

# LOWER BRAZOS RIVER FLOODPLAIN PROTECTION PLANNING STUDY

Angleton, Texas  
February 16, 2018

# Reasons for the Study

- \* One of the fastest growing areas in the country
- \* Hydrologic and hydraulic models/data are dated outside of Fort Bend County
- \* Need for consistent modeling methodology across county boundaries
- \* Need to assess lower Brazos watershed from a comprehensive basinwide perspective (existing conditions and alternatives)
- \* 10,000 square miles of uncontrolled drainage area

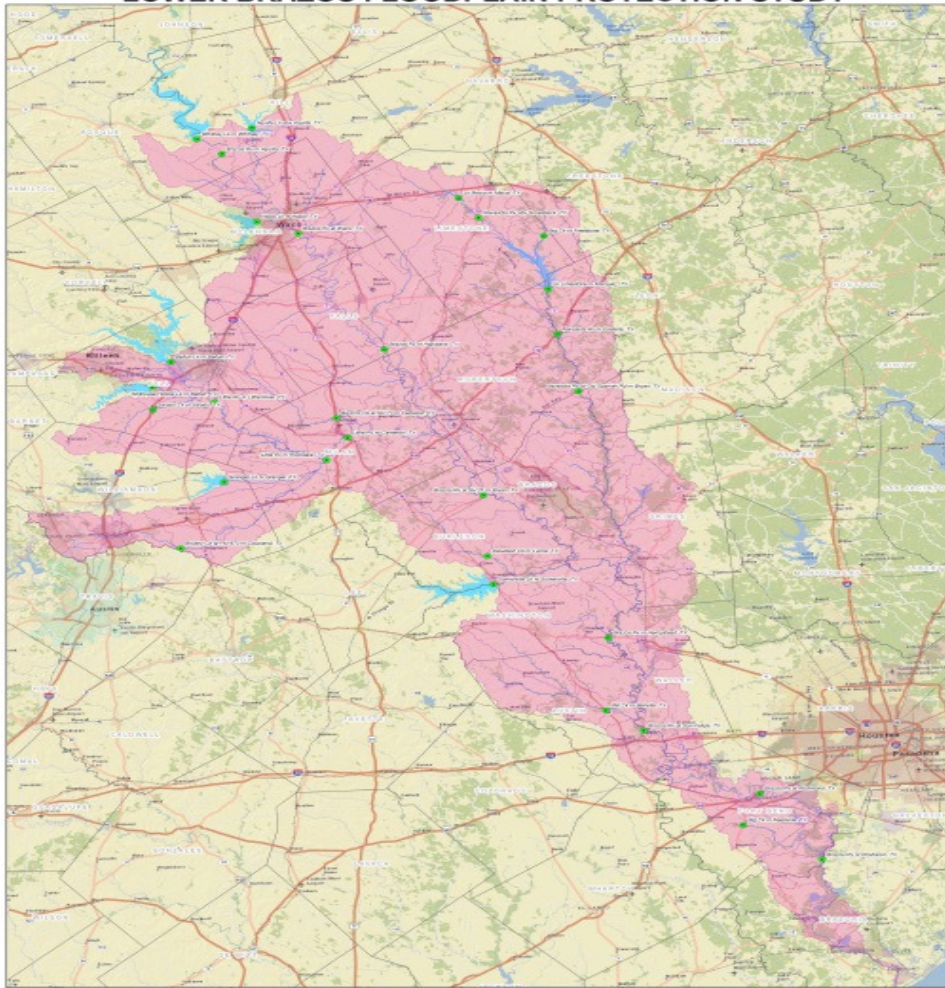


# Goals of the Study

- \* Quantify existing flooding issues and flood damage reduction alternatives
- \* Update hydrologic and hydraulic data for the lower Brazos River (above Hempstead gauge to mouth across 5 counties)
- \* Calibrate new models to historical events and provide flood volumes, flood depths, and flood durations
- \* Facilitate land use planning, emergency response, and sound floodplain management



# LOWER BRAZOS FLOODPLAIN PROTECTION STUDY

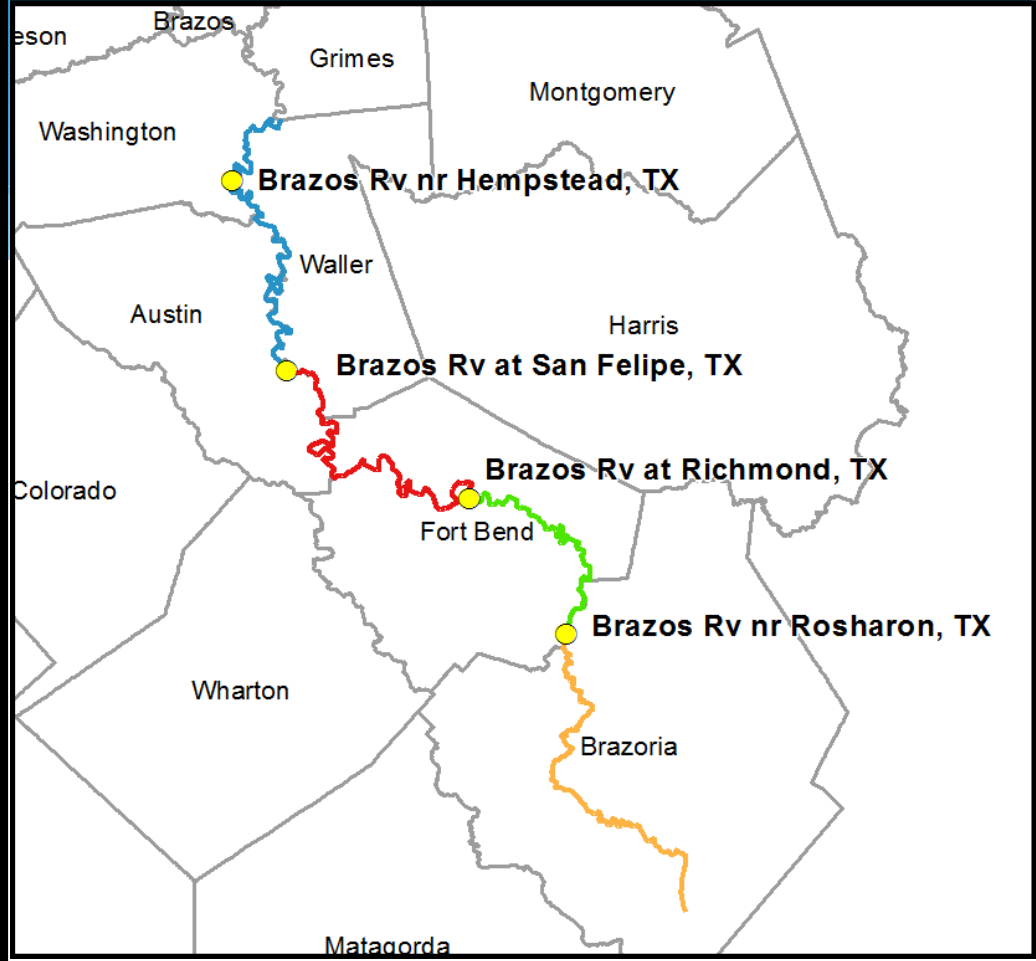


**Basin Stats:**  
 TOTAL NUMBER OF BASINS = 154  
 MAX AREA = 116 SQ MI  
 MIN AREA = 10 SQ MI  
 AVG AREA = 64 SQ MI

- LEGEND**
- USGS Stream Gage
  - Study Area
  - Sub-basin
  - River/Stream Centerline
  - County Boundary
  - Lake



0 5 10 20 30 40 Miles



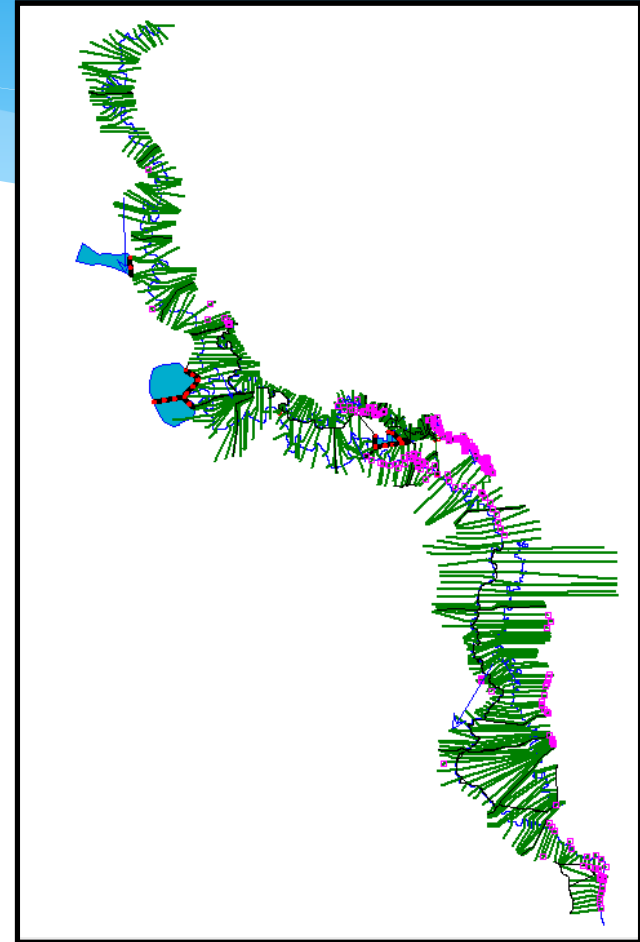
# Where are We Today?

- \* Contract was extended to include additional modelling for the impacts of Hurricane Harvey
- \* Basin wide hydrology is 100% complete
- \* Hydraulics models are 100% complete from the Washington/Waller County Line to the Gulf of Mexico
- \* Floodplain mapping in progress
- \* Alternative Analysis is underway
- \* Flood Damage Analysis Modeling is underway
- \* Environmental Constraints Analysis is underway

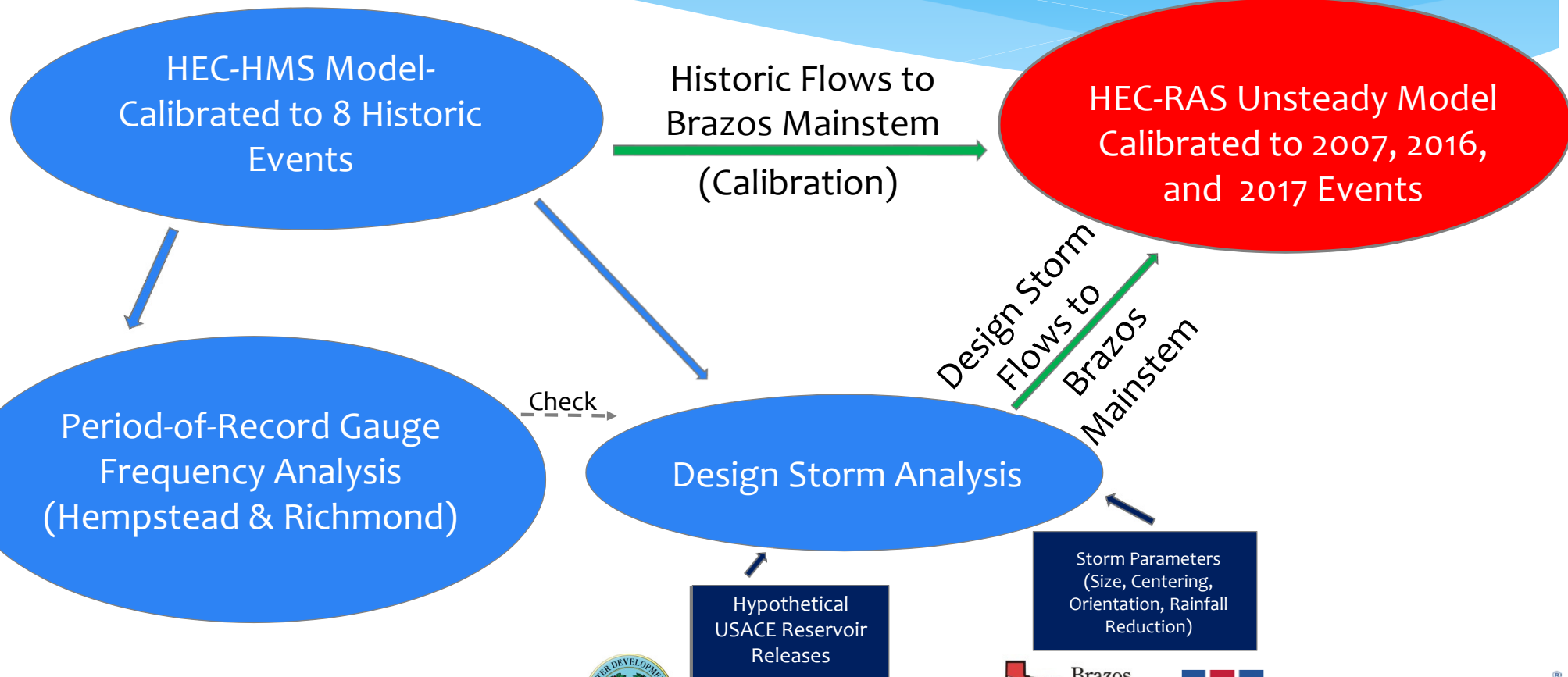


# Additional Modelling Efforts

- \* Calibration to Hurricane Harvey
- \* Additional Overflow Areas
  - \* Bessie's Creek
  - \* Ditch H
  - \* Oyster Creek
  - \* Bullhead Bayou
  - \* Brooks Lake Division



# Baseline H&H Modeling



# Hurricane Harvey

MONDAY, AUGUST 28, 2017

## Fort Bend Herald

AND TEXAS COASTER

204 www.fbherald.com ROSENBERG-RICHMOND, TEXAS 75 CENTS

### HARVEY'S NOT THRU YET

Brazos River in Fort Bend County expected to crest at 57.5 feet

BY SCOTT REESE WILLEY  
swilley@fbherald.com

The Fort Bend County Office of Emergency Management has issued a mandatory evacuation for some residents of Fort Bend County and a voluntary evacuation for others.

