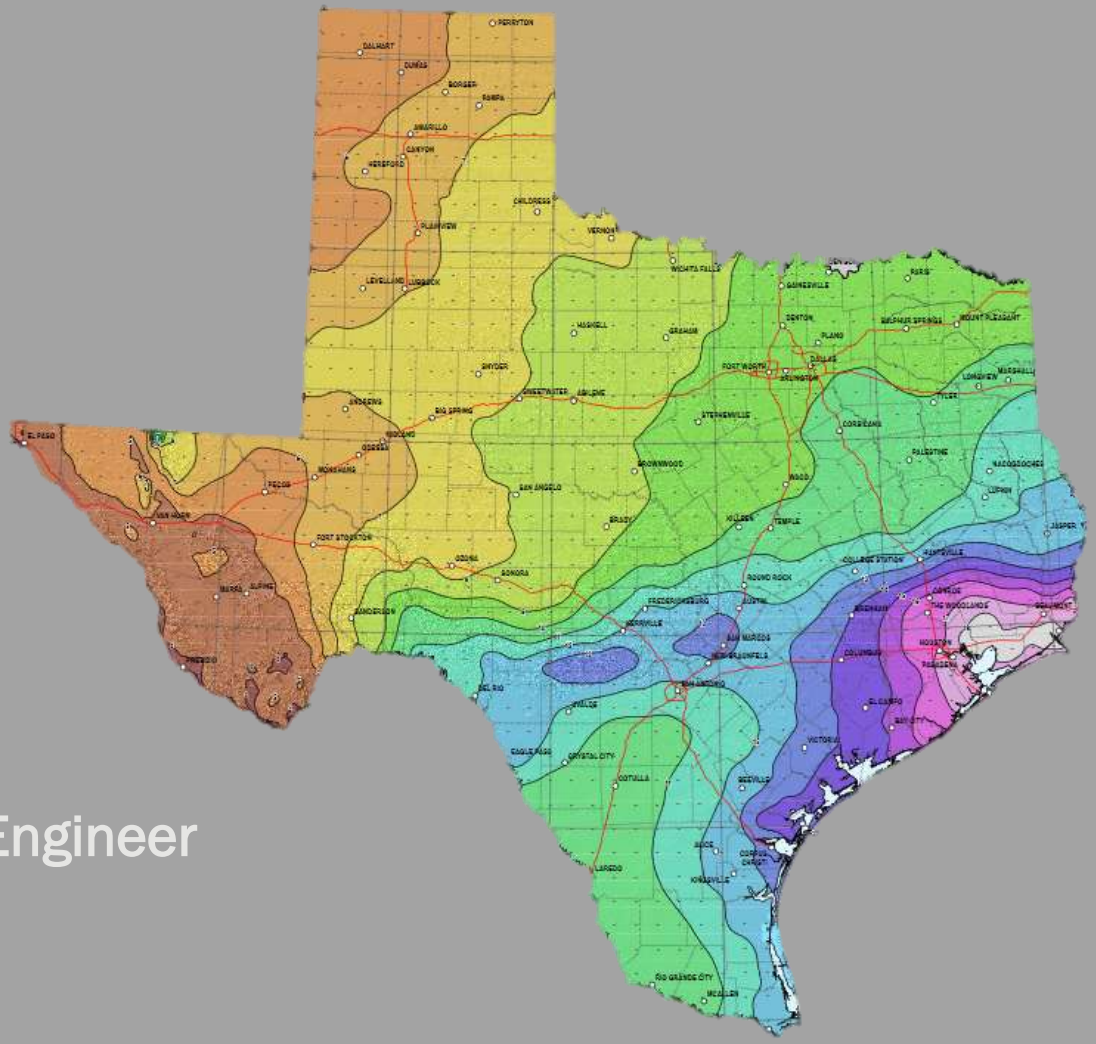
NOAA ATLAS 14 – VOLUME 11



February 27th, 2019
CRS Users Group Meeting
Mikaela Mahoney, Hydraulic Engineer
U.S. Army Corps of Engineers
Fort Worth District

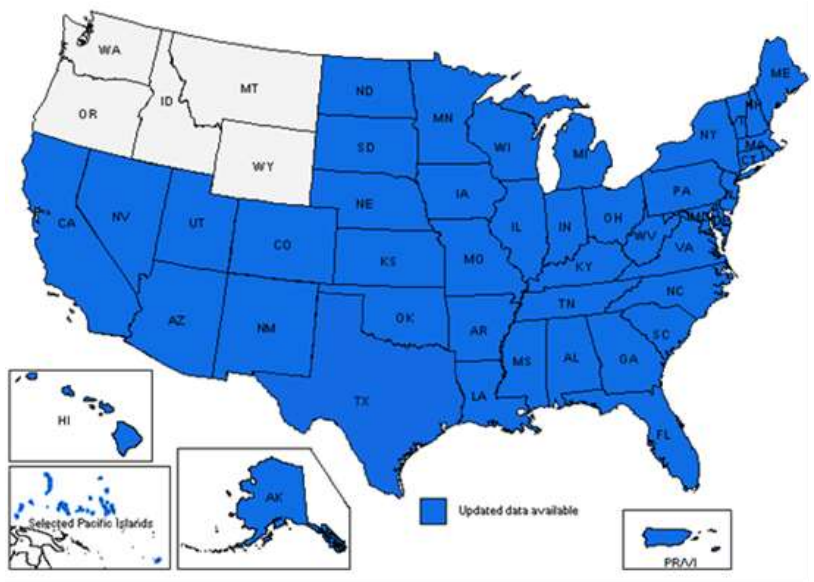
US Army Corps of Engineers ®

U.S.ARMY

NOAA ATLAS 14 METEOROLOGY RESEARCH INCENTIVE

- **What is it:**
  - Precipitation frequency estimates
  - How much rain in a 100-year storm event
  - Non-regulatory
- **Benefits:**
  - Better understanding of the risk from extreme precipitation events
  - Infrastructure design – parking lots to dams
  - Floodplain mapping (NFIP), where can we safely construct new neighborhoods
  - Preparedness or mitigation planning
- **Schedule: Complete**
  - Volume 11 (Texas) released September 2018
  - Documentation published January 2019
  - Further studies in the works with NOAA

NOAA Atlas 14



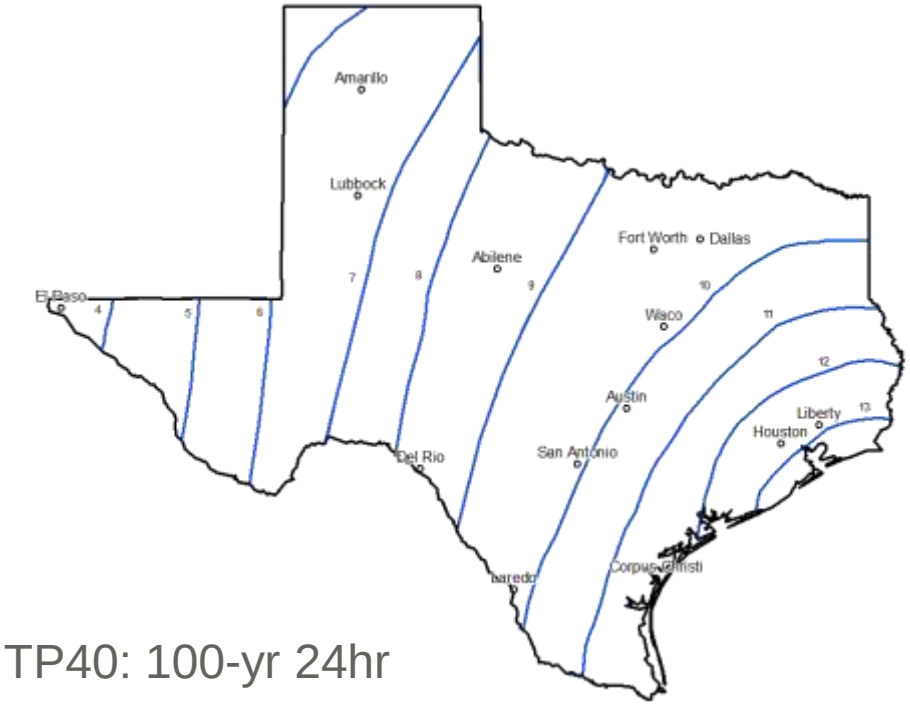
US Army Corps of Engineers ®

U.S.ARMY

PREVIOUS PRECIPITATION FREQUENCY PRODUCTS

NOAA/NWS

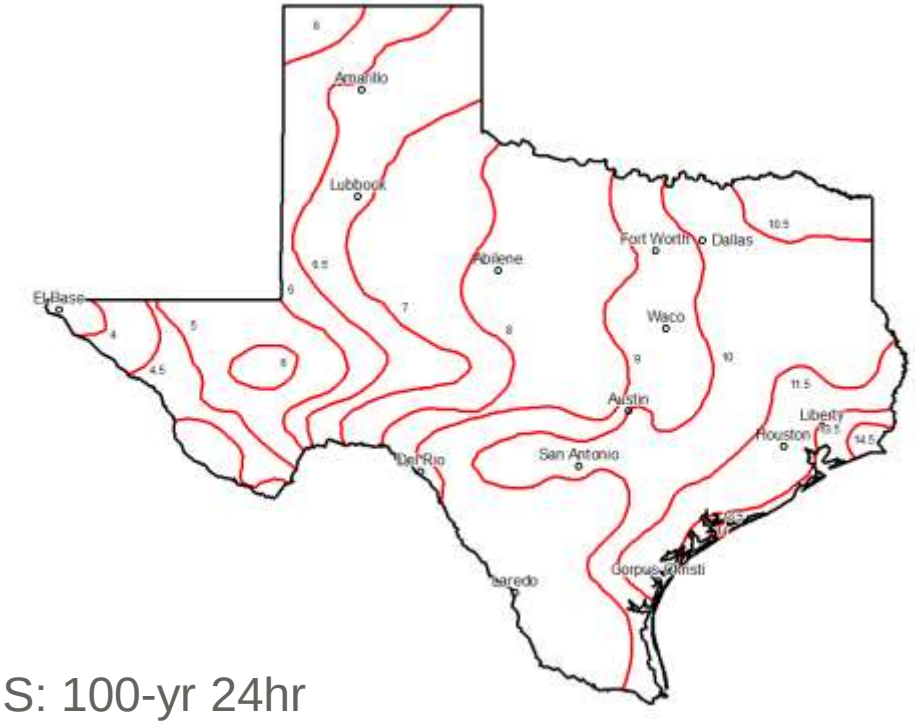
- NWS Technical Paper No. 40 (1961)
- NWS Technical Paper No. 49 (1964)
- NWS Hydro-35 (1977)



TP40: 100-yr 24hr

USGS

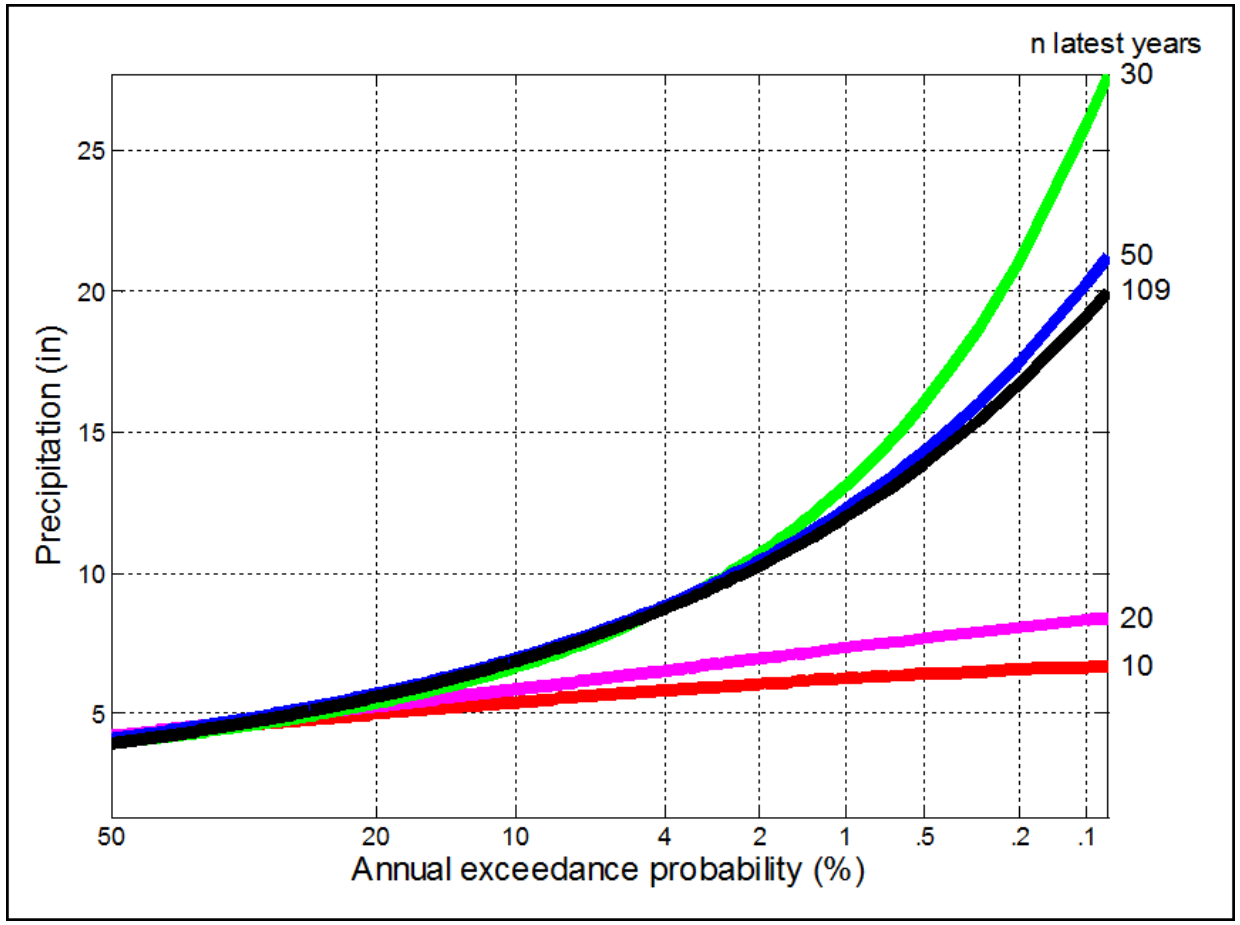
- Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas (2004)



USGS: 100-yr 24hr

U.S.ARMY

IMPORTANCE OF NEW DATA



- Hydro-35/TP 40 - ~20-years of record
- USGS - ~35-years of record
- NA14 - ~60-years of record

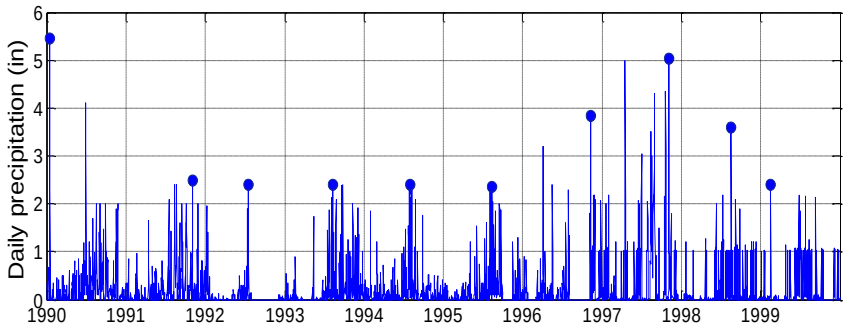
US Army Corps of Engineers ®

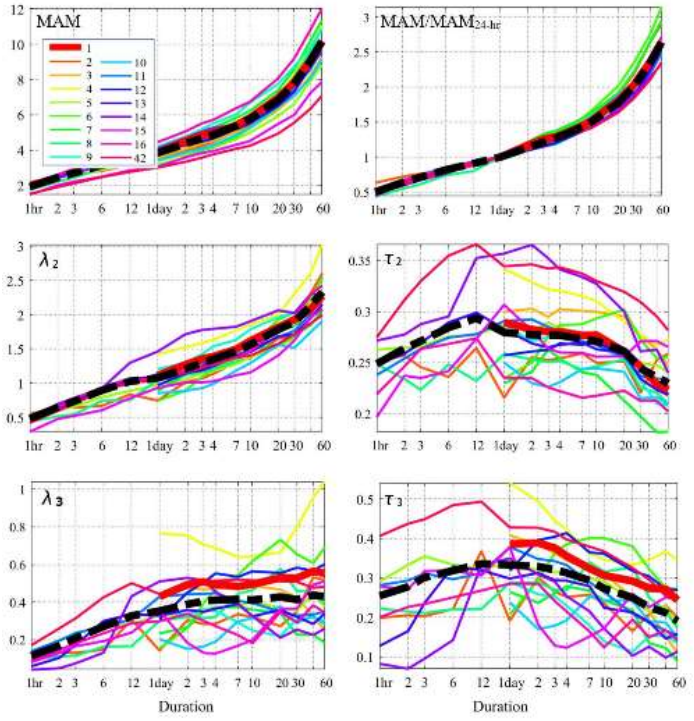
U.S.ARMY

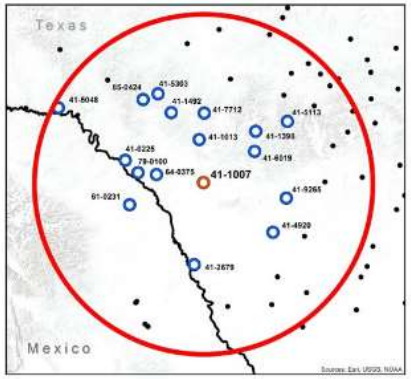
NUTS AND BOLTS OF NOAA ATLAS 14

Approach: Regional frequency analysis approach based on L–moment statistics calculated from annual maximum series (AMS)

- **Data Collection**
  - Gathered data from 11,930 stations; retained 3,900 stations
  - Extracted AMS from each station
- **Regionalization Approach**
  - Trading space for time
  - Results on more accurate estimates of extreme quantiles
- **Frequency Analysis**
  - Fit multiple distributions to identify best fit for each station and duration
  - Ultimately used GEV probability distribution







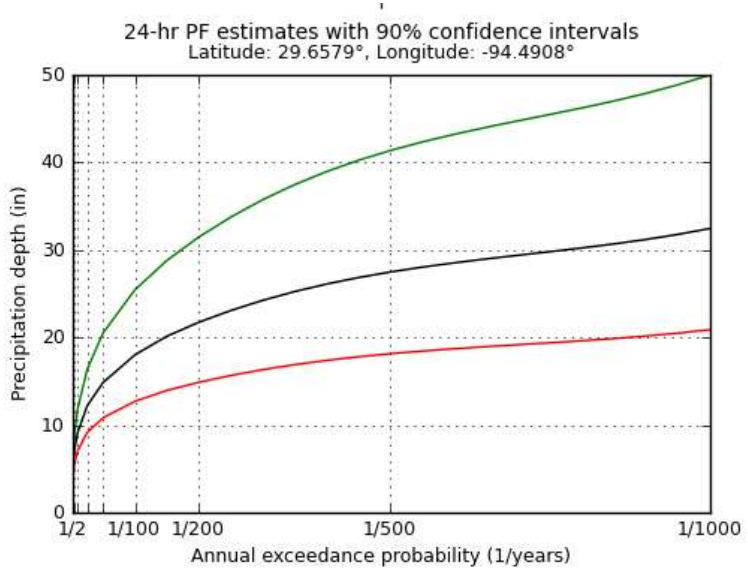
Source: NOAA Atlas 14 Volume 11 Version 2

US Army Corps of Engineers ®

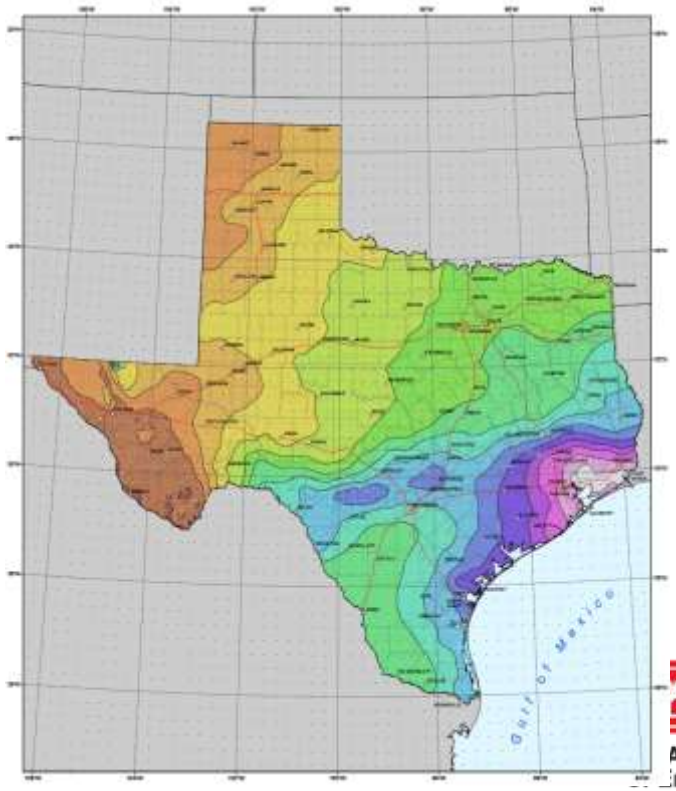
U.S.ARMY

NUTS AND BOLTS OF NOAA ATLAS 14

- Uncertainty Bounds
  - Utilized a Monte-Carlo approach to estimate 90% confidence bounds
  - Simulated 1,000 data sets for each station and duration



