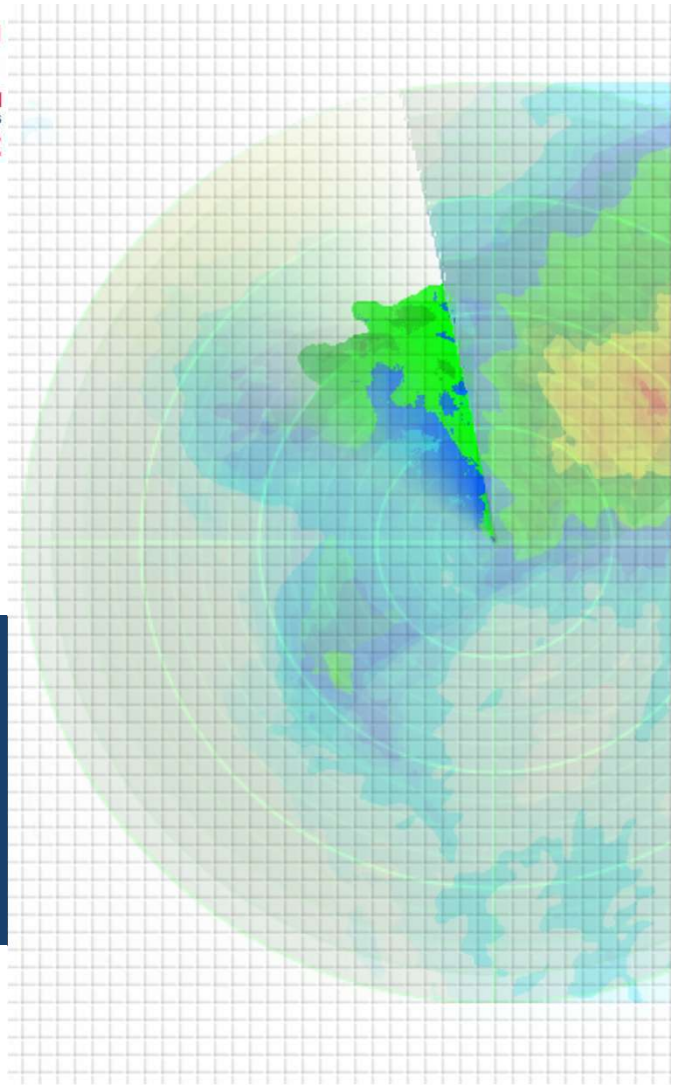
WERC
Water Engineering
Research Center

Society of SAME American Military Engineers Fort Worth Post

WATER ENGINEERING RESEARCH CENTER (WERC) – BUILD A RESILIENT COMMUNITY



Nick Z. Fang, Ph.D., P.E.,
Robert S. Gooch Endowed Professor
Director, Water Engineering Research Center (WERC)

Matthew Lepinski, P.E.
Assistant Program Director, Water Engineering Research Center (WERC)
The University of Texas at Arlington

Presented at the SAME June Monthly Meeting – 6/3/2026

UTA

Drought/Heat Wa

Central and Northeaster
Severe Weathe
June 24–2

Northwest Winter Storr
January 12–1

Colorado Hail Storms an
Southern Severe Weathe
May 31–June

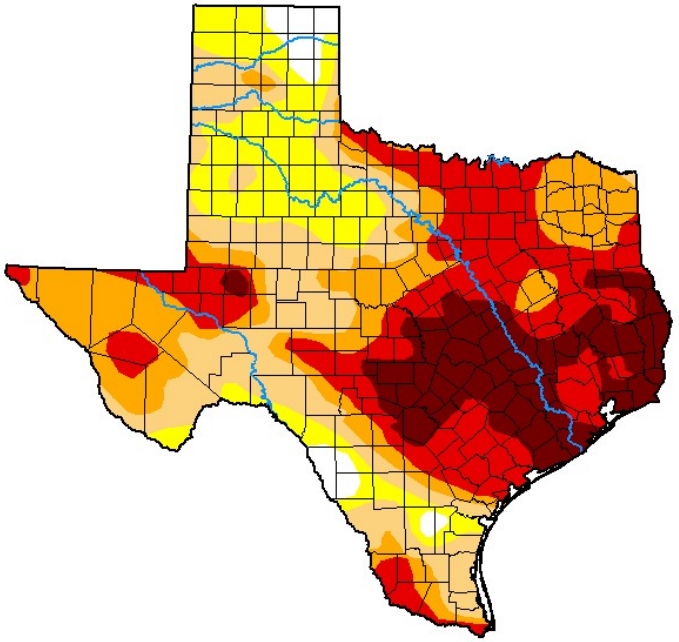
Central and Eastern
Severe Weathe
June 12–1

Central and Easter
Severe Weathe
March 12–1

Southern/East
Drough

This map c

U.S. Drought Monitor
Texas



September 19, 2023
(Released Thursday, Sep. 21, 2023)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	3.03	96.97	81.91	61.33	40.76	16.02
Last Week 09-12-2023	3.04	96.96	85.67	68.27	43.59	18.56
3 Months Ago 06-20-2023	41.61	58.39	22.81	6.31	1.37	0.29
Start of Calendar Year 01-03-2023	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year 09-27-2022	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago 09-20-2022	21.16	78.84	60.11	31.76	8.34	0.62

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:
Richard Heim
NCEI/NOAA

droughtmonitor.unl.edu

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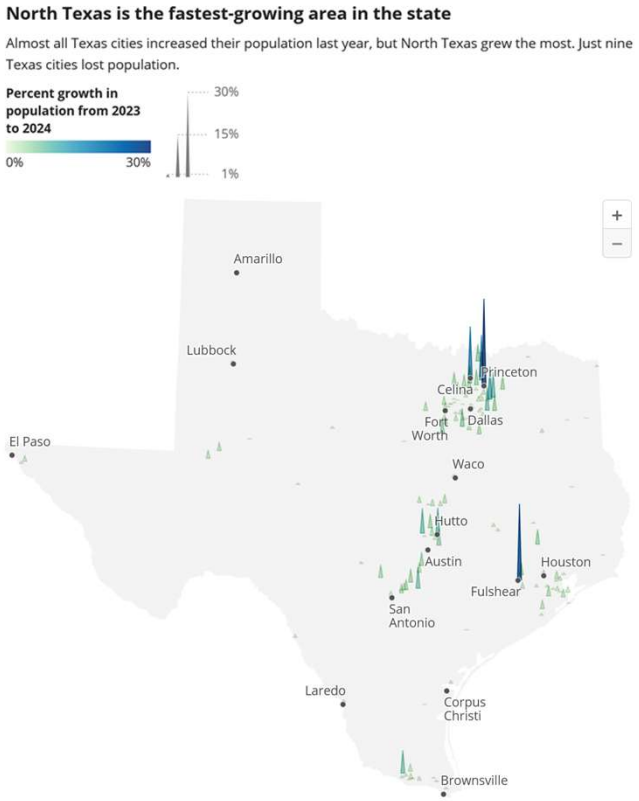
WERC Water Engineering Research Center

POPULATION GROWTH

Seven out of the 15 fastest-growing places in U.S. are in Texas

	City/Town	State	2023	2024	Percent growth
1	Princeton	Texas	28,336	37,019	30.6%
2	Fulshear	Texas	43,033	54,629	26.9%
3	Leesburg	Florida	31,913	37,815	18.5%
4	Celina	Texas	43,700	51,661	18.2%
5	Anna	Texas	27,909	31,986	14.6%
6	Haines City	Florida	37,538	42,073	12.1%
7	Foley	Alabama	25,031	28,043	12.0%
8	Fate	Texas	24,666	27,467	11.4%
9	Rosemount	Minnesota	27,654	30,581	10.6%
10	Garner	North Carolina	35,654	39,345	10.4%
11	Melissa	Texas	23,812	26,194	10.0%
12	Sugar Hill	Georgia	26,111	28,598	9.5%
13	Hutto	Texas	38,980	42,661	9.4%
14	Leland	North Carolina	31,495	34,451	9.4%
15	Erie	Colorado	35,333	38,594	9.2%

Source: The Texas Tribune /U.S. Census dated 5/15/2025



LONG-TERM WATER AVAILABILITY FORECAST

An innovative data-driven based method for estimating Net Water Availability (NWA)

- NWA = Precipitation (P) – Evapotranspiration (ET)
- Better than Climate Model outputs

Decadal Projection until 2070

- Moderate Warming (SSP 245)
- Extreme Warming (SSP 585)
- Compared with TWDB Water Demand Projections
- For each Regional Water Planning Areas

Li, W., Li, D., Fisher, J., and **Fang, Z.N.** (2023). "Evaluating future water availability in Texas through the lens of a data-driven approach leveraged with CMIP6 general circulation models", Science of the Total Environment, Volume 921, 2024, 171136, https://doi.org/10.1016/j.scitotenv.2024.171136.

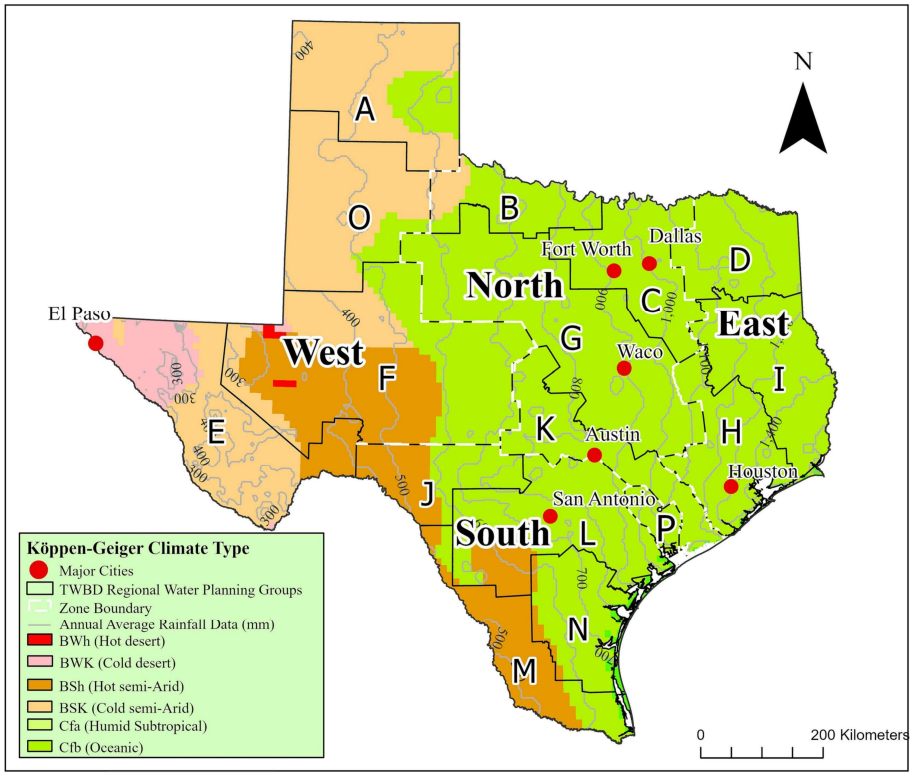
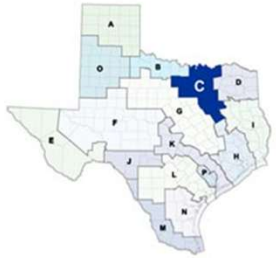


Figure: Texas Köppen-Geiger climate type overlaid with regional water planning areas and major cities. Source: USDA NRCS; TWDB; Kottek et al. 2006

Region C



Major Cities

Dallas

Fort Worth

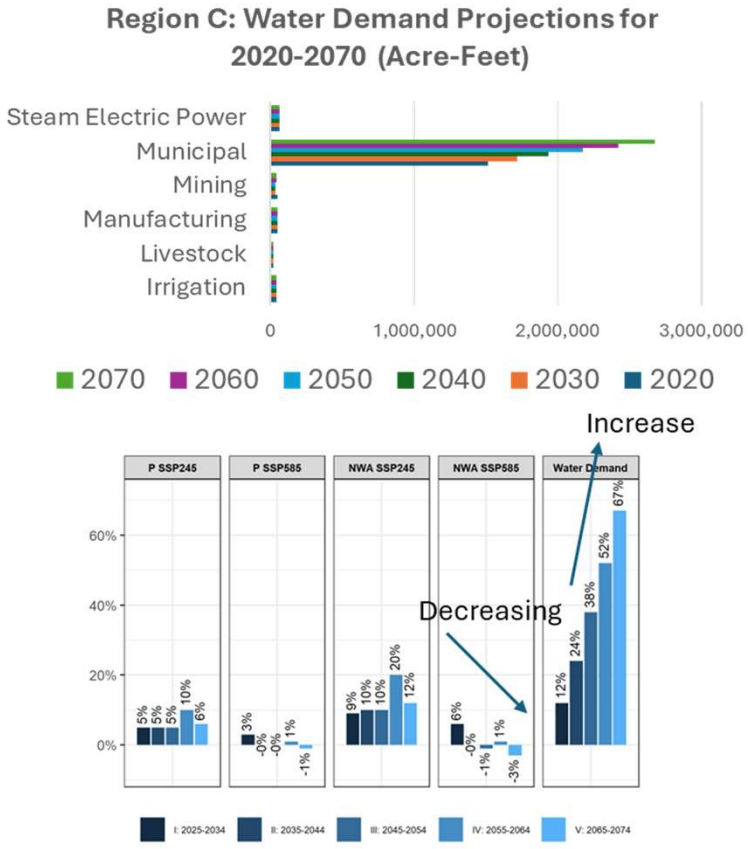
Water Demand

Fast Increasing Municipal Demand

67% more by 2070s

Water availability

Compared with 2020s, **12%** more (moderate warming) and **3%** less (extreme warming) by 2070s