Fort Bend County Judge Bob Hebert said the emergency operations agency personnel have been closely monitoring the water level in the Brazos River.

The National Weather Service forecast indicates that the Brazos River will crest sometime Tuesday, Aug. 29, in the late afternoon or early evening at an elevation of fifty nine feet at the Richmond gauge on U.S. 90A.

"A flood of this magnitude is an 800-year event and it exceeds the design specifications of our levees, and is potentially dangerous for a good portion of Fort Bend County," said Hebert, who directs the office emergency management.

"A 30-foot-river level threatens to overtop many of the levees in our area.

"As a result, I am ordering both voluntary and mandatory evacuations for many of the levee improvement districts along the Brazos River, based on all specific facts pertaining to each levee," Hebert announced late Sunday night.

The Brazos River at Richmond is presently at 43.6 feet.

During the record-setting 2016 Memorial Day flood, the Brazos River crested at 57.5 feet.

SEE HARVEY, PAGE 3



MASSIVE SINKHOLE formed on FM 762 in front of the 24 HR Fitness on Sunday afternoon, making the highway impassable.

TUESDAY, AUGUST 29, 2017

## Fort Bend Herald

AND TEXAS COASTER

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### First-responders help evacuate thousands in Fort Bend County

Weather Service says Brazos River will stop rising at 57.5 feet

BY SCOTT REESE WILLEY & RYAN DUNSMORE

First responders have helped evacuate thousands of residents in Fort Bend County and at least 100 have been rescued from high water, authorities reported.

Fort Bend County Judge Bob Hebert said first responders had effected 4,400 evacuations as of Monday.

On Tuesday morning, authorities at the Fort Bend County Office of Emergency Management had increased the evacuations to around 5,000.

Sgt. Stephen Woodard, a spokesman for the Texas Department of Public Safety told The Herald that 100 people had been rescued in Fort Bend County as of Monday evening.

No fatalities or major injuries in Fort Bend County as a result of Hurricane Harvey and its aftermath has been reported.

So far, 25 inches of rain has fallen on the Richmond/Rosenberg area since Harvey slammed into the Texas Gulf Coast late Friday the office of emergency management reported.

More rain has fallen on the Missouri City area, OEM authorities said.

According to the National Weather Service, "a persistent area of moderate rain" will continue today across the eastern third of the area as Tropical Storm Harvey tracks slowly east/northeast offshore and accelerates off to the northeast on Wednesday and Thursday.



ROSENBERG RESIDENT José Santiago rode his bike over the SH 36 bridge over the Brazos River in Rosenberg to shoot a video. He said he is safe, but is ready for this to be over.

WEDNESDAY, AUGUST 30, 2017

## Fort Bend Herald

AND TEXAS COASTER

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### Brazos likely won't top levees

Expected to flood 'tremendous area' of Fort Bend County

HERALD PHOTO BY SCOTT REESE WILLEY

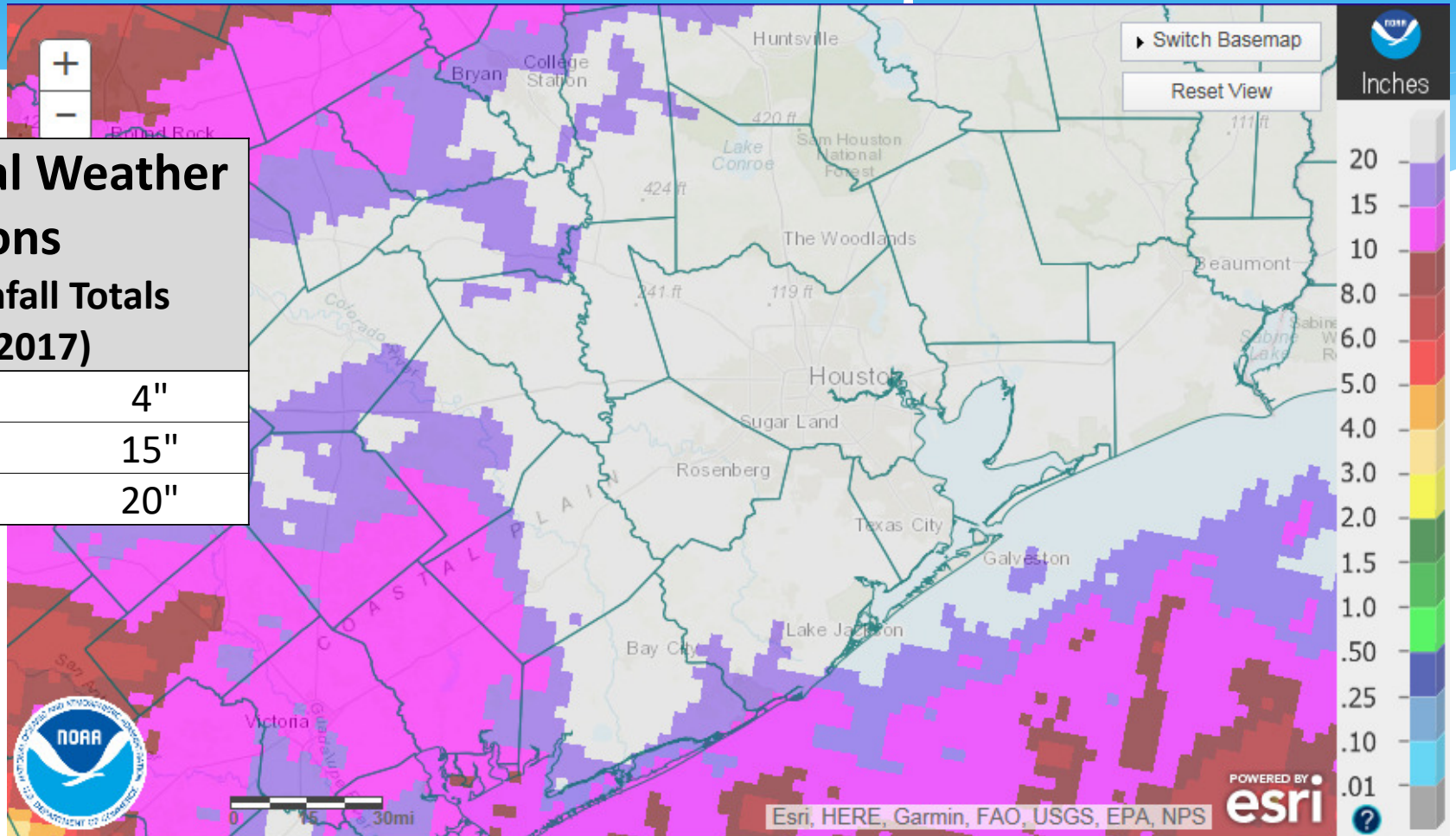
The Crawson family walks along a levee protecting their home in the River Park West subdivision on Tuesday. Residents in the subdivision were issued a mandatory evacuation earlier this week when authorities believed the nearby Brazos River might top the levee sometime Thursday. The Crawson family temporarily moved in with friends in the Summer Lakes subdivision off of SH 26. Chris and wife Laci, brought Colton, 3, Chesney, 7, and grandmother Margaret to check on their home and see how high the water had risen.

untold millions of dollars in property damage. ... water to wipe sheets, towels or other ob-





# NOAA Observed Precipitation



**NWS - Official Weather Stations**  
**Monthly Rainfall Totals**  
**(August 2017)**

Waco	4"
Bryan	15"
Sugar Land	20"

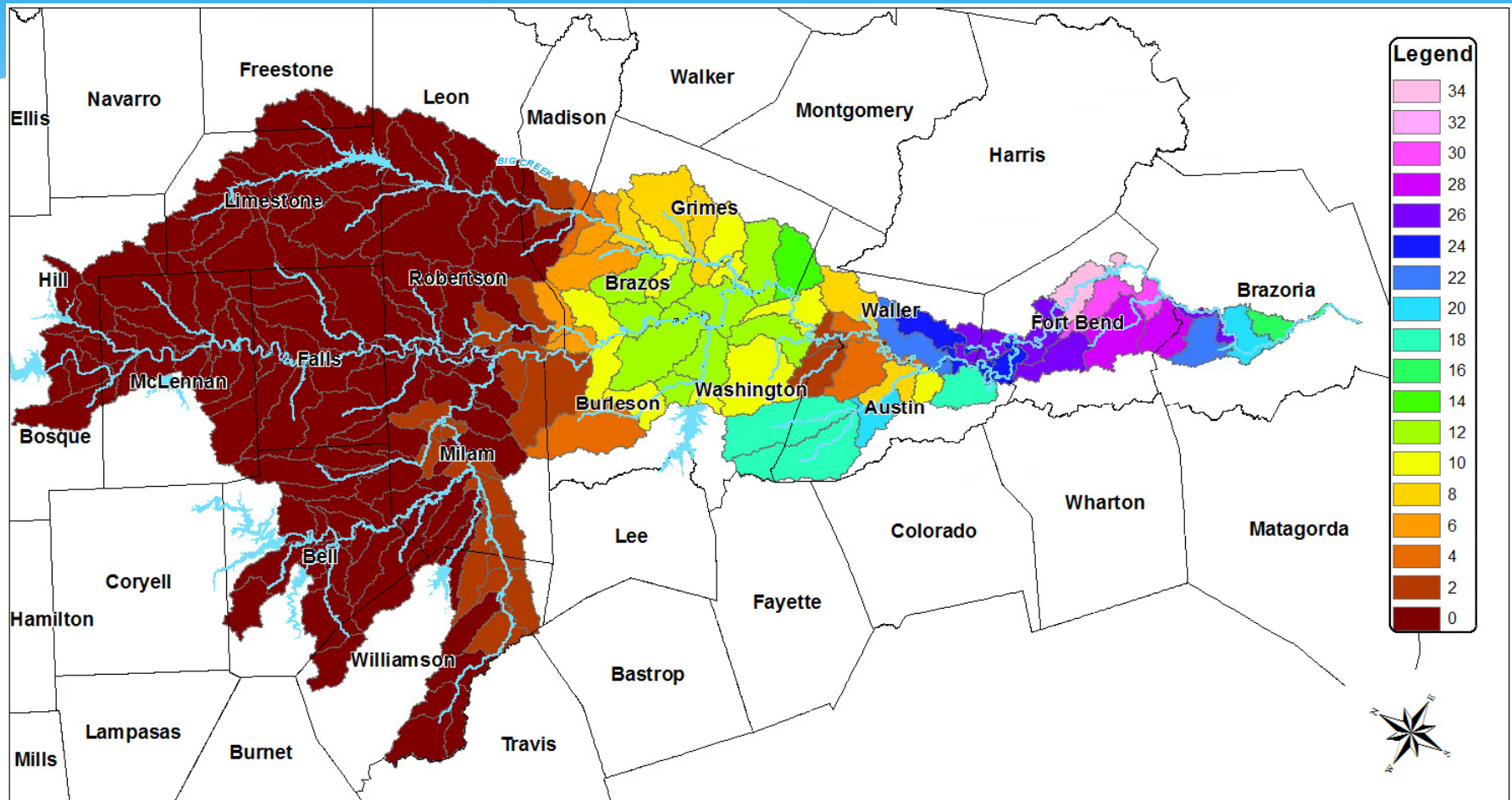


# Harvey USGS Gage Peaks

USGS Gauge	Peak Flow	Peak Stage NAVD88
Hempstead	101,000 cfs Aug 28 17:00	159.14 ft Aug 28 17:00
San Felipe	146,000 cfs Aug 28 03:00	129.00 ft Aug 28 03:30
Richmond	126,000 Sep 1 00:00	82.20 ft Sep 1 00:00
Rosharon	133,000 Aug 29 18:00	52.65 ft Aug 29 18:00