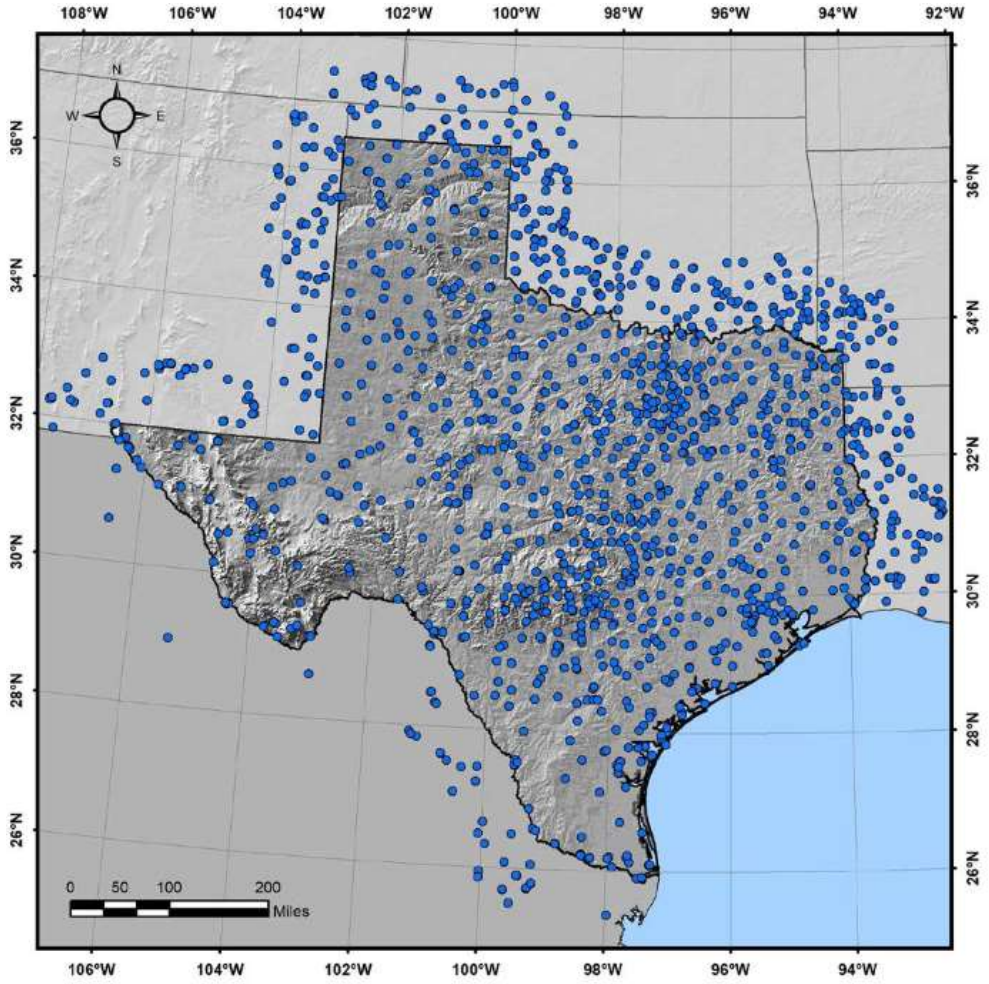
- Precipitation Grids
  - Accounts for variations in terrain, coastal proximity, mean annual precipitation, and distance from station



Source: NOAA Atlas 14 Volume 11 Version 2

PRECIPITATION DATA

- Digitized pre-1948 data from NCEI's Climate Database Modernization Program
  - Data screened for quality
  - Merged nearby stations (within 3–5 miles, ~same elevation)
  - Length of record (>30 years of data)
  - Extracted AMS for durations between 15-min and 60-day from precipitation records across the state
- Average record length ~60 years
- Records extended through December 2017, where available
  - A few stations included data through June 2018



Stations recording at 1-Day Intervals

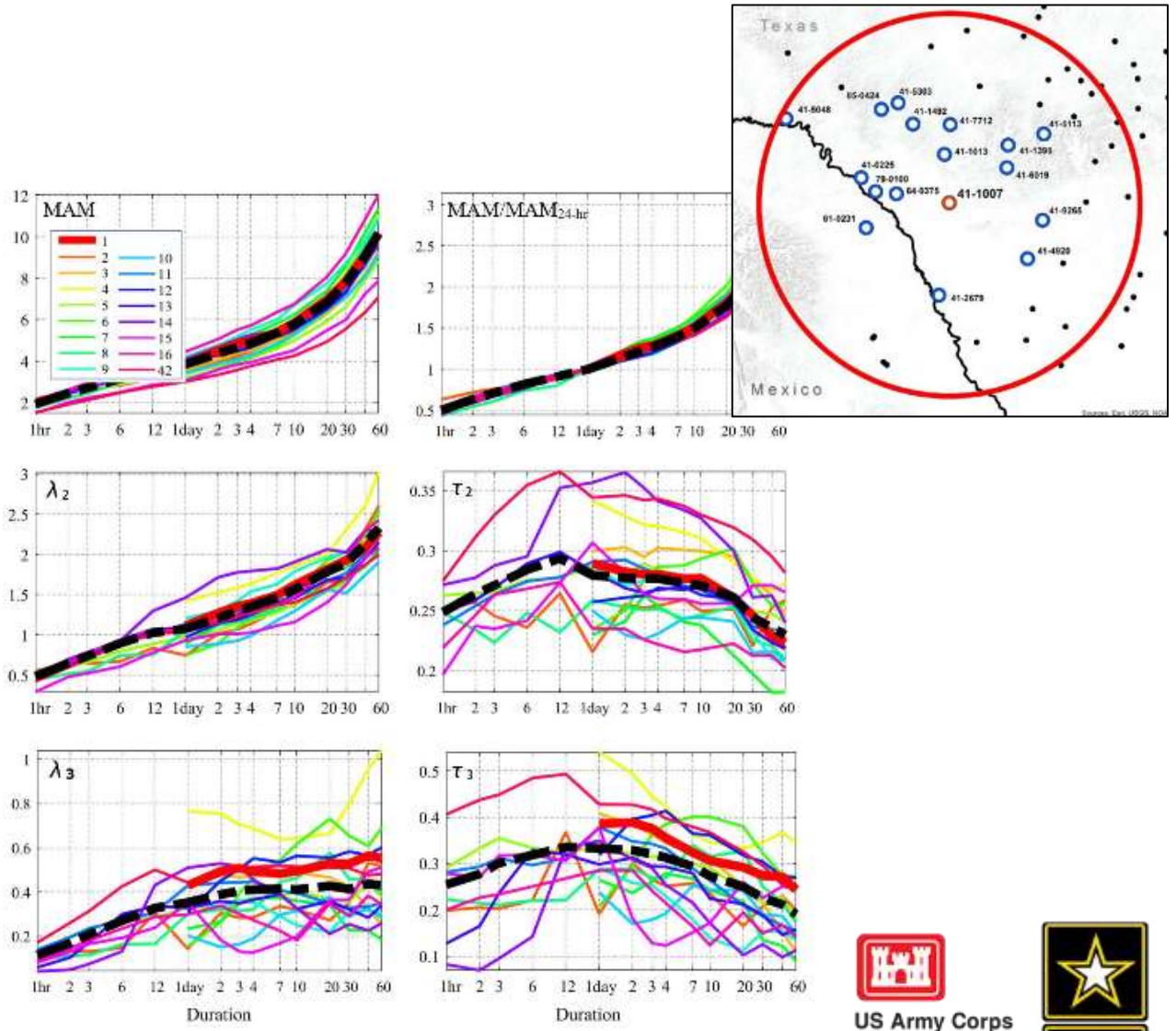
Source: NOAA Atlas 14 Volume 11 Version 2

US Army Corps of Engineers ®

U.S.ARMY

REGIONALIZATION

- Initial region for each station consisted of closest 15 gages
- Included highest 1-hour or 1-day peak within 60 miles
- Refinement of regional gages based on:
  - Distance from target station
  - Topography
  - Mean annual maxima
  - Maximum recorded values
  - Record lengths
- Analyzed L-moment statistics for each gage within the region
- Typical density: 15-25 gages, 700-1,800 data years (daily record)



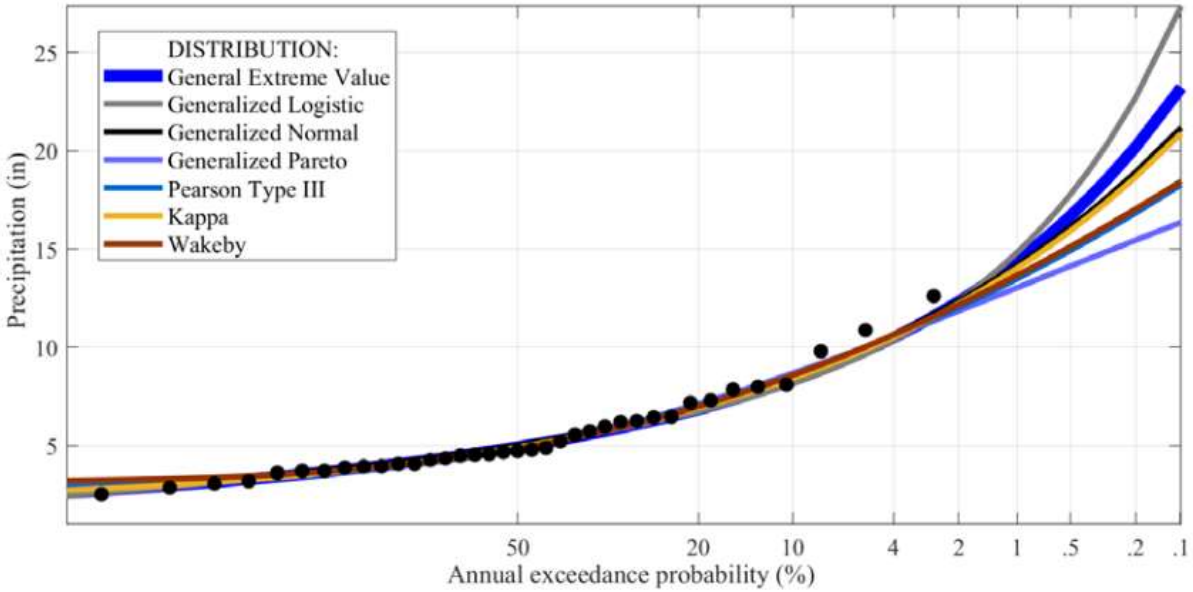
Source: NOAA Atlas 14 Volume 11 Version 2

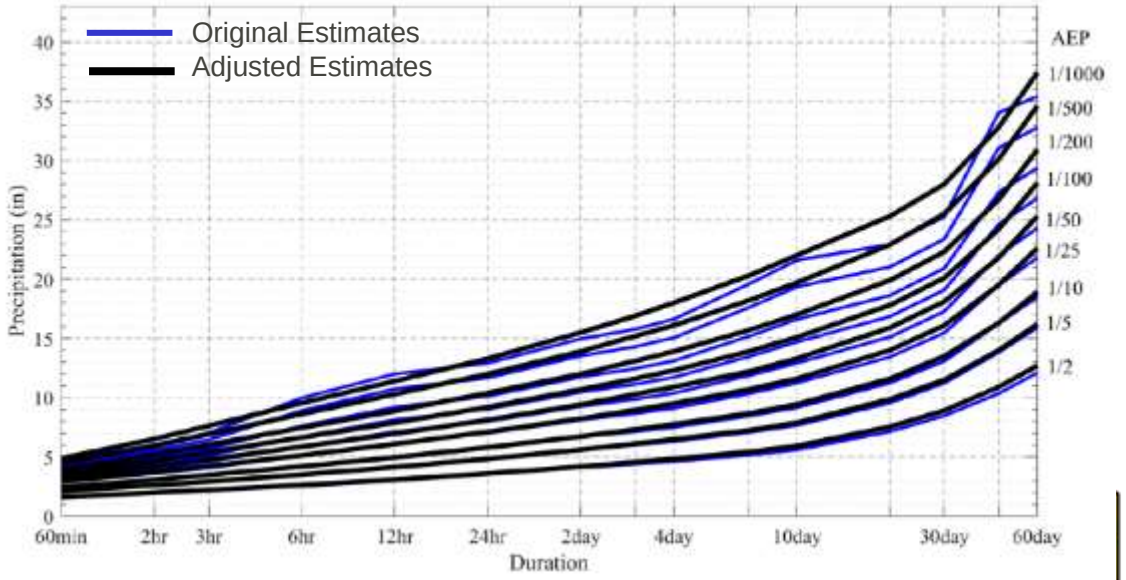
US Army Corps of Engineers ®

U.S.ARMY

FREQUENCY ANALYSIS

- Multiple probability distributions fit to each station and duration
- GEV distribution chosen for all durations based on multiple goodness of fit tests
  - Kolmogorov-Smirnov and X^2 Test
- Precipitation frequency estimates based on regional L-moments from each station
  - Some smoothing required



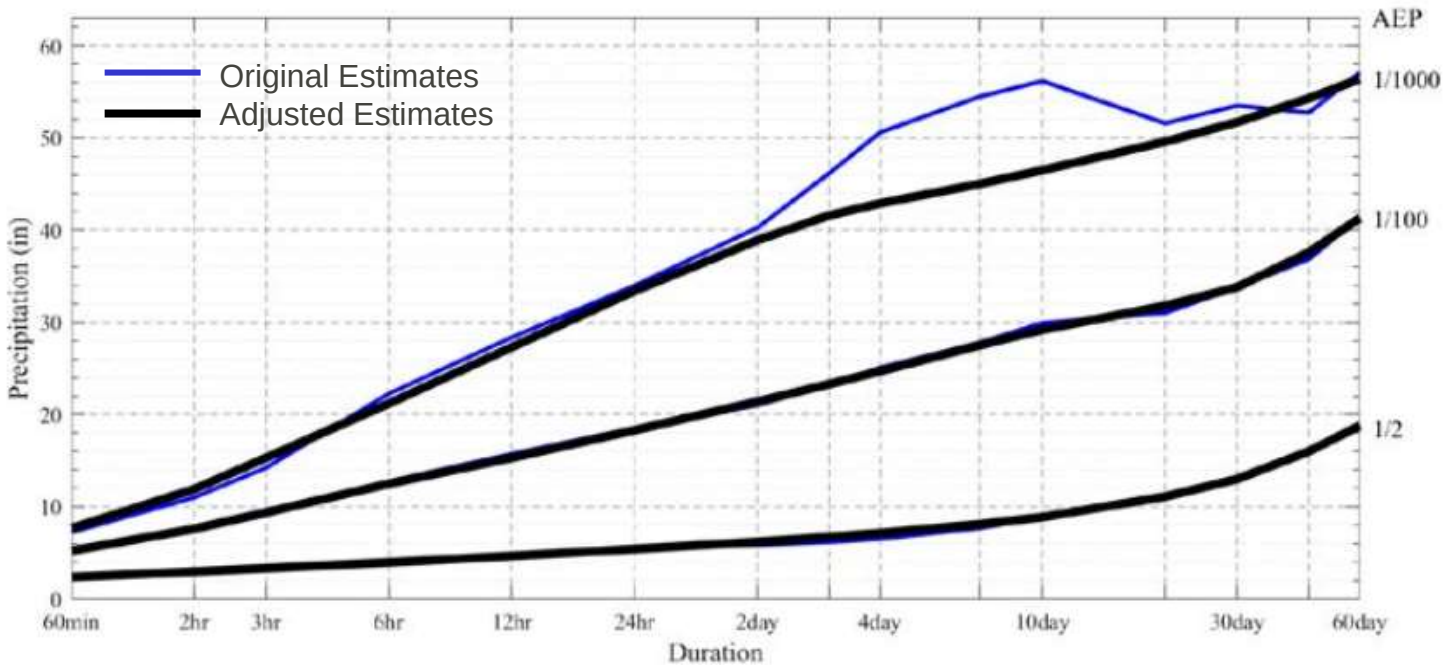


Source: NOAA Atlas 14 Volume 11 Version 2

US Army Corps of Engineers ®

U.S.ARMY

HURRICANE HARVEY



- Broke all multi-day rainfall records
- Official highest amount of rainfall ever to fall on the continental U.S.
- Harvey affected results of 2-day through 20-day estimates for 1000-year event
- No significant skew for the 1000-year 24-hour or 1000-year 30-day results

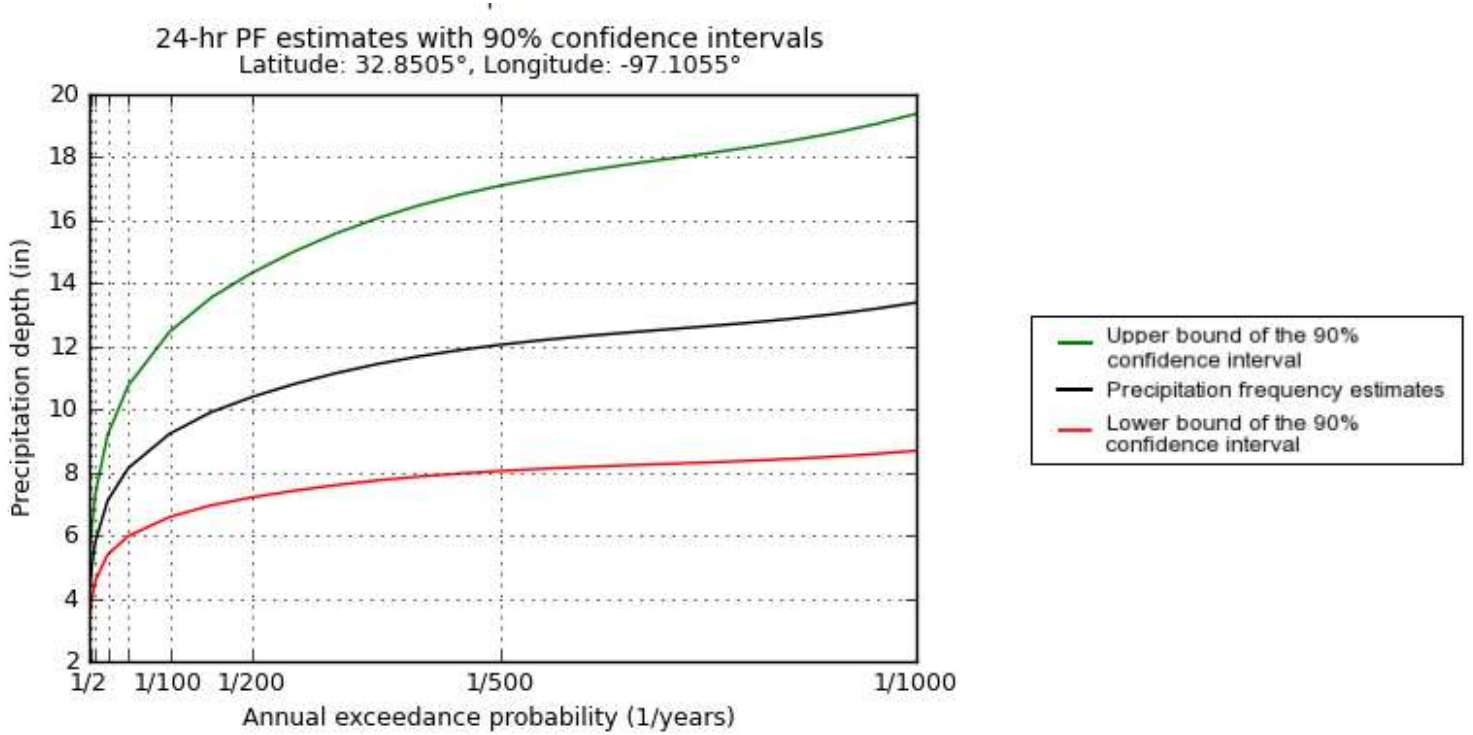
Source: NOAA Atlas 14 Volume 11 Version 2

US Army Corps of Engineers ®

U.S.ARMY

UNCERTAINTY BOUNDS

- Monte Carlo simulation accounts for inter-station dependencies
- 1,000 simulations simulated for each station
- Accounts for natural variability (uncertainty in parameters) but not knowledge uncertainty (selected distribution)



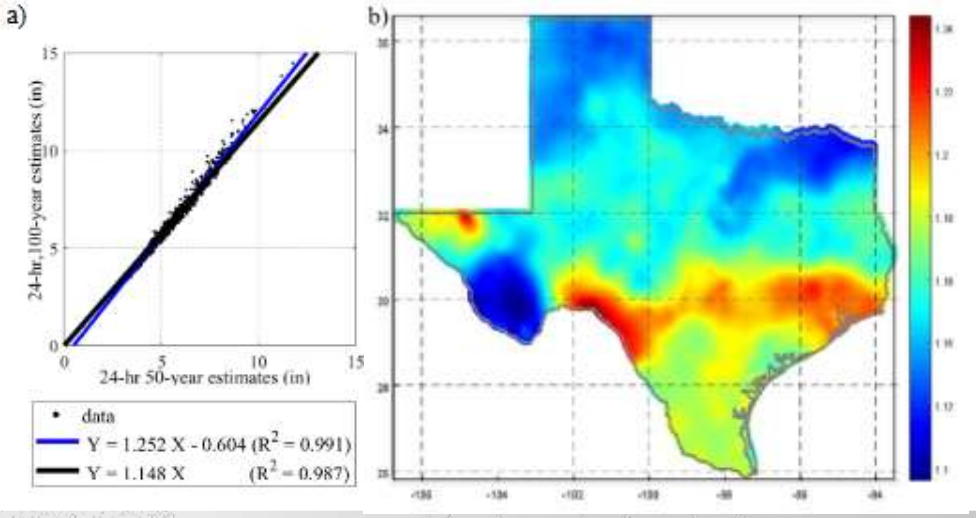
Source: NOAA Atlas 14 Volume 11 Version 2