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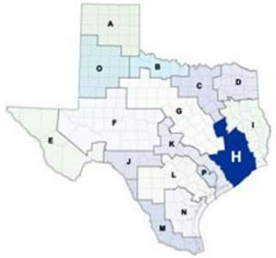
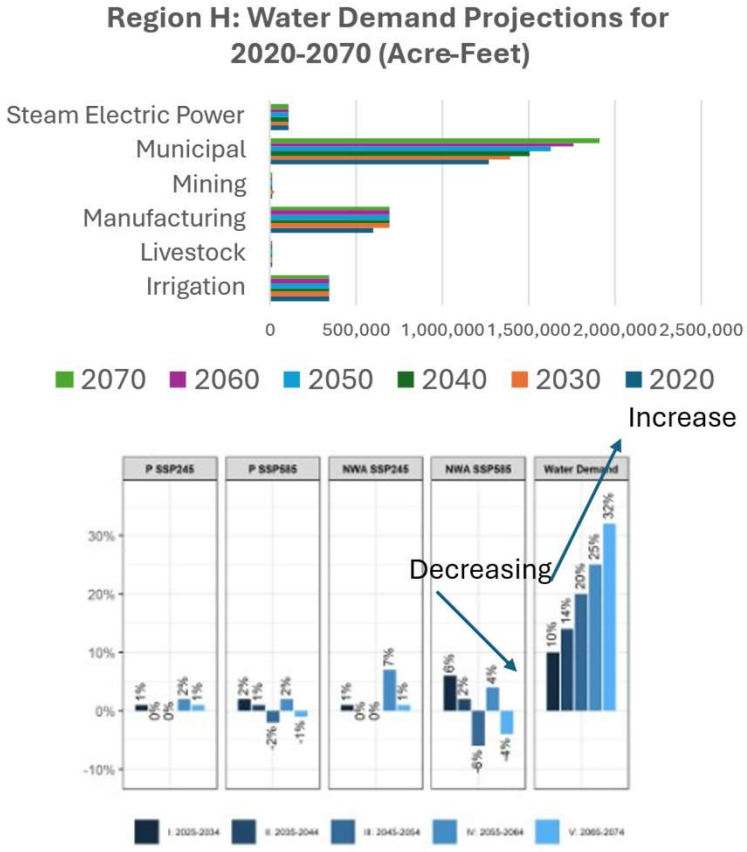
Region H



Major City	Water Demand	Water availability
Houston	Fast Increasing Municipal Demand, high demand of manufacturing and irrigation **32%** more by 2070s	Compared with 2020s, **1%** more (moderate warming) and **4%** less (extreme warming) by 2070s



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Water Engineering Research Center

- To tackle emerging challenges related to population growth, increased development, and changing climate in North Texas.
- To gain solid knowledge to ensure safe, sustainable water supplies and mitigating the impacts of extreme events on North Texas.
- To transform challenges into opportunities via more performing holistic research in collaboration with interdisciplinary educators, researchers, agencies, industries, and regulators to develop multidisciplinary strategies and sustainable solutions for urban waters and energy
- To help build public-private partnerships to address pressing needs associated with urban water issues.

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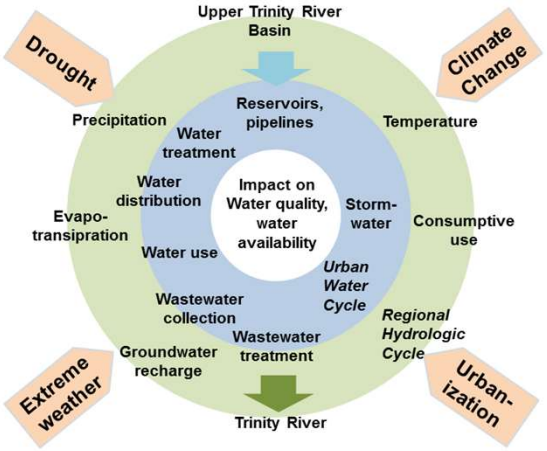


WATER ENGINEERING RESEARCH CENTER

- Newly established research center focusing on developing innovative water technologies and practical strategies that drive economic growth and sustainable development.
- Dedicated to addressing complex challenges in water resources, particularly in the State of Texas.
- Conducts vital projects that turn sciences and engineering into actionable solutions for flooding, stormwater, water supply, quality, and environmental resilience for the State of Texas and beyond.
- Recognized by the state legislators and across the nation, the WERC is one of the pioneering research thrusts that UTA invested in recent years.

WERC TEAM MEMBERS

Nick Fang, Ph.D., P.E
Director

Jerry Cotter, P.E
Program Director.

Daniel Li, Ph.D., P.E. Asst. Prof in Research

Matthew Lepinski P.E., Asst. Program Director

Shannon Abolmaali, Ph.D., Asst. Prof. in Research

Emily Halverson Administrative Assistant

Asim Paudel, GR

Binu Devkota, GR

Kelli Greenwood, GR

Mostafa Banihashem, GR

Sugam Mahat, GR

Pouria Fakhrabadi, GR

Hemanta Adhikari, GR

Jack Yohn, UGR

Jason Escobar, UGR

Rachel Chen, UGR

Amol Paudel, UGR

Isabella Rios, UGR

WERC Water Engineering Research Center

TSI Study Overview

TSI: *Integrating **T**ransportation and **S**tormwater **I**nfrastructure*

- **Proactive vs. Reactive**
- **Regional "System" Approach**

www.nctcog.org/tsi

Objective: a "roadmap" for communities

integrating **Transportation** & **Stormwater Infrastructure**

TSI Study Objectives

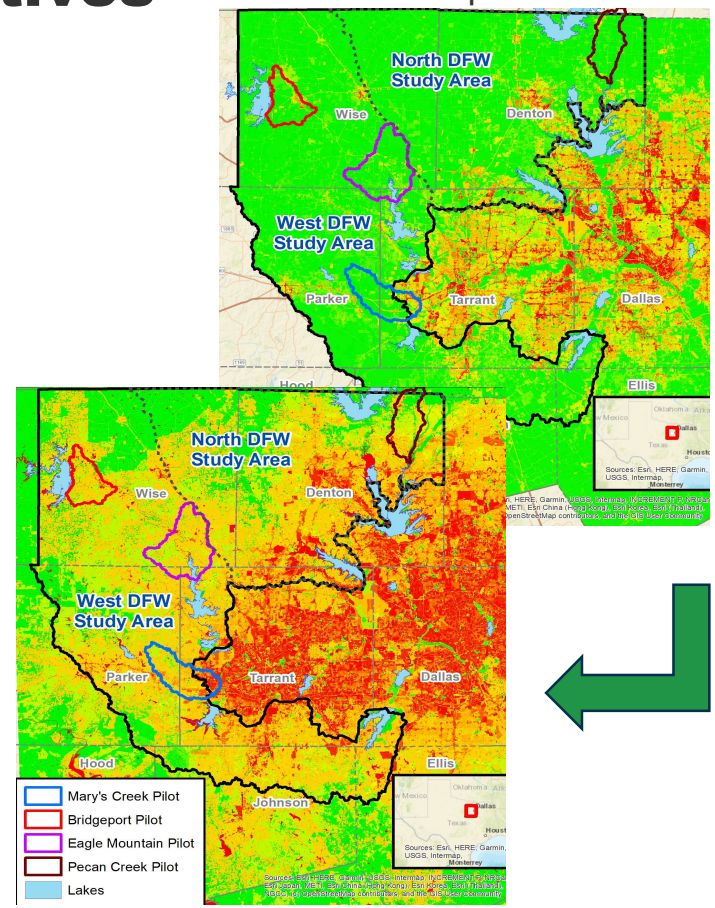
$10+ million comprehensive planning study

- Proactive planning
- Stormwater, environmental, and transportation infrastructure integration
- Safety of residents, property, and infrastructure
- State-of-the-art flood hazard area models
- Flood warning system framework
- Innovative infrastructure, nature-based solutions, and regulatory approach resources
- Tools, literature, and data

Expected completion:

- **Fall 2026**

2020 % impervious



2070 % impervious

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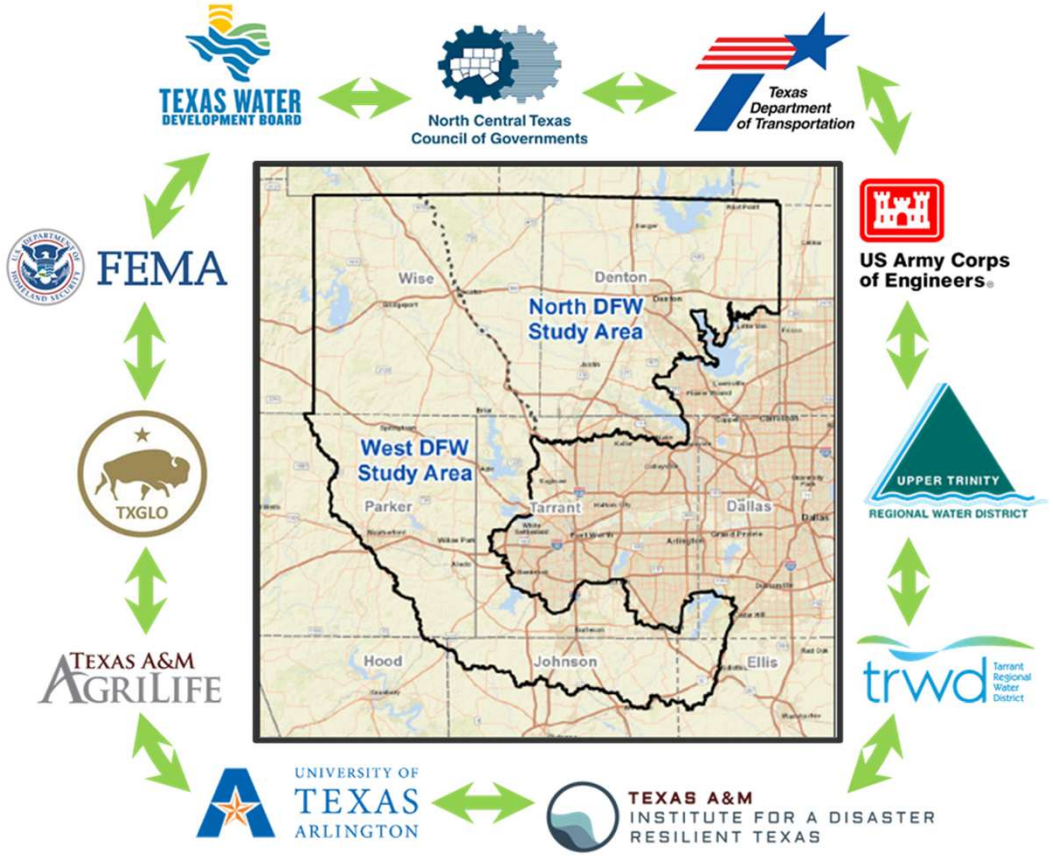
TSI Study Partners

Consultant Partners:

- Freese and Nichols, Inc.
- Halff Associates, Inc.
- Highland Economics



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Criticality of Transportation/Stormwater Integration

- High transportation and stormwater infrastructure costs
- Failures disrupt access, reliability, and system performance
- Flooding risks concentrated at road crossings and bottlenecks
- Upstream development overwhelms downstream systems