# Harvey HMS Model Rainfall

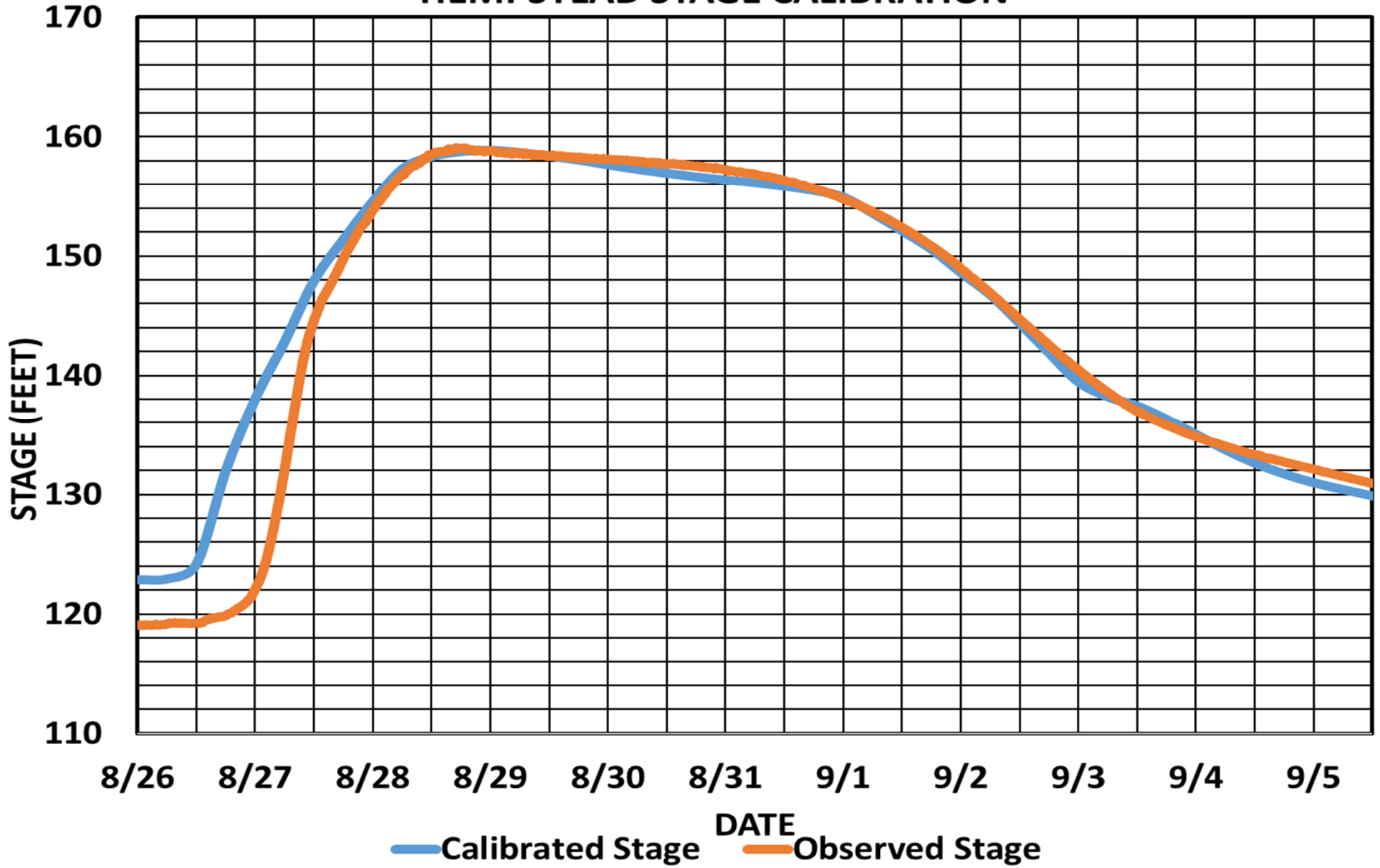


# Brazos Rv Nr Hempstead, Tx

- \* Waller County, TX
- \* Located on US Hwy 290
- \* Contributing Drainage Area = 34,314 sq mi
- \* Gage Datum = 107.90 NGVD29
- \* Period of Record – 1938 through Current Date
  - \* 79 Years of Record



# HEMPSTEAD STAGE CALIBRATION

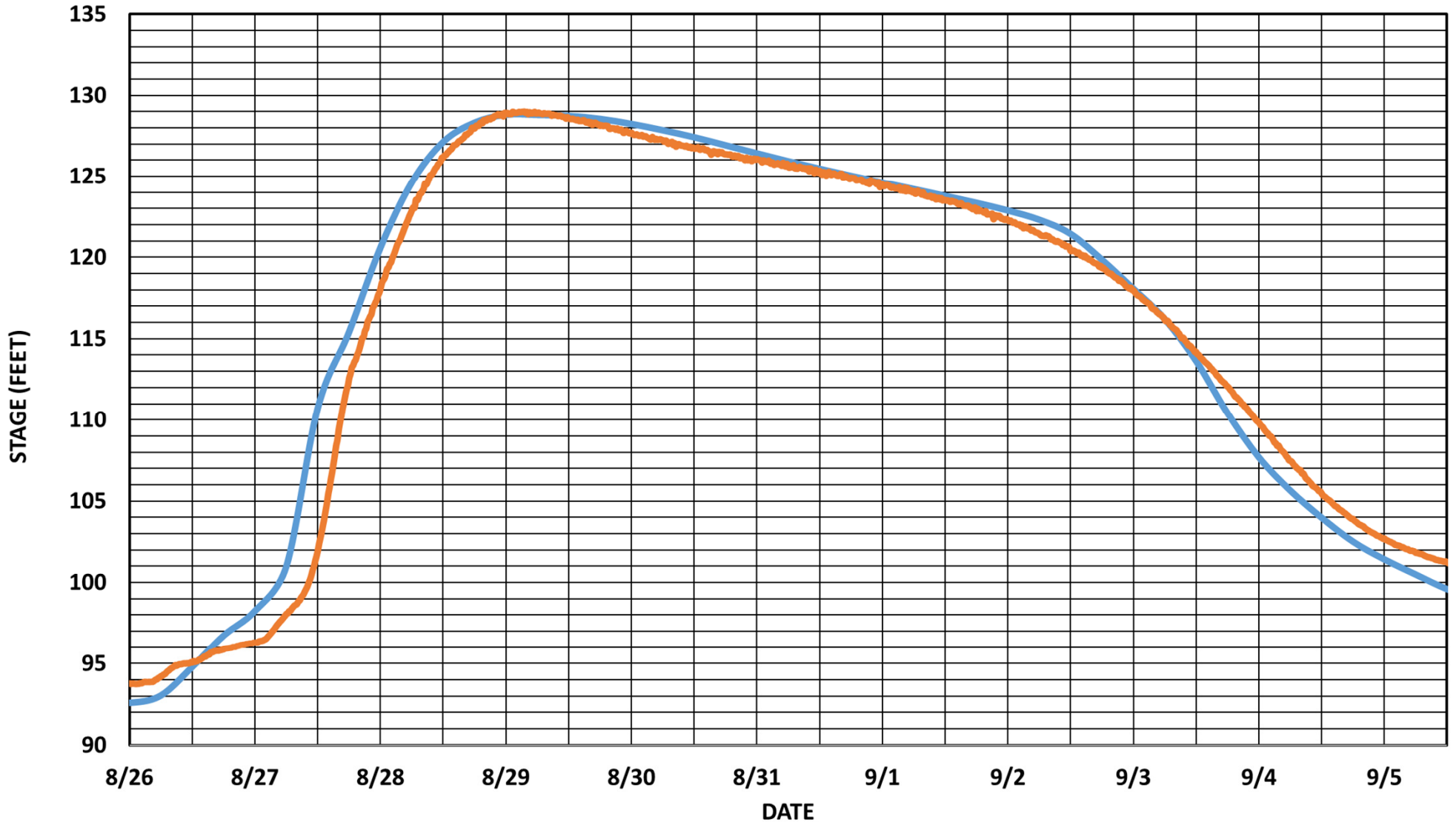


# Brazos Rv at San Felipe, TX

- \* Austin County, TX
- \* Located on FM 1458
- \* Contributing Drainage Area = 44,670 sq mi
- \* Gage Datum = 0 feet above NGVD88
- \* Period of Record – August 2013 through Current Date
  - \* 4 Years of Record



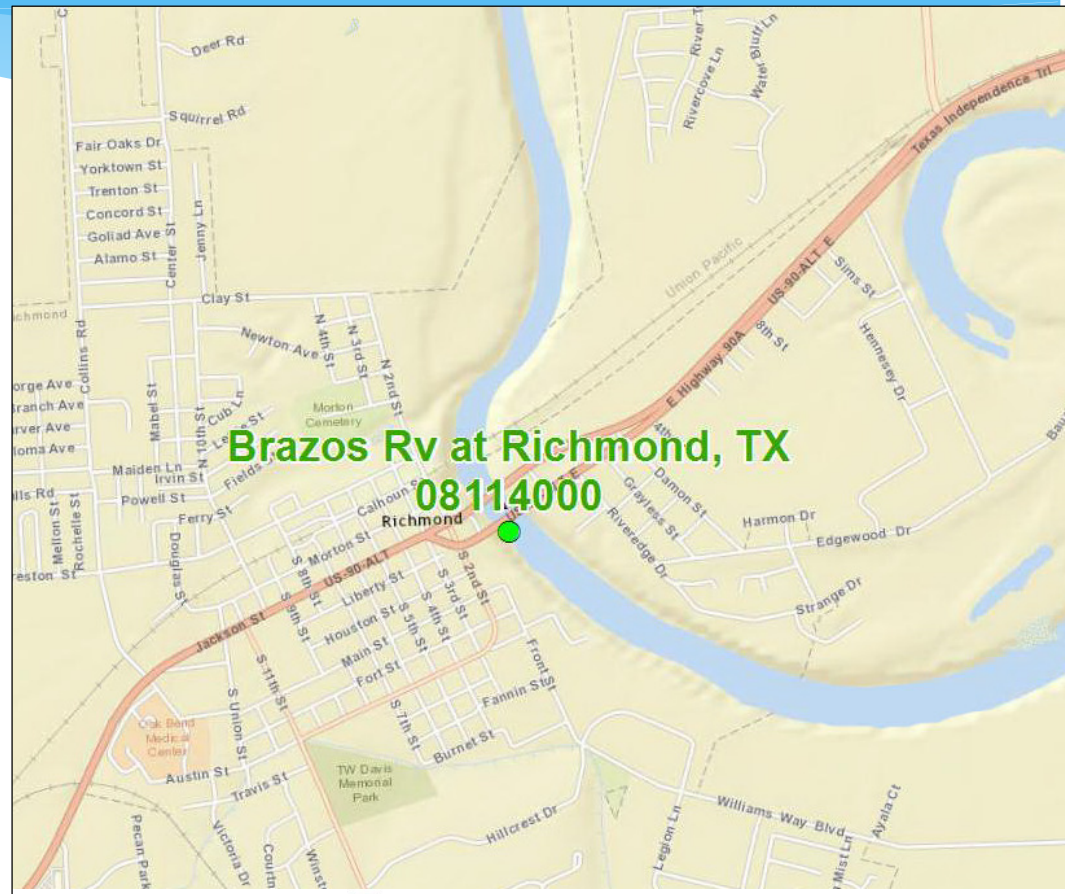
### SAN FELIPE STAGE CALIBRATION



— Calibrated Stage — Observed Stage

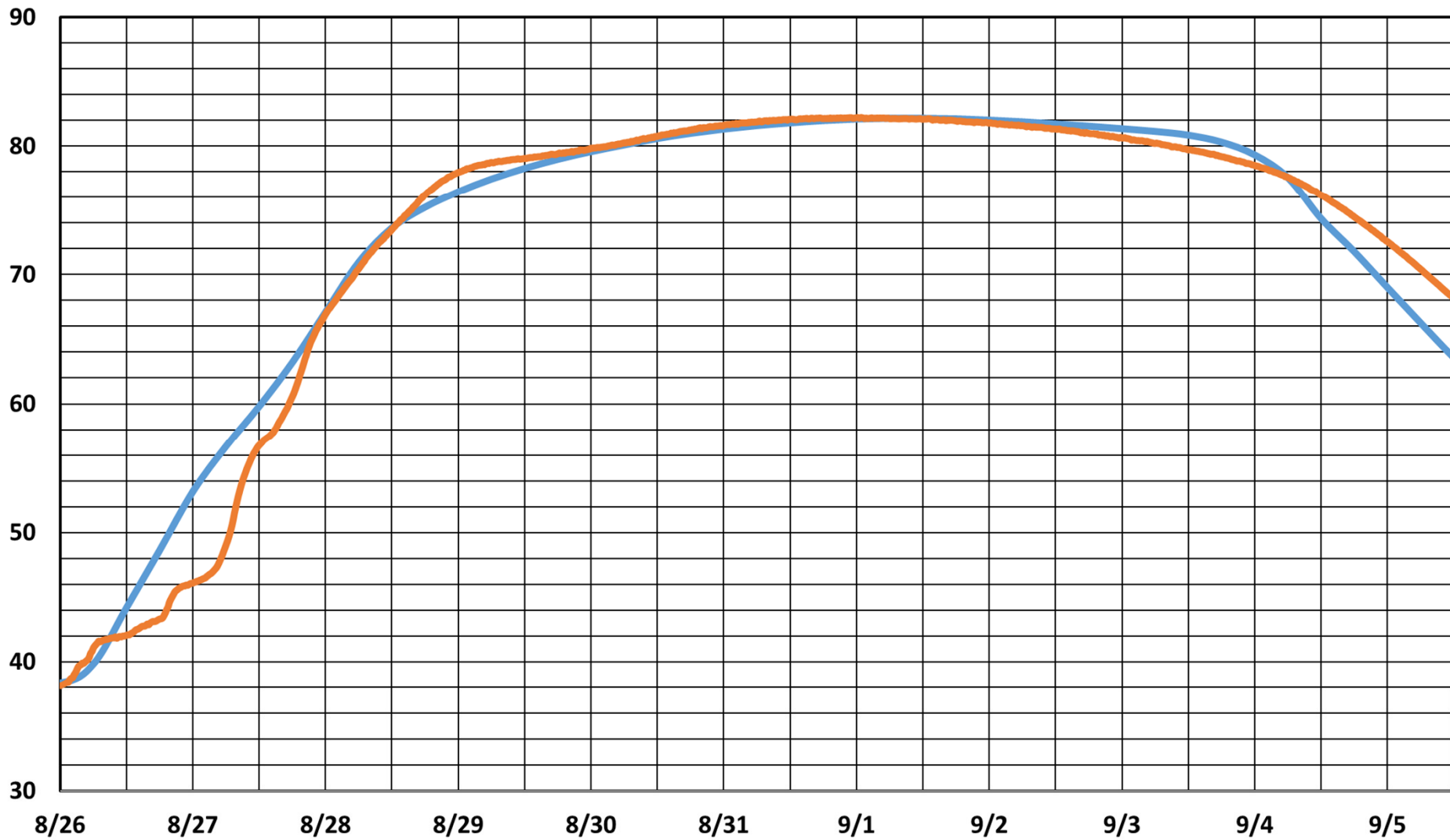
# Brazos Rv at Richmond, TX

- \* Fort Bend County, TX
- \* Located on Highway 90A
- \* Contributing Drainage Area = 35,541 sq mi
- \* Gage Datum = 27.94 feet above NGVD29
- \* Period of Record – 1922 through Current Date
  - \* 95 Years of Record