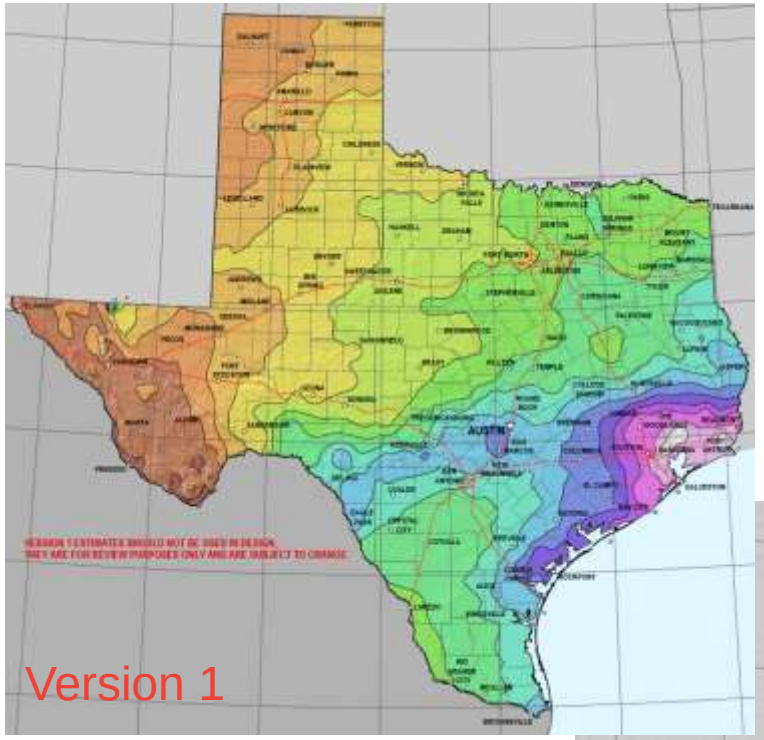
US Army Corps of Engineers ®

U.S.ARMY

GEOSPATIAL MAPPING

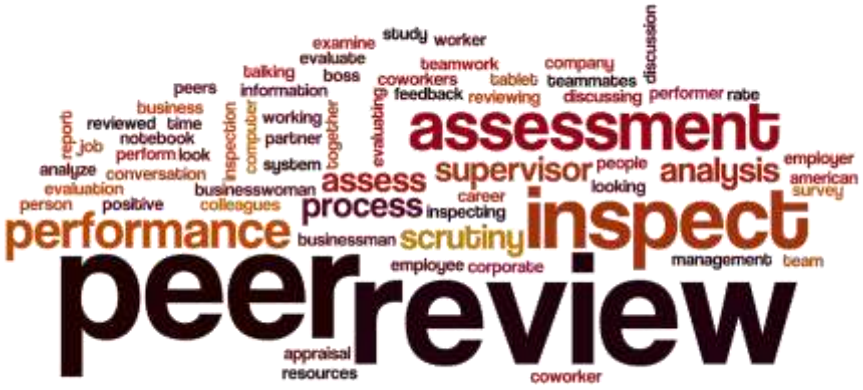
- Interpolated based on mean annual maxima and 2-year spatial pattern using a hybrid statistical-geographical approach developed by PRISM (Oregon State University)
- Multiple iterations were made to insure satisfactory spatial patterns and peer review comments
  - Bulls eyes, geographic features, logical distribution of precipitation





NOAA ATLAS 14 – PEER REVIEW BOARD

- Dr. John Nielsen-Gammon – Texas A&M University/State Climatologist
- Dr. William Asquith – Texas Tech University/USGS
- Dr. Nick Fang – University of Texas at Arlington
- Dr. Dongjin Seo – University of Texas at Arlington
- Steve Fitzgerald – Harris County Flood Control District
- Daniel Huckaby – NWS
- Paul McKee – NWS
- Maureen O'Leary – NWS
- Jon Zeitler - NWS
- Jason Johnson – NWS
- Alan Johnson – FEMA
- Saul Nuccitelli - TxDOT
- Simeon Benson – USACE
- Jerry Cotter - USACE
- Craig Loftin – USACE
- Helena Mosser – USACE
- Steve Pilney – USACE
- Max Strickler – USACE



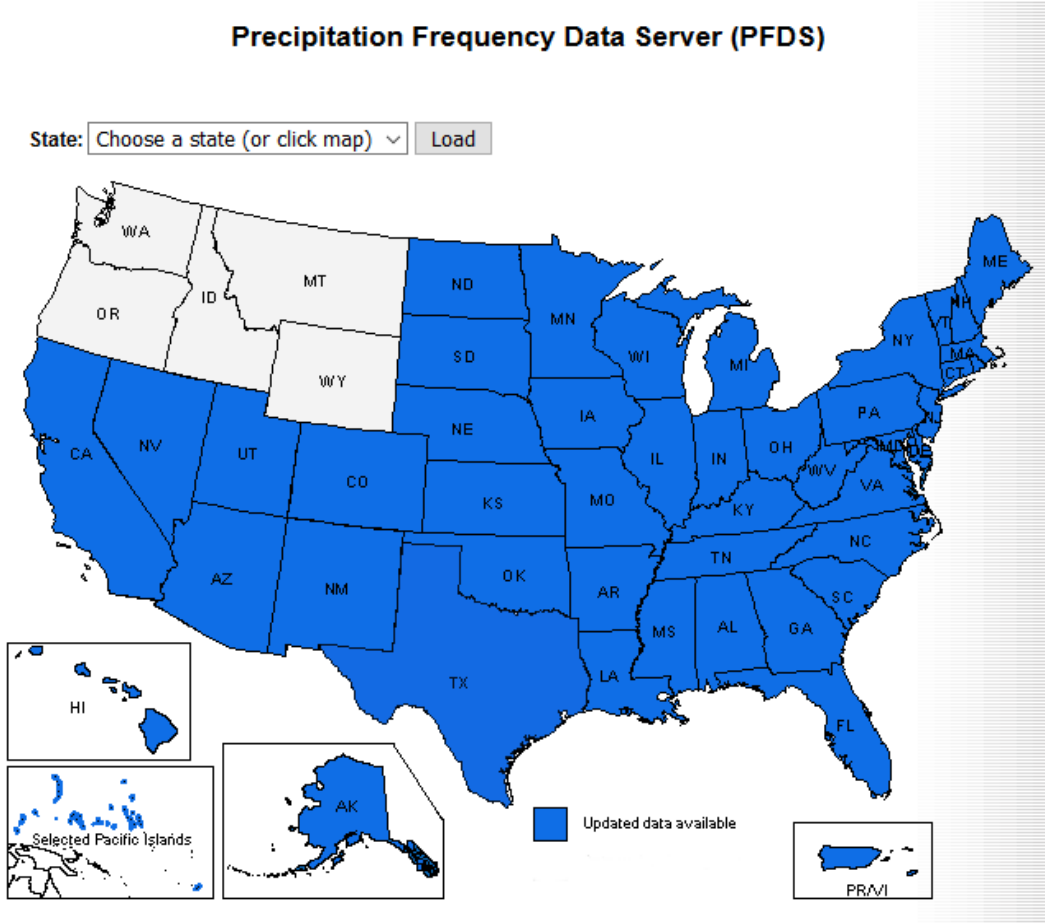
InFRM
INTERAGENCY FLOOD RISK MANAGEMENT

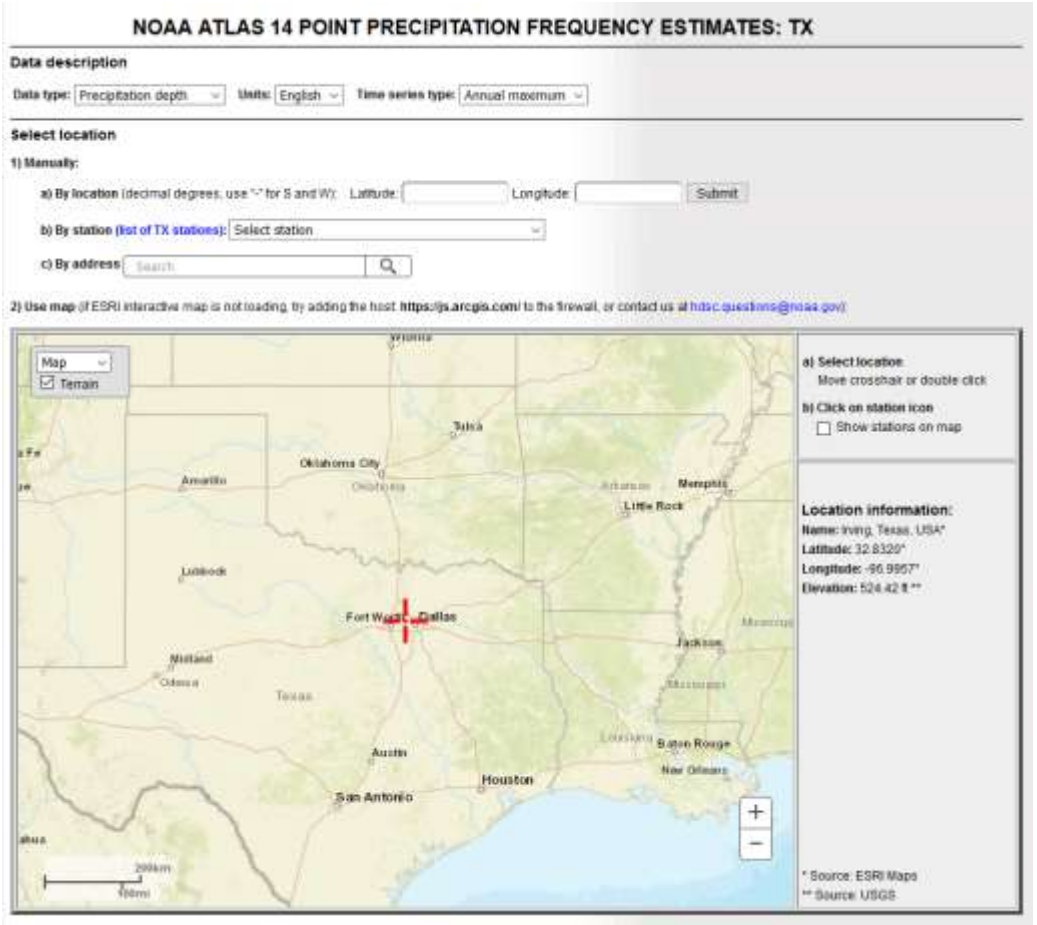
US Army Corps of Engineers ®

U.S.ARMY

NOAA ATLAS 14 - ACCESS

- All data and resources located on the Precipitation Frequency Data Server (PFDS)
  - http://hdsc.nws.noaa.gov/hdsc/pfds/





RESULTS

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 11, Version 2

PF tabular | PF graphical | Supplementary information | Print page

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

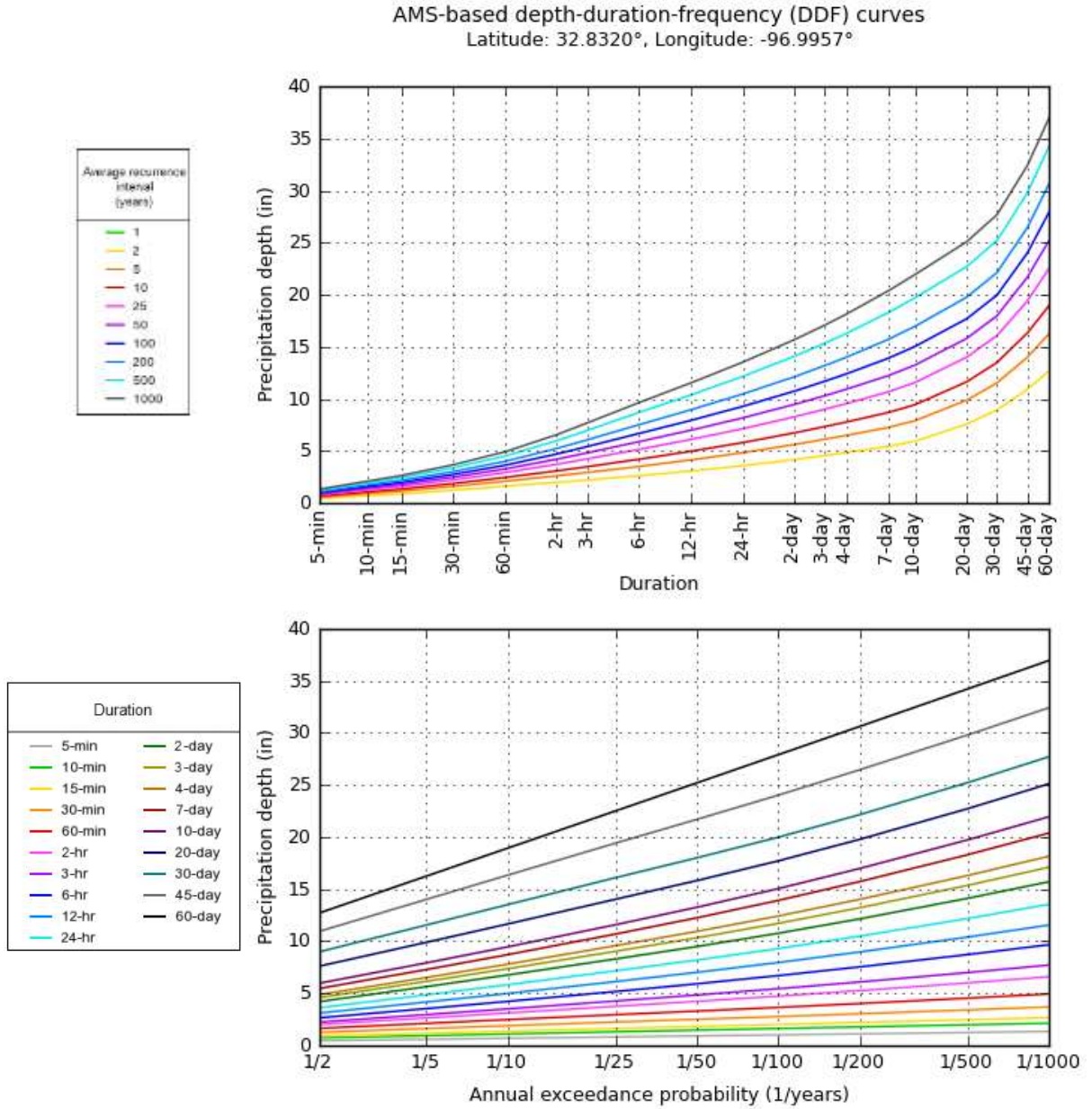
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	5.62 (4.25-7.42)	6.79 (5.18-8.66)	8.69 (6.62-11.4)	10.3 (7.72-13.7)	12.5 (9.06-17.1)	14.2 (10.0-20.0)	15.9 (11.0-23.1)	17.8 (11.9-26.4)	20.3 (13.2-31.3)	22.4 (14.1-35.3)
10-min	4.46 (3.37-5.89)	5.39 (4.12-7.04)	6.92 (5.27-9.08)	8.20 (6.15-10.9)	9.97 (7.25-13.7)	11.3 (8.04-16.0)	12.7 (8.78-18.5)	14.1 (9.50-21.0)	16.0 (10.4-24.6)	17.4 (11.0-27.5)
15-min	3.88 (2.94-5.13)	4.63 (3.53-6.04)	5.84 (4.45-7.67)	6.86 (5.15-9.14)	8.28 (6.02-11.4)	9.38 (6.64-13.2)	10.5 (7.25-15.2)	11.7 (7.86-17.4)	13.4 (8.70-20.6)	14.7 (9.31-23.2)
30-min	2.73 (2.07-3.61)	3.26 (2.49-4.26)	4.11 (3.13-5.48)	4.82 (3.62-6.42)	5.80 (4.20-7.94)	6.54 (4.61-9.21)	7.31 (5.04-10.6)	8.19 (5.51-12.2)	9.45 (6.14-14.6)	10.5 (6.64-16.6)
60-min	1.77 (1.34-2.34)	2.14 (1.64-2.79)	2.74 (2.09-3.60)	3.24 (2.43-4.32)	3.93 (2.85-5.38)	4.46 (3.14-6.27)	5.02 (3.46-7.27)	5.67 (3.81-8.45)	6.64 (4.31-10.3)	7.45 (4.71-11.8)
2-hr	1.09 (0.828-1.42)	1.37 (1.03-1.74)	1.79 (1.37-2.32)	2.17 (1.64-2.87)	2.72 (1.99-3.71)	3.18 (2.26-4.46)	3.68 (2.55-5.29)	4.25 (2.87-6.27)	5.08 (3.31-7.79)	5.78 (3.67-9.07)
3-hr	0.798 (0.611-1.04)	1.03 (0.777-1.29)	1.37 (1.05-1.77)	1.69 (1.28-2.22)	2.17 (1.60-2.96)	2.58 (1.85-3.61)	3.04 (2.11-4.35)	3.55 (2.40-5.22)	4.30 (2.81-6.56)	4.93 (3.14-7.70)
6-hr	0.468 (0.361-0.606)	0.624 (0.467-0.761)	0.842 (0.649-1.07)	1.06 (0.806-1.36)	1.39 (1.03-1.88)	1.68 (1.21-2.34)	2.01 (1.41-2.87)	2.39 (1.62-3.46)	2.94 (1.93-4.45)	3.40 (2.17-5.27)
12-hr	0.270 (0.210-0.347)	0.363 (0.272-0.436)	0.491 (0.381-0.621)	0.618 (0.476-0.802)	0.817 (0.612-1.10)	0.996 (0.724-1.38)	1.21 (0.847-1.70)	1.45 (0.987-2.09)	1.81 (1.19-2.72)	2.13 (1.36-3.27)
24-hr	0.155 (0.121-0.198)	0.210 (0.158-0.250)	0.284 (0.222-0.357)	0.360 (0.279-0.463)	0.477 (0.368-0.639)	0.584 (0.427-0.804)	0.710 (0.502-0.995)	0.857 (0.587-1.23)	1.08 (0.714-1.61)	1.27 (0.829-1.95)
2-day	0.087 (0.069-0.110)	0.120 (0.090-0.140)	0.163 (0.129-0.203)	0.208 (0.162-0.266)	0.278 (0.212-0.371)	0.343 (0.254-0.470)	0.419 (0.296-0.583)	0.504 (0.346-0.717)	0.628 (0.416-0.929)	0.733 (0.473-1.11)
3-day	0.063 (0.050-0.079)	0.086 (0.068-0.101)	0.118 (0.094-0.147)	0.151 (0.118-0.192)	0.201 (0.154-0.267)	0.247 (0.183-0.337)	0.300 (0.214-0.416)	0.359 (0.248-0.509)	0.445 (0.295-0.654)	0.516 (0.334-0.778)
4-day	0.050 (0.040-0.062)	0.069 (0.053-0.080)	0.094 (0.074-0.116)	0.119 (0.094-0.151)	0.158 (0.121-0.209)	0.194 (0.144-0.263)	0.234 (0.167-0.324)	0.279 (0.193-0.394)	0.343 (0.228-0.503)	0.396 (0.257-0.596)
7-day	0.033 (0.027-0.041)	0.044 (0.034-0.052)	0.060 (0.048-0.073)	0.075 (0.059-0.094)	0.098 (0.076-0.129)	0.119 (0.089-0.161)	0.143 (0.102-0.196)	0.168 (0.117-0.236)	0.204 (0.136-0.298)	0.234 (0.152-0.349)
10-day	0.026 (0.021-0.032)	0.034 (0.027-0.040)	0.045 (0.036-0.055)	0.056 (0.045-0.070)	0.073 (0.056-0.095)	0.088 (0.066-0.118)	0.104 (0.075-0.143)	0.122 (0.085-0.171)	0.147 (0.098-0.213)	0.167 (0.109-0.249)
20-day	0.017 (0.014-0.021)	0.022 (0.017-0.026)	0.028 (0.023-0.034)	0.034 (0.027-0.042)	0.042 (0.033-0.055)	0.050 (0.037-0.066)	0.057 (0.041-0.078)	0.066 (0.046-0.092)	0.078 (0.052-0.112)	0.088 (0.057-0.129)
30-day	0.014 (0.011-0.017)	0.017 (0.014-0.020)	0.022 (0.018-0.026)	0.026 (0.021-0.032)	0.032 (0.024-0.040)	0.036 (0.027-0.048)	0.041 (0.030-0.055)	0.046 (0.033-0.064)	0.054 (0.037-0.078)	0.061 (0.040-0.089)
45-day	0.011 (0.009-0.014)	0.014 (0.011-0.017)	0.017 (0.014-0.021)	0.021 (0.017-0.025)	0.025 (0.019-0.031)	0.028 (0.021-0.036)	0.031 (0.022-0.041)	0.034 (0.024-0.047)	0.039 (0.027-0.056)	0.043 (0.028-0.063)
60-day	0.010 (0.008-0.012)	0.012 (0.010-0.015)	0.015 (0.013-0.018)	0.018 (0.014-0.022)	0.021 (0.016-0.026)	0.023 (0.017-0.030)	0.025 (0.018-0.034)	0.028 (0.020-0.038)	0.032 (0.021-0.045)	0.035 (0.023-0.050)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