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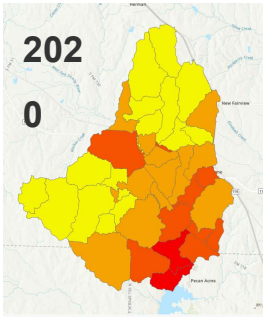
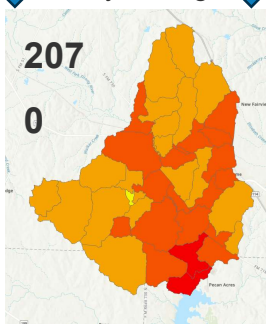
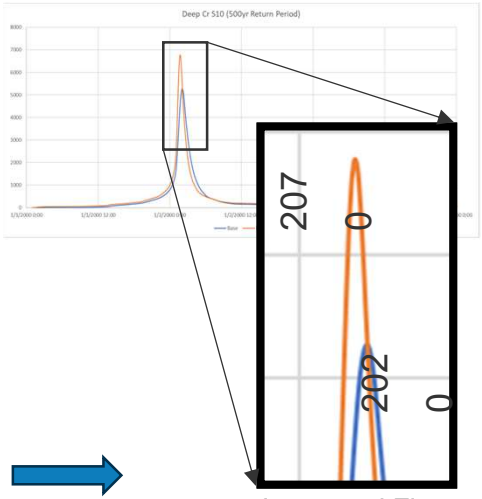
Enhanced Drainage Models to Optimize Alternatives

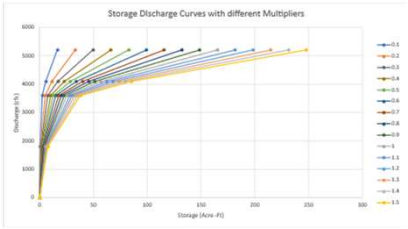


Urbanization Changes to Permeability and Valley Storage





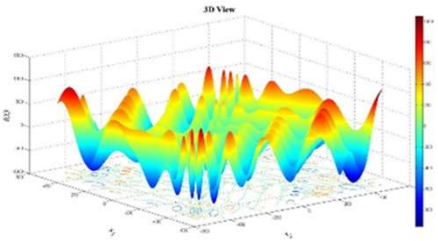
Increased Flow



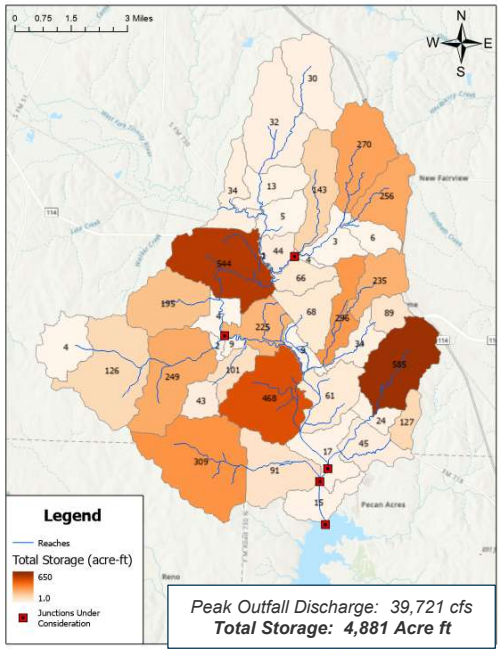
Vary Storage Values to Best Reduce the Peak Flow

Set Up Hydrologic & Hydraulic (H&H) Model w/ Reservoirs at Each Subbasin

Optimize Flow Resistance and Storage Values Generated from H&H Model Runs



Distributed Detention Optimization Example – **Eagle Mountain Pilot**

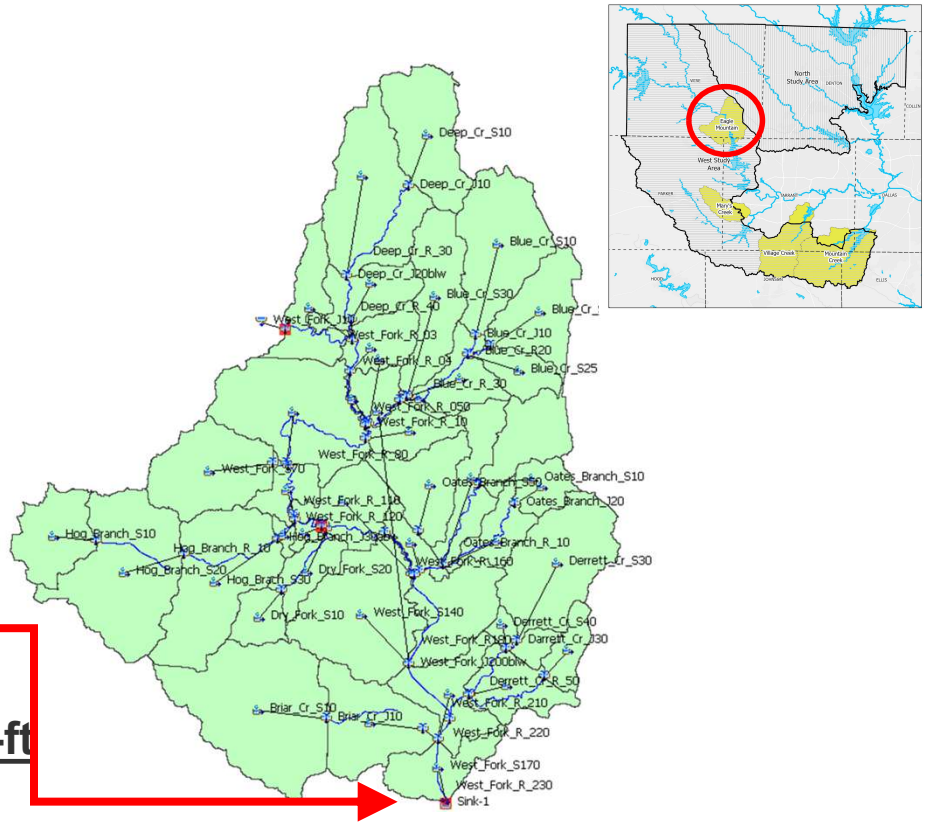


Focus on Critical Reaches and Transportation Junctions for **Reducing Flow to 2020 Conditions**

integrating **Transportation & Stormwater Infrastructure**

EXAMPLE: Optimization Summary

- Basin Model Information
  - ~75 square miles
  - 41 Subbasins and 42 Reaches
- Anticipated Imperviousness Increase
  - Avg: **25**%
  - Max: **47**%
- Anticipated Reduction in Response Time
  - Avg: **-0.41** hr
  - Max: **-0.67** hr
- Downstream Peak Discharge
  - 2020: **40,300** cfs
  - 2070: **51,100** cfs
- Theoretical Storage Required: **6,200 acre-ft**



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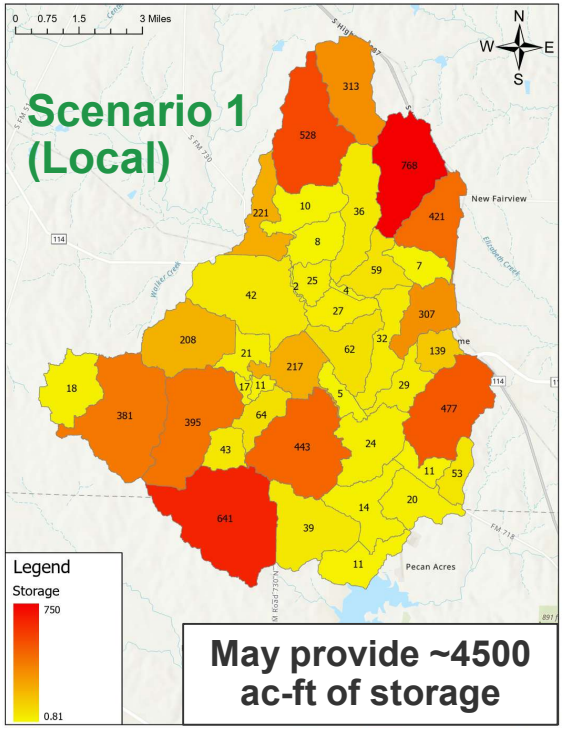
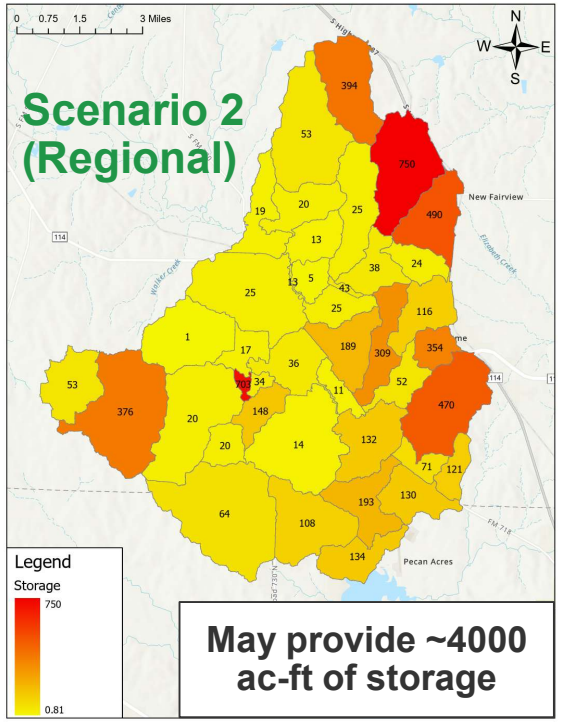
EXAMPLE: Optimization Results



- Flows limited to current levels
- Both options provide benefit but still result in less storage than theoretical requirement
  - A menu of options is needed

Note: All results are considered preliminary and are subject to change.



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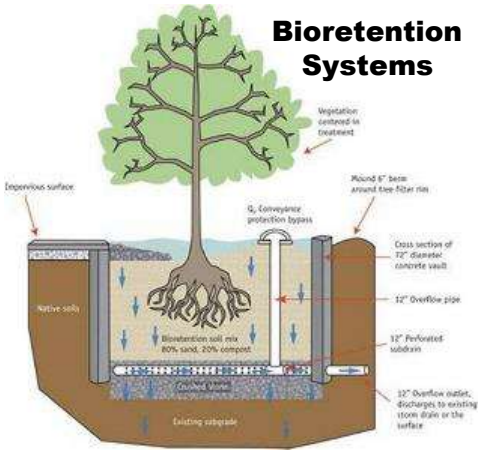
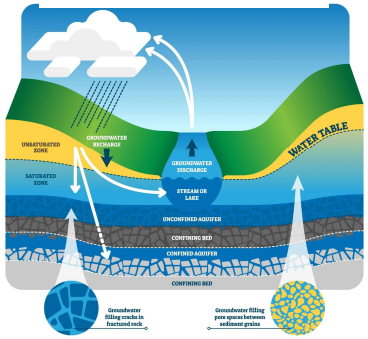
TSI Integration: Menu of Options

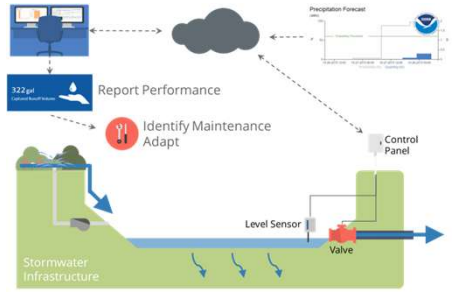
Bioretention Systems



Groundwater Recharge/Reuse



Smart Stormwater Infrastructure



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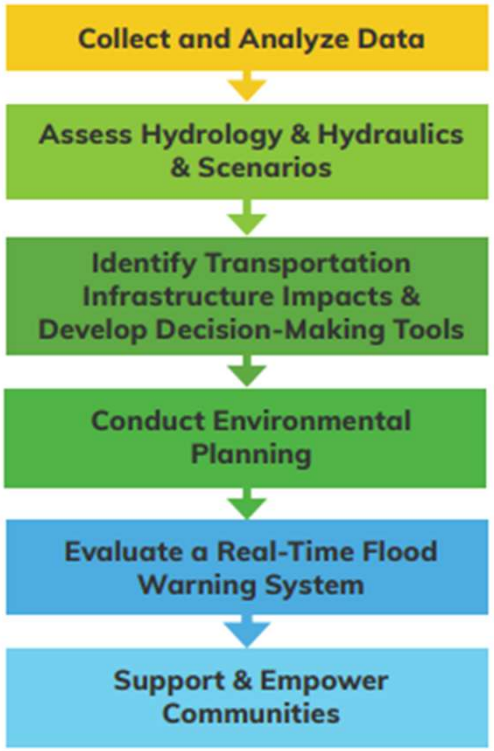
Menu of Options Examples

- Hydrology and Hydraulic Modeling Enhancements
- Alternatives Analysis
- Transportation and Detention/Retention Integration
- Transportation Planning Linkages
- Flood Control Prioritization
- Green Stormwater Infrastructure Implementation
- Flood Early Warning Systems Planning
- Funding Opportunities
- Policy Recommendations