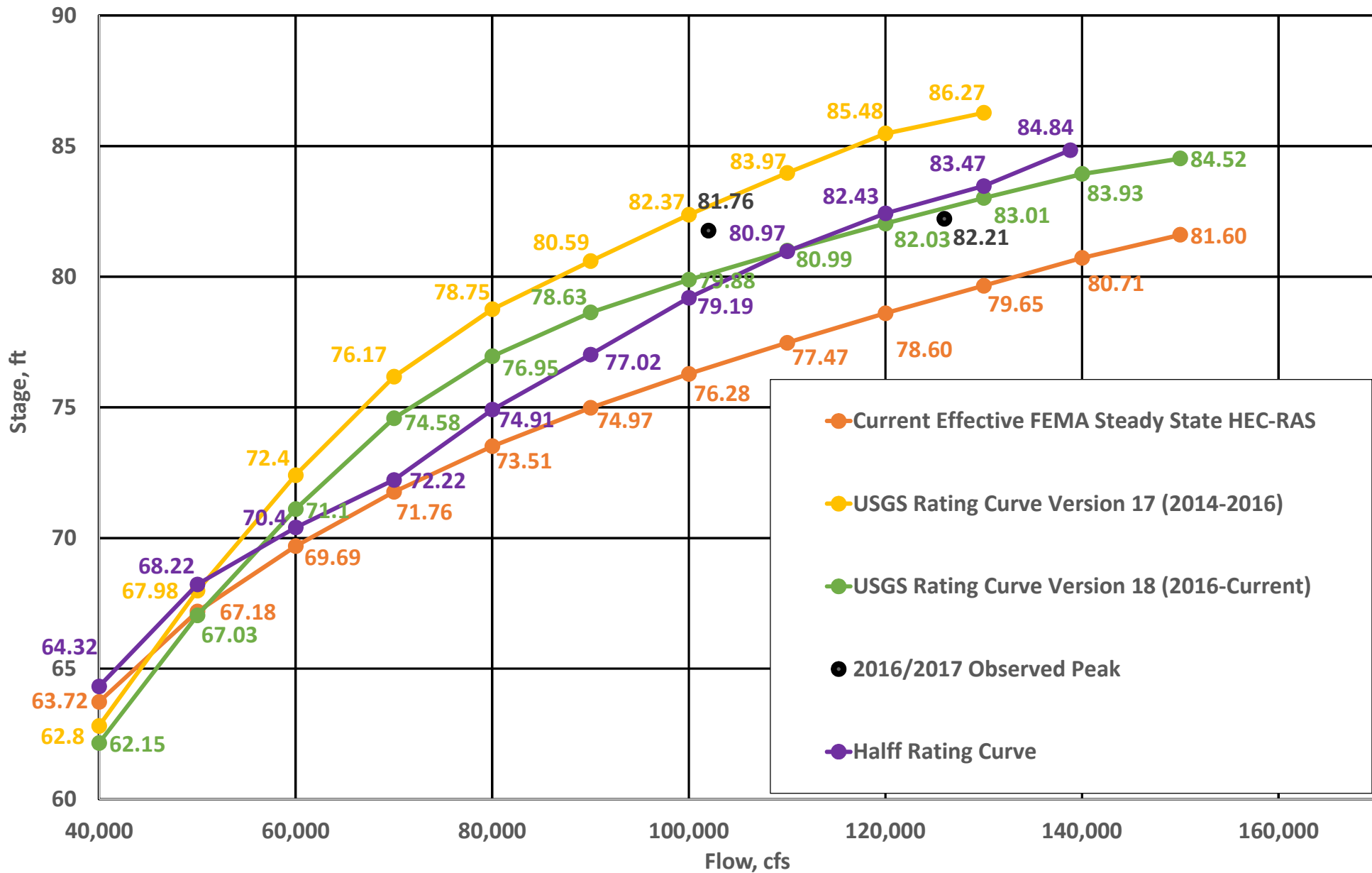


### RICHMOND STAGE CALIBRATION



— Calibrated Stage — Observed Stage

### Richmond Rating Curve Comparison

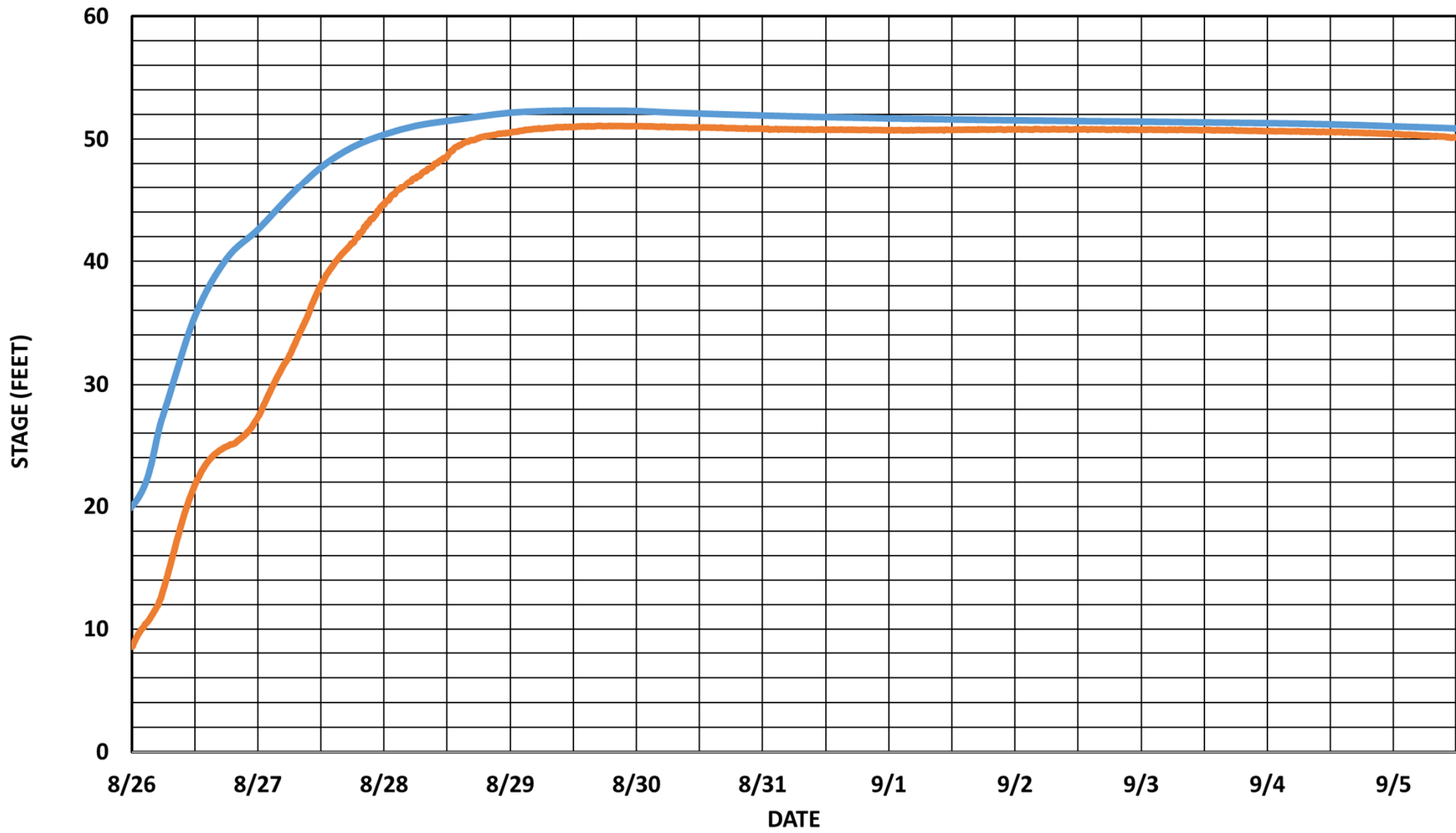


# Brazos Rv at Rosharon, TX

- \* Brazoria County, TX
- \* Located at FM 1462
- \* Contributing Drainage Area = 35,773 sq mi
- \* Gage Datum = 0 feet above NGVD29
- \* Period of Record – 1967 through Current Date
  - \* 49 Years of Record



### ROSHARON STAGE CALIBRATION



— Calibrated Stage — Observed Stage

# Hempstead

Event	Peak Observed Flow cfs	Peak Model Flow cfs	Peak Observed Stage ft	Peak Modelled Stage ft
2007	80,100	77,500	153.38	155.55
2016	157,000	142,500	162.79	162.44
2017	101,000	113,700	159.14	158.89

## Average Roughness Coefficients

Low Flow	0.78
High Flow	1.16

\*Low flow is below 80,000 cfs

\*High flow is above 80,000 cfs

## Manning's N-Value

	Channel	Overbank
Min	0.035	0.06
Max	0.042	0.09



# San Felipe

Event	Peak Observed Flow cfs	Peak Model Flow cfs	Peak Observed Stage ft	Peak Modelled Stage ft
2007	-	-	-	-
2016	143,000	137,900	128.85	128.3
2017	146,000	148,000	129	128.83

## Average Roughness Coefficients

Low Flow	1.09
High Flow	1.37

\*Low flow is below 80,000 cfs

\*High flow is above 80,000 cfs

## Manning's N-Value

	Channel	Overbank
Min	0.023	0.05
Max	0.042	0.12



# Richmond

Event	Peak Observed Flow cfs	Peak Model Flow cfs	Peak Observed Stage ft	Peak Modelled Stage ft
2007	72,100	70,600	72.82	72.62
2016	102,000	109,700	81.76	81.83
2017	126,000	125,300	82.21	82.19

## Average Roughness Coefficients

Low Flow	1.07
High Flow	1.35

\*Low flow is below 80,000 cfs

\*High flow is above 80,000 cfs

## Manning's N-Value

	Channel	Overbank
Min	0.038	0.04
Max	0.055	0.12



# Rosharon

Event	Peak Observed Flow cfs	Peak Model Flow cfs	Peak Observed Stage ft	Peak Modelled Stage ft
2007	67,800	69,000	48.71	49.06
2016	112,000	117,700	50.5	50.58
2017	133,000	134,600	52.65	52.34