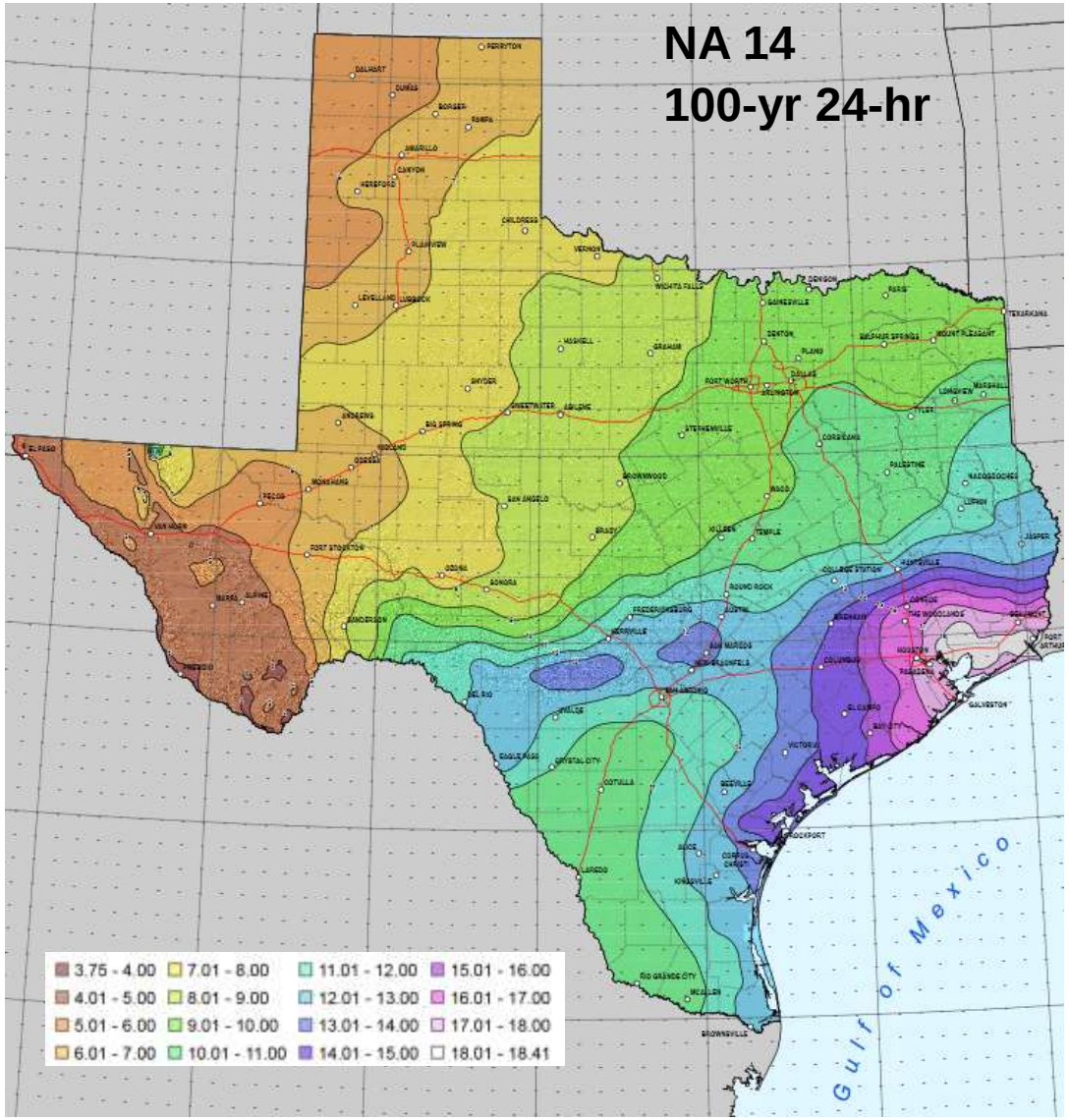
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

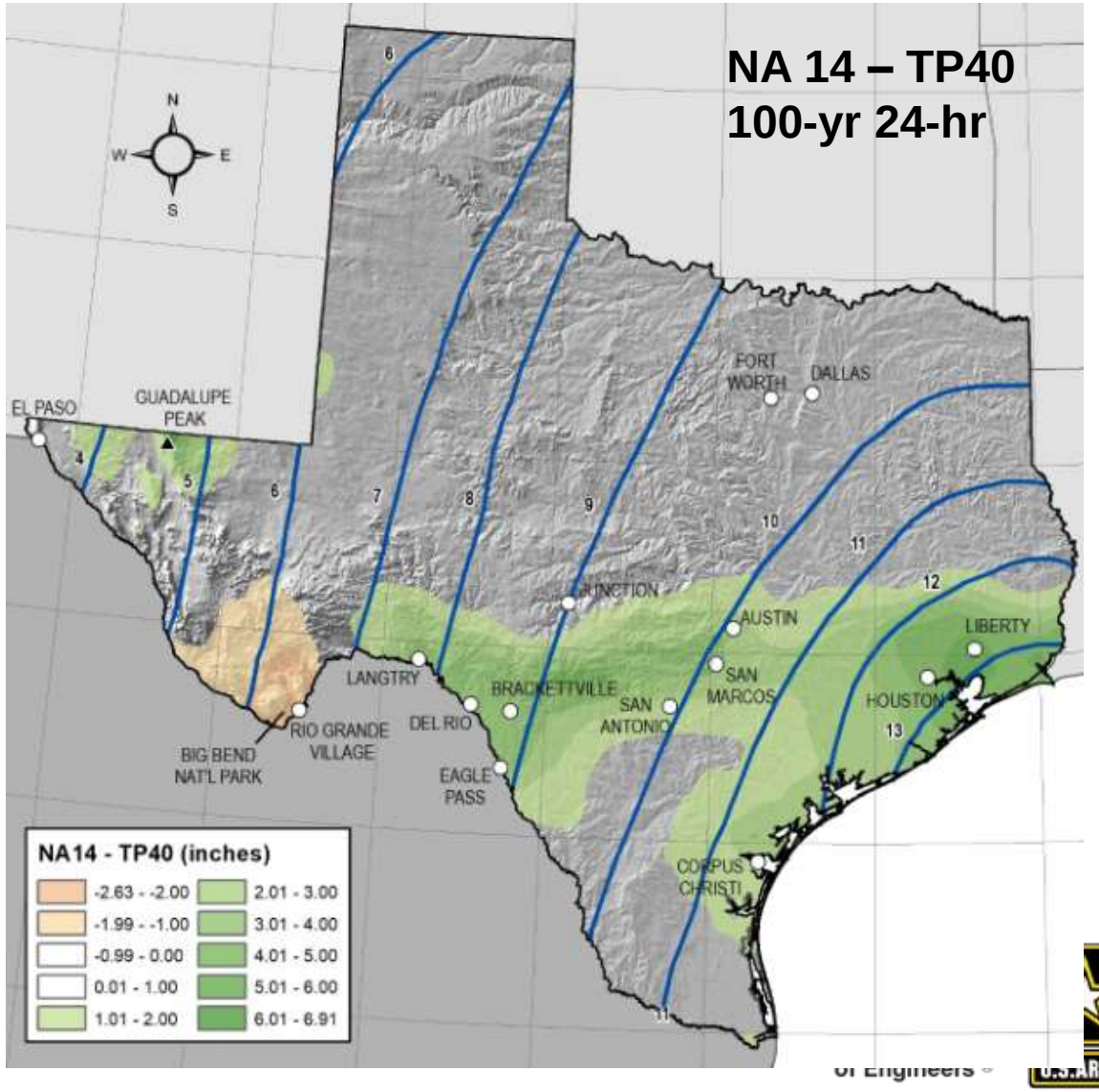
Please refer to NOAA Atlas 14 document for more information.

Estimates from the table in CSV format: Precipitation frequency estimates | Submit



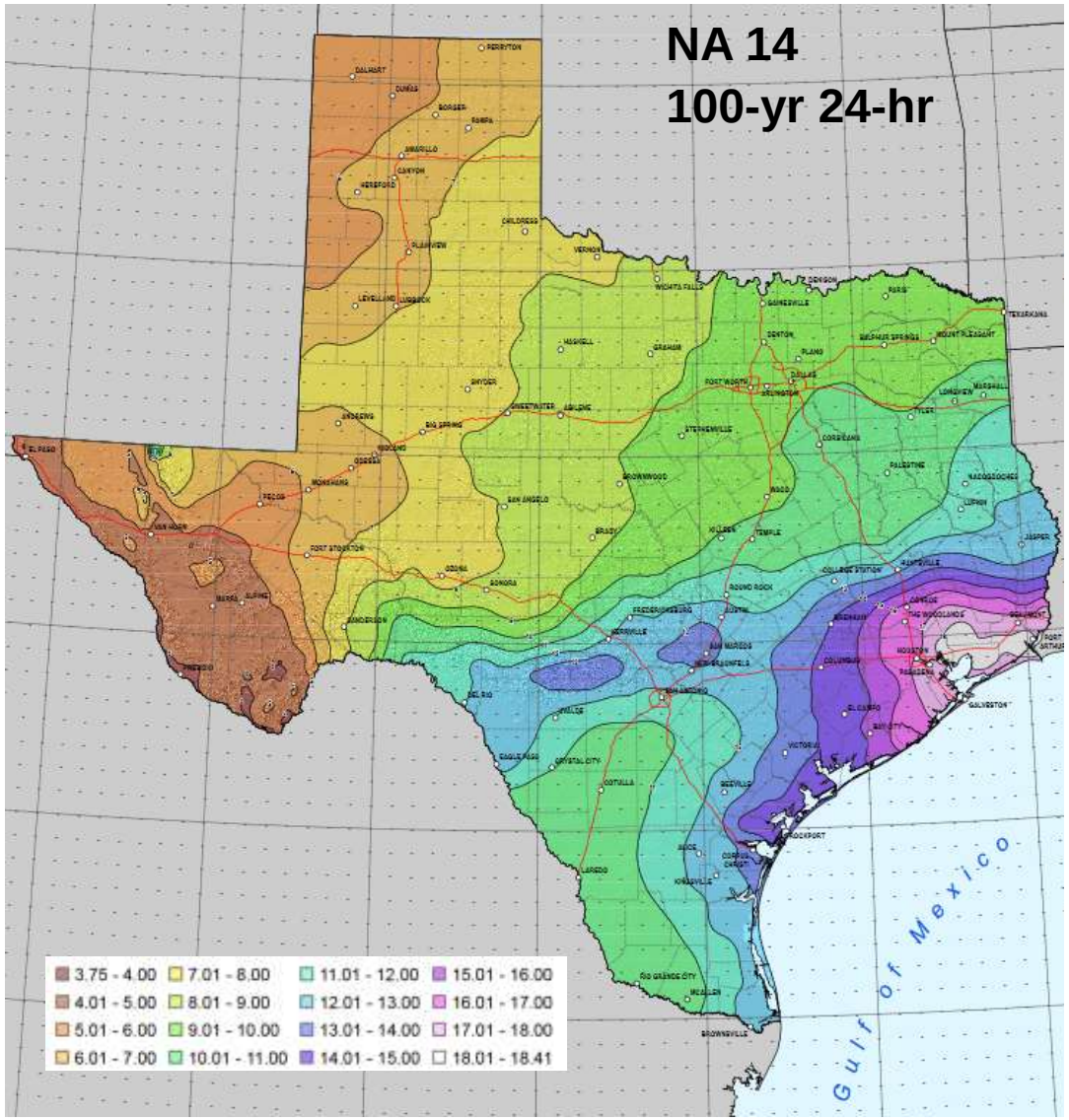
COMPARISON TO PREVIOUS STUDIES

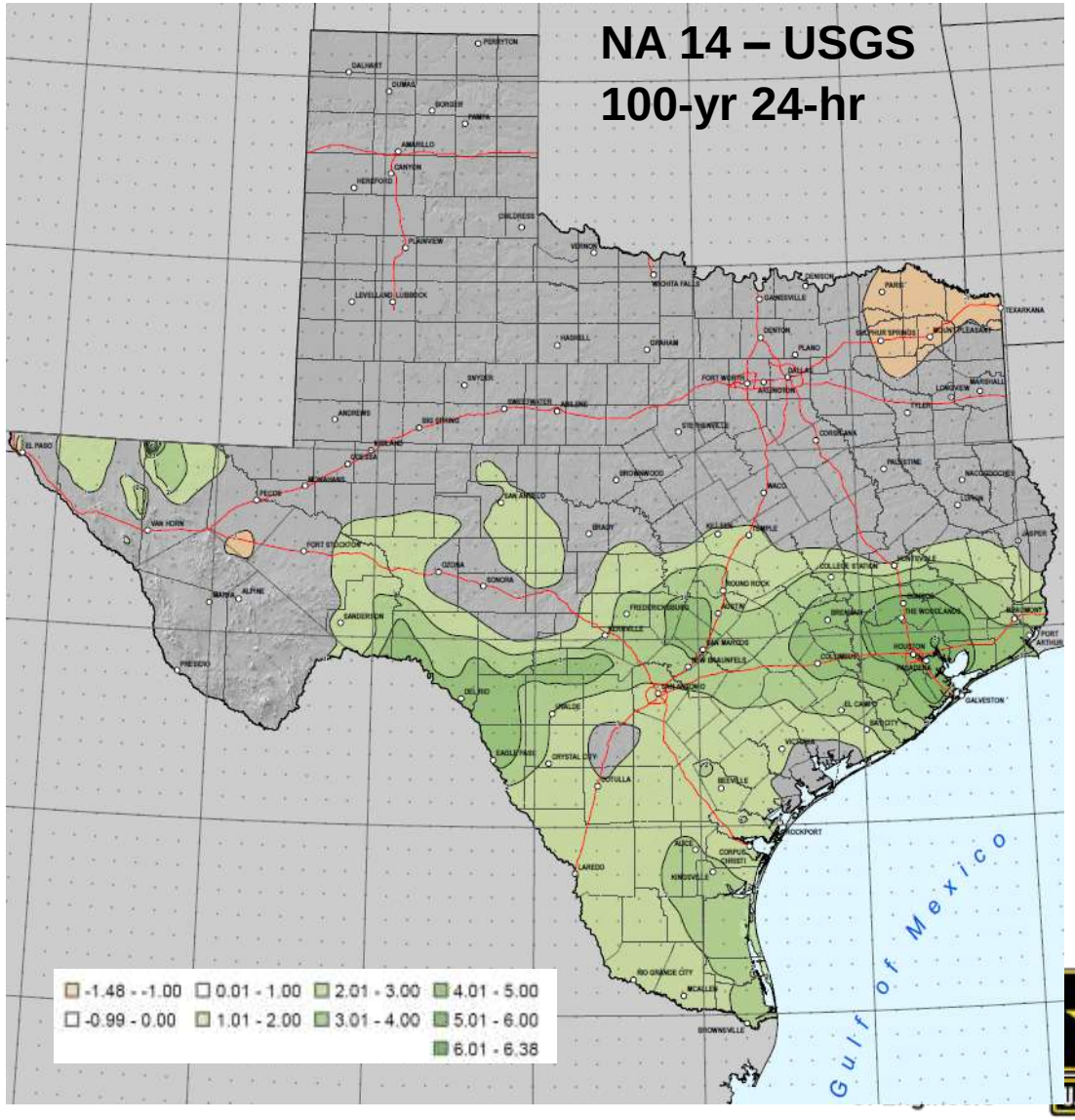




COMPARISON TO PREVIOUS STUDIES

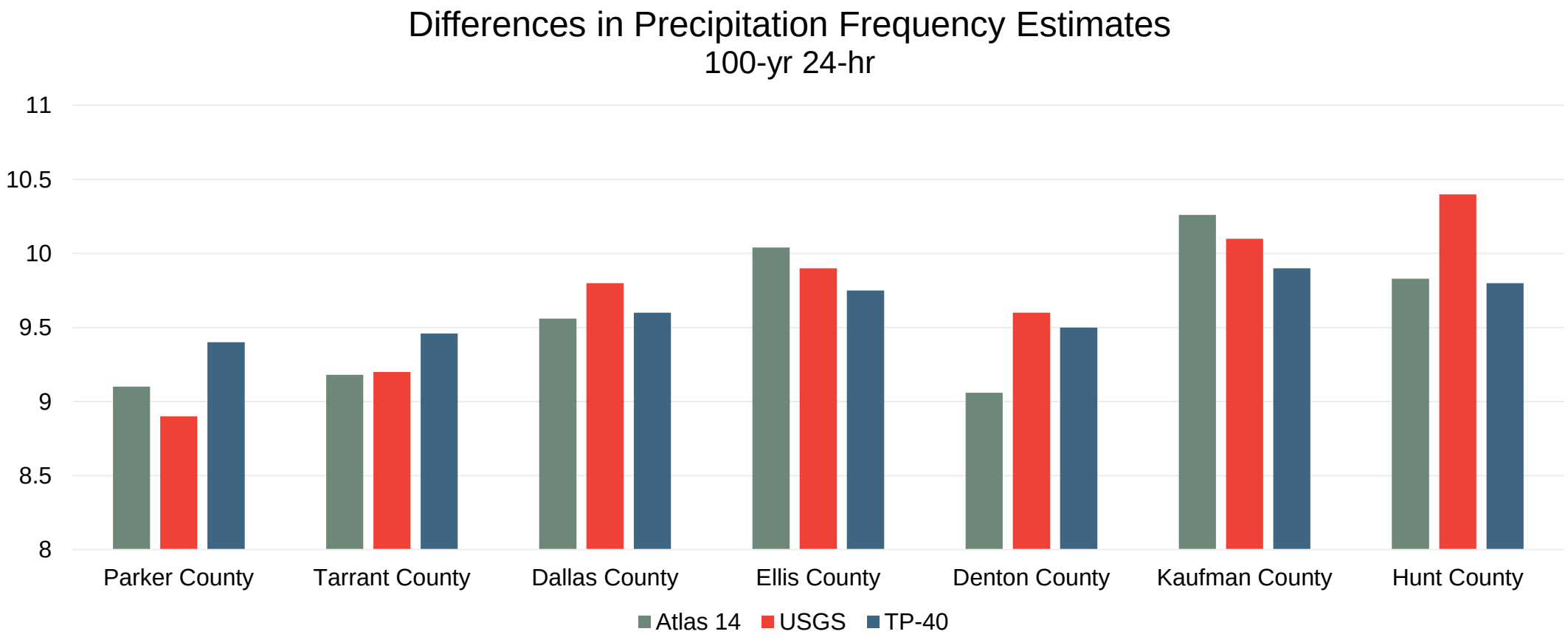
Up to 30% increase for 100-year 24-hour precipitation from USGS





U.S.ARMY

NORTH CENTRAL TEXAS PRECIPITATION FREQUENCY DIFFERENCES



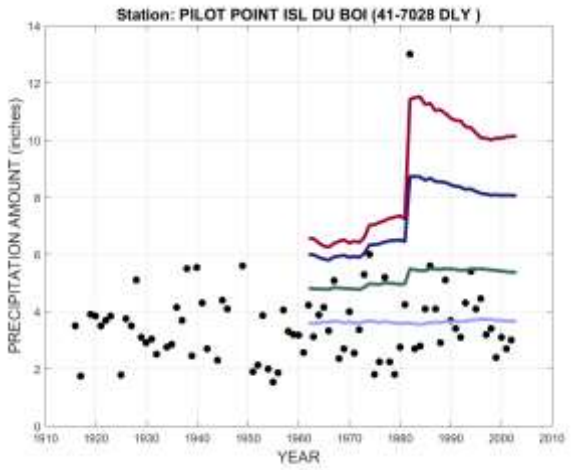
- Between 5% decrease and 2% increase in precipitation in North Central Texas

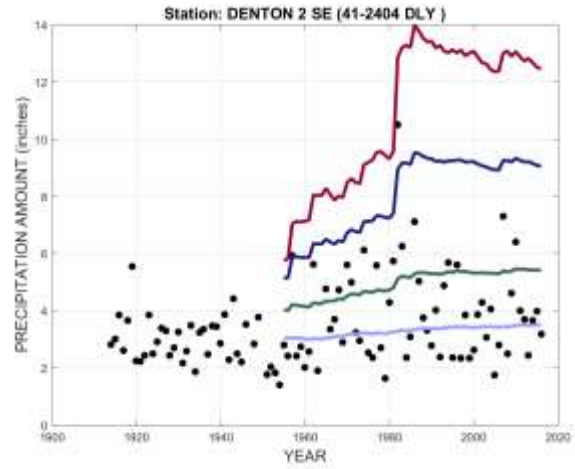
US Army Corps of Engineers ®

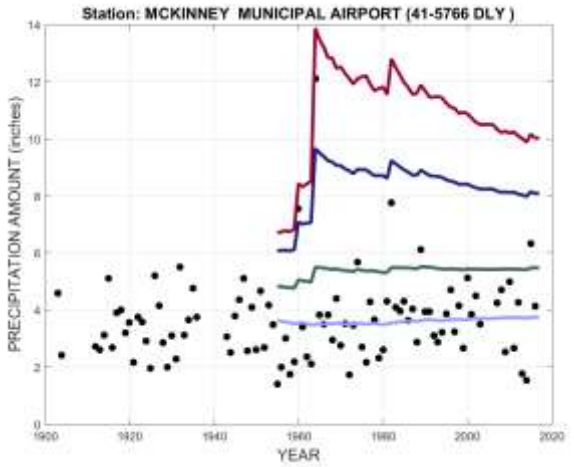
U.S.ARMY

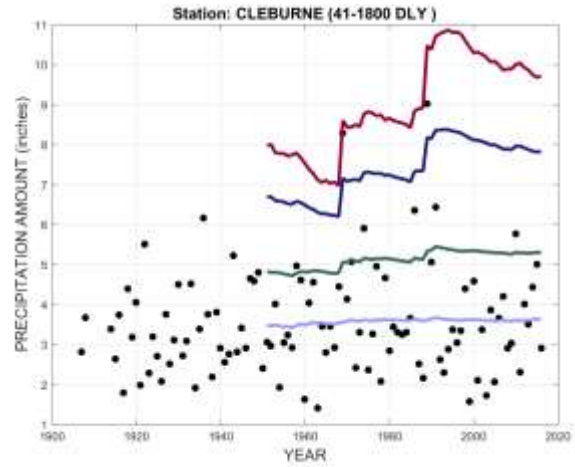
WE HAVE NOAA ATLAS 14, ARE WE DONE YET?

- Areas of concern
  - Short period of observations
  - Relationship between extreme weather variability and climate change/climate variability
    - Evaluation of non-stationarity with respect to estimates
- NA 14 are point estimates
  - Need to update Area Reduction Factors (ARF)
- Need for additional studies ($3 - $4M)
  - Other methods to estimate precipitation frequency Trend analysis
  - Storm studies (design storms)
- Atlas 14 Upkeep
  - Who will update in 10-20 years?
  - How will it be funded?









