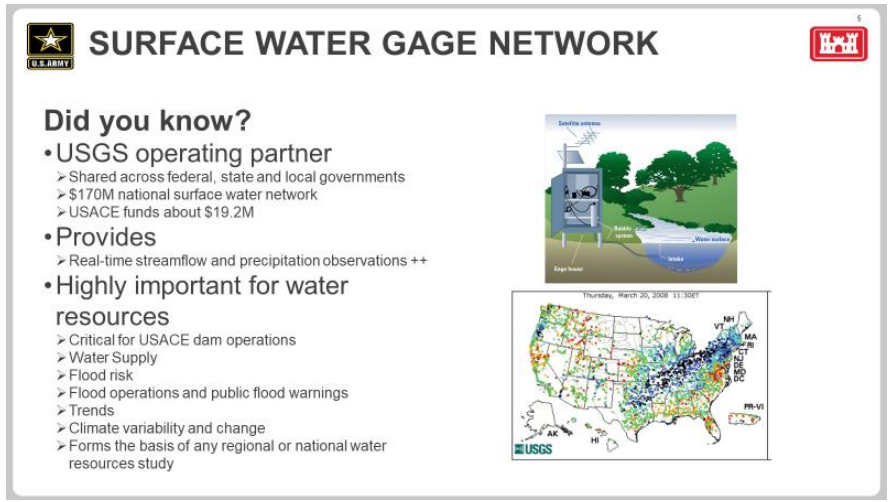
INCREASING RESILIENCY - STATEWIDE FEDERAL RESERVOIR DEVELOPMENT

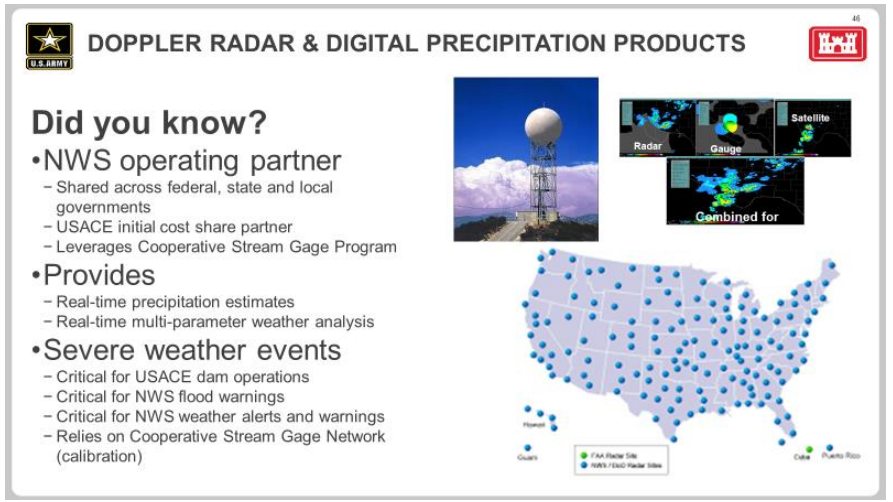
- Multi-purpose reservoirs, 32 statewide, $8B investment
- WS storage 6.5 M ac-ft contracted, 1/3 TX surface water. >50% along I35
- **Flood storage 13.4 M ac-ft, $150 B benefits**
- Population growth, 1100/day, 30M to >50M 2050
- ½ population along I35
- Texas is 2nd in GDP, 3rd in Ag. production
- 32% of refinery capacity
- Significant drought vulnerabilities
- WS deficits 3M ac-ft (current), 7M ac-ft (future)
- $80B projected cost including 23 new reservoirs
- **What about adaptive management?**
  - **Forecast Informed Reservoir Operations (FIRO)**
  - **Could release patterns be altered to provide increased benefits? (SRP)**

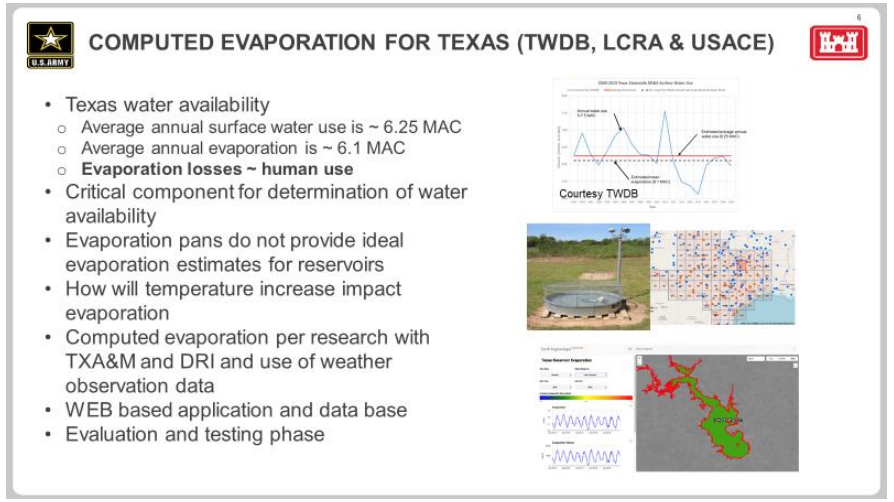


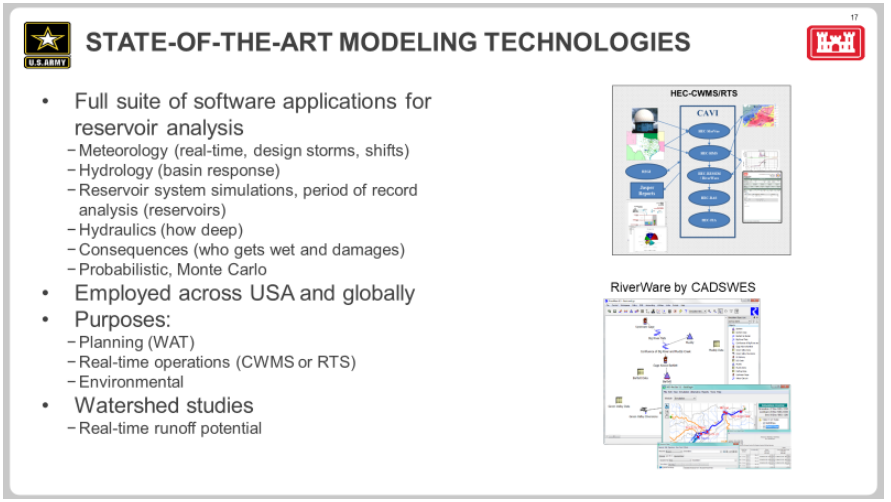
INVESTMENTS IN NEW TECHNOLOGIES, TOOLS AND DATA

- Surface Water Gage Network – Critical to dam operations and understanding watersheds
- Doppler Radar and Digital Precipitation Products – Critical to flood sciences and water resource investigations
- Computed Evaporation Tool – Evaporation estimates from pans have significant error and uncertainty
- State of the Art Numerical Modeling Tools – Critical for flood warning, flood mitigation and water availability