## Average Roughness Coefficients

Low Flow	1.04
High Flow	1.44

\*Low flow is below 80,000 cfs

\*High flow is above 80,000 cfs

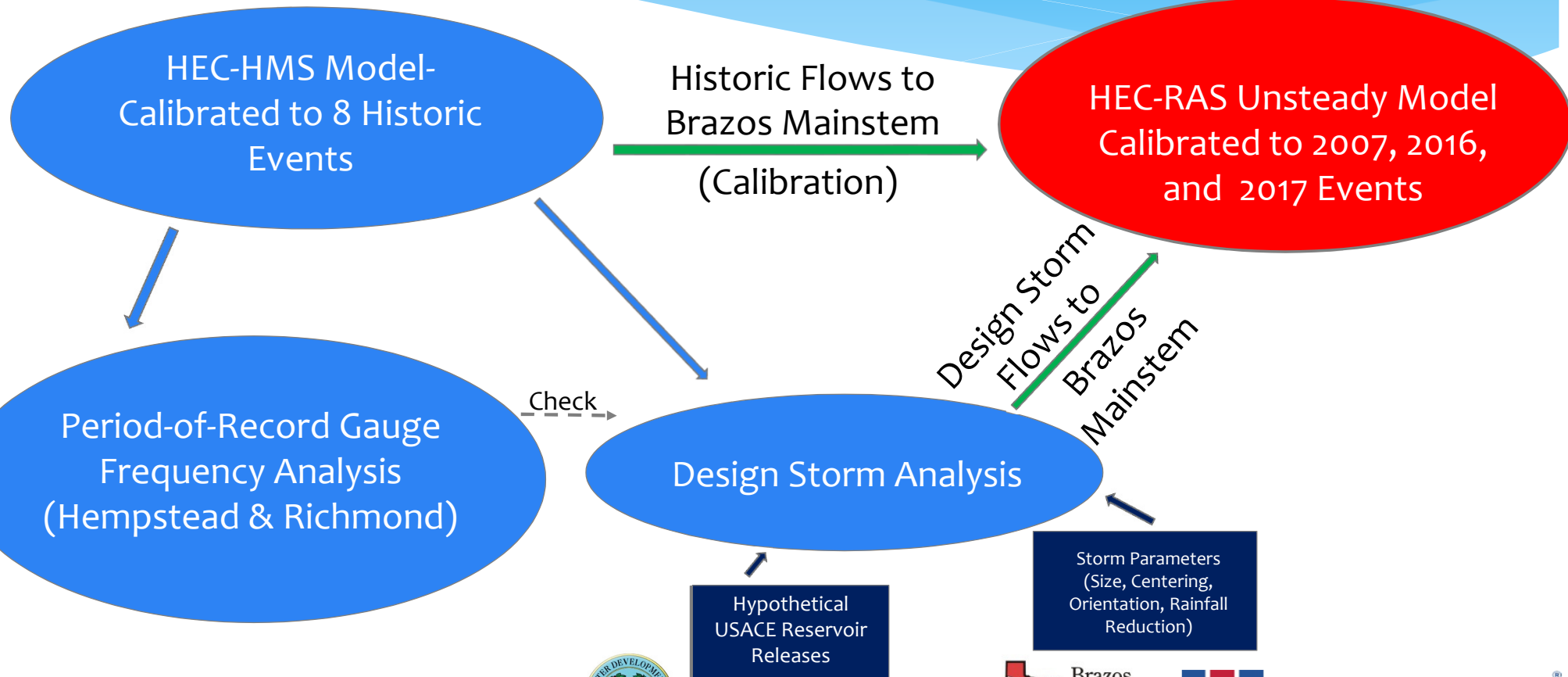
## Manning's N-Value

	Channel	Overbank
Min	0.03	0.04
Max	0.055	0.1



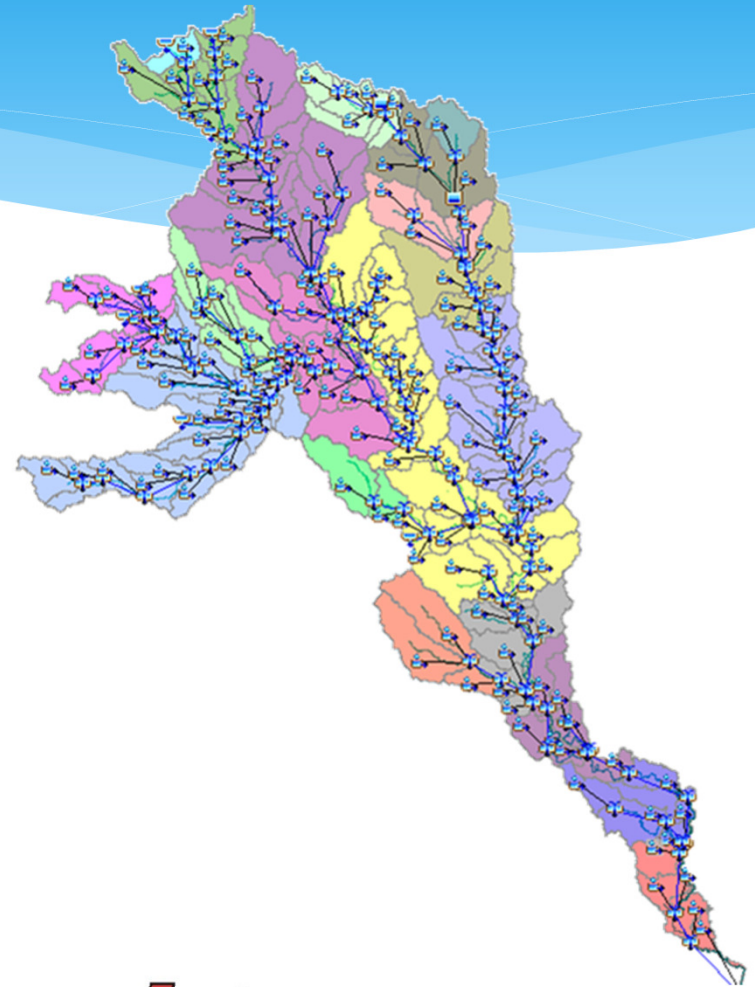


# Baseline H&H Modeling



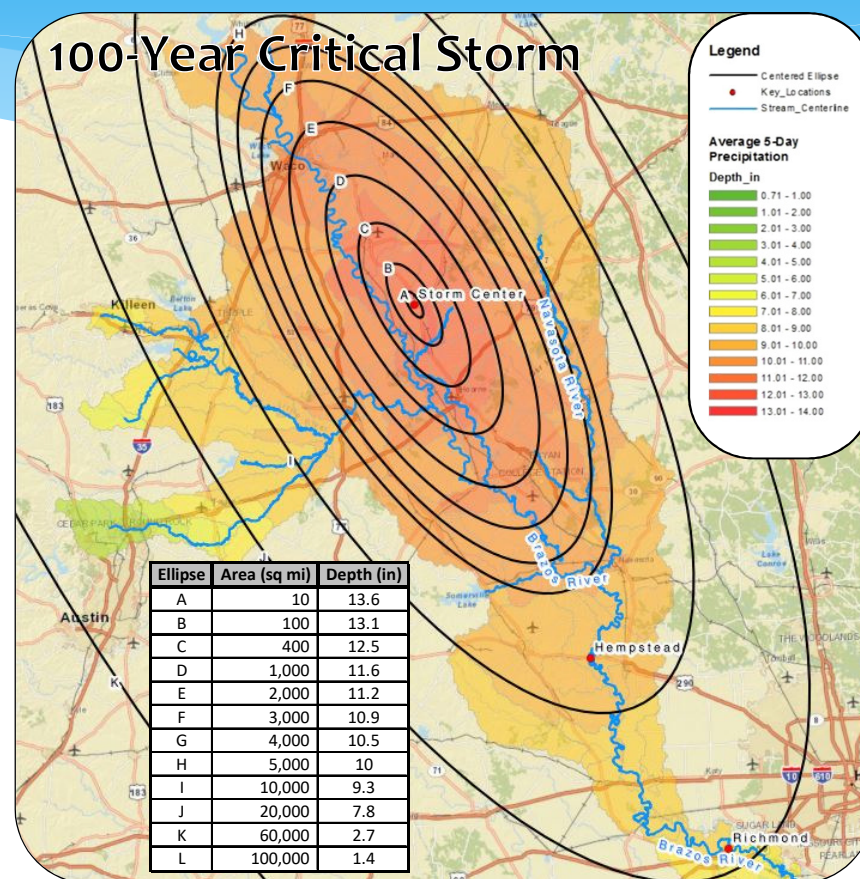
# Hydrologic Model

- \* Lower Brazos HMS Model
  - \* 9,766 sq. mi. below 7 USACE reservoirs
  - \* 154 sub-basins (63 sq. mi. avg. size)
  - \* 114 routing reaches (over 1,240 river miles modeled)
  - \* Reach Routing
    - \* Muskingum – Brazos & Navasota
    - \* Modified Puls - Elsewhere
  - \* Above Hempstead Gauge
    - \* Initial and Constant Loss Method
    - \* Snyder Unit Hydrograph Method
  - \* Below Hempstead Gauge
    - \* Exponential Loss Method
    - \* Clark Unit Hydrograph Method

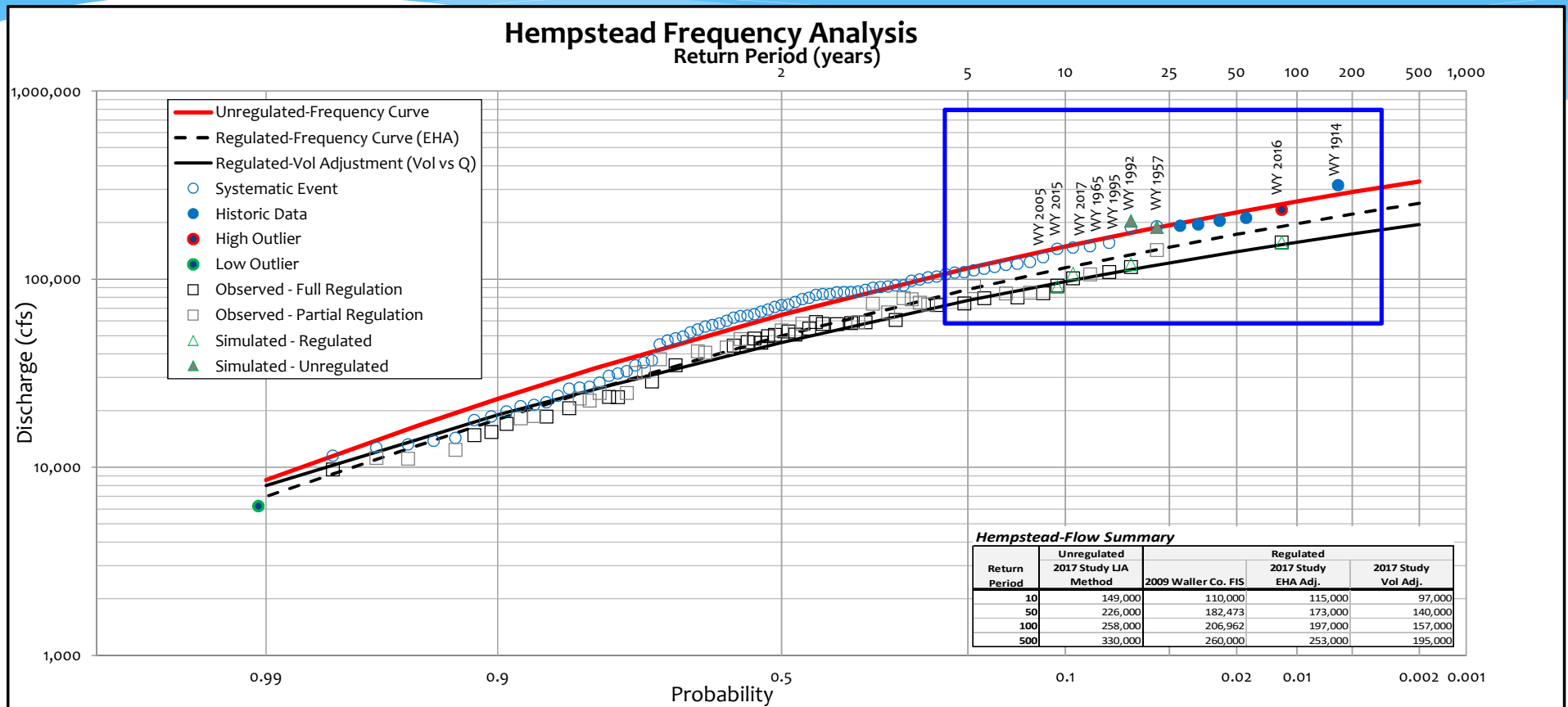


# Design Storm Analysis

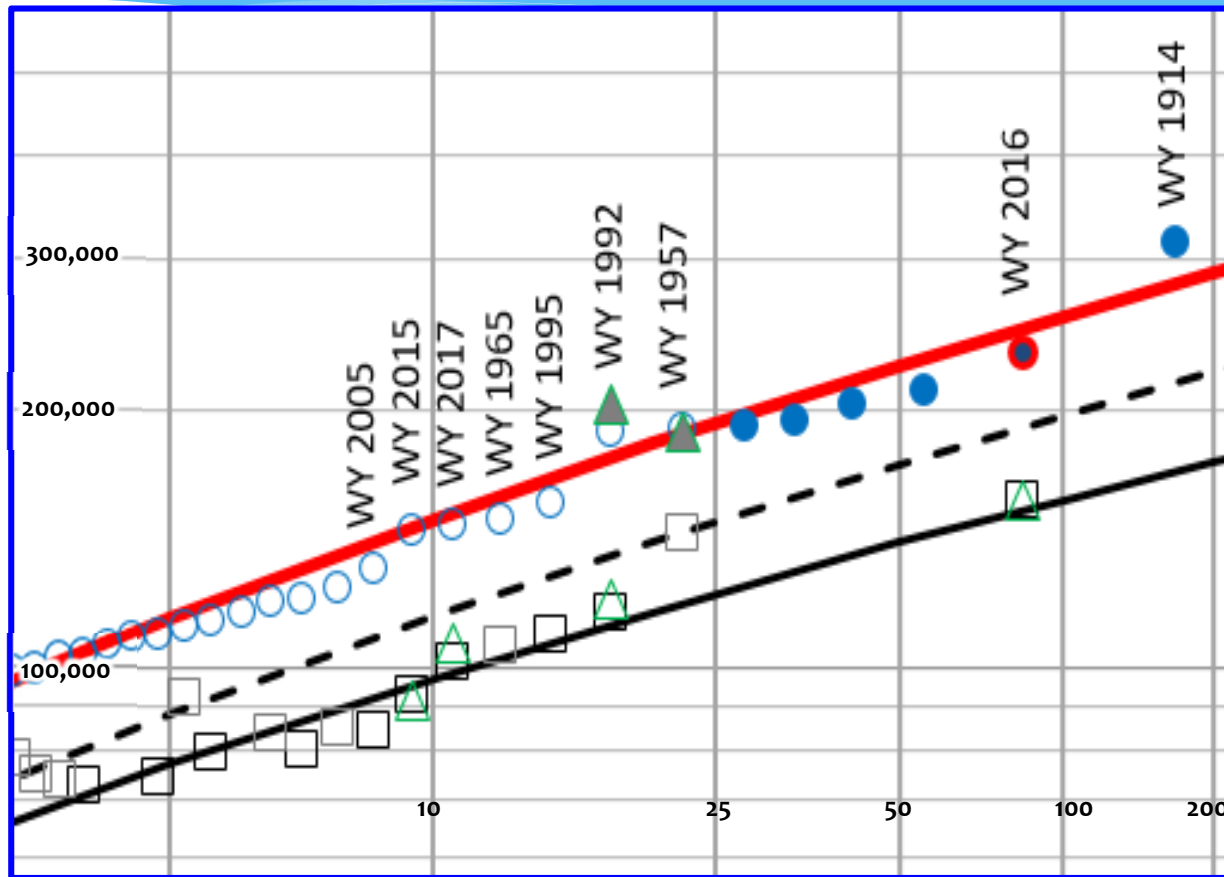
- \* Lower Brazos Critical Storm
  - \* Located near Hwy. 6 and 14
  - \* Near Bremond
  - \* Orientated 330° CW from N
  - \* Location and Orientation used for all frequencies
  - \* Maximum 5-Day Depths
    - \* 10-yr = 8.4”                      50-yr = 12.0”
    - \* 100-yr = 13.6”                    500-yr = 17.7”
  - \* Rainfall Source: Asquith 2004
  - \* Aerial Reduction: SWF Curve up to 10,000 sq mi extended using TS Cluadette up to 200,000 sq mi.