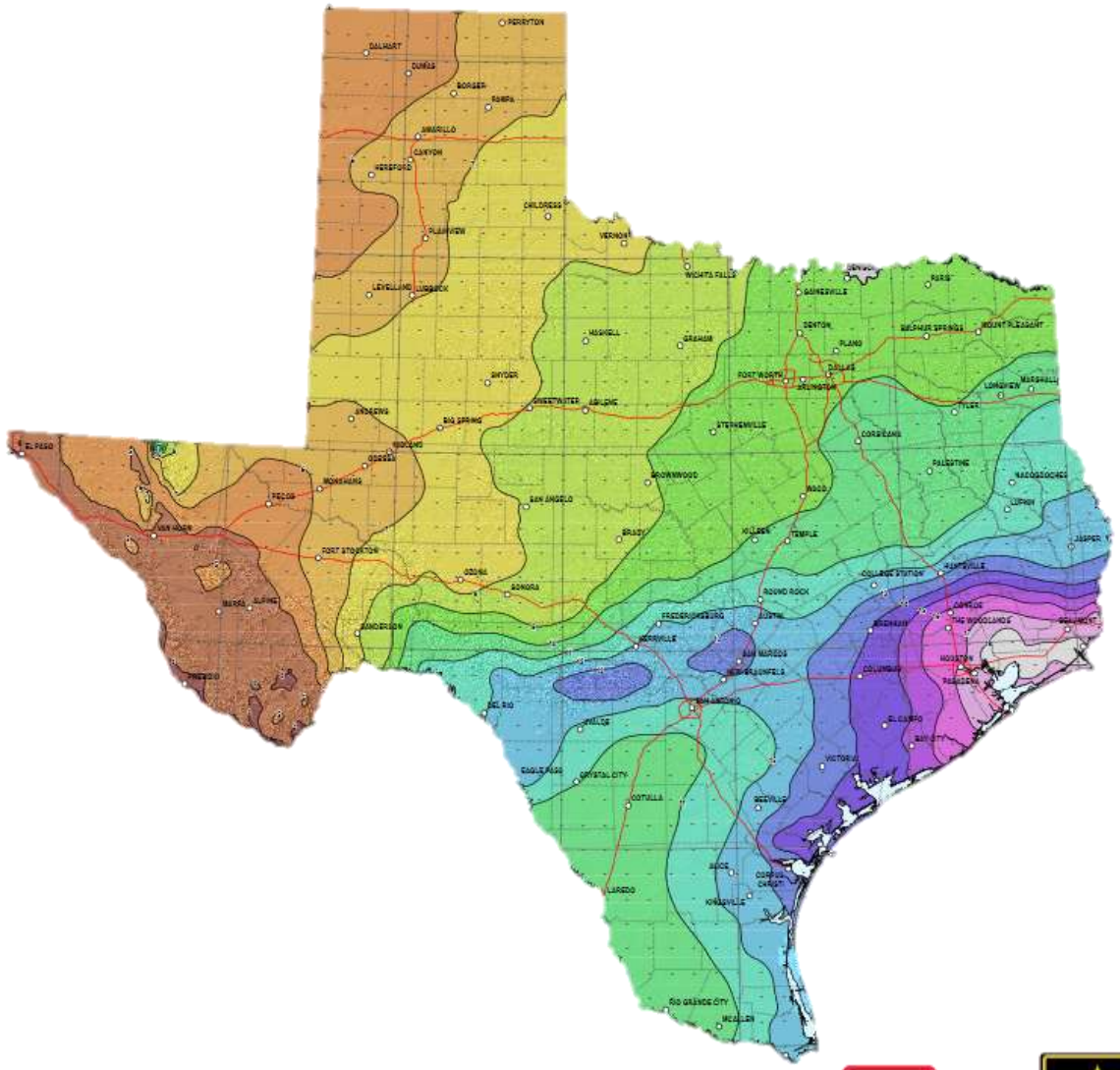
InFRM
INTERAGENCY FLOOD RISK MANAGEMENT

US Army Corps of Engineers ®

U.S.ARMY

NOAA ATLAS 14 IMPACTS

- More accurate estimates spatially → better preparedness and response
  - Able to better quantify the degree or risk of flooding at a location
- New delineation of floodplain maps
  - Frequency of precipitation does not equate to frequency of flooding
- Better planning/design of infrastructure
- More resilient towards future storms
- Non-Regulatory
  - No current requirement for communities or agencies to use Atlas 14 values



US Army Corps of Engineers ®

U.S.ARMY

QUESTIONS?

Mikaela Mahoney

Mikaela.Mahoney@usace.army.mil
817-886-1546

US Army Corps of Engineers ®

U.S.ARMY

WHAT IS NOAA ATLAS 14?

- NOAA's Office of Water Prediction, Hydro-meteorological Design Studies Center
- National initiative which begun around 2000
- Today's de facto national standard for precipitation frequency estimates
- 30 arc-second resolution, ~800 meter grid
  - Durations from 5 minutes to 60 days for
  - Average recurrence intervals (ARIs) from 1 to 1,000 years
- Electronically accessible
  - http://hdsc.nws.noaa.gov/hdsc/pfds/
- Funded locally

US Army Corps of Engineers ®

U.S.ARMY

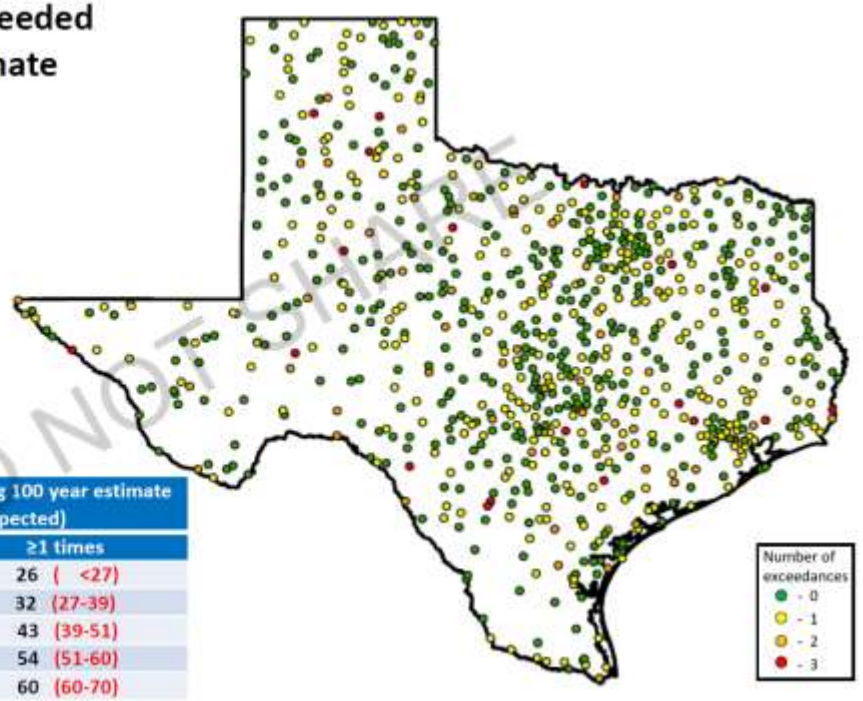
INFRM – NOAA ATLAS 14 PEER REVIEW BOARD

- Appropriateness of selected distribution
- How many data points equaled or exceeded estimate
- Variability of estimates over time

Number of times AM exceeded 24-hour 100-year estimate

Record length	# of stations	# of exceedances 0	1	2	3
≤ 30	129	96	30	2	1
31- 50	296	202	78	12	4
51 - 70	356	204	125	25	2
71 - 90	224	104	97	18	5
> 90	223	89	89	32	13

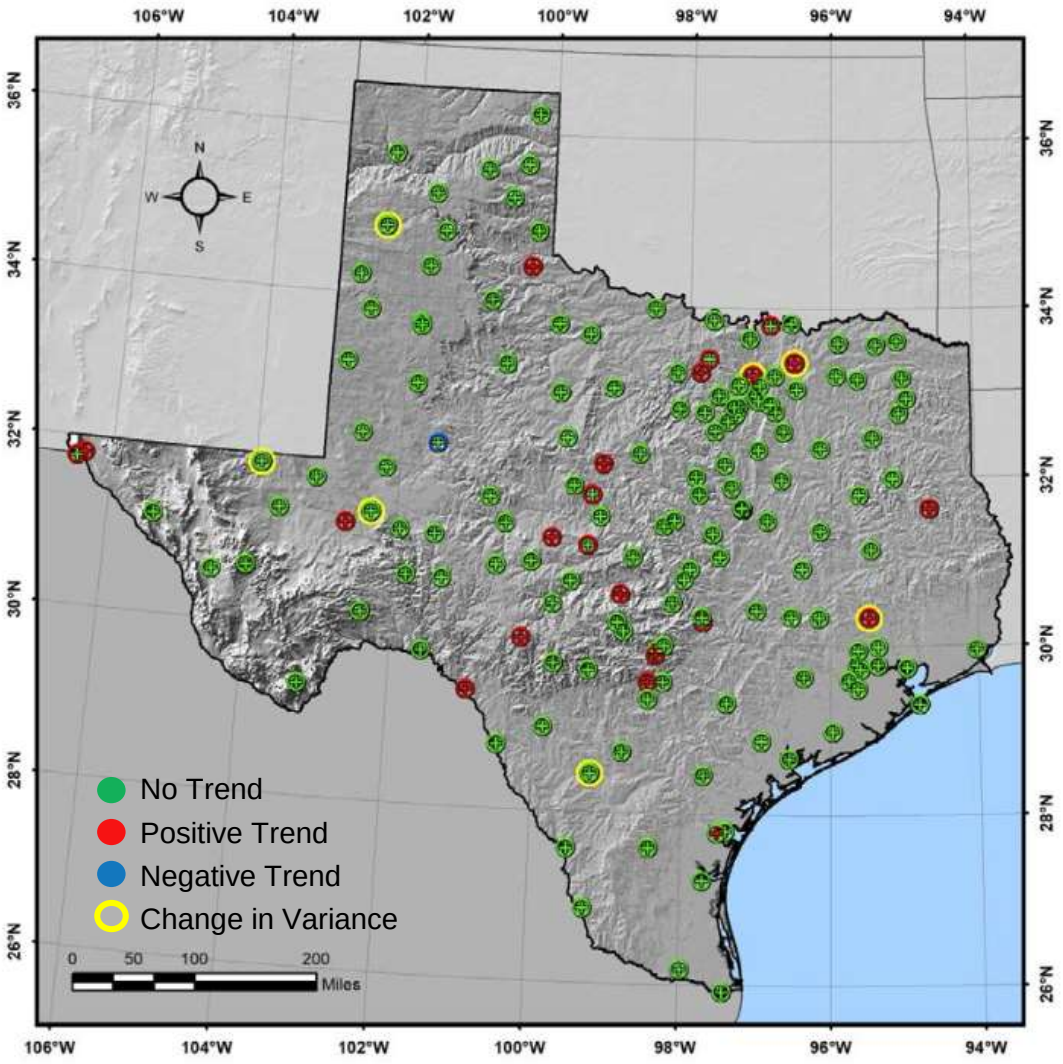
Record length	# of stations	% of stations exceeding 100 year estimate actual (expected) 0 times	≥1 times
≤ 30	129	74 (>73)	26 (<27)
31- 50	296	68 (61-73)	32 (27-39)
51 - 70	356	57 (49-61)	43 (39-51)
71 - 90	224	46 (40-49)	54 (51-60)
> 90	223	40 (30-40)	60 (60-70)



US Army Corps of Engineers ®

U.S.ARMY

TREND ANALYSIS



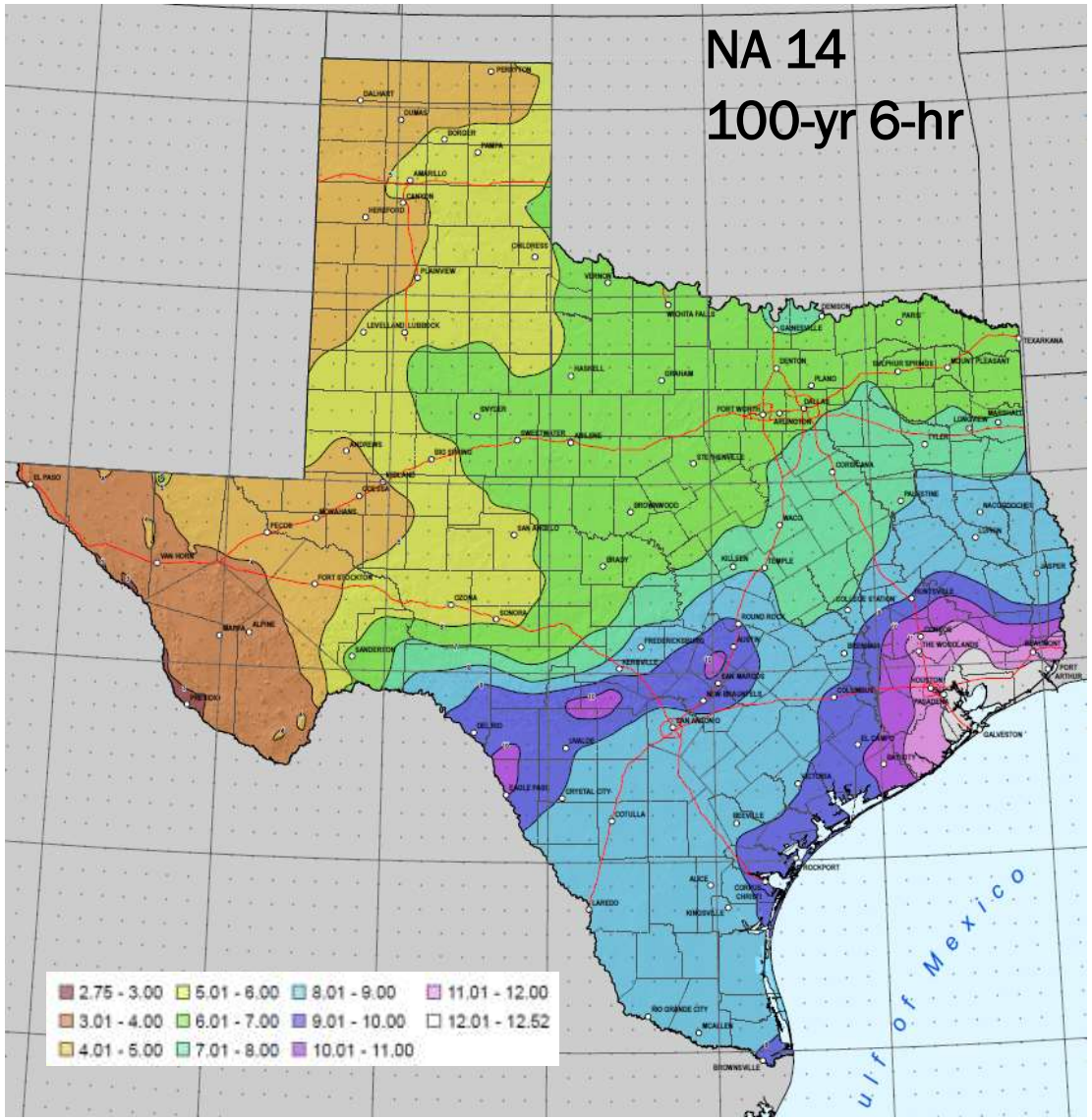
Number of stations	1-hour			1-day		
	t-test	M-K test	Levene's	*t*-test	M-K test	Levene's
no trend	148	142	157	294	287	308
positive trend	16	21	7	29	34	17
negative trend	0	1		2	4	

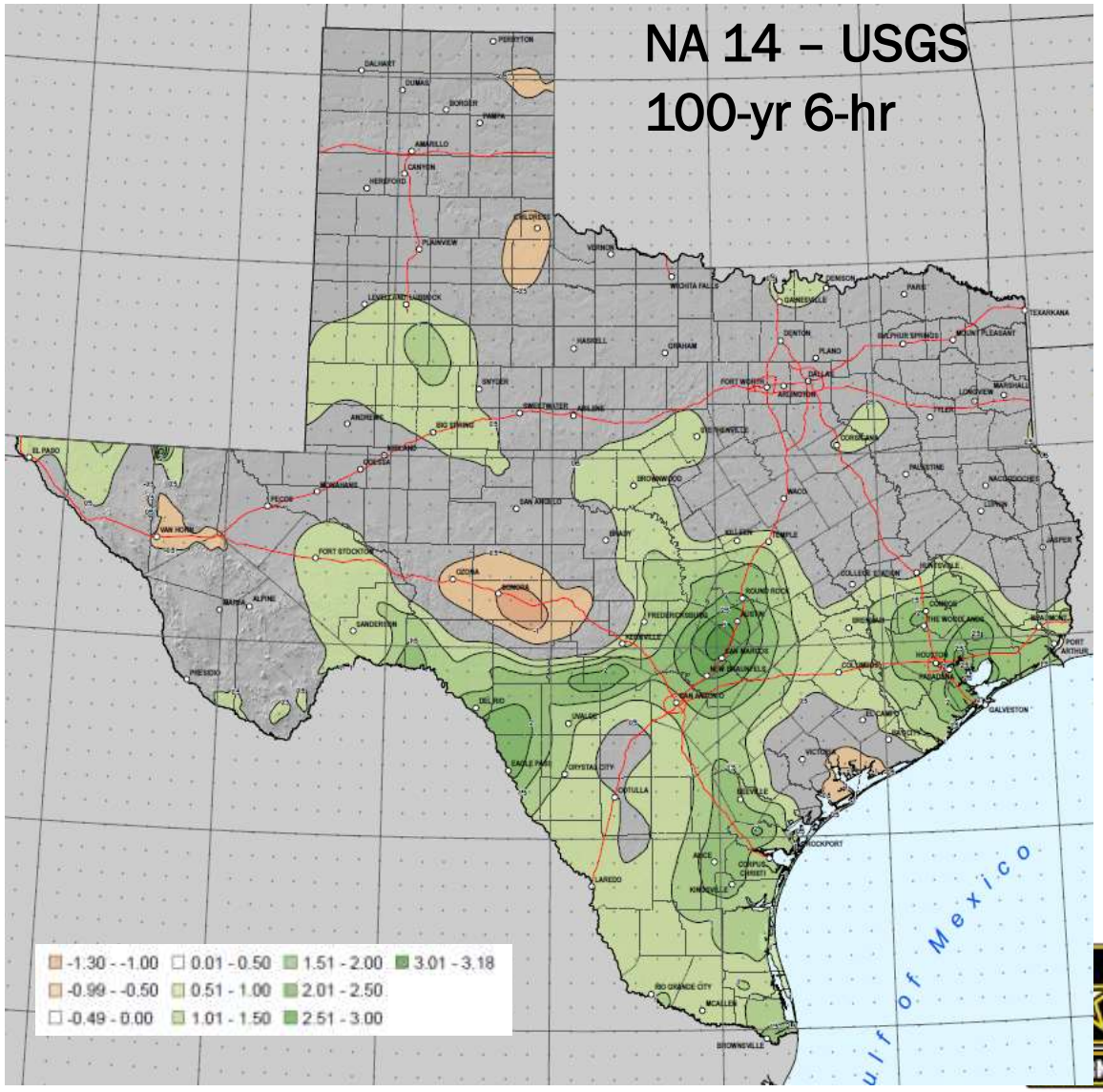
Spatial results of *t*-, Mann-Kendal, and Levene's test for 1-day AMS.
Source: NOAA Atlas 14 Volume 11 Version 2