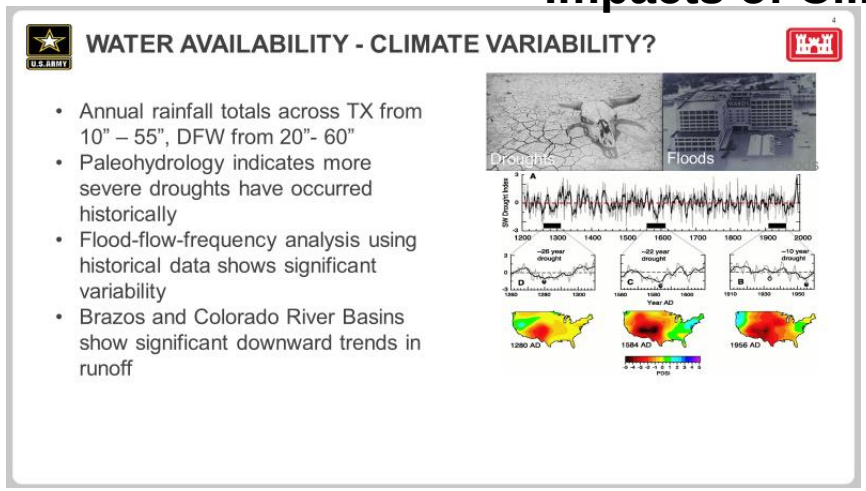


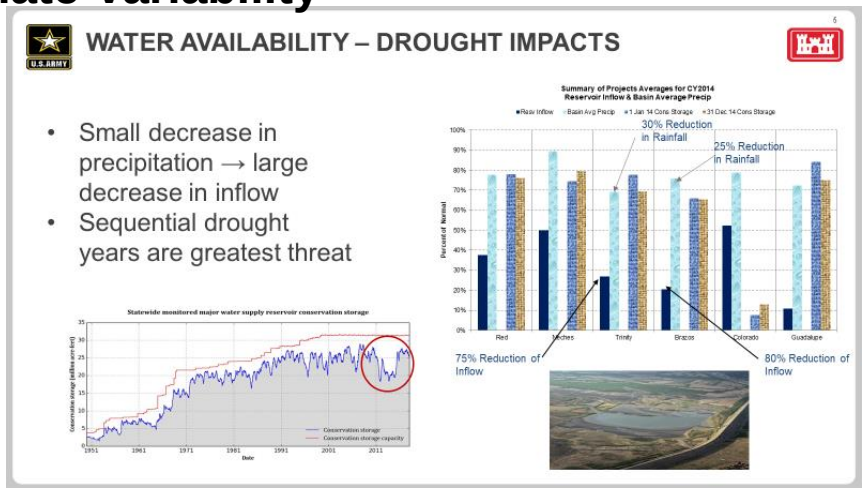


CURRENT AND FUTURE CHALLENGES IN WATER AVAILABILITY

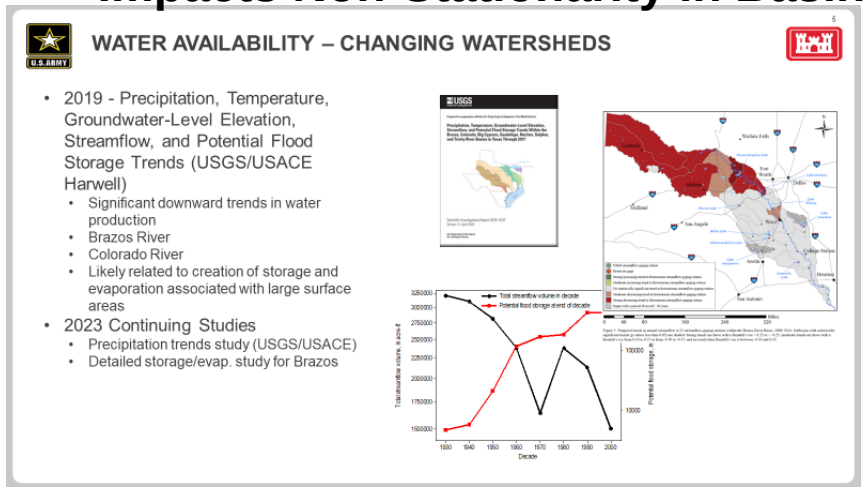
- The region experiences extreme climate variability
  - DFW Precipitation range
    - Max. 62”
    - Min. 18”
    - Normal 36”
- Rainfall-runoff is non-linear with a 30% decrease in precipitation = 75% decrease in runoff
- Sequential drought years most impactful
- Upper Brazos and Colorado Basins producing significantly less runoff
- Population growth, extreme and distributions distributed differently than earlier estimates

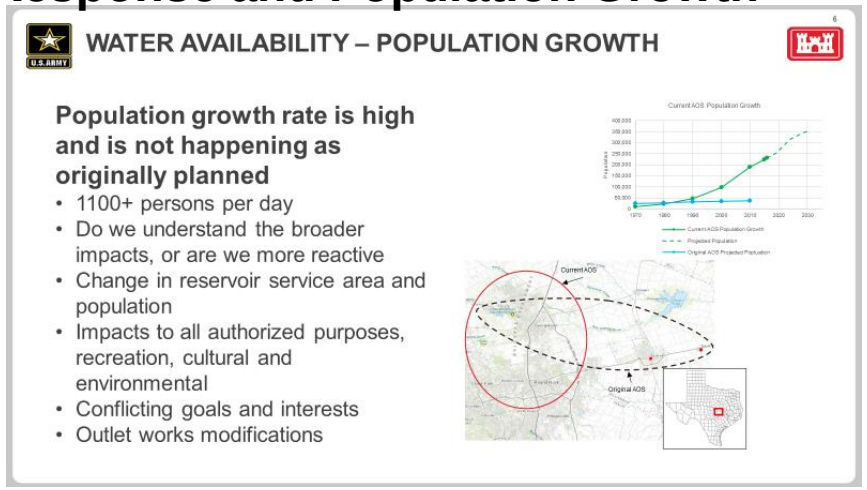
Impacts of Climate Variability





Impacts Non-Stationarity in Basin Response and Population Growth

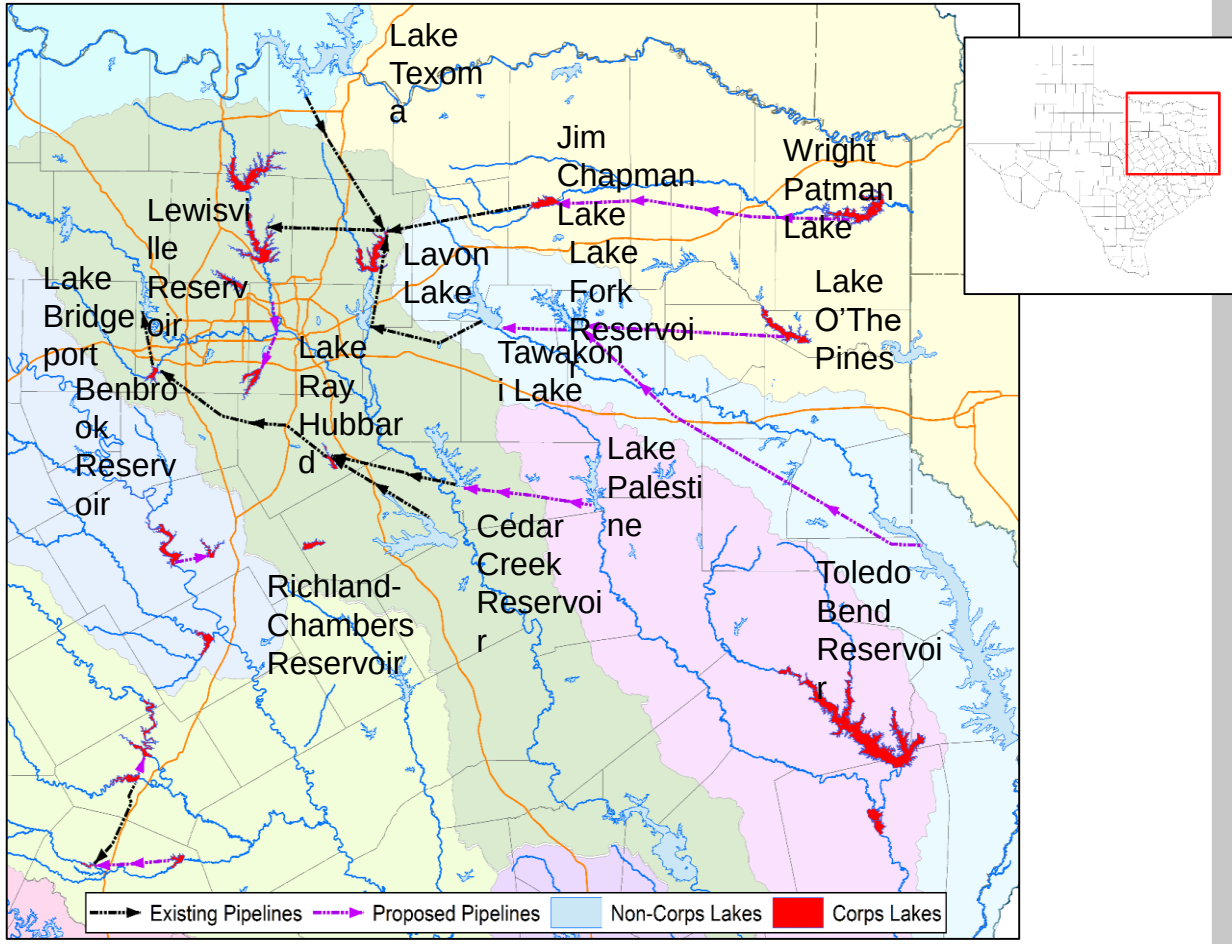




FUTURE CHALLENGES
RESPONSE TO INCREASING WATER NEEDS

Water Supply Community

- ~1500 miles of constructed or planned pipelines
- Transport of water to population centers
- Can be seasonal or shortage driven
- New reservoir construction
- Increased conservation