Project Example: TSI Integration

- Integrated transportation, stormwater, and environmental elements
- Static control structure limiting the discharge and generating storage volume

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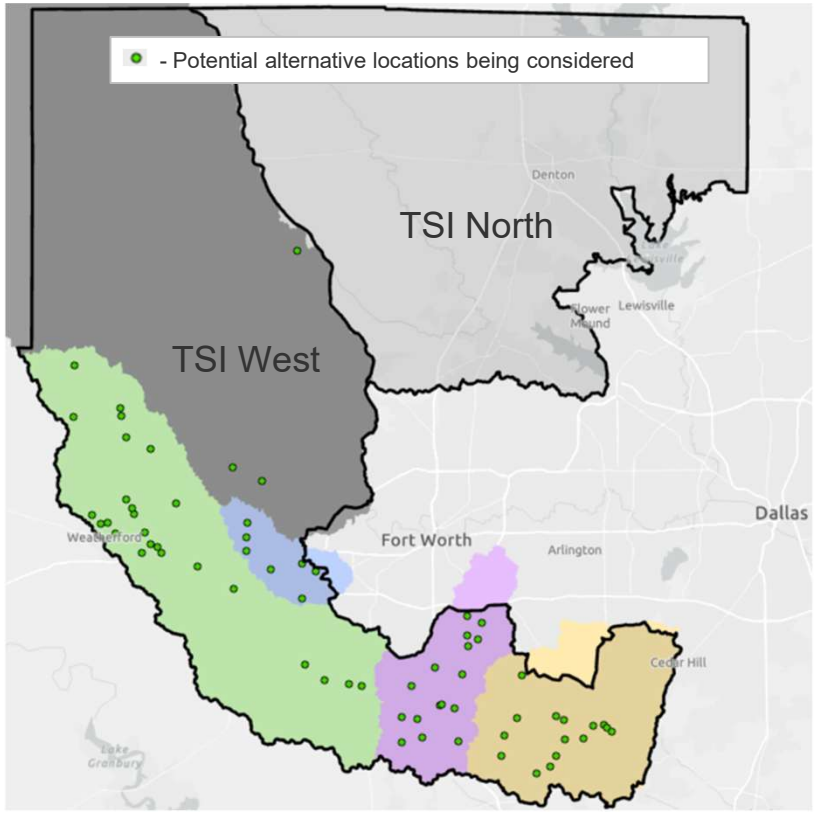
TSI Flood Mitigation Alternatives *(in progress)*

- **Goal – Reduce current and future flows**
- **Considerations:**
  - Effective flood reduction?
  - Avoids negative impacts?
  - Downstream flooding?
  - Economic benefits?
  - Future transportation improvements?
- **Promising locations identified to-date**
  - **Clear Fork at Sarra Ln**
  - Chambers Creek at Enon Ave
  - South Mary's Creek at IH-20
  - Mountain Creek at FM 2738 and/or CR 616
  - Village Creek at FM 731
  - Little Mary's Creek Tributary at FM 3325



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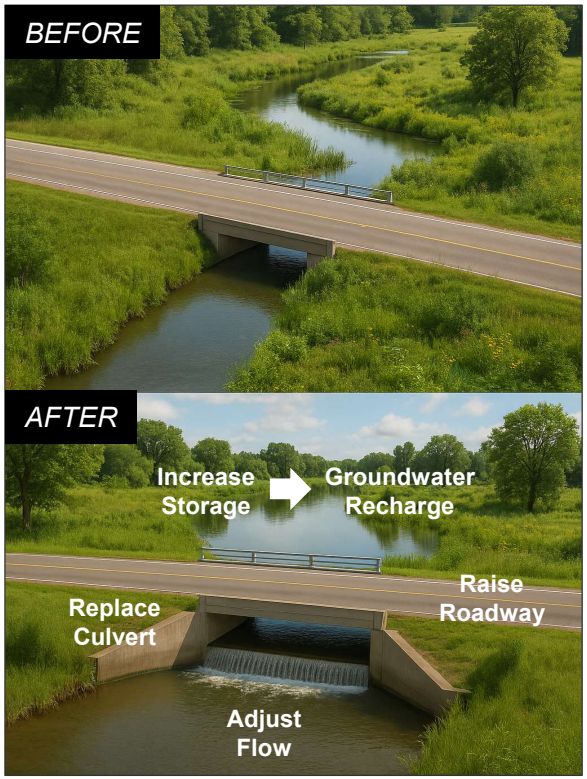
Project Example: Detention *(Sarra Ln – Parker County)*



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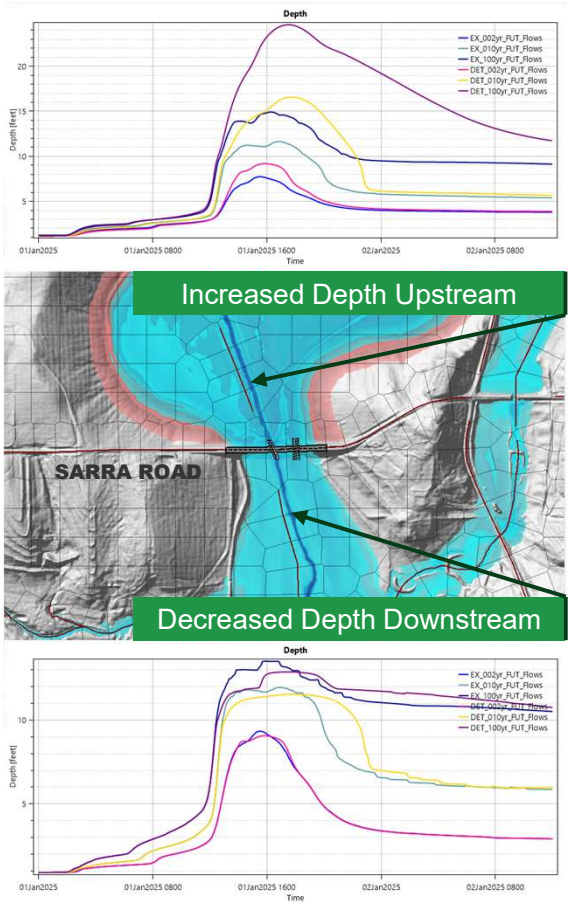
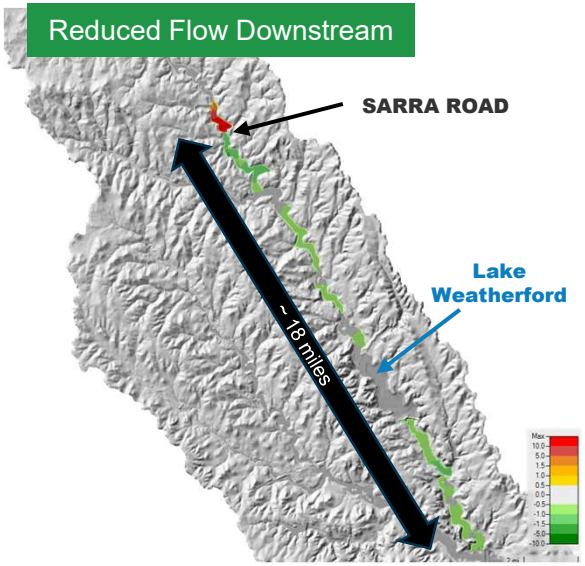




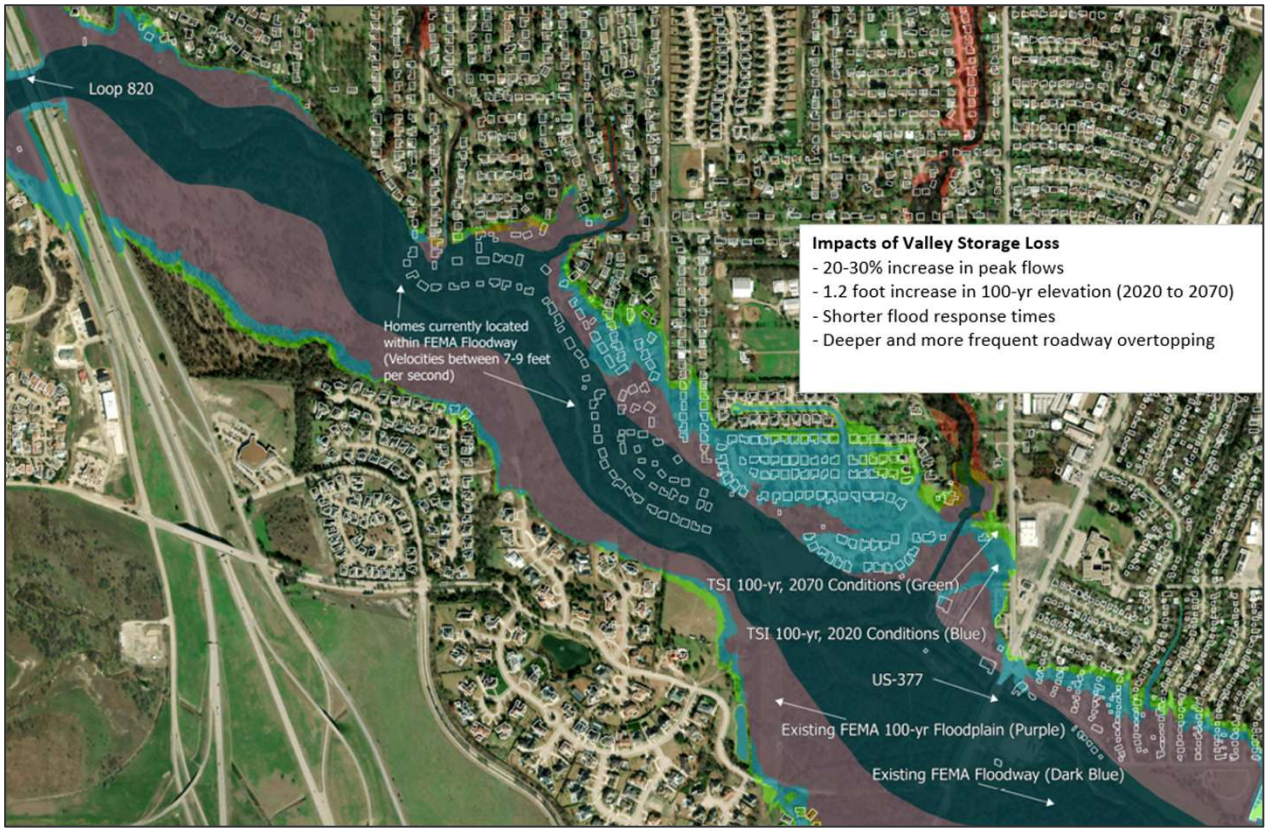
Key Summary Statistics – 2070

- **100-year Conditions** *(upstream)*:
  - Valley Storage: + 2,000 acre-ft
  - Flow Rate: - 3,000 ft^3/sec
- **10-year Conditions** *(downstream)*:
  - Flow Rate: - 1,000 ft^3/sec
  - Elevation Reduction: 0.5-1.0 ft

Project Example: Buyouts

Mary's Creek in Benbrook

- "Flashy" watershed like Hill Country
- Homes in the FEMA floodway
- History of flooding and projected increases