US Army Corps of Engineers ®

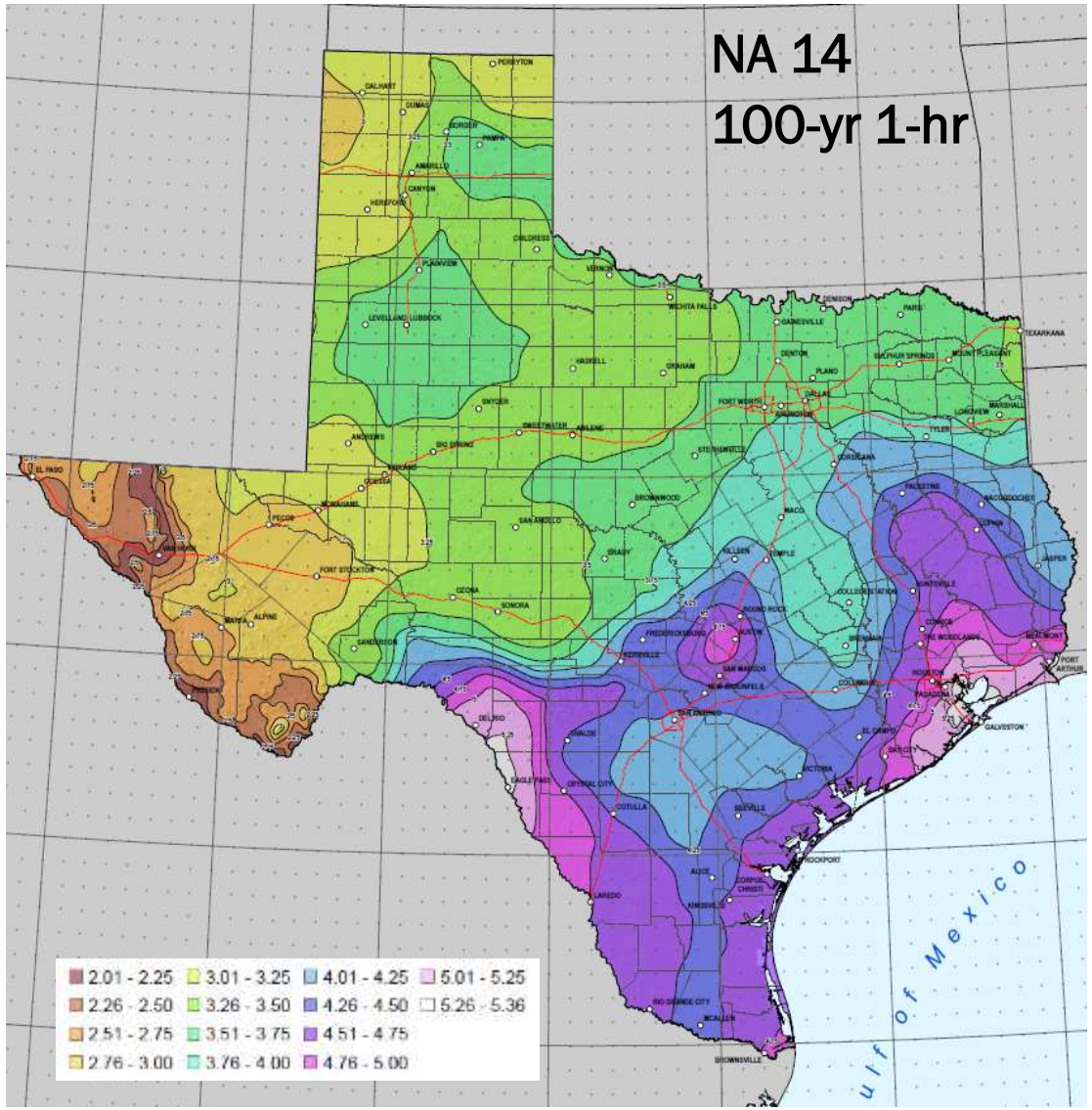
U.S.ARMY

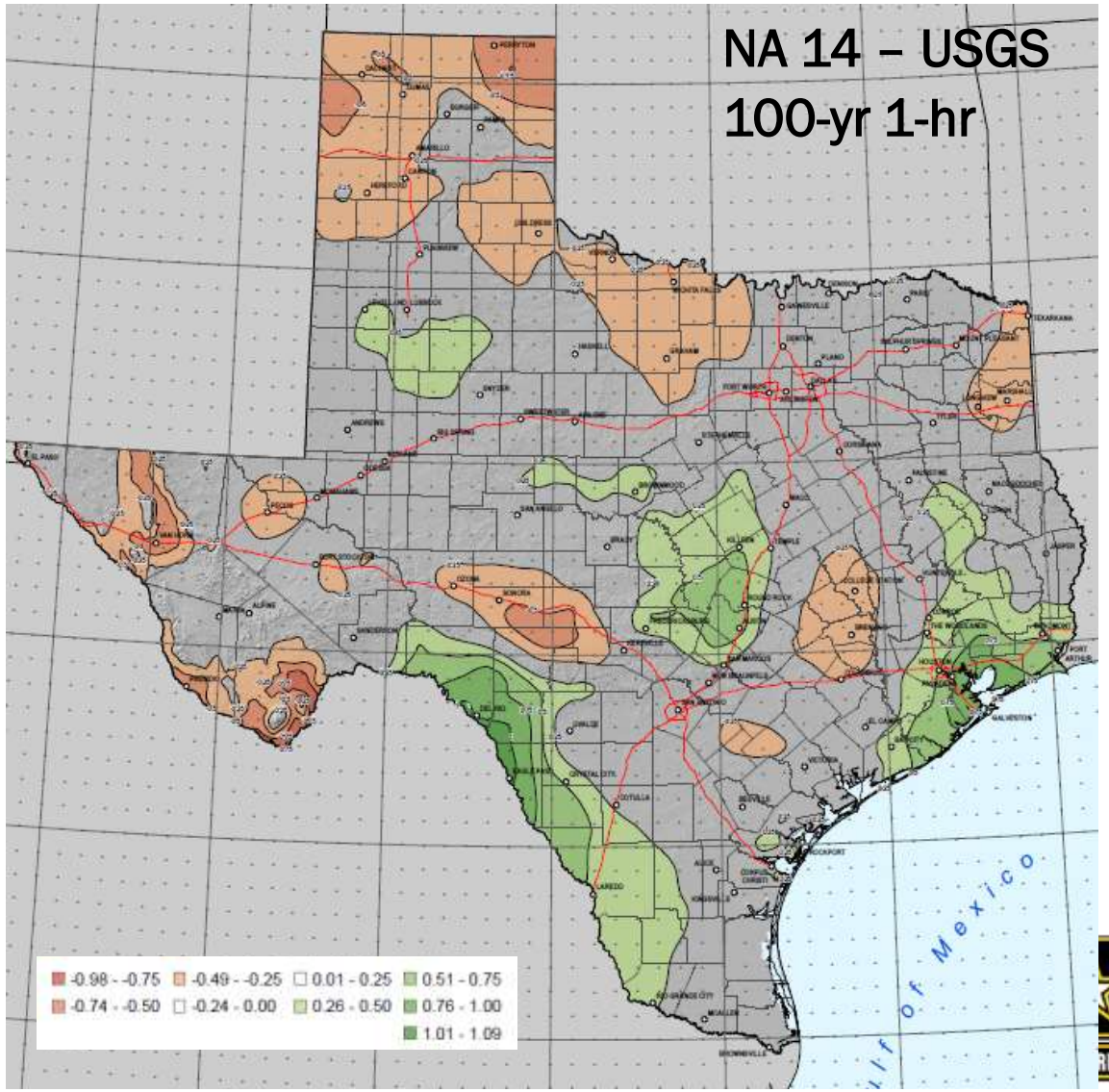
COMPARISON TO PREVIOUS STUDIES





COMPARISON TO PREVIOUS STUDIES





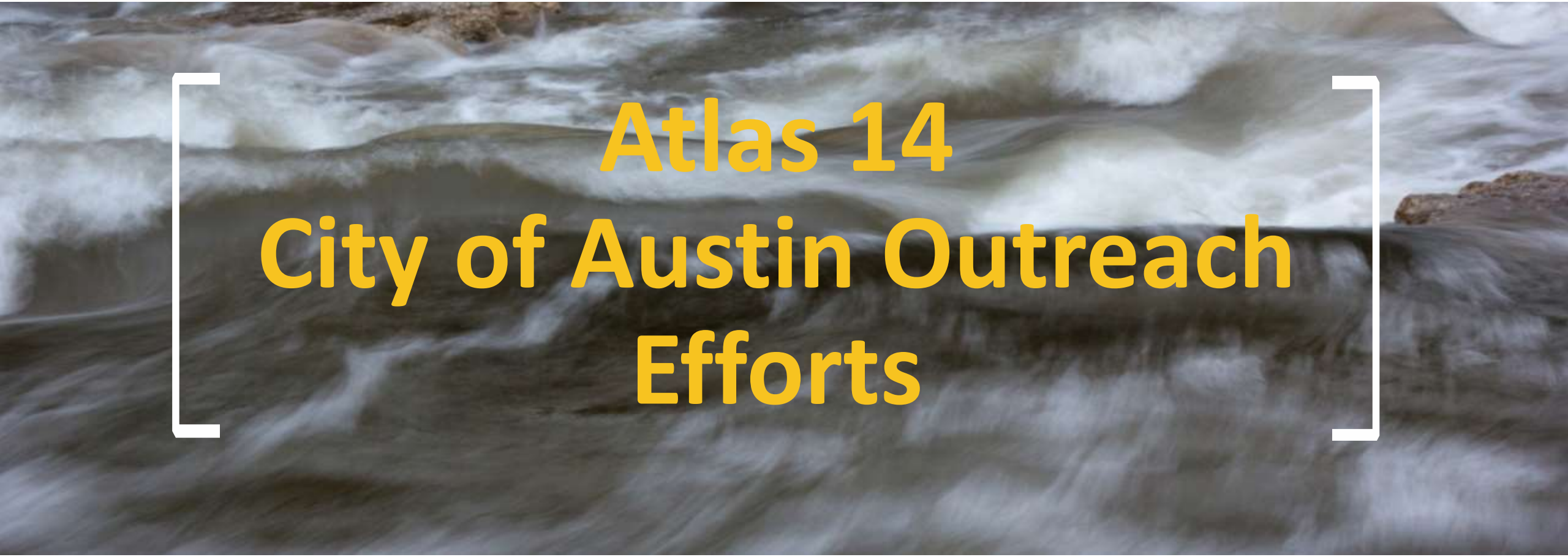
NOAA ATLAS 14 – VOLUME 11

- Updated precipitation frequency estimates for Texas
  - Quantify the degree or risk of flooding at a location
  - Improved statistical techniques with longer record lengths – more reliable estimates
  - Easily accessible
- Not done yet, still need more research
  - Area Reduction Factor
  - Non-stationarity of data
  - Climate change

US Army Corps of Engineers ®

U.S.ARMY

ATX FLOOD SAFETY



Atlas 14
City of Austin Outreach Efforts

Communicating risk, educating the public, and engaging the development community.

City of Austin Watershed Protection Department
North Texas Floodplain Administrators Group | February 27, 2019

WATERSHED PROTECTION

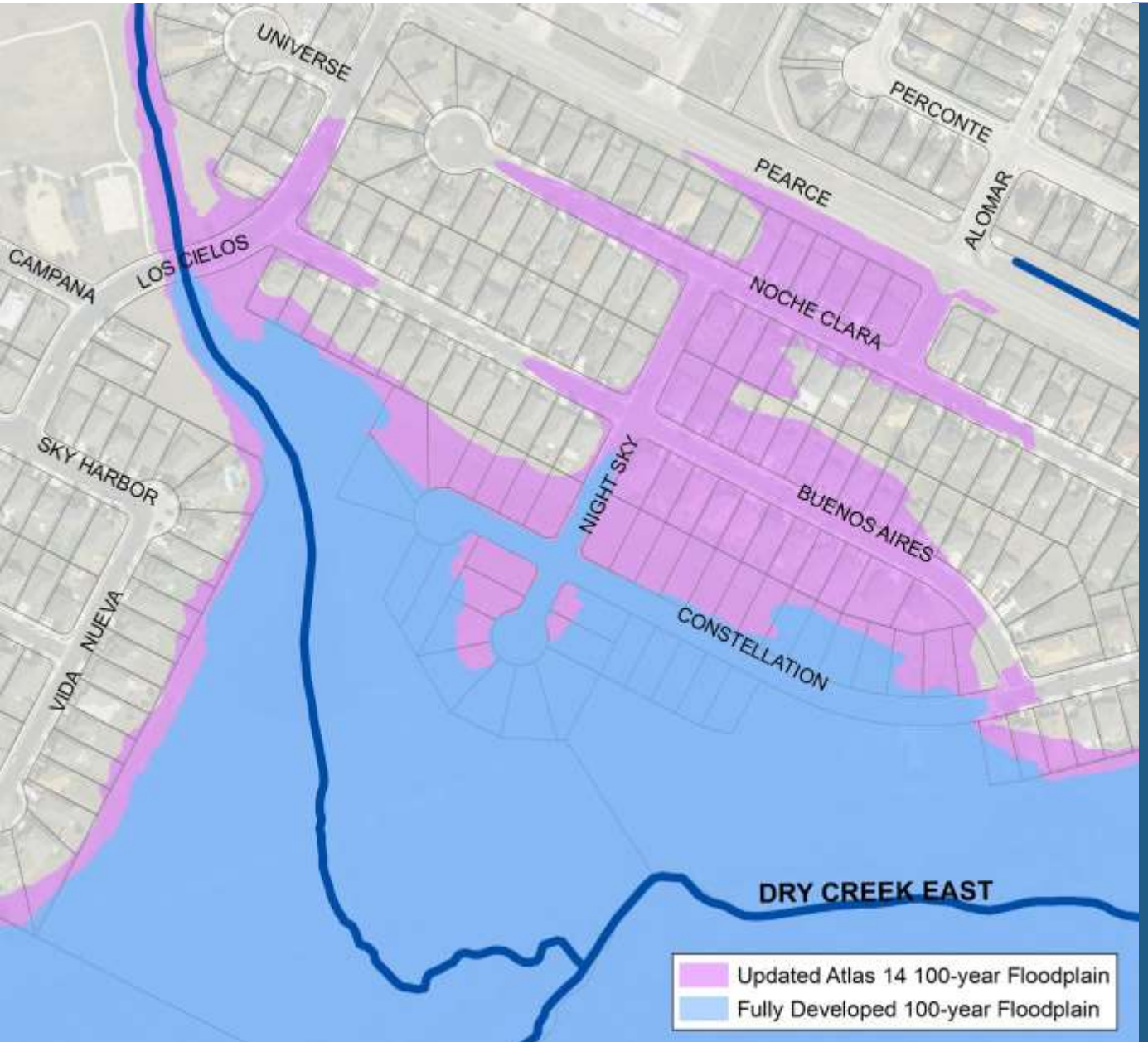
Overview

- Study background
- Summary of key impacts
- Recommended response
- Next steps

Key impacts of Atlas 14 updated rainfall data

Measure	Current	Updated	Percent Increase
100-year rainfall	10.2 inches	Up to 13+ inches	**30%**
Buildings in 100-year floodplain	4,000	7,200*	**80%**

**Excludes Colorado River floodplain and associated lakes*



Austin's

Floodplains Will Expand

- More homes and businesses are at risk of flooding than previously thought.
- Affects ability to develop, remodel, or redevelop property.
- Affects the need for and the cost of flood insurance.
- Floodplains will need to be re-studied.
- See impacts at ATXfloodpro.com

WATERSHED PROTECTION

ATX FLOOD SAFETY

Austin's

Floodplains Will Expand

- More homes and businesses are at risk of flooding than previously thought.
- Affects ability to develop, remodel, or redevelop property.
- Affects the need for and the cost of flood insurance.
- Floodplains will need to be re-studied.
- See impacts at ATXfloodpro.com

WATERSHED PROTECTION

What is the

Impact to Flood Insurance?

- Flood insurance impacts are dependent on FEMA map update
- Map updates at least 3 years away
- Rates may go up
- Insurance requirements may change
- Talk to an insurance agent now

Proposed Floodplain Regulations

Recommended Response

Step 1

Land Development Code amendments

Step 2

Drainage Criteria Manual revisions

Step 3

Floodplain Study and Mapping Updates

Step 1: Land Development Code Amendments

Floodplain Management Regulation Changes

- Redevelopment Exception
- Colorado River Exception
- Freeboard

WATERSHED PROTECTION

Step 1: Land Development Code Amendments

Proposed Interim Floodplain Definitions

New 100-yr floodplain ==>> Current 500-yr floodplain

New 25-yr floodplain ==>> Current 100-yr floodplain

Storm Level	Current Rainfall Depth (24 hour storm)	Updated Rainfall Depth (24 hour storm)
25-year (4% chance)	7.6 inches	Almost 10 inches
100-year (1% chance)	10.2 inches	Up to 13+ inches
500-year (0.2% chance)	13.5 inches	Up to 19.5 inches

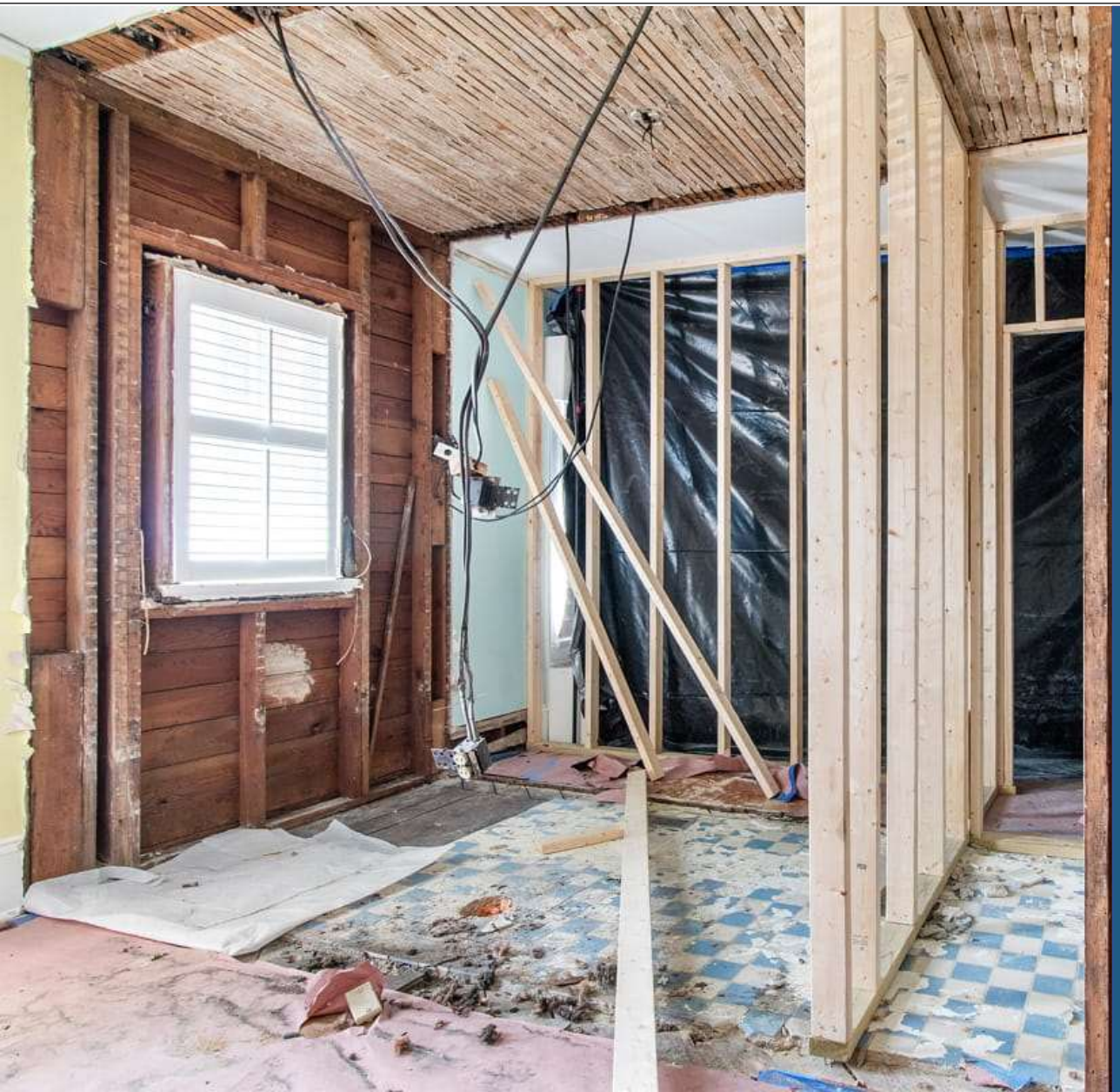
WATERSHED PROTECTION

Redevelopment Exception

A residential building may encroach in the 25- or 100-year floodplain as long as it:

- Replaces an existing building
- Is above 100-year floodplain by 2 feet
- Does not increase number of dwelling units
- No adverse flooding impact

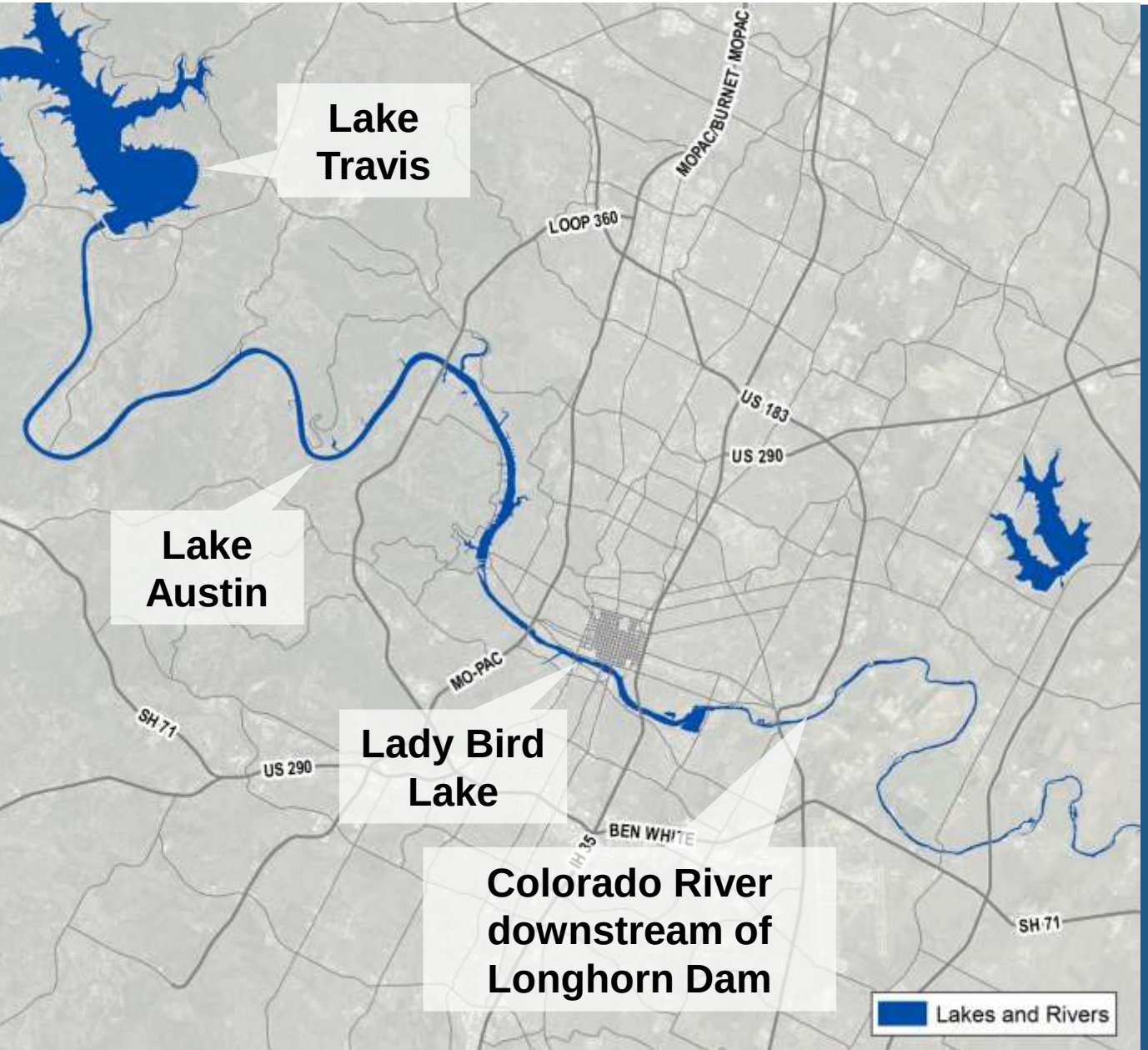
If these conditions are met, safe access requirement is waived.