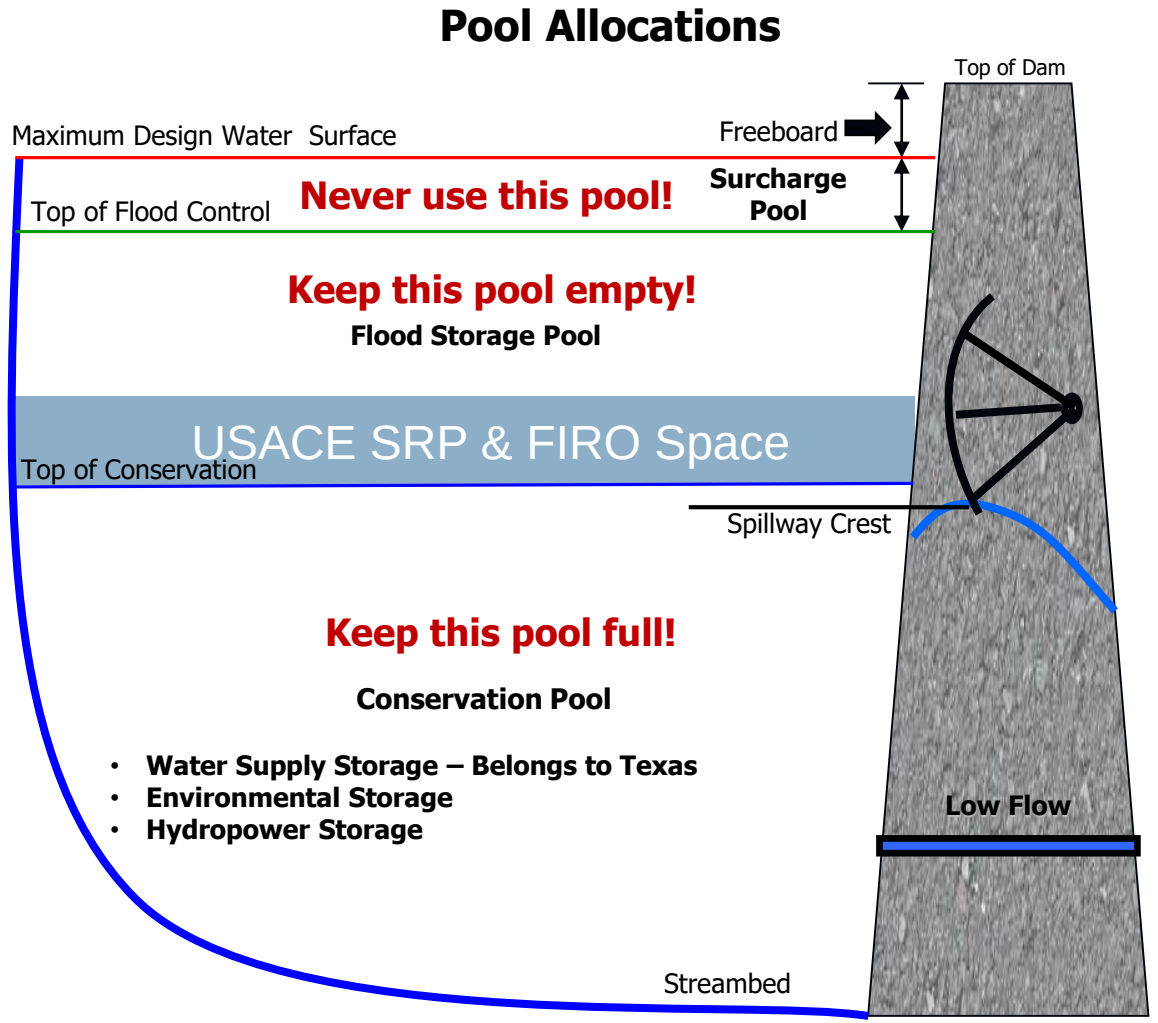


USACE OPERATIONS – WHAT ARE SRP & FIRO OPERATIONS

- 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
  - **Forecasts are used**

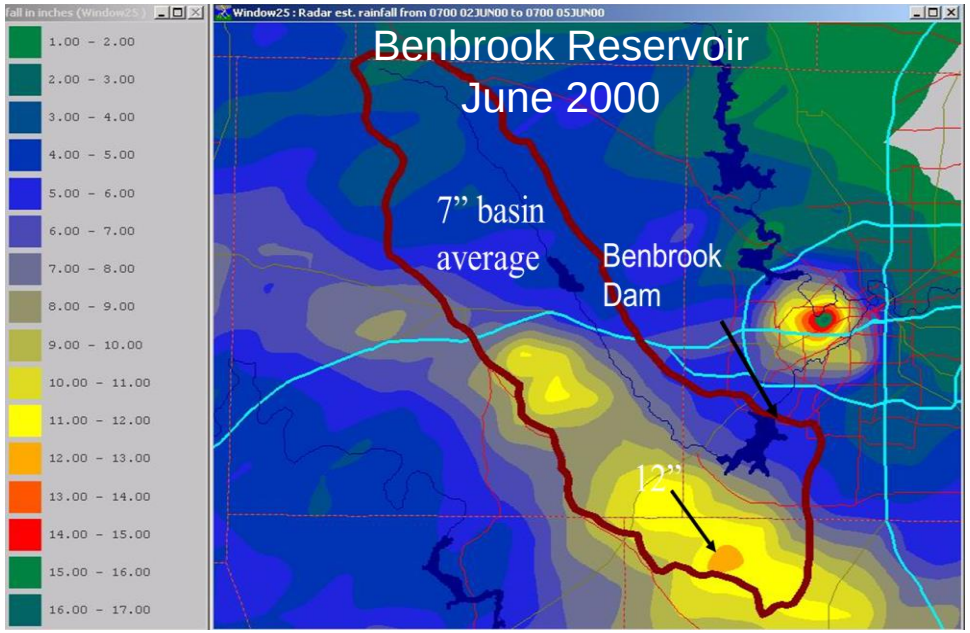
- USACE FIRO (adaptive management)
  - Explores technology driven flexibilities
  - Targets lower 5% - 20% of flood pool
  - Climatology currently supports limited FIRO
  - Requires improvements in sub-seasonal and seasonal forecasts
  - Initially supported thru deviations
  - GOAL: Codified within a WCP
  - Broad national and regional support
  - Identifies the need for greater investments in weather/climate prediction research

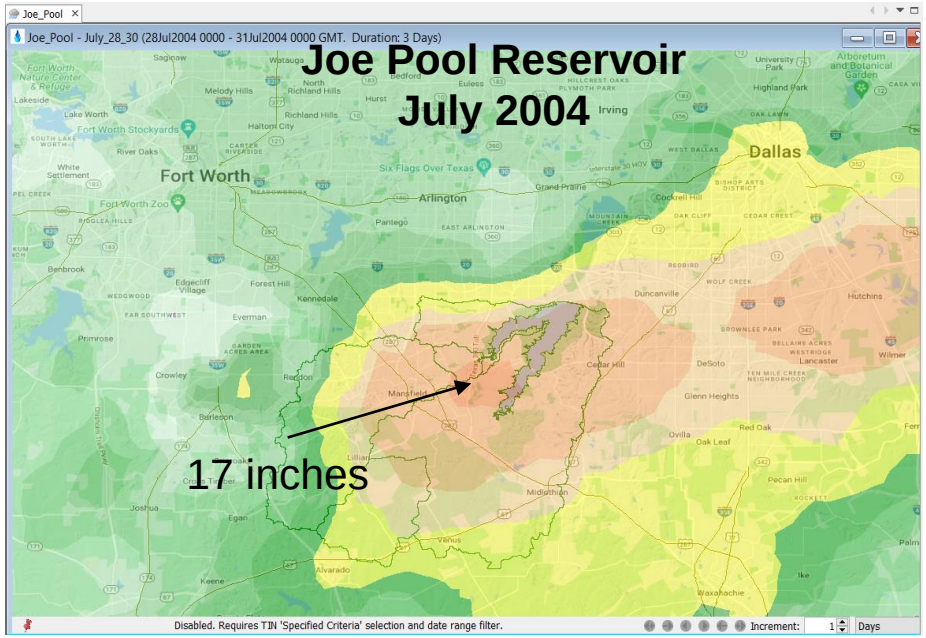
- USACE SRP Space (adaptive management)
  - Operational flexibilities for lower 20% of FP
  - Taper program
  - Improving releases in lower portion of the flood pool
    - Enhancing biology
    - Threatened and endangered species
    - Recreation opportunities
  - Goal: Codified within a WCP