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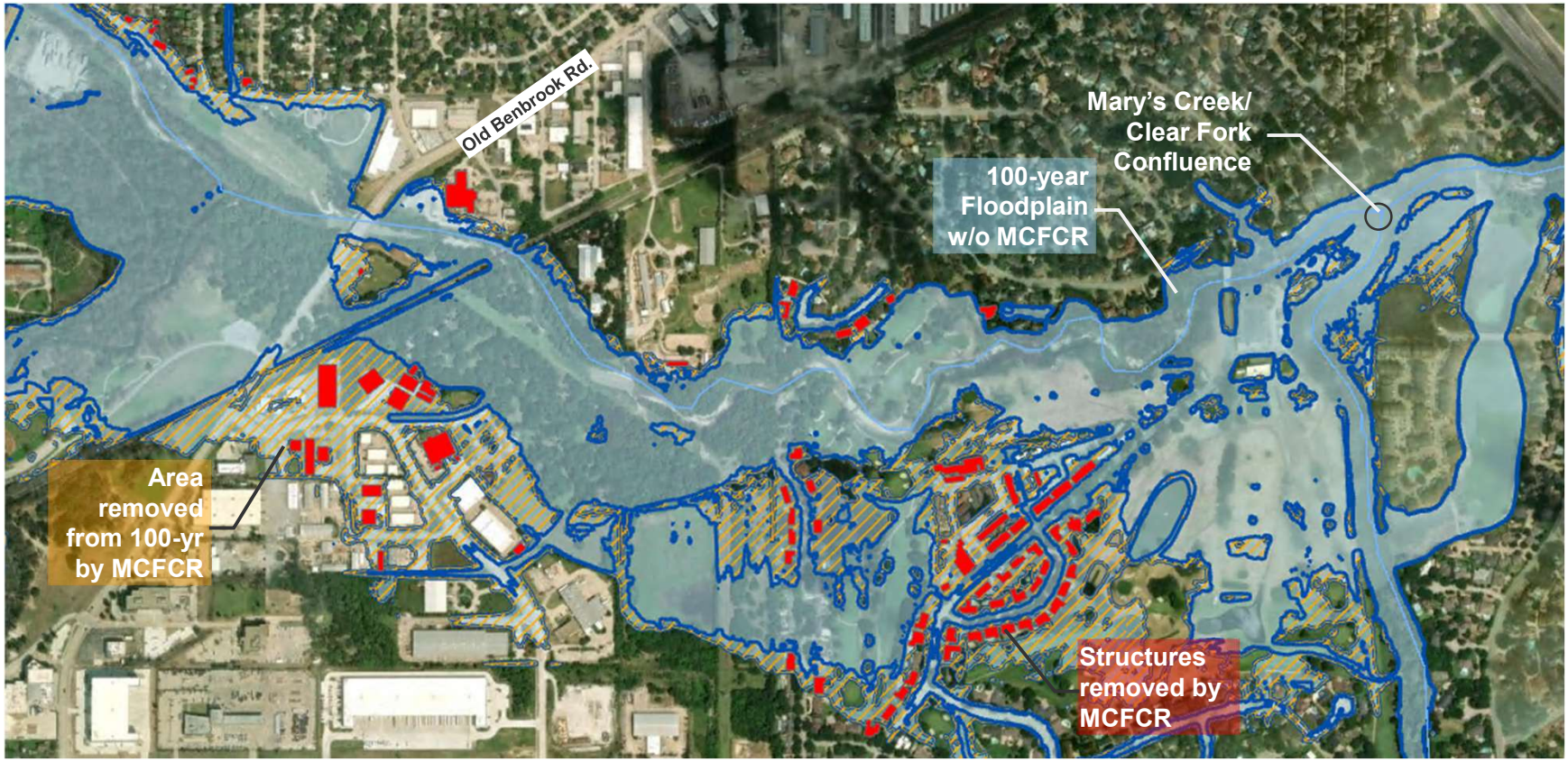
Project Example: Mary's Creek Flood Control Reservoir (MCFRC)



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Complementing Buyouts by Reducing System-Level Risk

Project Status: Planned, Eligible, and Advancing

FME 031000456: Abridged application submitted for SFY 24-25 FIF

FMP 033000112: Amended to 2023 RFP and eligible for SFY 26-27 FIF

TSI integrating Transportation & Stormwater Infrastructure

Stakeholders

FORT WORTH®

Benbrook TEXAS

TARRANT COUNTY, TEXAS

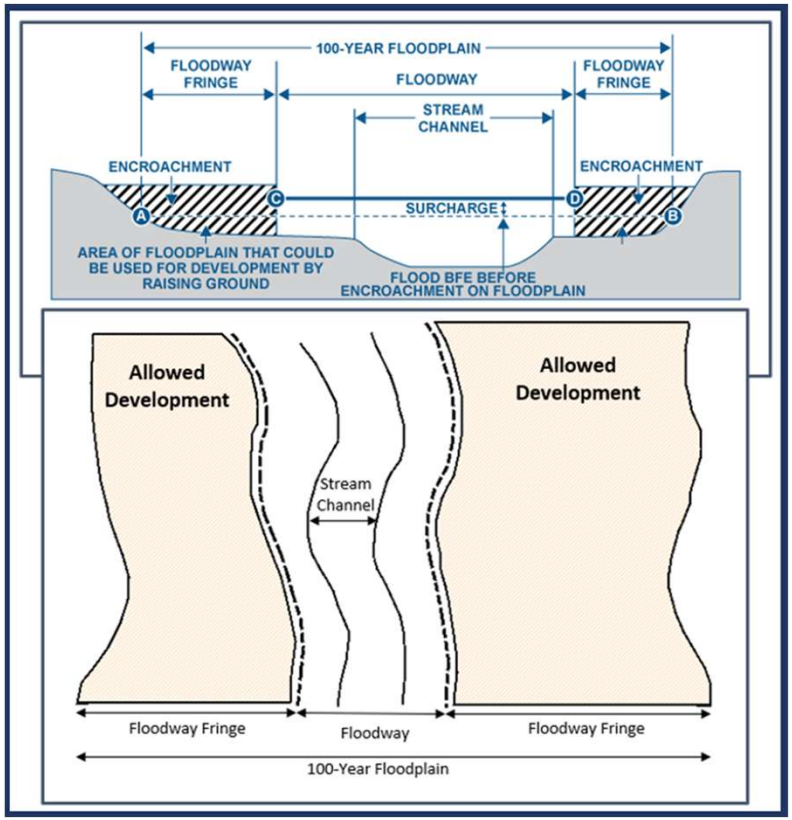
THE STATE OF TEXAS PARKER COUNTY

TEXAS WATER DEVELOPMENT BOARD

North Central Texas Council of Governments

Project Example: Valley Storage Preservation

- **Definition** – The volume of water in a river's floodplain during a flood
- **Function** – Flood water storage…like a reservoir
- **Regulation** – FEMA NFIP
  - Development allowed within Floodway Fringe
- **Impacts of Valley Storage Loss**
  - Peak flow increases
  - Peak water surface elevation increases
  - Deeper and more frequent roadway overtopping
  - Shorter flood response times
  - Life safety threat



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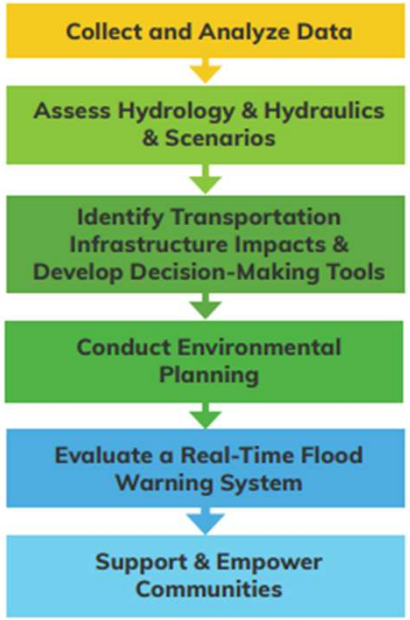
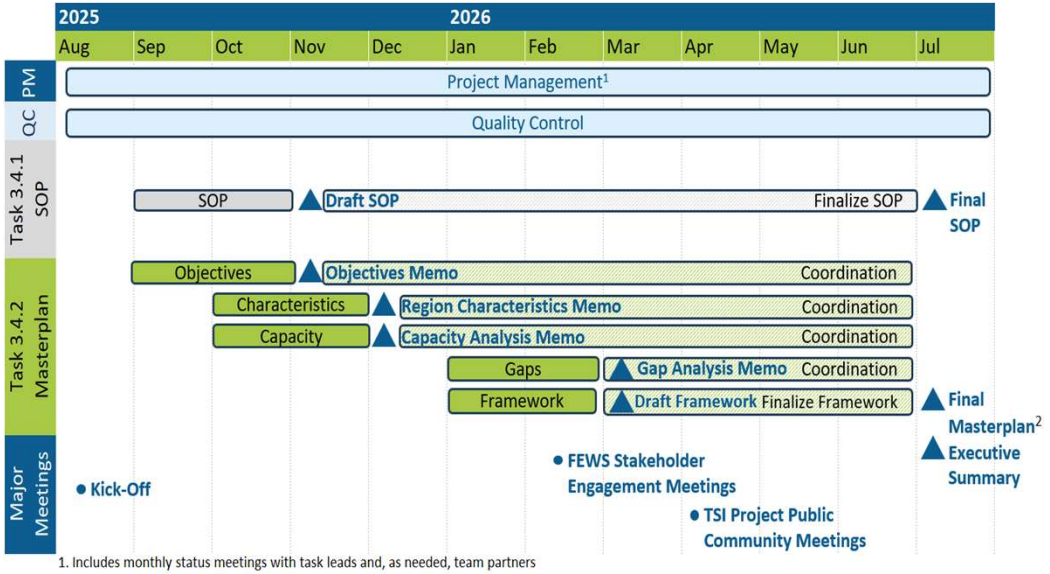
Project Example: Flood Early Warning System (FEWS)





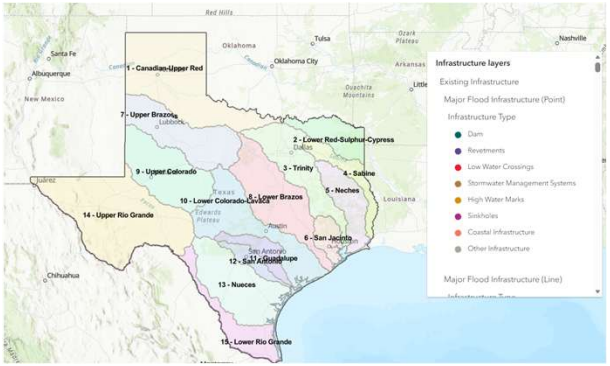
1. Includes monthly status meetings with task leads and, as needed, team partners
2. Although it is not within the scope to develop a detailed implementation plan for the TSI region, it is a recommended next step

integrating Transportation & Stormwater Infrastructure

How Does TSI Get Implemented?

TSI will…

- Leverage, enhance, and/or recommend expanding existing regulatory frameworks, such as:
  - The NCTCOG integrated Stormwater Management (iSWM) Program
  - The Upper Trinity River Corridor Development Certificate (CDC) Program
- Identify and recommend TSI Flood Management Projects (FMPs), Flood Management Evaluations (FMEs), and Flood Management Strategies (FMSs).
- **Collaboratively** explore and promote other avenues for flood resiliency.



integrating Transportation & Stormwater Infrastructure

View Interactive TSI Results

TSI Website

nctcog.org/tsi

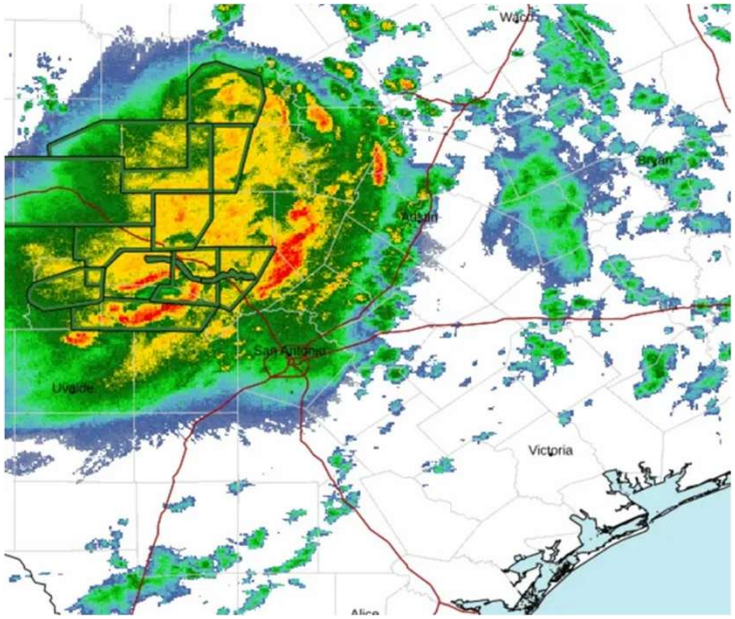
TSI Story Map

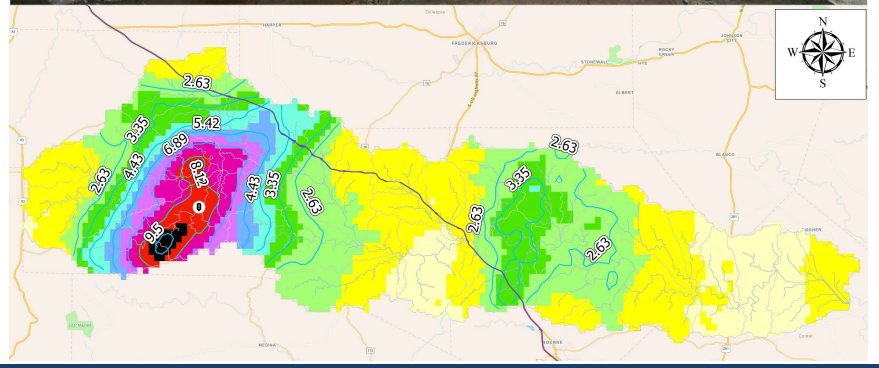
INCLUDES:

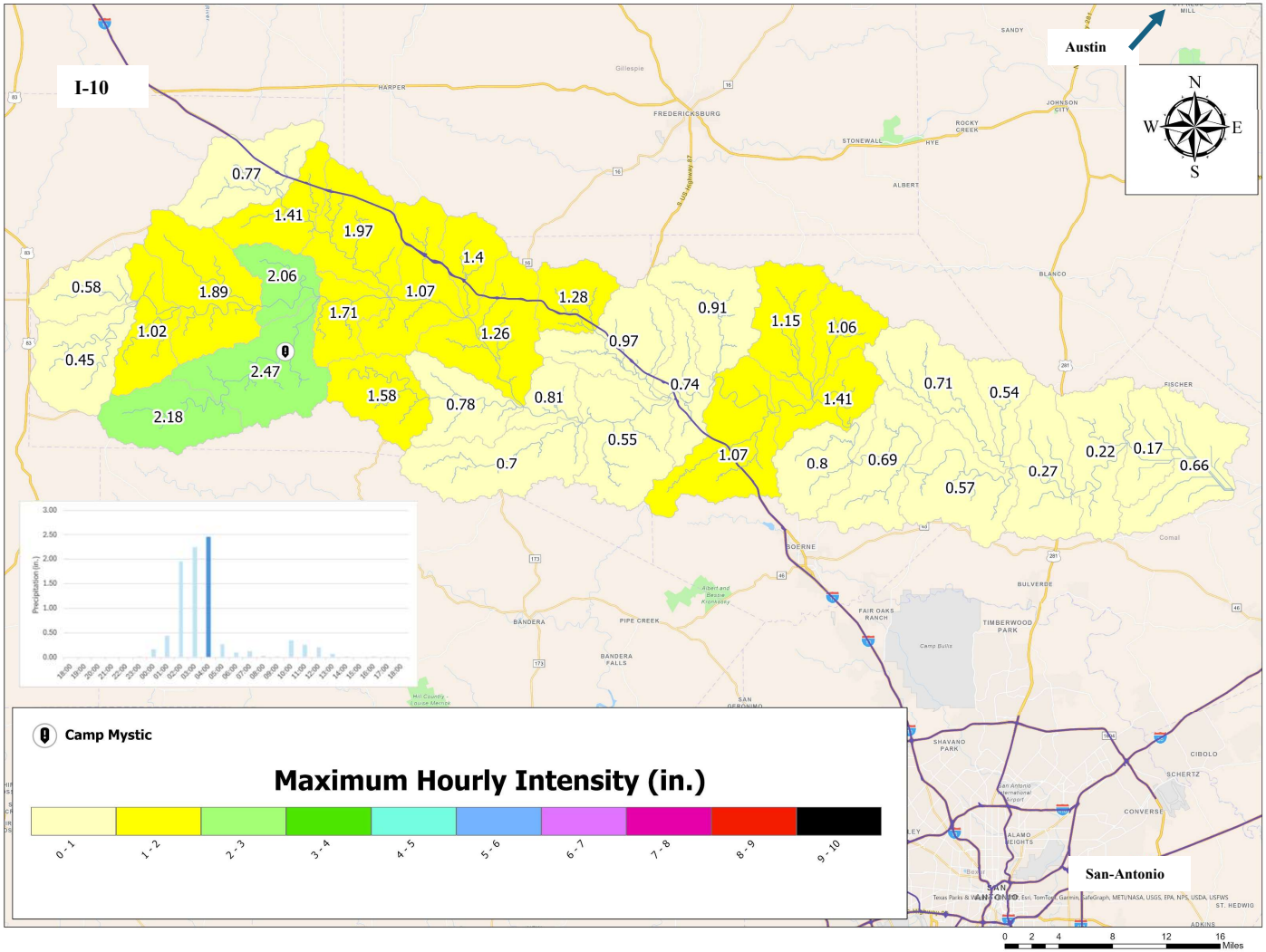
- **History and Context**
- **What We're Doing**
- **Results and Resources**

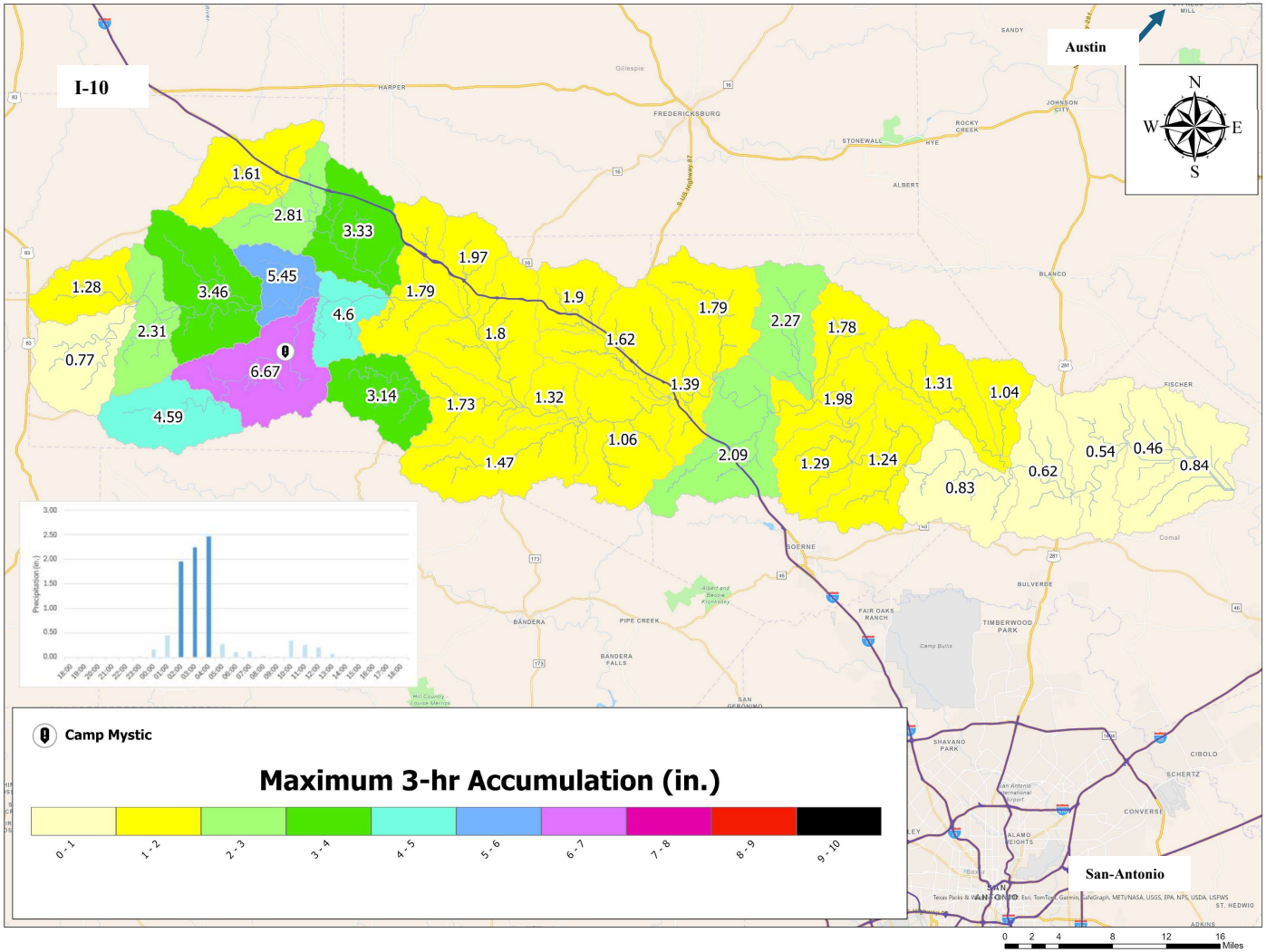
integrating **Transportation & Stormwater Infrastructure**

KERR COUNTY FLOOD (7/4/2025)