Redevelopment Exception Remodels

Additions and substantial renovations can be approved if:

- The home meets 2 feet freeboard requirement.

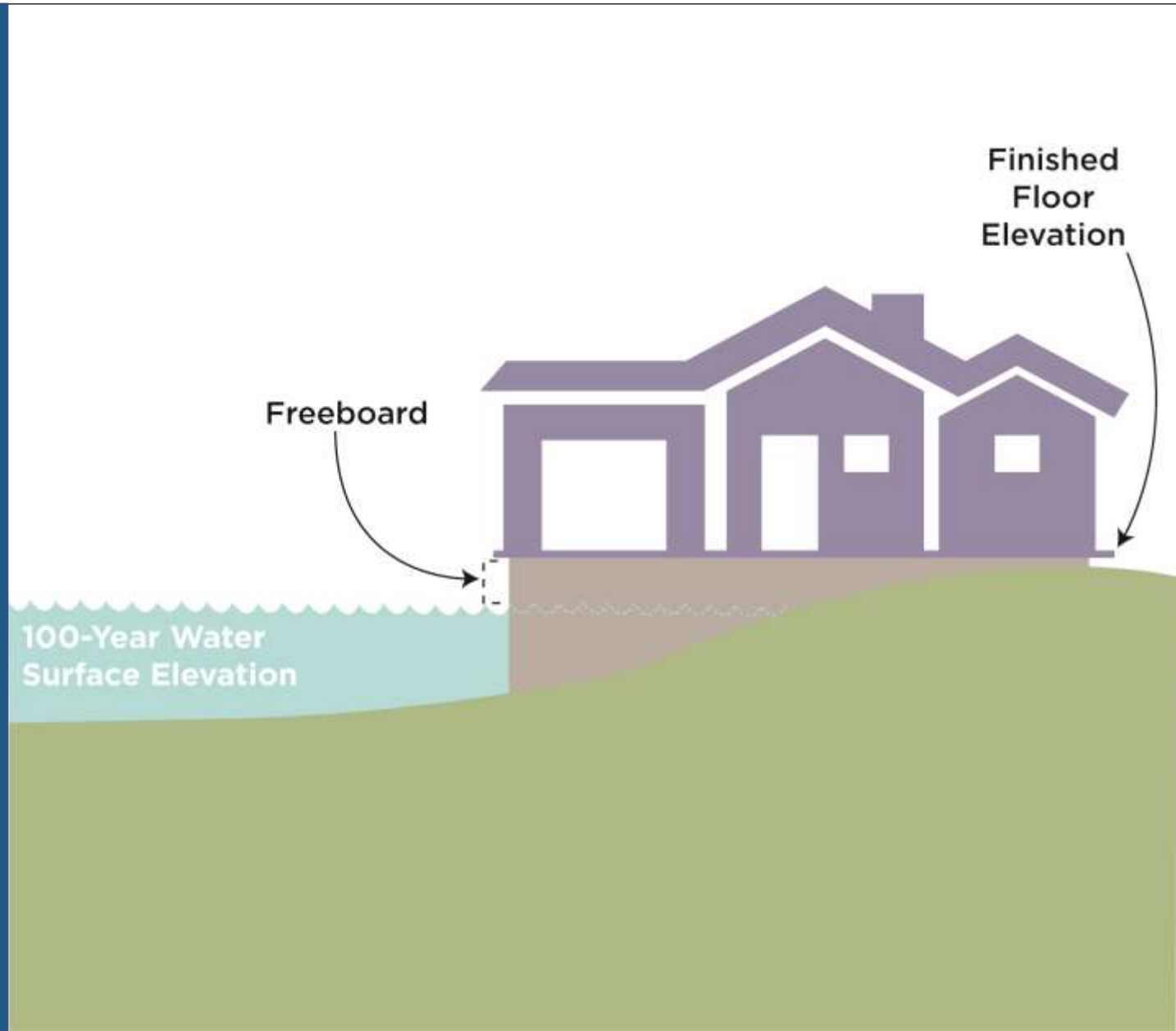


Colorado River Exception

- Expand 100-year encroachment exception to include Lake Austin and Lake Travis
- Maintain prohibition on encroachment on 25-year floodplain

Increase Minimum freeboard to 2 feet

- Minimum height between building's lowest floor and 100-year floodplain
- Freeboard is the single-most effective means for reducing flood risk to a building in the floodplain
- More than 140 Texas communities have freeboard of 2 feet or higher



WATERSHED PROTECTION

Helpful Documents to View

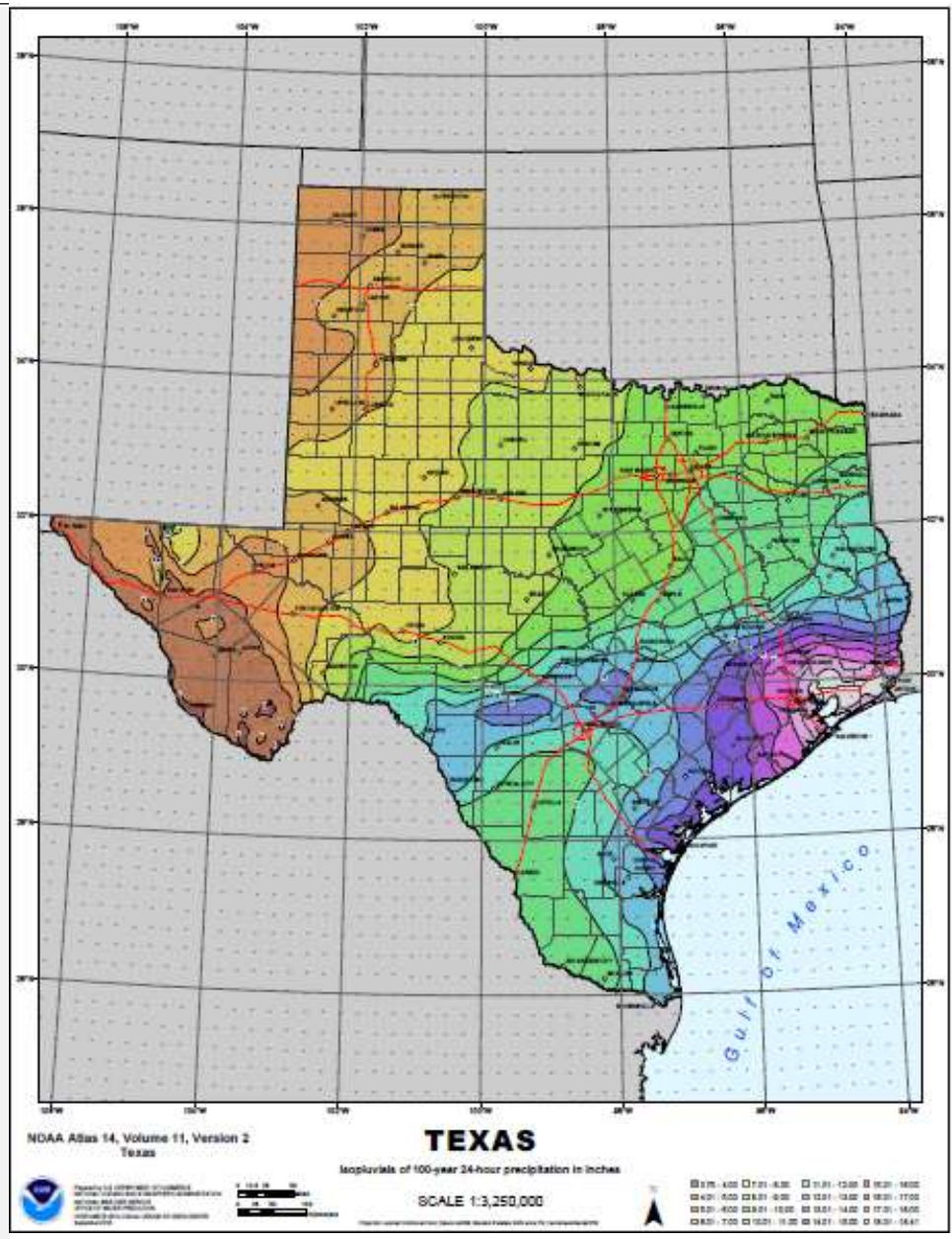
- Guidance document
  - Long-term planning recommendations regarding the proposed floodplain regulations and drainage rules
- Summary of recommended code changes
  - Draft ordinance explanation in non-legislative language
- Draft ordinance
  - Proposed changes to the Land Development Code in legislative format

Step 2: Drainage Criteria Manual Revisions

- DCM updates are related to but independent from floodplain code amendments
- Potential changes include:
  - Design rainfall depths
  - Rainfall temporal distribution (hyetograph)
  - Intensity-duration-frequency curves
- Additional Considerations
  - Impact on storm drain and detention pond sizing
  - Level of service requirements

Key Changes

- Higher Rainfall Depths across all depths and durations
- Increased geographic variability



Percent increase indicated by Atlas 14 versus current DCM

	Recurrence Interval (year)							
	2	5	10	25	50	100	250/200	500
5 min*	9%	8%	11%	14%	17%	18%	17%	21%
15 min	8%	7%	8%	10%	10%	10%	5%	7%
30 min	12%	10%	12%	14%	15%	14%	11%	15%
1-hr	13%	9%	10%	11%	10%	9%	4%	7%
2-hr	11%	8%	10%	13%	14%	14%	11%	15%
3-hr	14%	11%	14%	18%	20%	22%	20%	25%
6-hr	16%	15%	19%	24%	27%	30%	29%	34%
12-hr	16%	16%	20%	25%	27%	30%	28%	33%
24-hr	17%	9%	11%	14%	16%	20%	21%	28%

Key Changes

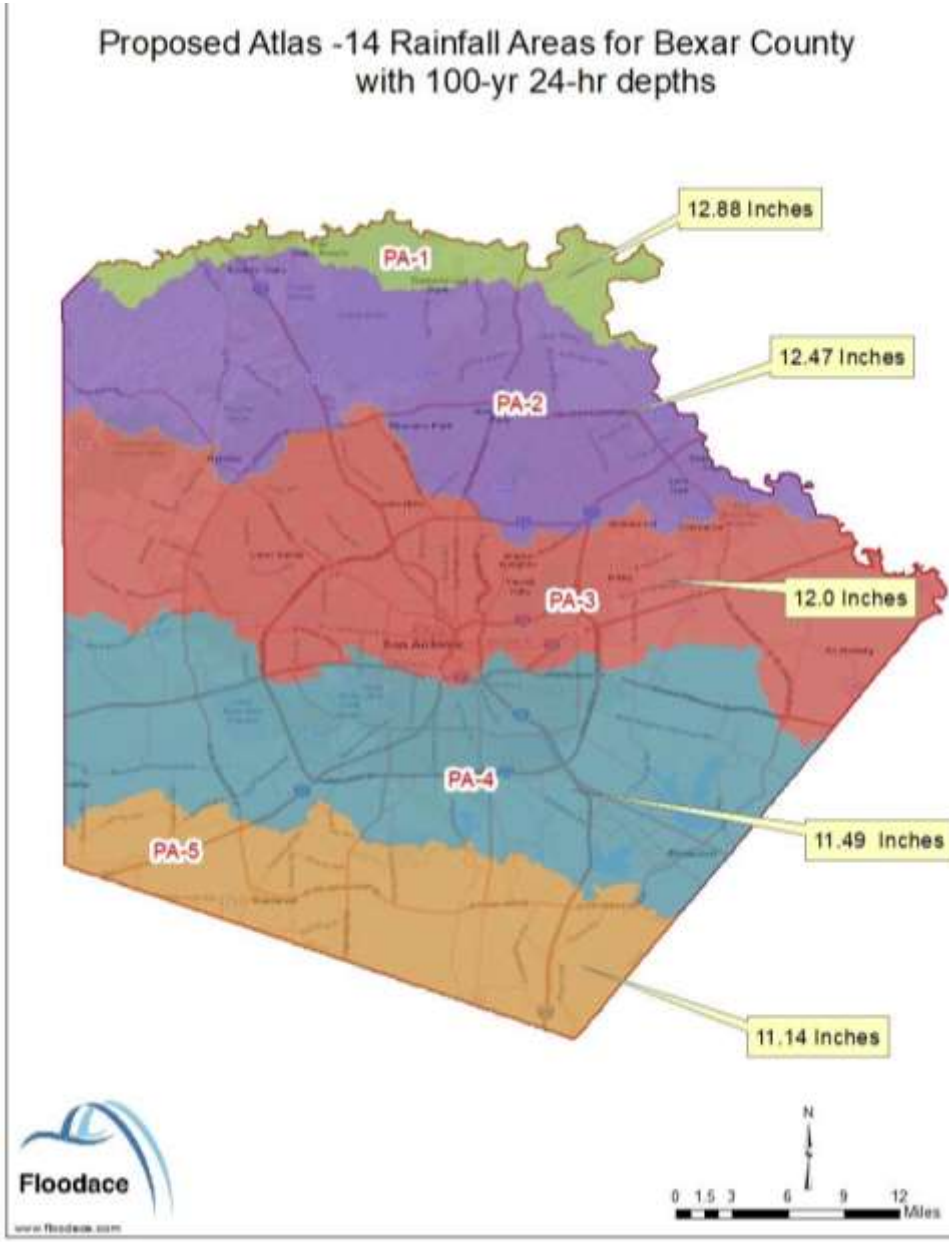
- Increased geographic variability

Geographic variation: Percent difference indicated by Atlas 14 Manchaca (South) versus Round Rock (North)

	1	2	5	10	25	50	100	200	500	1000
5-min:	0.00	0.02	0.04	0.05	0.06	0.04	0.05	0.06	0.07	0.08
10-min:	0.00	0.02	0.04	0.05	0.05	0.06	0.05	0.06	0.06	0.08
15-min:	0.00	0.02	0.04	0.05	0.06	0.05	0.05	0.06	0.07	0.08
30-min:	0.01	0.02	0.05	0.06	0.06	0.06	0.05	0.06	0.07	0.09
60-min:	0.01	0.03	0.05	0.06	0.07	0.06	0.06	0.07	0.08	0.10
2-hr:	0.03	0.04	0.06	0.06	0.07	0.08	0.08	0.09	0.10	0.11
3-hr:	0.02	0.04	0.06	0.06	0.08	0.08	0.09	0.10	0.12	0.13
6-hr:	0.03	0.05	0.06	0.07	0.08	0.09	0.11	0.11	0.13	0.14
12-hr:	0.03	0.05	0.06	0.07	0.09	0.10	0.12	0.13	0.14	0.14
24-hr:	0.02	0.04	0.06	0.07	0.09	0.10	0.12	0.13	0.14	0.15
2-day:	0.00	0.03	0.05	0.07	0.09	0.11	0.12	0.13	0.15	0.16
3-day:	0.00	0.03	0.05	0.07	0.09	0.11	0.12	0.13	0.15	0.16
4-day:	-0.01	0.03	0.05	0.06	0.08	0.10	0.13	0.14	0.15	0.16
7-day:	-0.01	0.02	0.04	0.06	0.09	0.10	0.12	0.14	0.15	0.16
10-day:	-0.01	0.02	0.04	0.06	0.08	0.09	0.11	0.13	0.15	0.16
20-day:	-0.02	0.01	0.03	0.05	0.07	0.08	0.10	0.12	0.13	0.15
30-day:	-0.02	0.01	0.02	0.04	0.06	0.07	0.09	0.11	0.13	0.14
45-day:	-0.01	0.01	0.03	0.04	0.06	0.07	0.08	0.09	0.12	0.13
60-day:	-0.01	0.01	0.02	0.04	0.05	0.07	0.08	0.09	0.10	0.11

Evaluate various approaches to capturing the spatial variability of extreme rainfall

- Single value
- Major Watersheds
- North/South
- By County
- Something Else

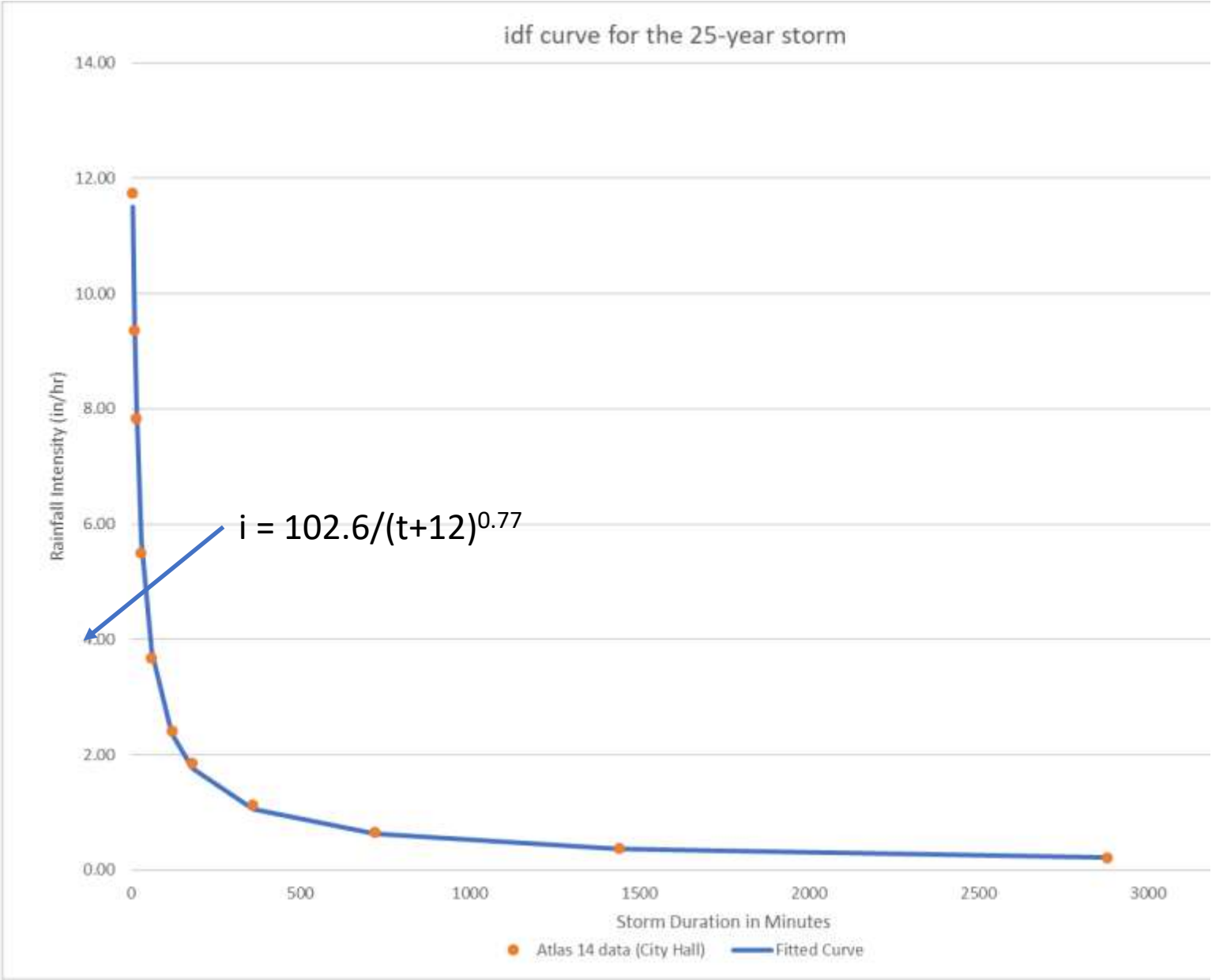


IDF Curves

Fit the depth values to a power function to obtain a continuous curve

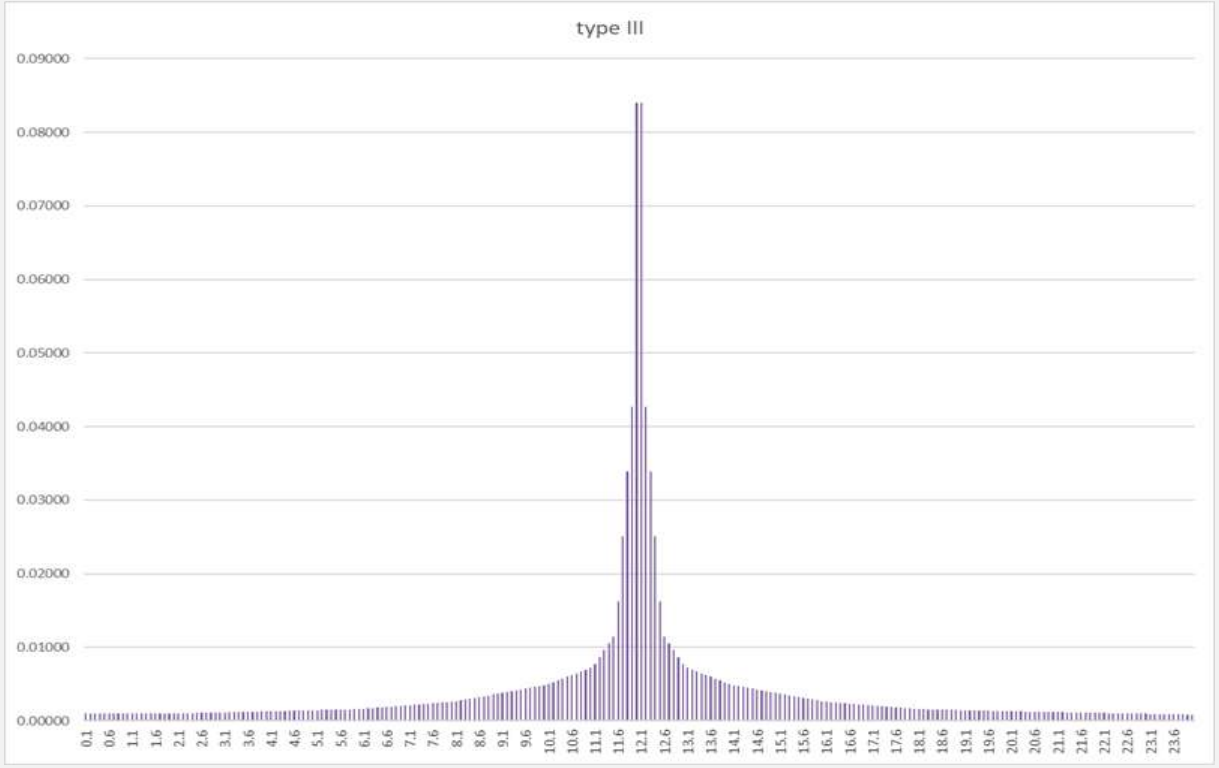
TxDOT format:

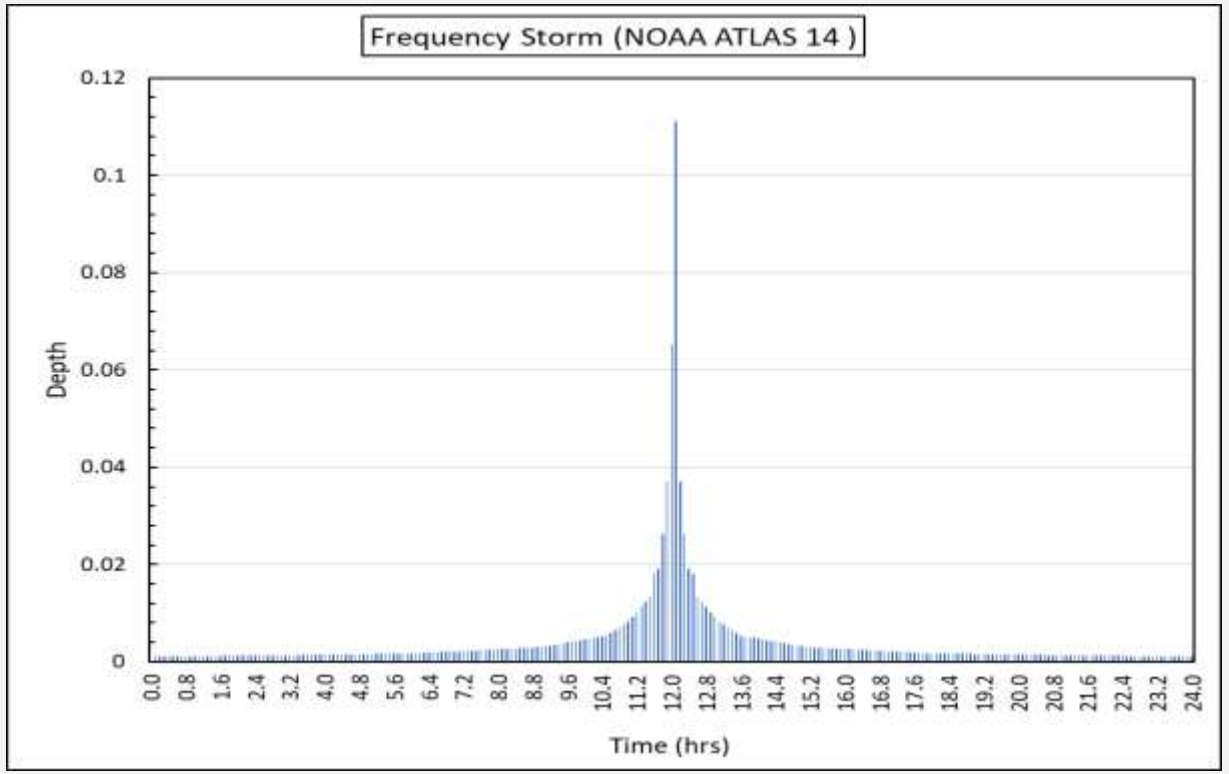
Intensity (in/hr) = $a/(t+b)^c$



Time Distribution Issues

- NRCS Type III
- HEC-HMS Frequency Storm
- An invariant nested Scheme





Step 3: Floodplain Study and Mapping Updates

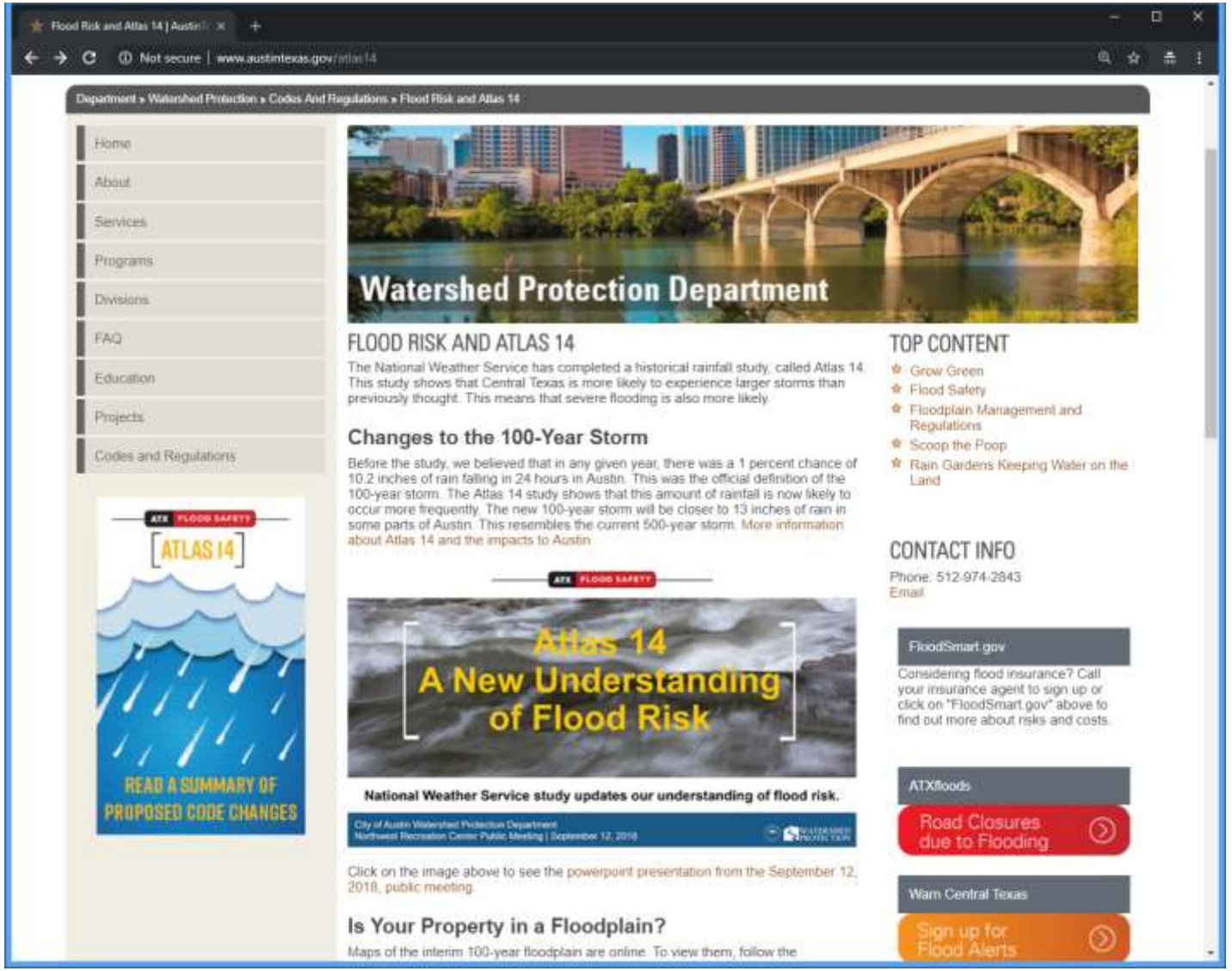
- **2019 to 2021 –** Re-mapping of Austin floodplains
  - Approximately 1200 stream miles
  - HEC-RAS 2D modeling in selected areas
  - Coordination with other impacted communities
- **2022 to 202? –** FEMA map updates
  - Letters of Map Revision
  - Physical Map Revision

Outreach

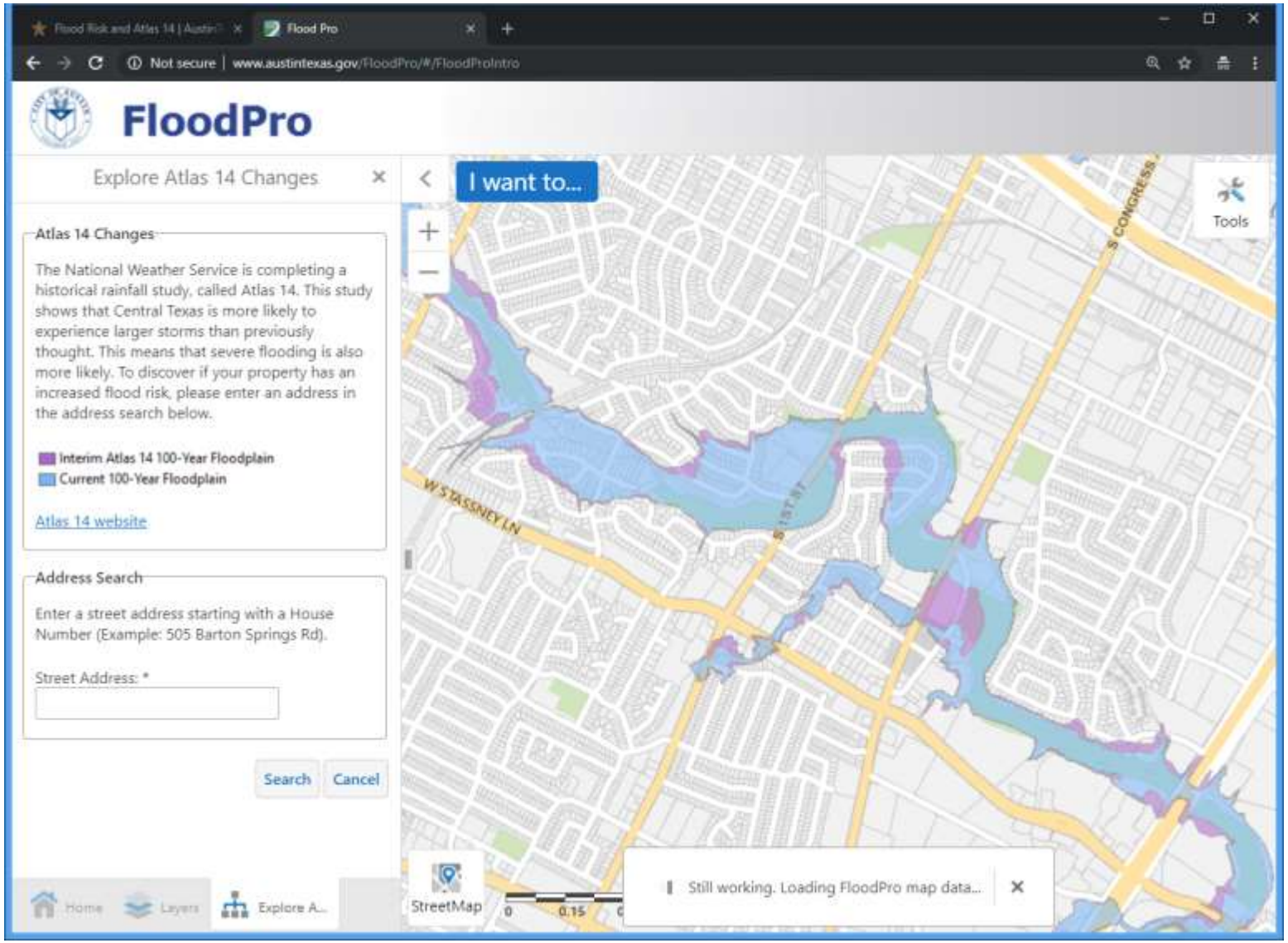
Atlas 14 Web Pages

Coming Attractions

- Frequently Asked Questions Page
- Presentation video with Spanish narration
- Draft code language
- Dates for Boards and Commission meetings
- Dates for Council meeting



FloodPro



ATX FLOOD SAFETY

ATLAS 14 QUICK REFERENCE SHEET

What is Atlas 14?

The National Weather Service, in partnership with many other federal, state, and local agencies, is in the process of reassessing historic rainfall intensities for Texas with a study called Atlas 14. Rainfall intensities tell us the likelihood of rainfall events of different sizes. Rainfall intensities are used by FEMA and local communities to determine flood risk and to make floodplain maps. Rainfall intensities for the State of Texas have not been assessed since 1994. Atlas 14 is an update of this data meant to incorporate almost a quarter century of rainfall data collected statewide since the last study, up to and including Hurricane Harvey. The graphic to the right indicates in green the areas of Texas where rainfall intensities are increasing.

How Does Atlas 14 Affect Austin?

The Atlas 14 draft study shows the Austin area to be one of the most significantly impacted areas in the State of Texas. In general, this means that, in Austin, what had been considered a 500-year rainfall is in fact a 100-year rainfall. This indicates that many homes and businesses in Austin may be expected to flood more frequently than had been previously thought. However, only 9% of the land area in Austin is projected to be in the new 100-year floodplain.

How Is the City of Austin Responding?

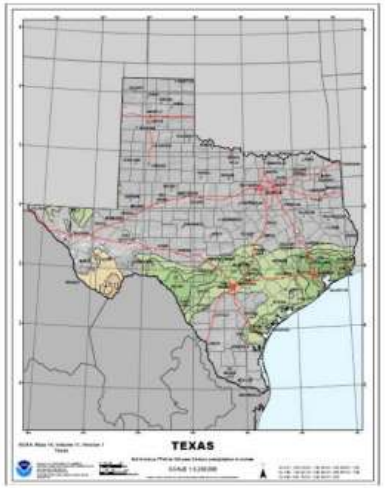
The **Watershed Protection Department** is acting quickly to respond to this more accurate assessment of flood risk. It is critical that we continue to ensure that future development is built to be sufficiently resilient to protect lives and properties of our residents. To that end, we have initiated a code amendment process to adopt this new rainfall information as well as other changes meant to enable properties to redevelop in a safer fashion.

How Do I Get More Information?

Website: www.AustinTexas.gov/Atlas14
Email: Atlas14@AustinTexas.gov

WATERSHED PROTECTION

MAP CHANGES TO RAINFALL INTENSITY



IMPACTS TO HOMEOWNERS

How does this affect my property?
Visit our website **www.austintexas.gov/atlas14** to access maps of floodplain changes in Austin.

Do I need to buy flood insurance?
While FEMA flood insurance rate maps will not be immediately affected, property owners shown in the 500-year floodplain on the current FEMA maps should consider purchasing flood insurance as soon as possible to best protect their property.

How does this impact development regulations?
Properties located in the City's regulatory floodplain are subject to additional development restrictions. Please visit **www.austintexas.gov/floodplainrules** to learn more.

Who We Have Talked To

Presentations to over 1,200 people from 40 different groups

Stakeholder Meetings

- Two internal stakeholder meetings
- Two external stakeholder meetings

General Public meetings (5)

- Determined location by most impacted areas
- Two meetings regarding floodwalls (Districts 1 and 2)

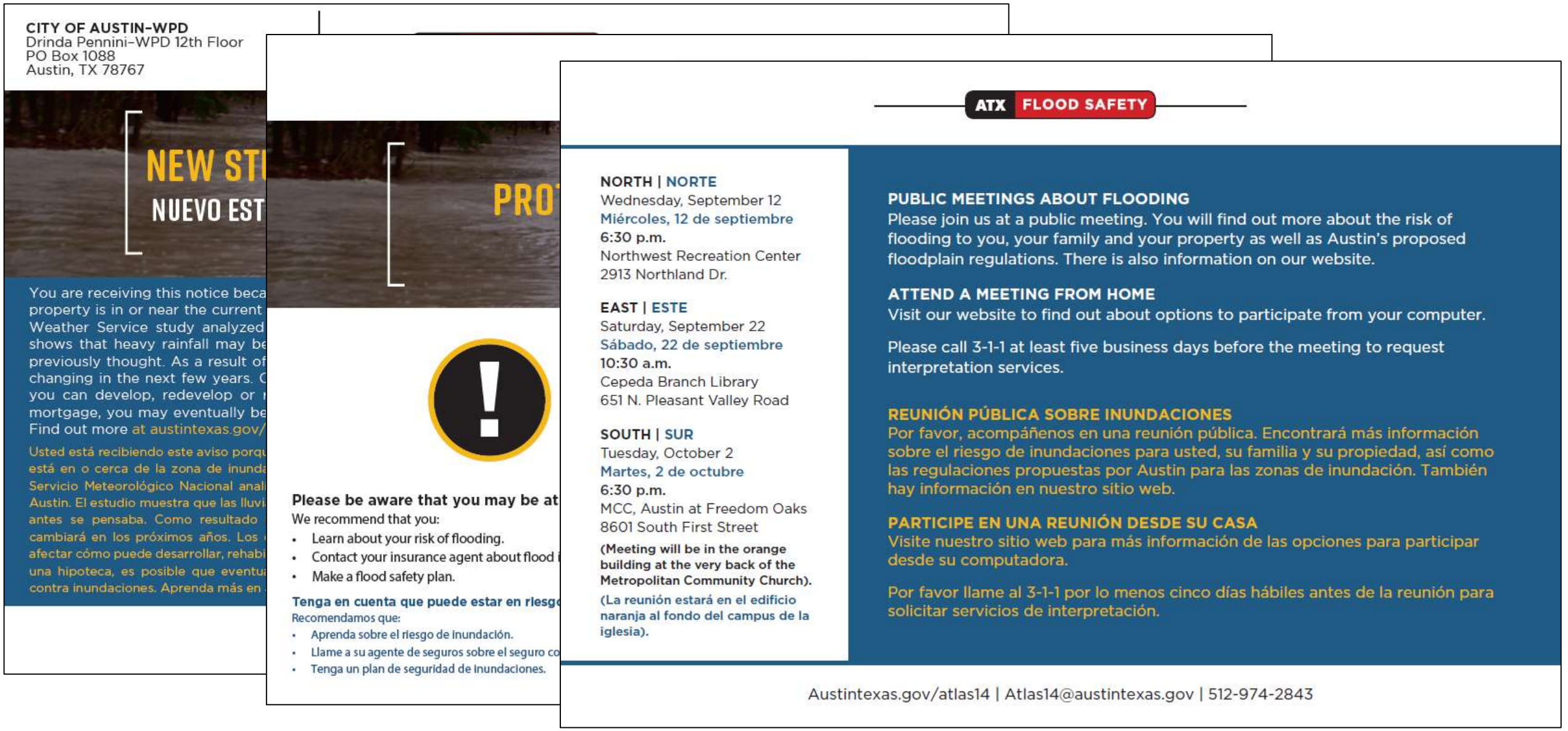
Webinar access provided for external stakeholder and public meetings

- Presentations and Webinar files available on City website

Outreach through social med 

24,000 postcards sent to residents in the floodplain

Postcards (100-year, 500-year, Meeting Notices)



Who We Have Talked To

Presentations to over 1,200 people from over 40 different groups

Professional Associations

- ASCE, ACEA, AIA, ABoR, NAPMW, TWRN, SMPS

Development Organizations

- RECA, HBA, DAA, WCC, SCC, AIC

Neighborhood groups

- ANC, OCHOA, SCNPCT

Boards and Commissions

- COJC, EC, ZAP

Individual Engineering, Real Estate, and Title Company Representatives

Who We Have Talked To

Presentations to over 1,200 people from 40 different groups

Internal Departments

- Development Services Department
- COA Director's meeting
- Parks and Recreation Department
- Capital Planning Office
- Law
- Public Works Department

Council Offices

- Districts 1, 2, 6, 10

- Austin Transportation Department
- Austin Water Utility
- Neighborhood Housing and Community Development
- Sustainability Office
- Office of Real Estate Services
- Aviation Department

Coordination with Travis County

- Parallel updates to Title 30 of the Land Development Code
- July 31, 2018 – Initial presentation to Commissioners Court
- November 13, 2018 – Commissioners Court voted to approve $22 million increase in 2017 bond program
- January 2019 – Public hearing to consider Atlas 14 changes to Title 30

Coordination with Other Communities

Regional Coordination

- Series of meetings with Central Texas counties and communities
- Hosted by TxDOT

North Austin Metro Area

- Williamson County
- Upper Brushy Creek WCID
- Other cities

Hot Button Issues

Issue	Ramification	Resolution
Subchapter F (McMansion) compliance	Higher floodplain and freeboard have impacts on maximum height	No change recommended; Analysis shows minimal impact
Visitability Compliance	Higher floodplain and freeboard have impacts on accessibility	No change recommended; Existing code offers way to comply
Maximum home size in redevelopment exception	Limits desired home size	Removed from exception requirement
Ordinance approval timeline too fast	Impacts development in progress	Extended timeline and outreach efforts
Permitting uncertainty for long-term planning and multi-phase developments	Uncertainty increases development costs	Providing floodplain recs. since July; drainage design recs. by December
No commercial use allowed to use redevelopment exception	No incentive for commercial properties to reduce flood risk	Will consider during FP restudy period recs. by December
Environmental buffer zone enlargement	Less developable area	No change recommended; Small area impacted
Environmental Resources Inventory required more often	Increased Development Costs	Revise ECM to eliminate requirement of ERI outside of buffer zone
Parkland dedication impacts	Floodplain area discounted toward required area dedicated	No change recommended; Relatively small area impacted
No floodplain disclosure for tenants	Residents not aware of flood risk	Will consider during FP study period

Follow our progress

AustinTexas.gov/atlas14

Contact us

Atlas14@AustinTexas.gov

Floodplain Hotline 512-974-2843

View floodplains

ATXfloodpro.com