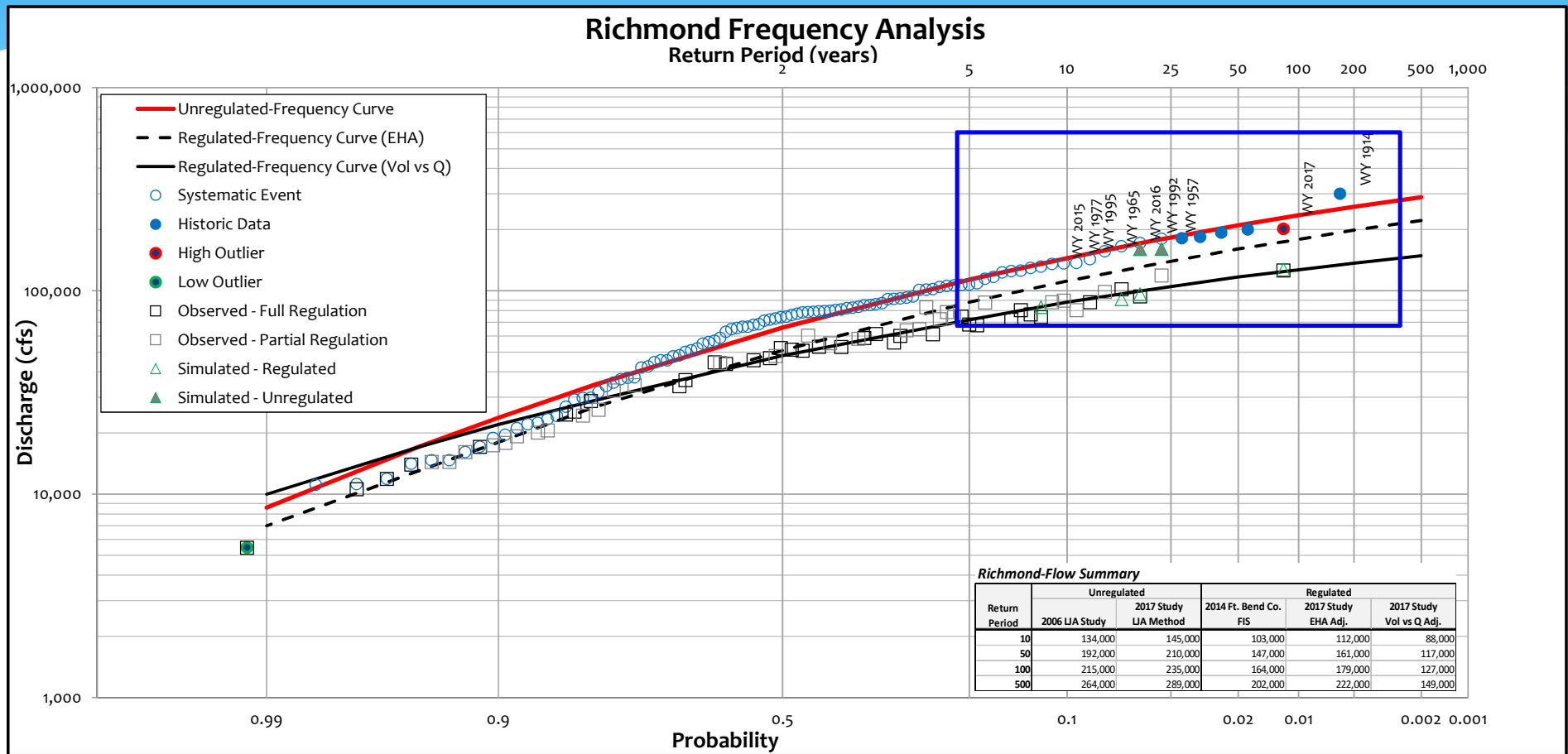
# Flood Frequency Analysis



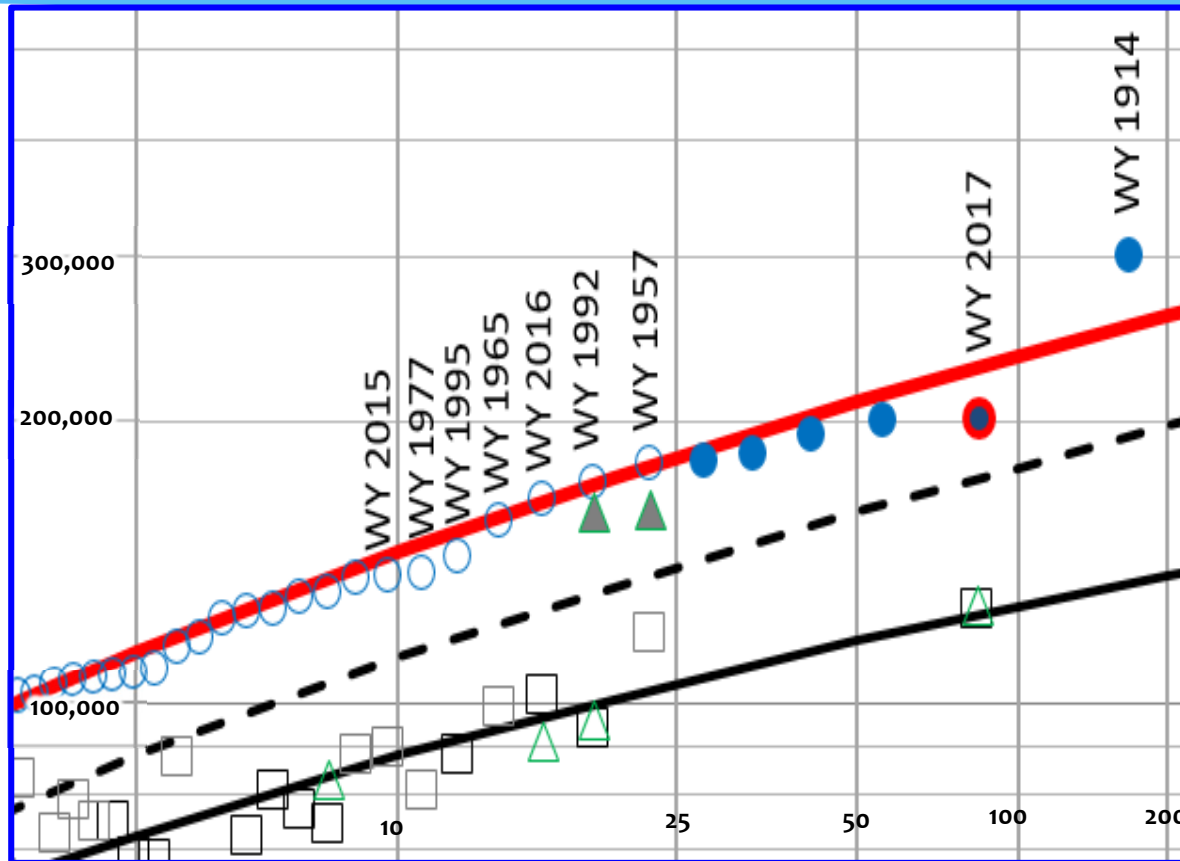
# Flood Frequency Analysis



# Flood Frequency Analysis



# Flood Frequency Analysis



# Preliminary Discharge Comparison

## Hempstead

Return Period	2009 Waller Co. FIS	Gage Freq. Storm Analysis	HEC-RAS Design Storm Analysis
10-Year	110,000	97,000	
50-Year	182,473	140,000	
100-Year	206,962	157,000	<b>166,000</b>
500-Year	260,000	195,000	
100-yr WSEL	169.0		<b>163.13</b>

## San Felipe

Return Period	HEC-RAS Design Storm Analysis
10-Year	
50-Year	
100-Year	<b>165,000</b>
500-Year	





# Preliminary Discharge Comparison

## Richmond

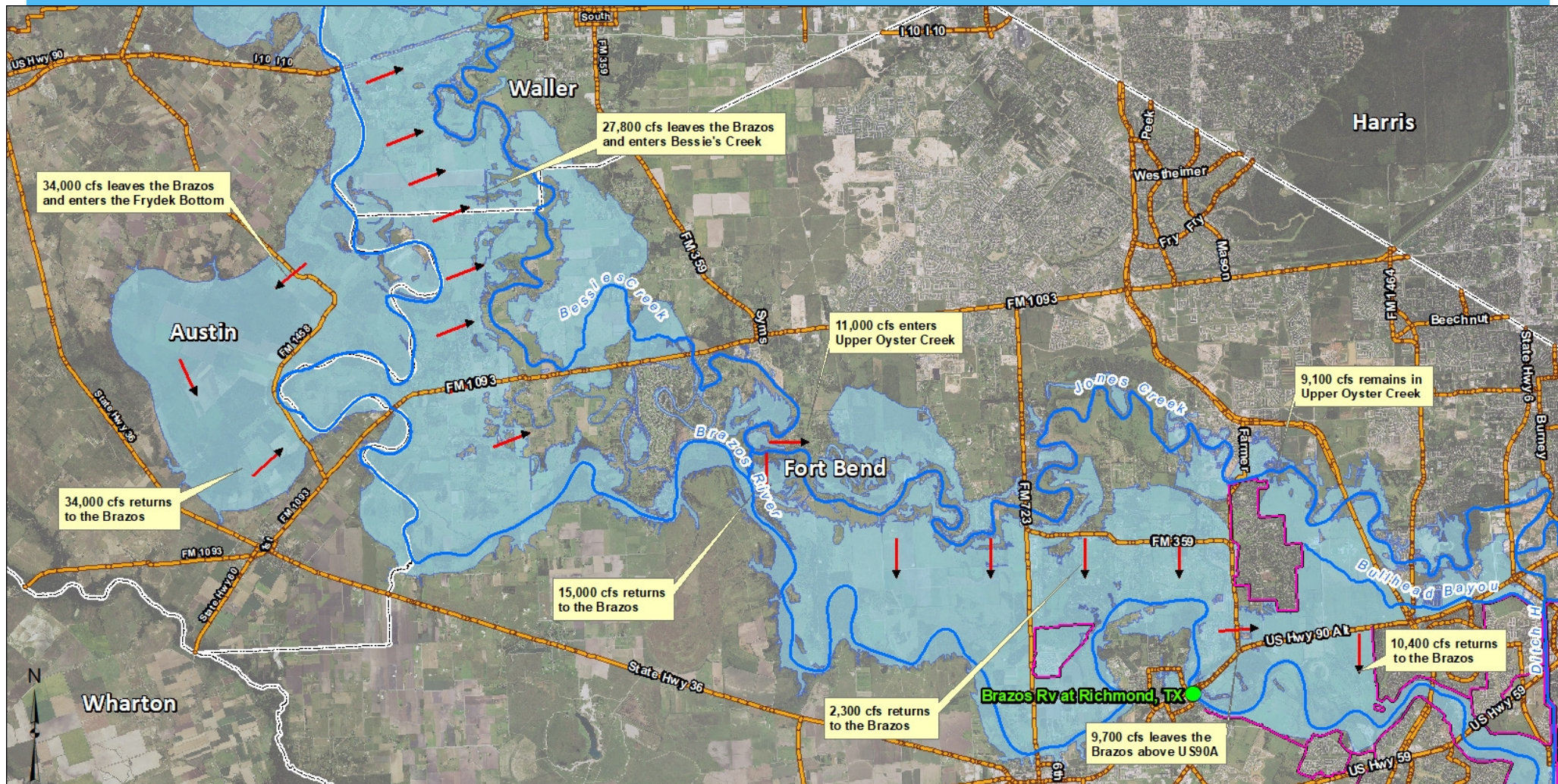
Return Period	2014 Ft. Bend Co. FIS	Gage Freq. Storm Analysis	HEC-RAS Design Storm Analysis
10-Year	103,000	88,000	
50-Year	147,000	117,000	
100-Year	164,000	127,000	<b>139,000</b>
500-Year	202,000	148,000	
100-yr WSEL	82.8		<b>84.84</b>

## Rosharon

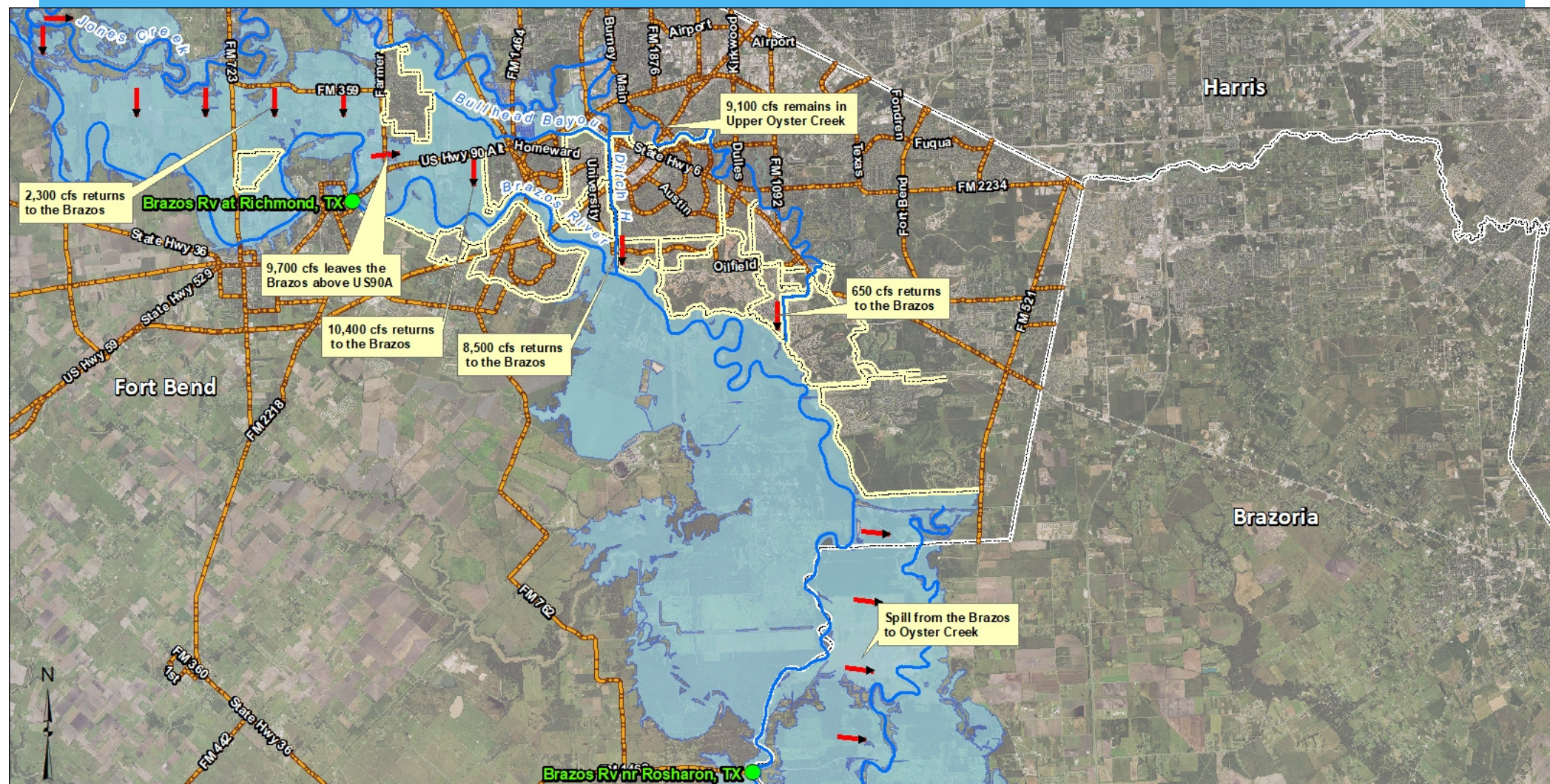
Return Period	2014 Ft. Bend Co. FIS	HEC-RAS Design Storm Analysis
10-Year	103,000	
50-Year	145,000	
100-Year	162,000	<b>156,000</b>
500-Year	200,000	
100-yr WSEL	52.0	<b>51.24</b>