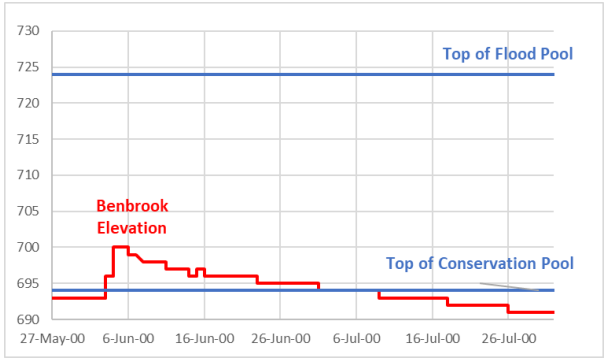


EXTREME EVENTS – SMALLER EVENTS WITH DRY ANTECEDENT CONDITIONS

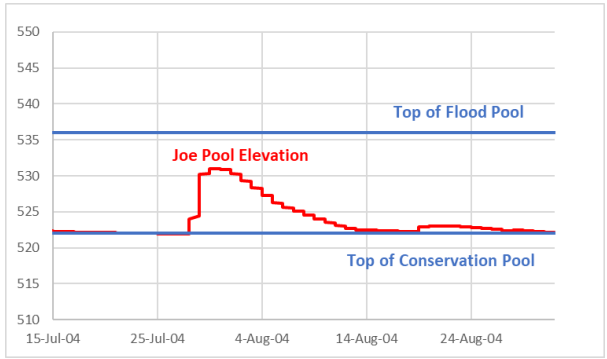
- Reservoirs are designed to operate thru extreme events
- June 2000 and July 2004 dry WS events suggest:
  - ➢ Projects operate through 12” & 17” events
  - ➢ 15% storage in Benbrook
  - ➢ 50% storage in Joe Pool
  - ➢ Ok for FIRO 5% - 20 % retention in flood pool







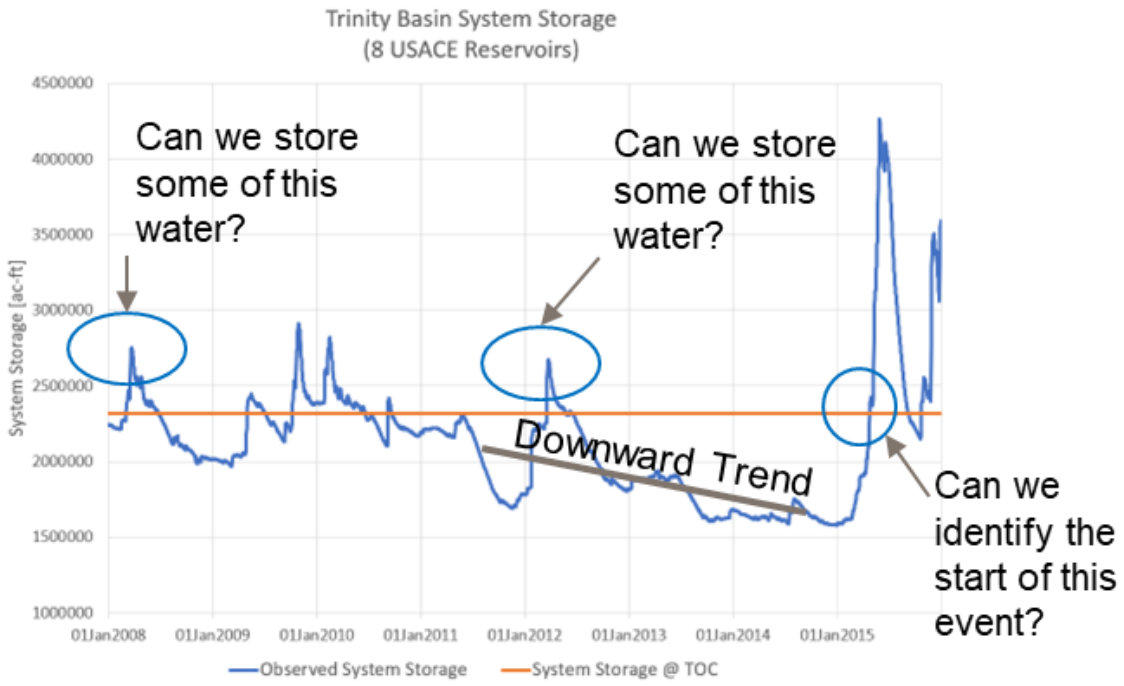
Benbrook Lake rose 6’



Joe Pool Lake rose 12’

INITIAL FIRO GOALS

- More water available without costly infrastructure investments
- Storing flood water in late spring and early summer (reduced 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

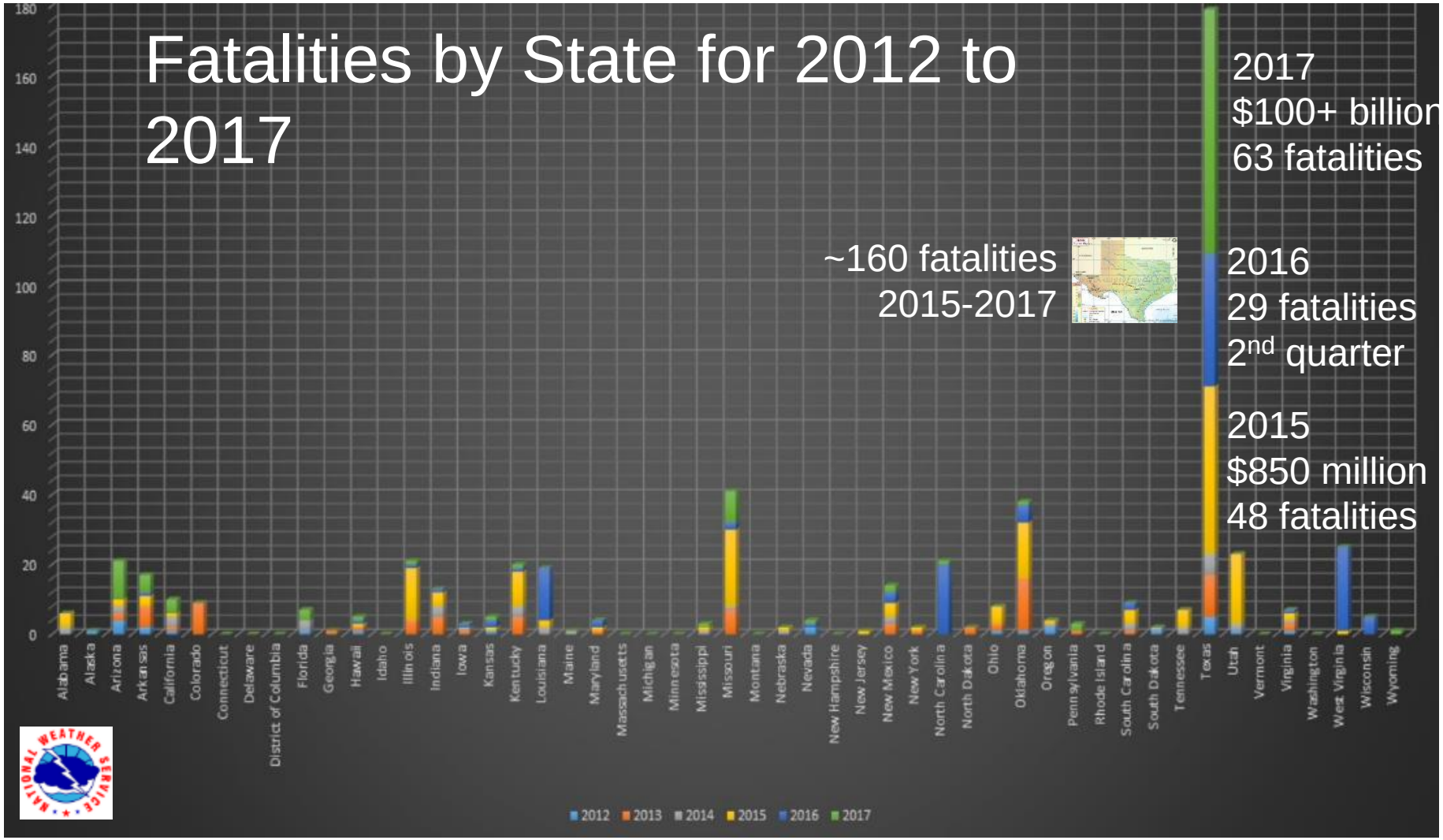


SUSTAINABLE RIVERS PROGRAM OBJECTIVES

- Build collaboration across competing business lines
- Modify reservoir releases to provide additional benefits
  - Environmental
  - Socioeconomic
  - Cultural
  - Recreational
- Think of the future and identify needs outside of SRP. USACE CAP programs for environmental restoration, fish habitat
- Build partnerships the research community
- Advocacy – we can accomplish SRP but only with your help