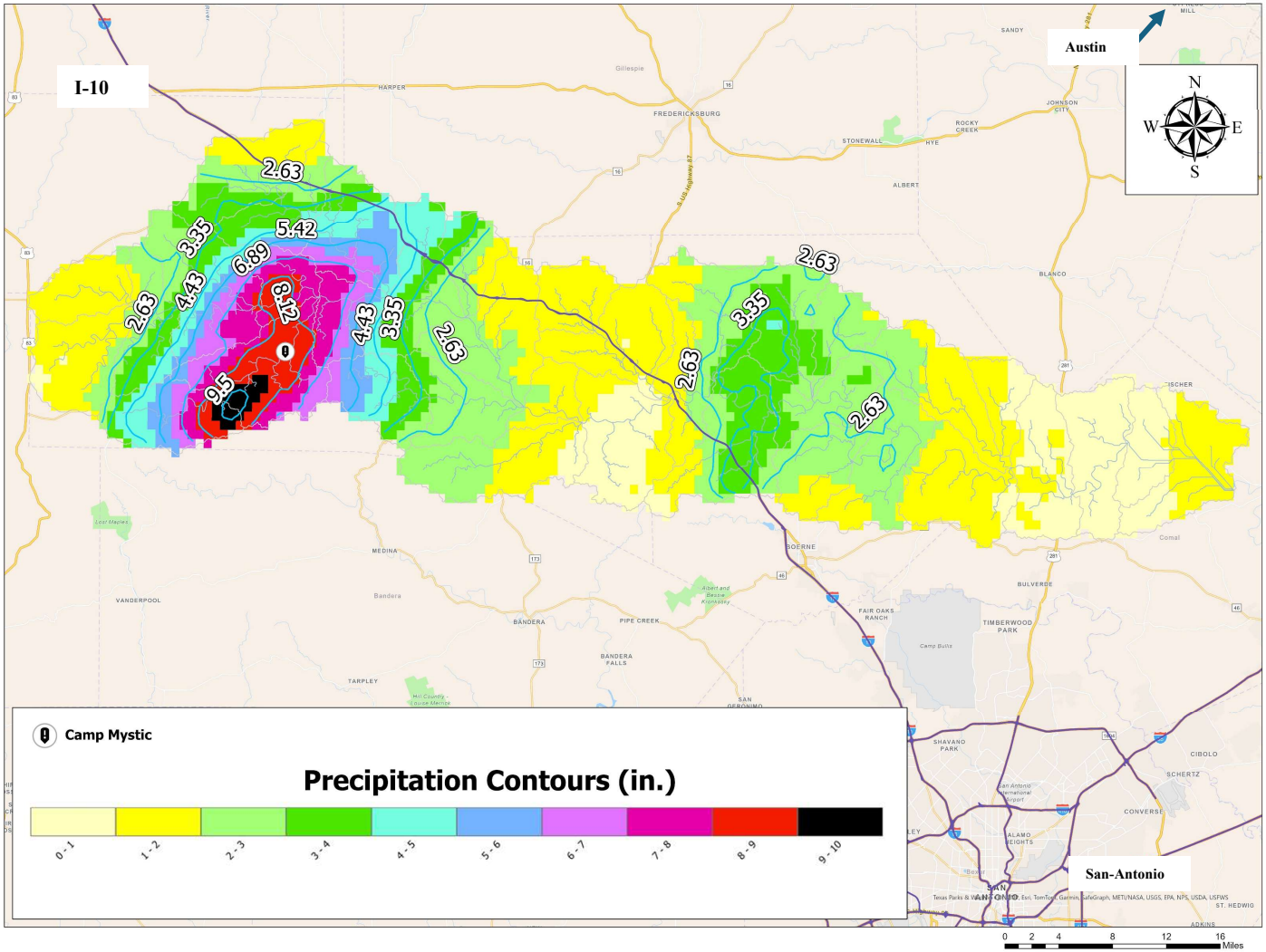




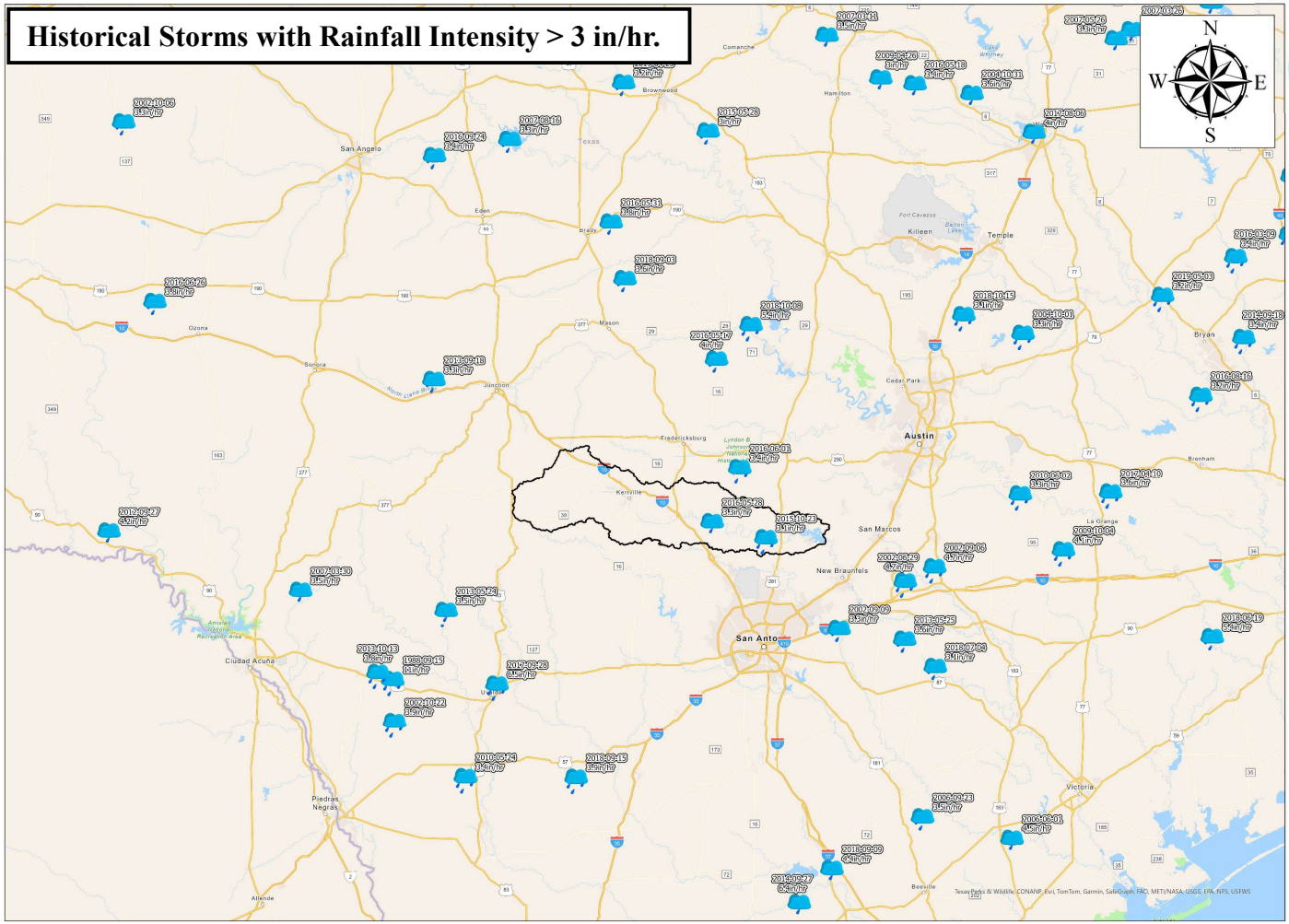

I-10
Austin
San-Antonio
N
W
E
S
0.77
1.41
1.97
1.4
0.58
2.06
1.89
1.07
1.28
1.71
0.91
1.15
1.06
1.02
1.26
0.97
0.45
2.47
0.74
0.71
0.54
1.58
0.78
0.81
1.41
2.18
0.55
0.22
0.17
1.07
0.8
0.69
0.27
0.66
0.7
0.57
Camp Mystic
Maximum Hourly Intensity (in.)
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
8 - 9
9 - 10
Precipitation (in.)
0 2 4 8 12 16
Miles



WERC
Water Engineering
Research Center

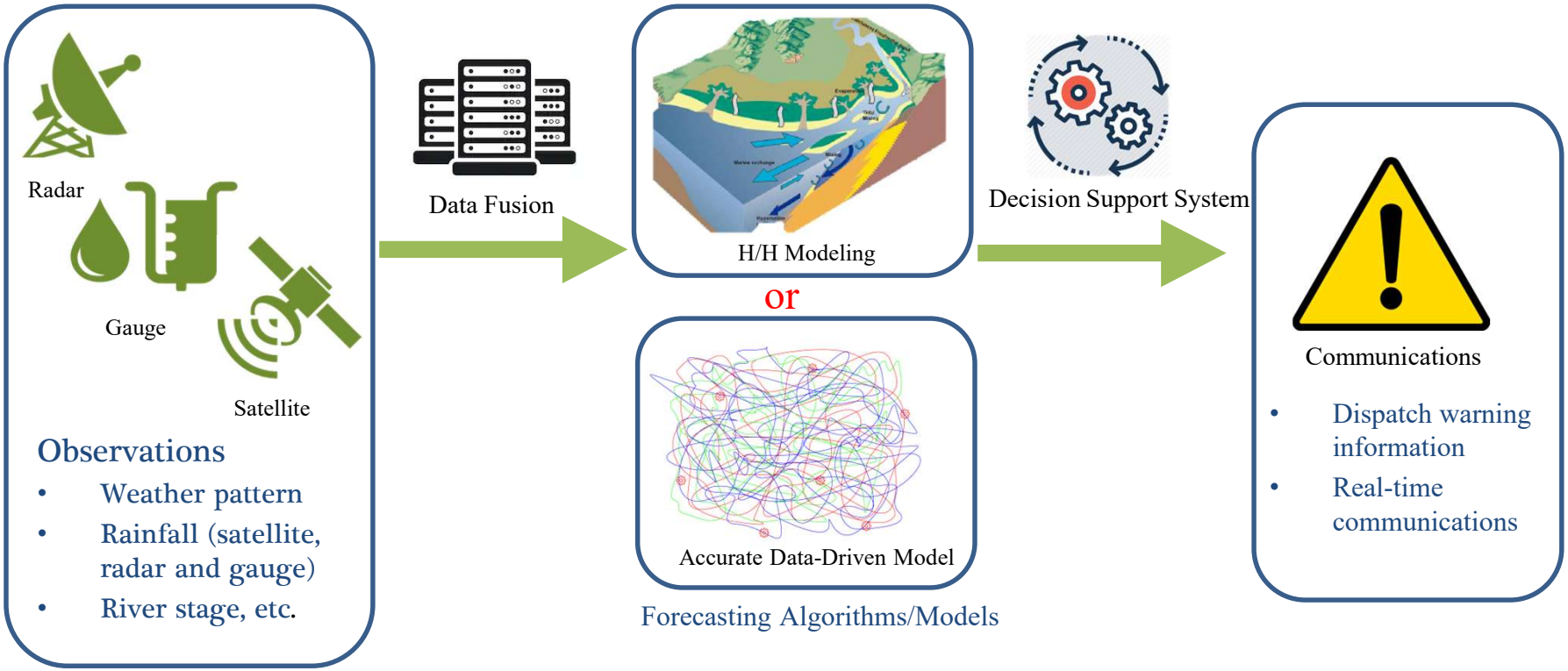

I-10
Austin
San-Antonio
N
W
E
S
2.63
3.35
5.42
6.89
8.42
4.43
9.5
Camp Mystic
Precipitation Contours (in.)
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
8 - 9
9 - 10
0 2 4 8 12 16
Miles

Historical Storms with Rainfall Intensity > 3 in/hr.



WERC
Water Engineering Research Center

FLOOD ALERT SYSTEM-CONCEPT

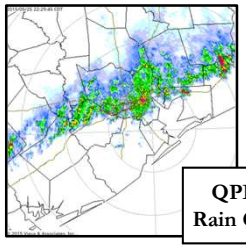


FLOOD ALERT SYSTEM 5

RICE
Unconventional Wisdom

Data Retrieval

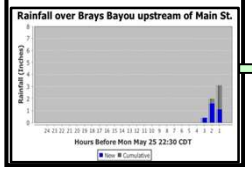
NEXRAD



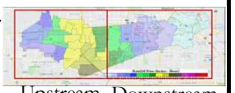
QPE & Rain Gages

Flood Prediction Core Engine

Real-Time Rainfall



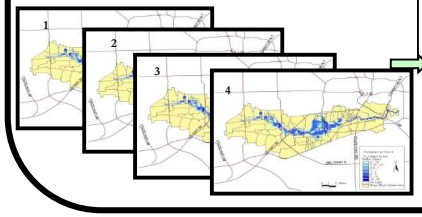
RT Rainfall/Runoff Correlation



Upstream Downstream

Indicator (Rainfall Intensity -RI)

Flood Plain Map Library



Inundation **maps with IDs**

Inundation **depth at selected locations**

COH API/Data Portal

Watershed	Rainfall (inch)	Map ID
Brays Bayou	4	1
Huntington Bayou	5	3
…	…	…

Redundant Terminal

Real-Time Forecast Flood Map from 2nd Display Portal, also Includes Data Storage and Operation Engine

Warnings & Communication

Alert Levels

& Flood Protection Action Levels

Flood Protection & Emergency Actions

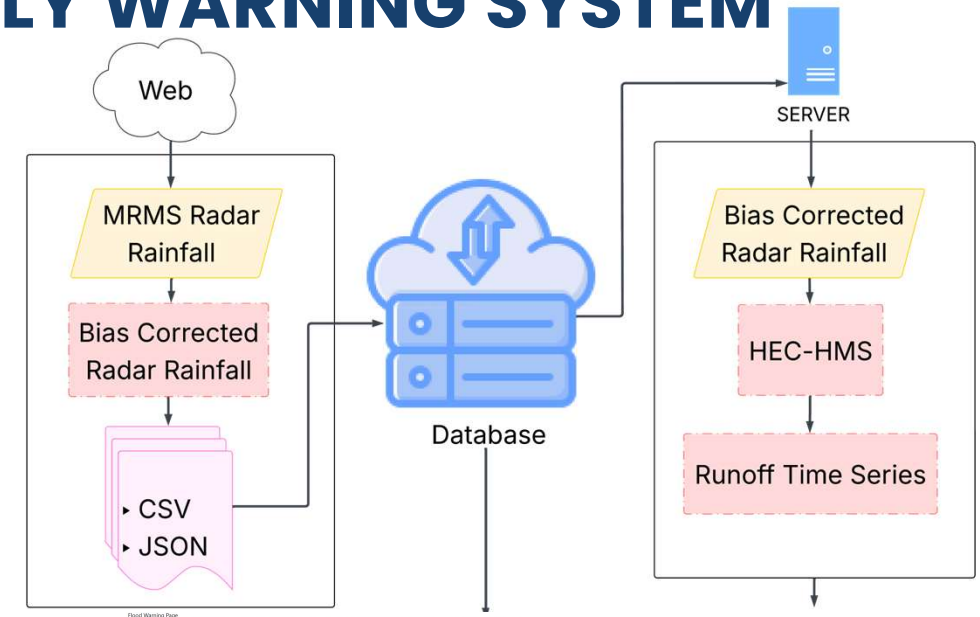
- **Evacuations**
- **Flood door closure**
- **Recall of Personnel**
- **Backup Power**

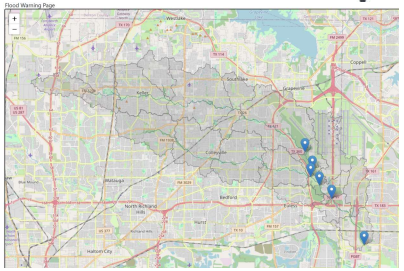
WERC Water Engineering Research Center

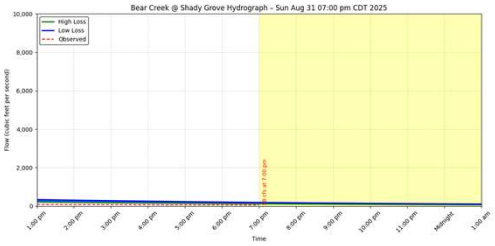
DFW FLOOD EARLY WARNING SYSTEM

DALLAS FORT WORTH INTERNATIONAL AIRPORT

- Technology Framework
  - Digital Twining Coupled Atmosphere/Land Surface/Hydrologic systems
  - Hydrologic Models Development & Calibration
  - Advanced Radar-based Rainfall Monitoring/Correction
  - Cloud Computing and Web-based Platform Integration







- Developed for the **Bear Creek Watershed,** North Texas
- Provide **2–4 hours of hydrologic lead time**.
- Calibrated over the entire data time span.
- Incorporates **real-time radar-based precipitation** with **bias correction**.
- Enables **sensor calibration** and creation of **virtual gages** across the watershed.