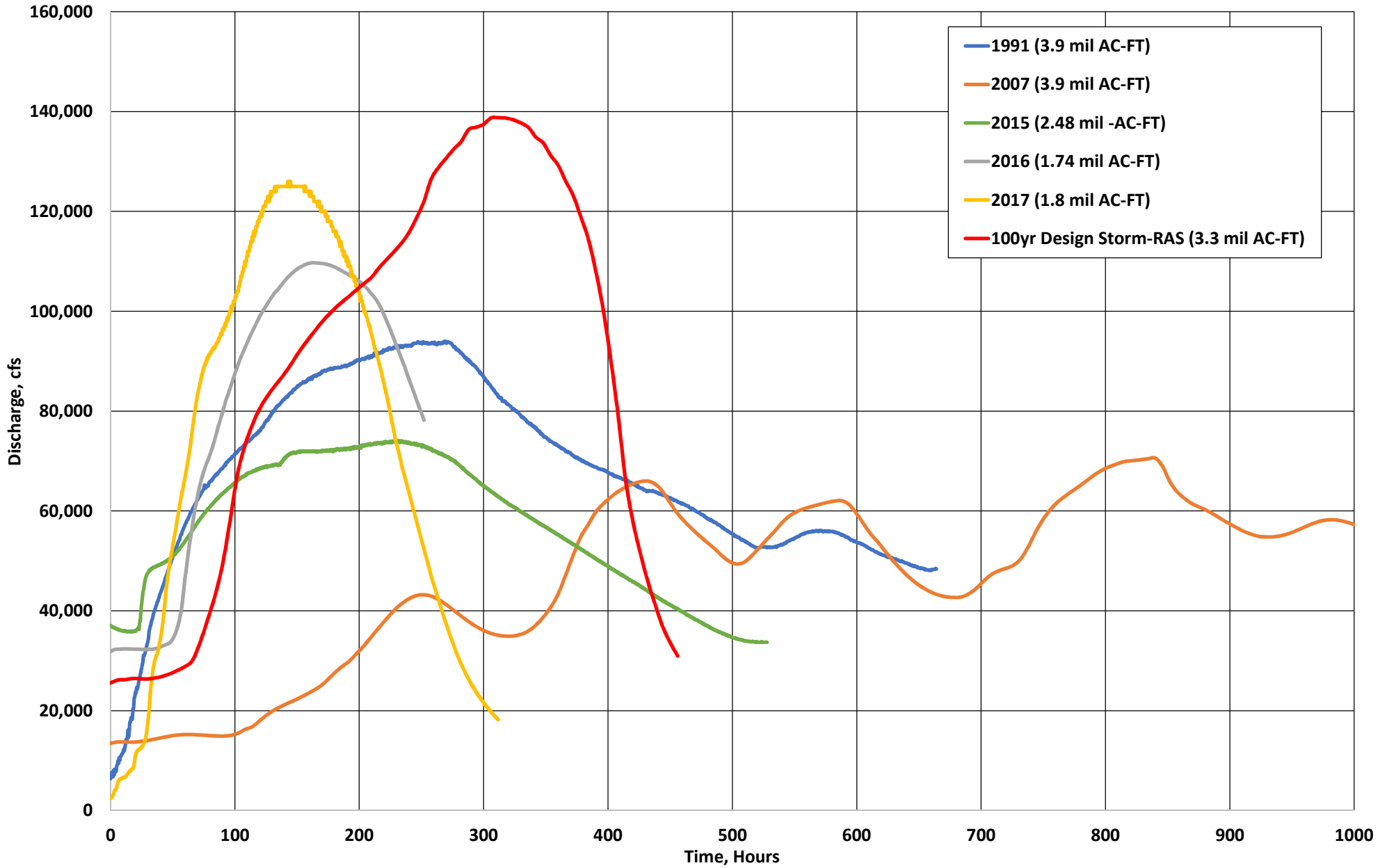
# Brazos River Lateral Flows



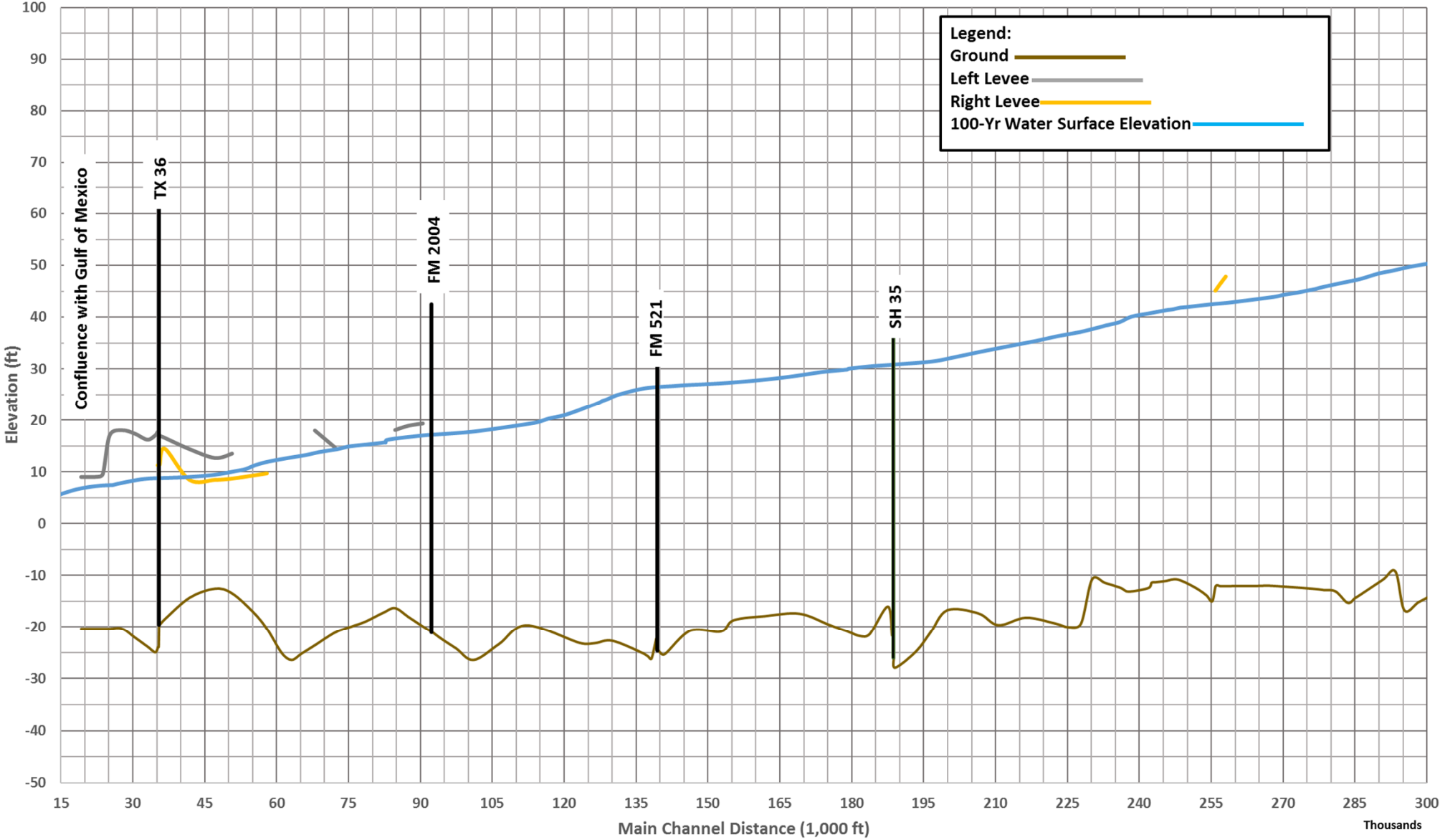
# Brazos River Lateral Flows



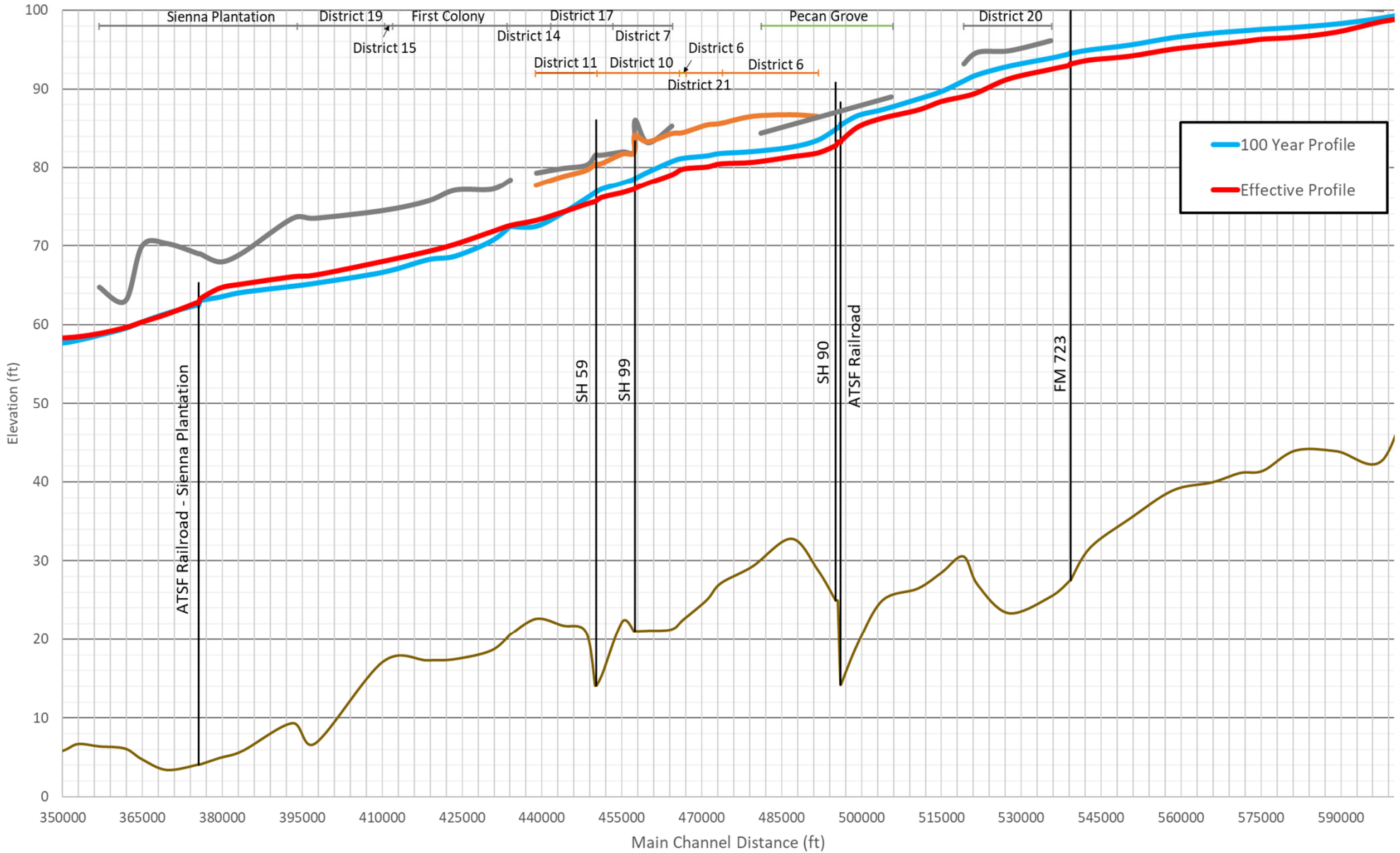
### Richmond Volume Comparison



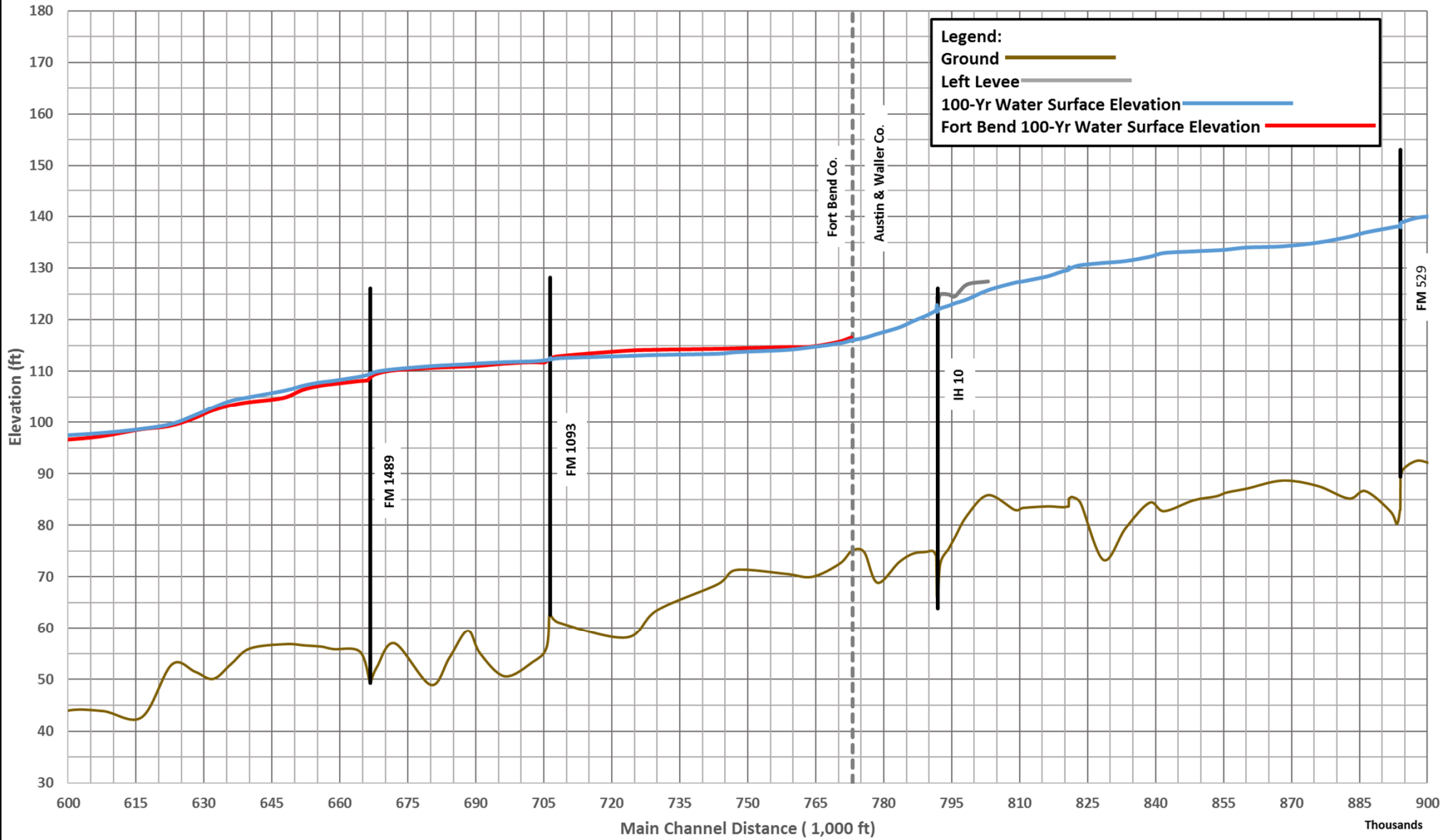
100-Year Flood Profile - 1 of 4



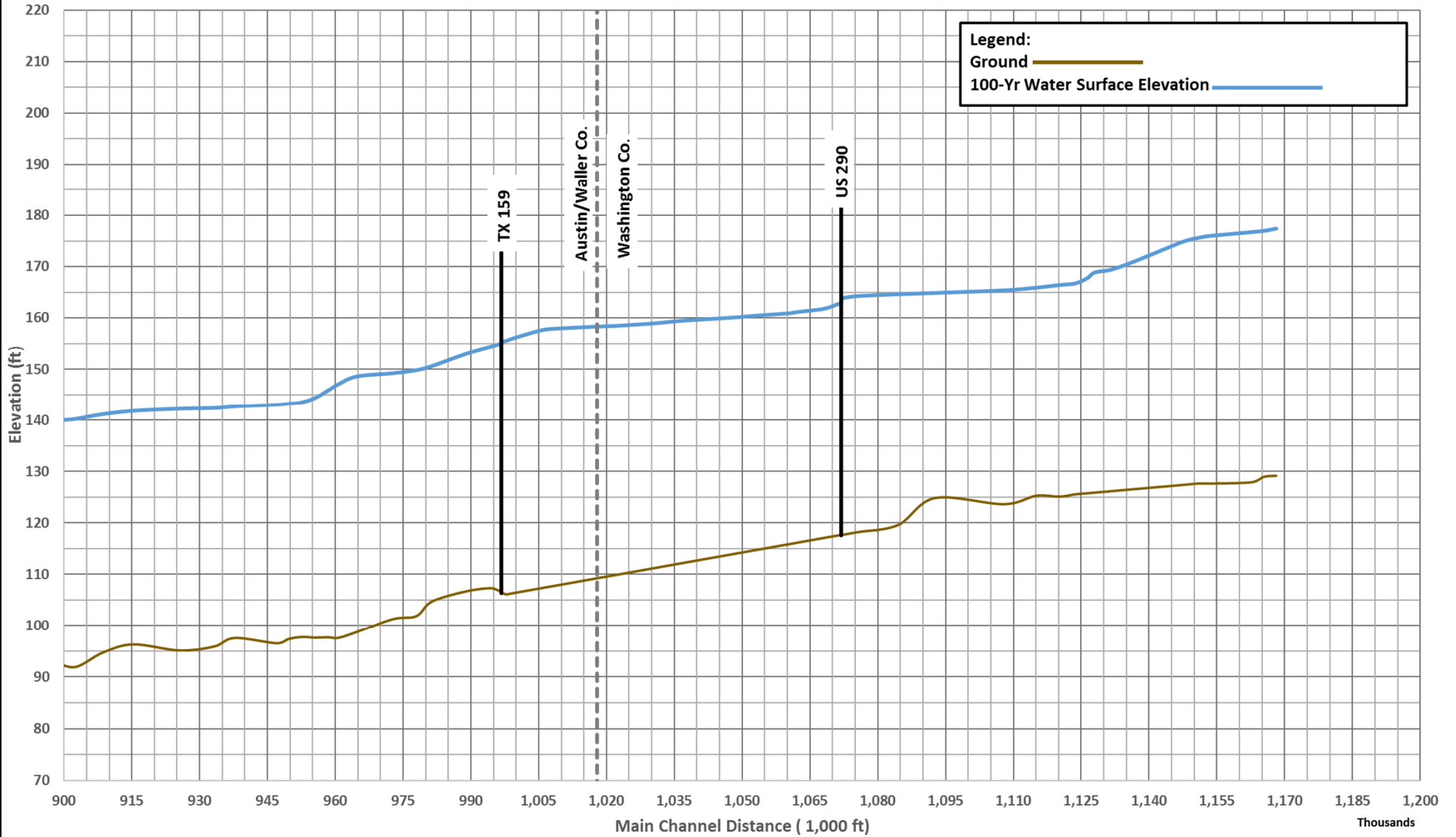
100-Year Flood Profile - 2 of 4



### 100-Year Flood Profile - 3 of 4

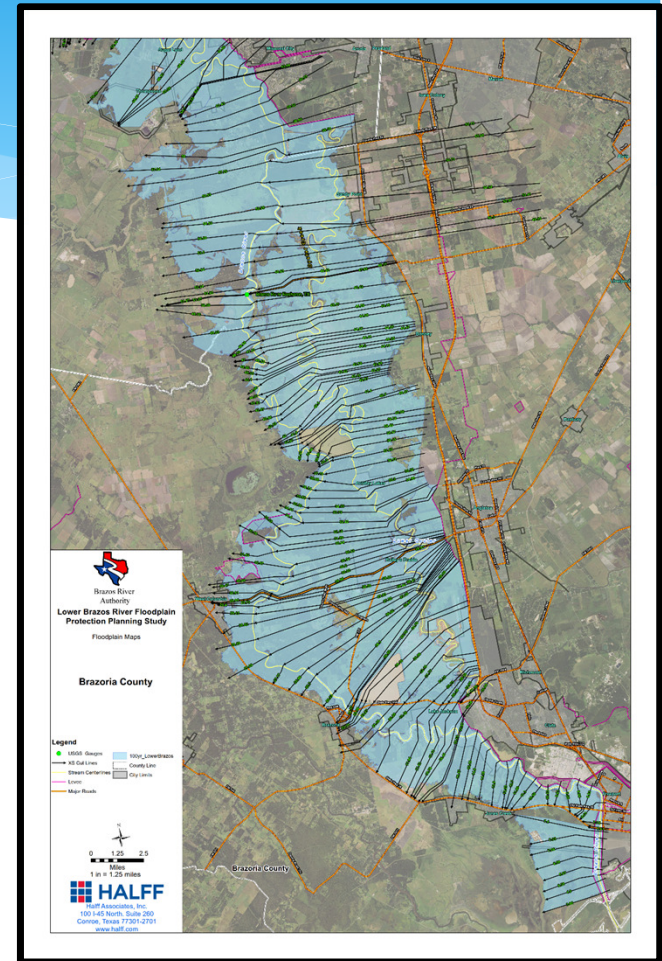
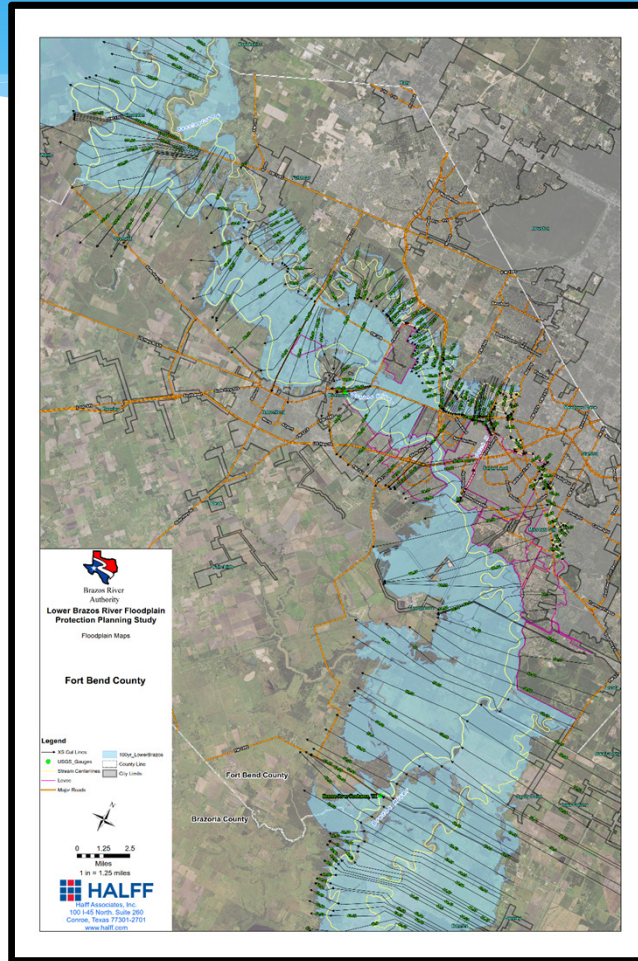
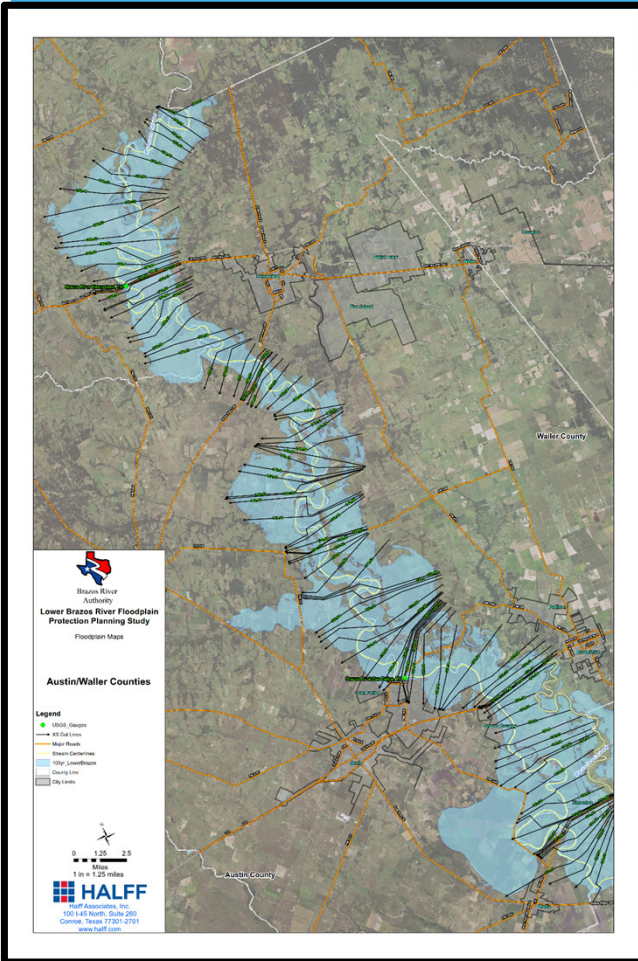


### 100-Year Flood Profile - 4 of 4





# Draft 100-Year Floodplain Maps



# Next Steps

- \* Phase II Field Surveys – Complete
- \* Finalize Hydrology –Complete
- \* Hydraulics – Feb 2018
- \* Alternatives Formulation – March 2018
- \* Flood Damage Analysis Modeling – May 2018
- \* Environmental Constraints Analysis – May 2018
- \* Draft Report – August 2018
- \* Final Report – September 2018



# Flood Reduction Alternatives

- \* Structural
  - \* New levees or improvements to existing levees
  - \* Large scale detention or off-channel storage
- \* Non-Structural
  - \* Buyouts of floodprone areas
  - \* Elevation of structures in floodprone areas
- \* Key points for Flood Monitoring Curves at Rosharon
- \* Focus on areas with large numbers of flood claims



# Flood Damage Analysis

- \* Developed a building layer to determine potential flood damages
  - \* Utilized current data from appraisal districts in Brazoria, Fort Bend, Waller, Austin and Washington Counties
- \* Identified Repetitive Loss Areas along the Brazos River to help determine flood alternative locations



# Environmental Constraint Analysis

- \* Desk level environmental analysis was completed to determine environmental sensitive areas
- \* Environmental field visits will be completed on selected alternative areas



Questions?