FLOODING FATALITIES AND DAMAGES

Texas far outpaces other states in flood related fatalities & flood related damages



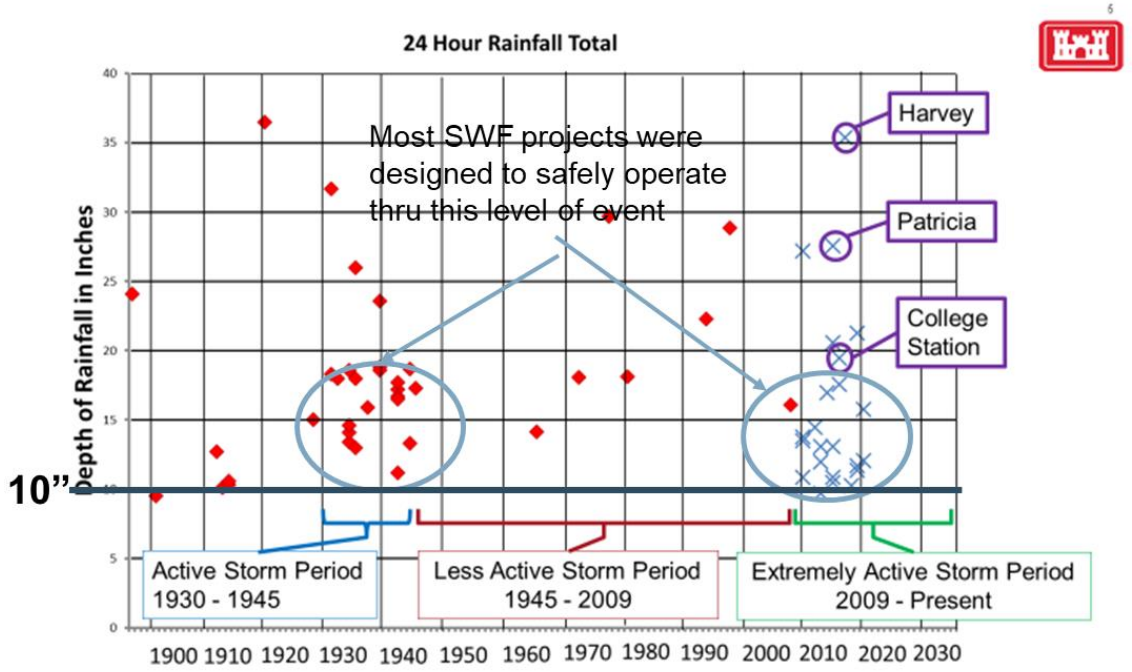
5 Year Tally of Flood Fatalities

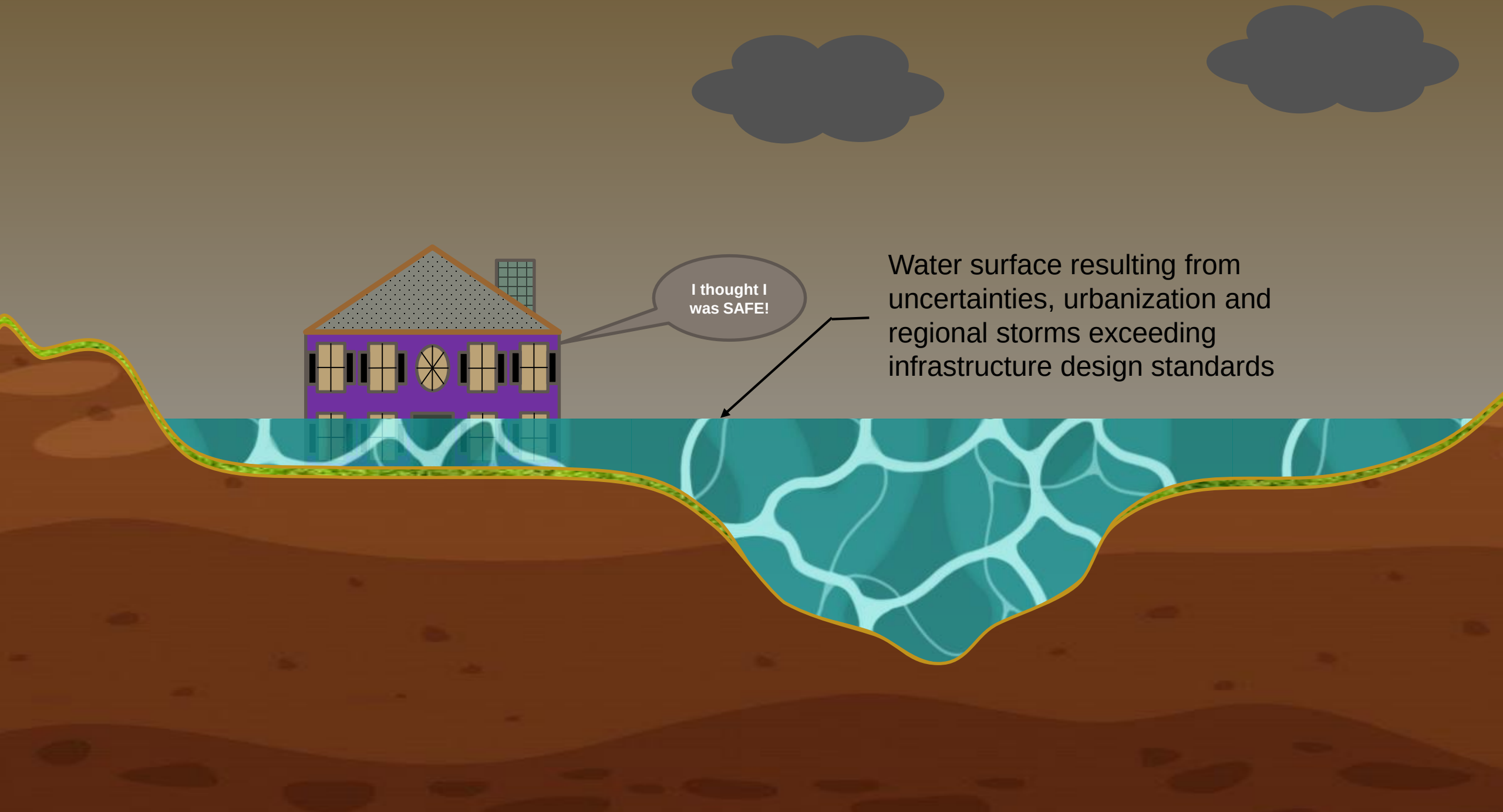
North Central Texas Council of Governments

(Source: Gregory Waller, Service Coordination Hydrologist, NWS – West Gulf River Forecast Center, http://www.nws.noaa.gov/om/hazstats.shtml, 11/18 TFMA)

FLOODING CYCLES

- Severe flooding events in Texas can occur anytime
- Normally 1-2 events per decade exceed infrastructure design standards
- Severe flooding events in Texas also occur in cycles
- 1930-1945 with over 20 events exceeding infrastructure design standards
- 2009-2020 with over 20 events exceeding infrastructure design standards
- Events can exceed 35” in 24 hours
- Most common are < 20” in 24 hours
- DFW standard is 10” in 24 hours

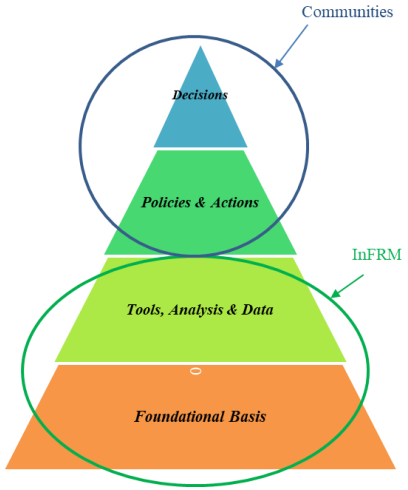



I thought I was SAFE!
Water surface resulting from uncertainties, urbanization and regional storms exceeding infrastructure design standards

INTERAGENCY FLOOD RISK MANAGEMENT (INFRM)