Guidance Document of Flood Early Warning Systems

PROJECT REPORT

Grant Sponsor

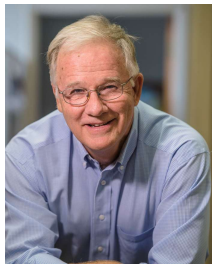
Texas Water Development Board

PROJECT MANAGEMENT

Principal Investigators

Nick Fang, PhD, PE

UNIVERSITY OF TEXAS ARLINGTON



Phil Bedient, Ph.D., P.E.

Sam Brody, Ph.D.

TEXAS A&M UNIVERSITY GALVESTON CAMPUS.

Michael Zaretsky, AIA

UNIVERSITY OF TEXAS ARLINGTON

COMMUNITY OUTREACH

Texas Water Development Board

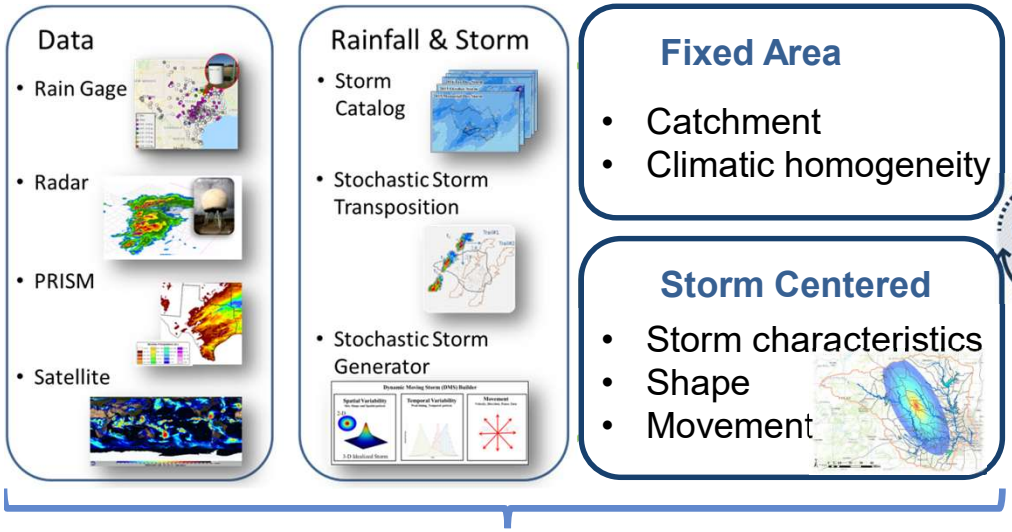
Flood Early Warning Systems (FEWS) Guidance Document

for Texas

Contract Number 2101792481

DRAFT

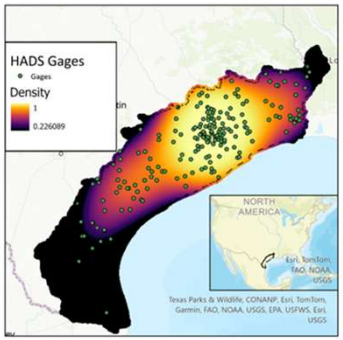
Texas Storm Study
(USACE-FWD – WEST/UTA/TAMU/RICE)



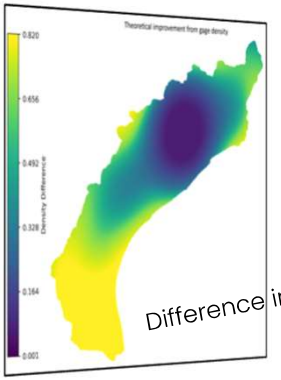
WERC Water Engineering Research Center

STATEWIDE RAINFALL REANALYSIS ESTIMATION

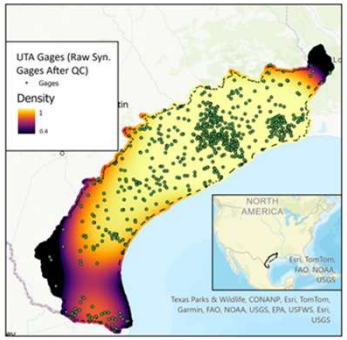
Spatial Gage Density Comparison:



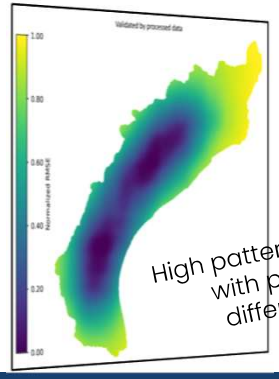
Gages (HADS)



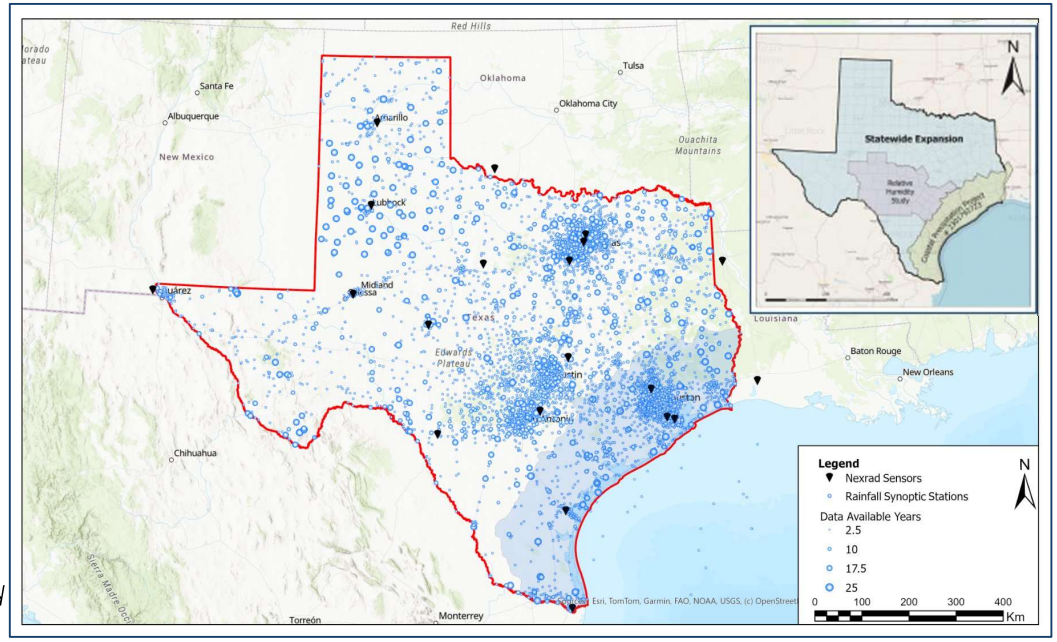
Difference in density



Gages (QC'd synoptic)



High pattern similarity with product differences



InFRM Academic Council Members

Philip Bedient

RICE

Collaborators

FEMA

NATIONAL WEATHER SERVICE

USGS science for a changing world

Nick Fang

UNIVERSITY OF TEXAS ARLINGTON

Clint Dawson

TEXAS The University of Texas at Austin

John Nielsen-Gammon

TEXAS A&M UNIVERSITY

Sam Brody

TEXAS A&M UNIVERSITY GALVESTON CAMPUS

Hatim Sharif

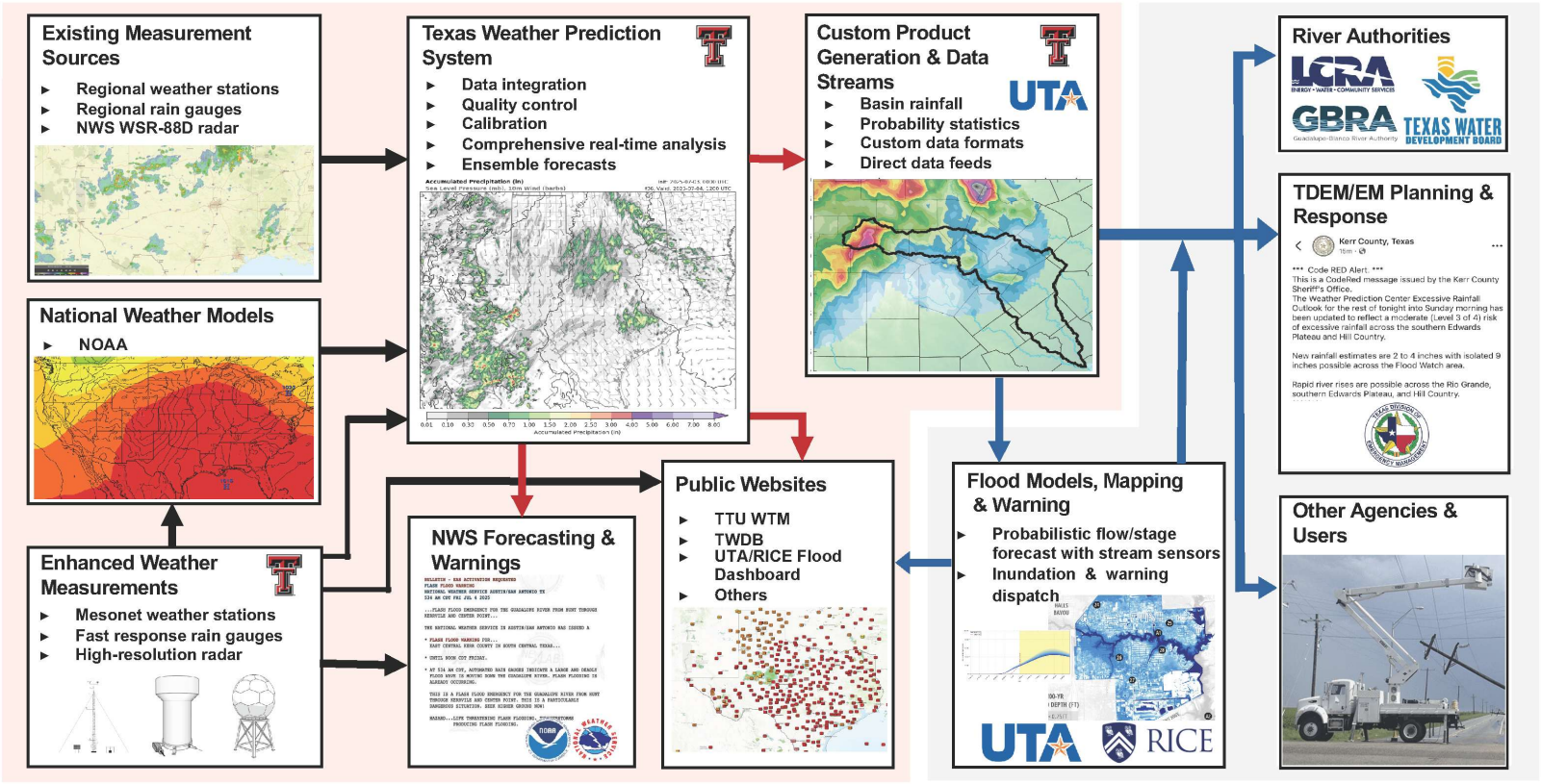
THE UNIVERSITY OF TEXAS UTSA AT SAN ANTONIO

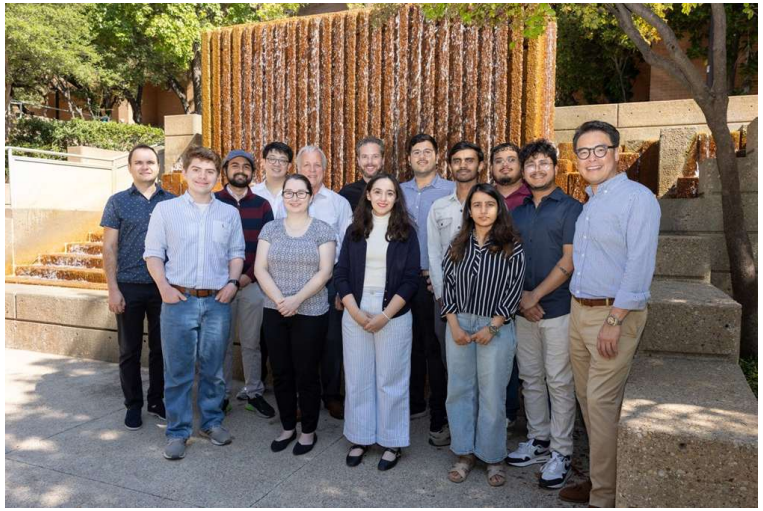
Jamie Padgett

RICE

TEXAS WEATHER MEASUREMENT & PREDICTION SYSTEM

TEXAS TECH





Nick Fang, Ph.D., P.E.
Robert S. Gooch Endowed Professor
Director, Water Engineering Research Center (WERC)
Civil Engineering Dept.
Email: nickfang@uta.edu
Web: http://werc.uta.edu

WERC Water Engineering Research Center