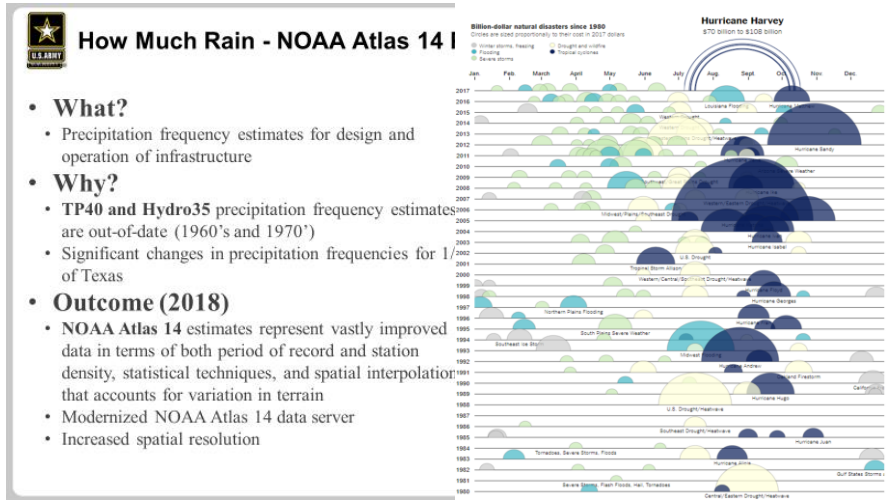
- Multi-agency collaboration and expertise
- Established 2014
- Integrated Water Resources Science and Services (IWRSS) program
- **Supports Statewide/Regional/Watershed approach**
  - **Incorporates regulation from dams**
  - **Spans community boundaries**
- Leveraging information, programs and resources across agencies
- Actionable data, tools and analysis for communities
- InFRM Academic Council 2017 (IAC)
  - Links researchers and applied scientist/engineers
- www.InFRM.us

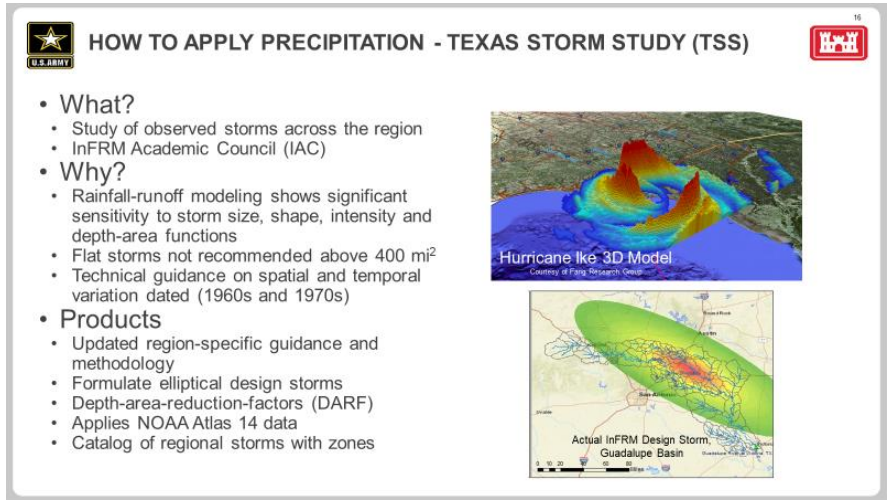
InFRM Academic Council

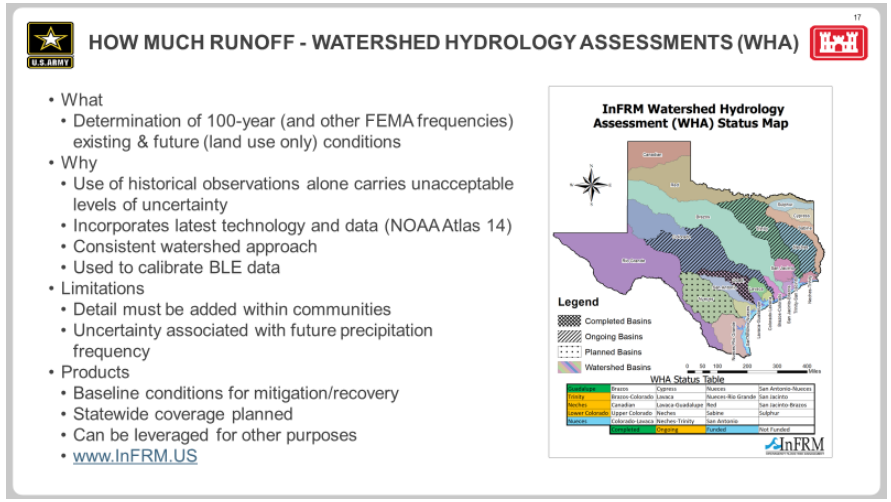


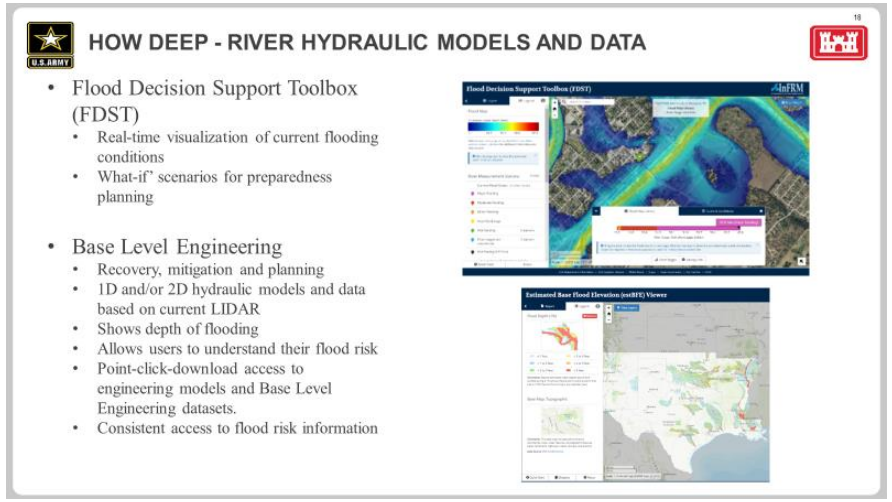
INVESTMENTS IN NEW TECHNOLOGIES, TOOLS AND DATA

- NOAA Atlas 14 – Provides state-of-the-art precipitation frequency estimates in a spatial viewer
- Texas Storm Study – Informs us in how to formulate design storms using NOAA Atlas 14 data
- Watershed Hydrology Assessments – Determine the 100-yr and other runoff values used to design infrastructure
- BLE and the FDSTB tell us how deep the water will be with the runoff reaches the river



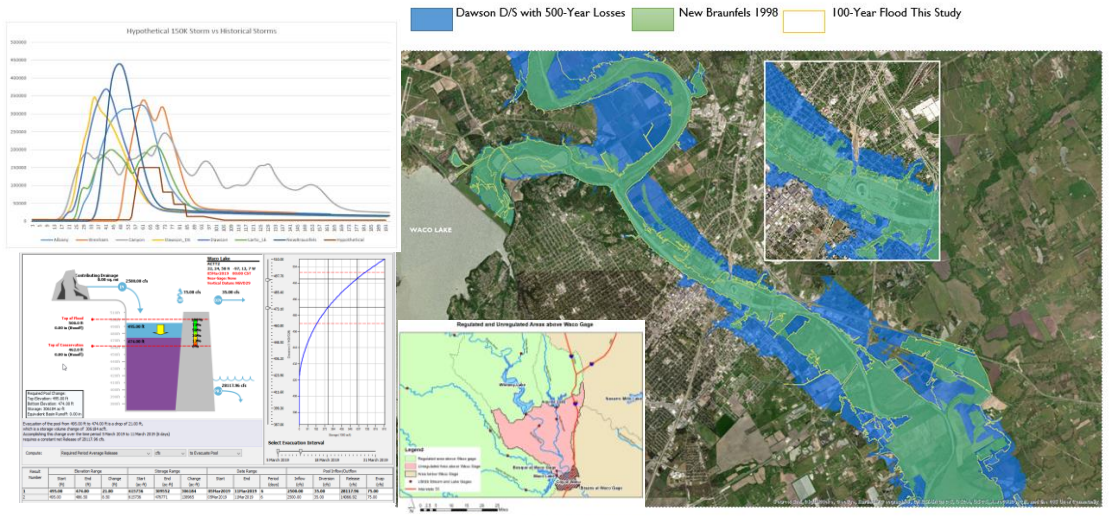


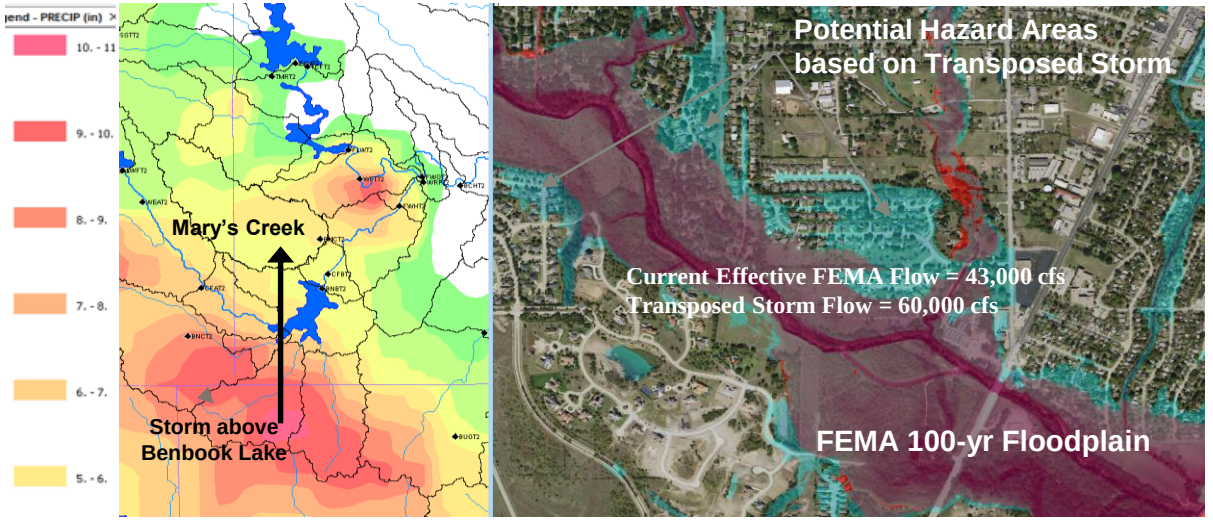




WHAT-IF SCENARIOS - METVUE STORM SHIFT TECHNOLOGY

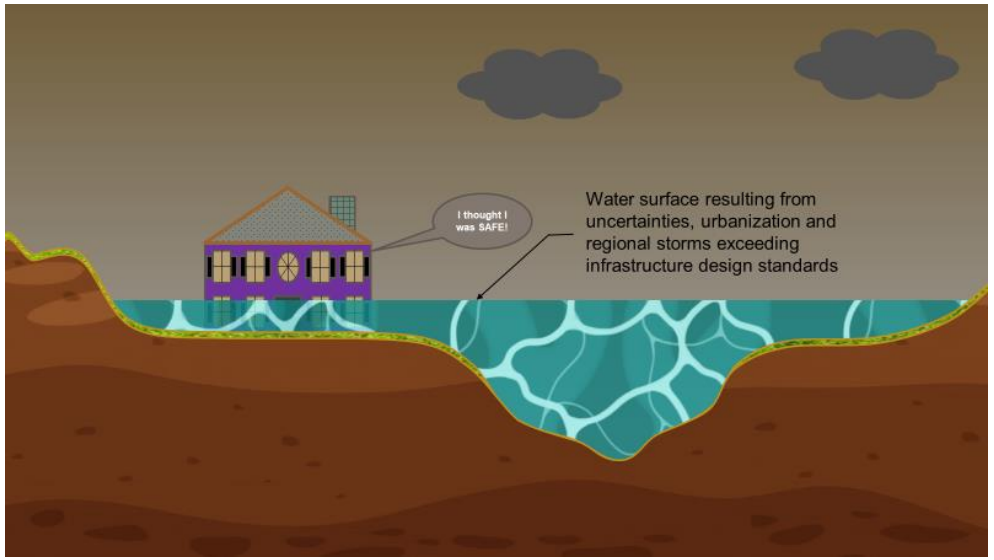
- Waco, TX
  - **Issue:** Uncertainty and dam operations
  - Shifted range of storms
  - Examined different operational constraints, multiple scenarios
  - **Outcome:** Illustrated full risk envelop
- Mary's Creek, DFW, TX area
  - **Issue:** Uncertainty
  - Shifted 2010 100-year± storm 10 miles
  - **Outcome:** Decreased uncertainty, full risk envelop
- Dallas County, TX
  - **Issue:** Uncertainty & lack of FRM data
  - Shifted range of storms
  - **Outcome:** Decreased uncertainty, full risk envelop

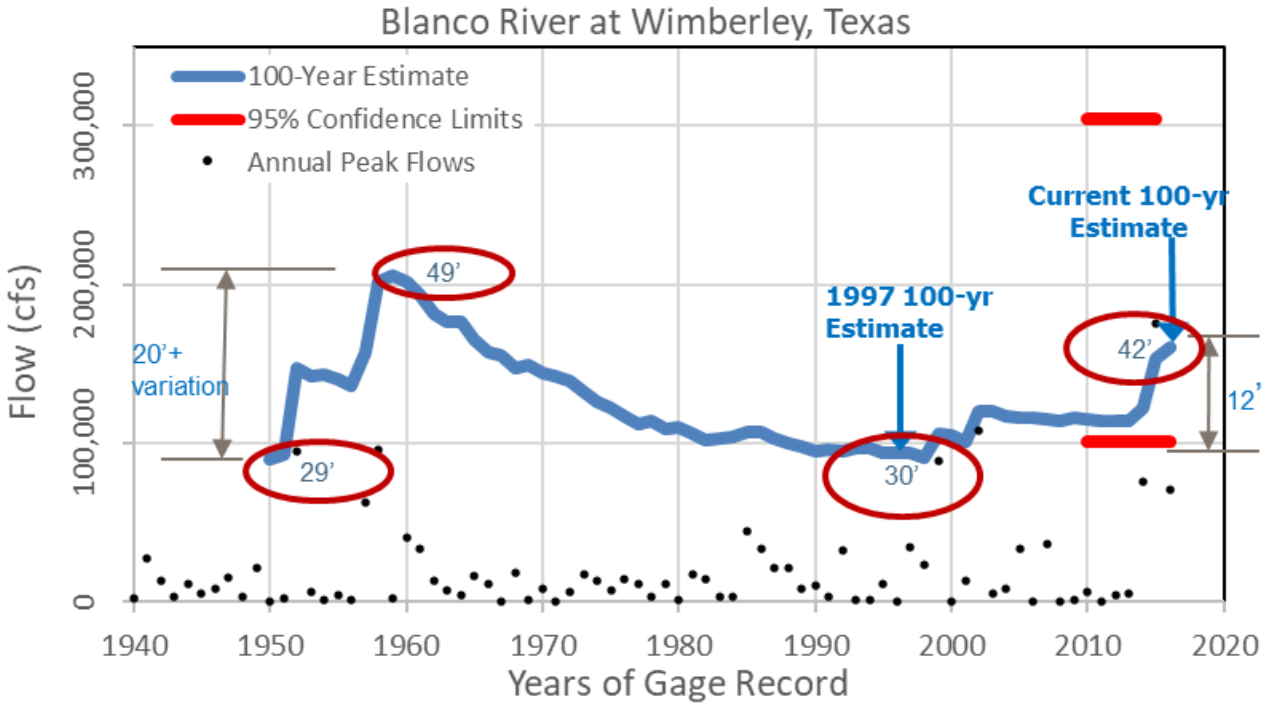




INFRM PRODUCTS ARE IMPORTANT – A CASE STUDY?

- Statistical Hydrology - The most commonly used techniques to estimate flood and rainfall frequencies rely on observations
- Need record length 3-4 times estimated return interval
- Short Observation Periods - On average TX has 50 years of stream record and 70 years of precipitation records
- Significant variability and/or non-stationarity observed in flood flow and rainfall frequency estimates

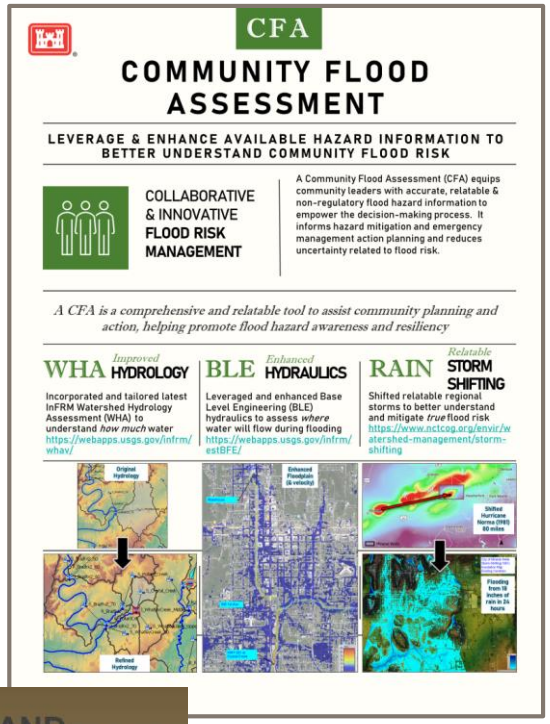


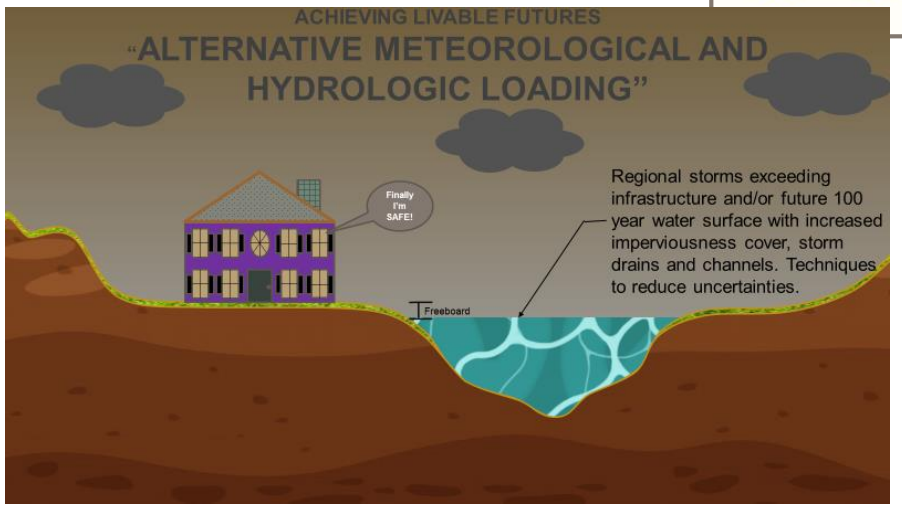


WHAT HAPPENS WHEN WE DON'T MANAGE FLOOD SCIENCE UNCERTAINTIES?

BRINGING IT ALL TOGETHER - COMMUNITY FLOOD ASSESSMENTS

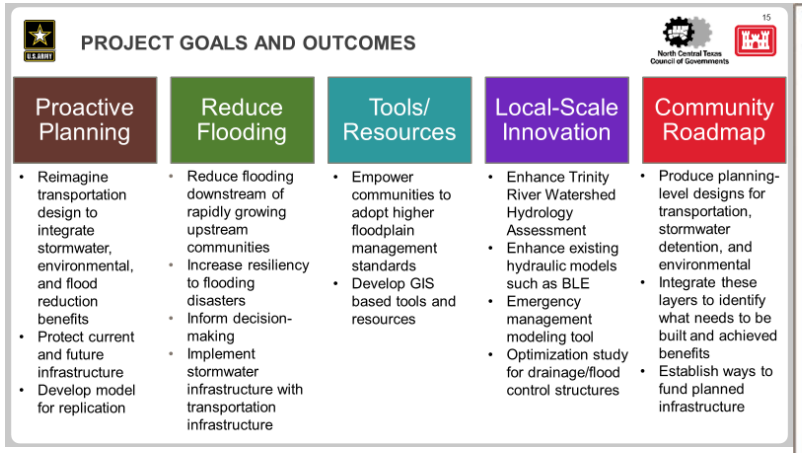
- InFRM products allow communities to understand the full range of flood risk they face
- Community Flood Assessments
  - Utilize Watershed hydrology Assessments (WHA)
    - Incorporate latest precipitation frequency estimates from NOAA ATLAS 14
    - Formulate NOAA ATLAS precipitation estimates into appropriate design storms
    - Determine runoff for 100-year and other frequency storms
    - Determine runoff from regional storms matching frequency design storms (storm shifting)
    - Determine runoff from nearby storms exceeding infrastructure design standards (storm shifting)
  - Utilize and enhance BLE data
  - Provide the full flood risk envelop for communities
  - Allow communities to make infrastructure adjustments which will enable them to better manage flooding disasters
- Provide a starting point for mitigation designs
- Provide the data and analysis to apply for flood mitigation grants and funding from organizations like TWDB, FEMA, USACE
- Provide the basis for flood warning systems

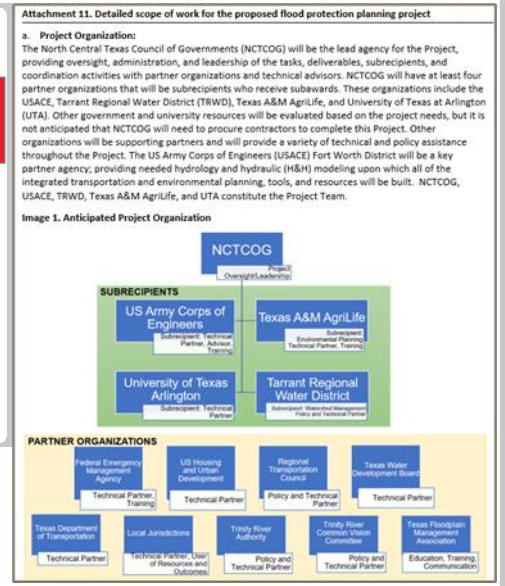


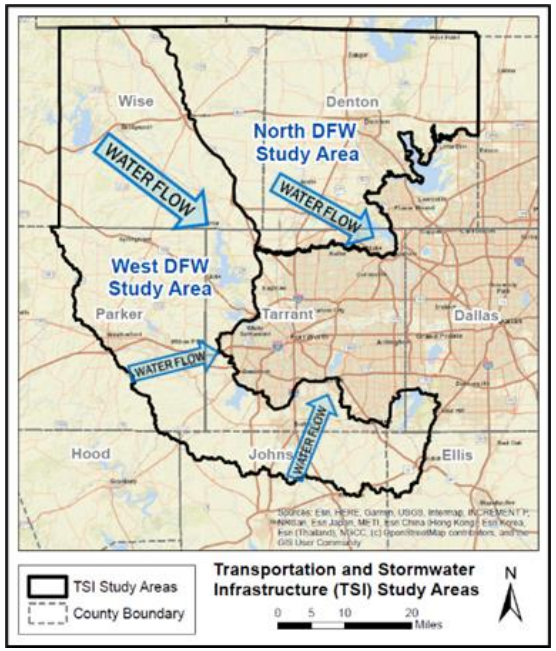


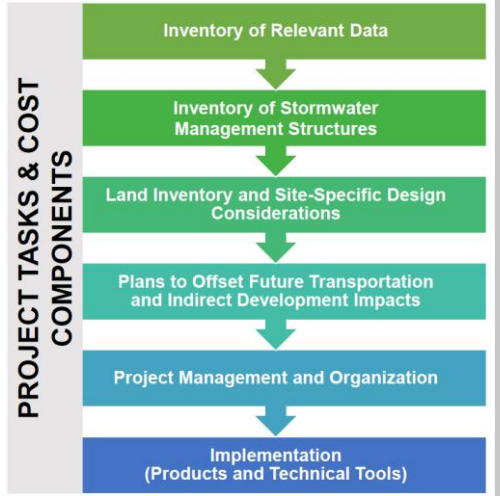
TSI PROJECT SUMMARY

- **Project Organization:** NCTCOG is lead agency for project with subrecipients including (but not limited to) USACE, Tarrant Regional Water District (TRWD), Texas A&M AgriLife, and University of Texas at Arlington (UTA).
- **Purpose:** Minimize overall life cycle costs, decrease flood risk, and reduce impacts to the natural environment as a result of future population growth in study area.
- **Scope: Proactive vs. Reactive** through integration of regional stormwater management, urban development, transportation, and environmental planning: a collaborative effort with regional Transportation planners
- Identify impacts and alleviate risks from severe weather events such as flooding in (and downstream of) rapidly developing study areas 100-yr and alternative hydrologic loading
- Develop a comprehensive and transferrable plan for risk awareness and resiliency
- Utilizes InFRM products
- **Timeline & Budget:** 3-5 years and $10 million (via NCTCOG, TWDB, transportation & GLO)
- Yes, opportunities for the AE community









QUESTIONS?

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