

LOWER BRAZOS RIVER FLOODPLAIN PROTECTION PLANNING STUDY

Richmond, Texas
November 4, 2016

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

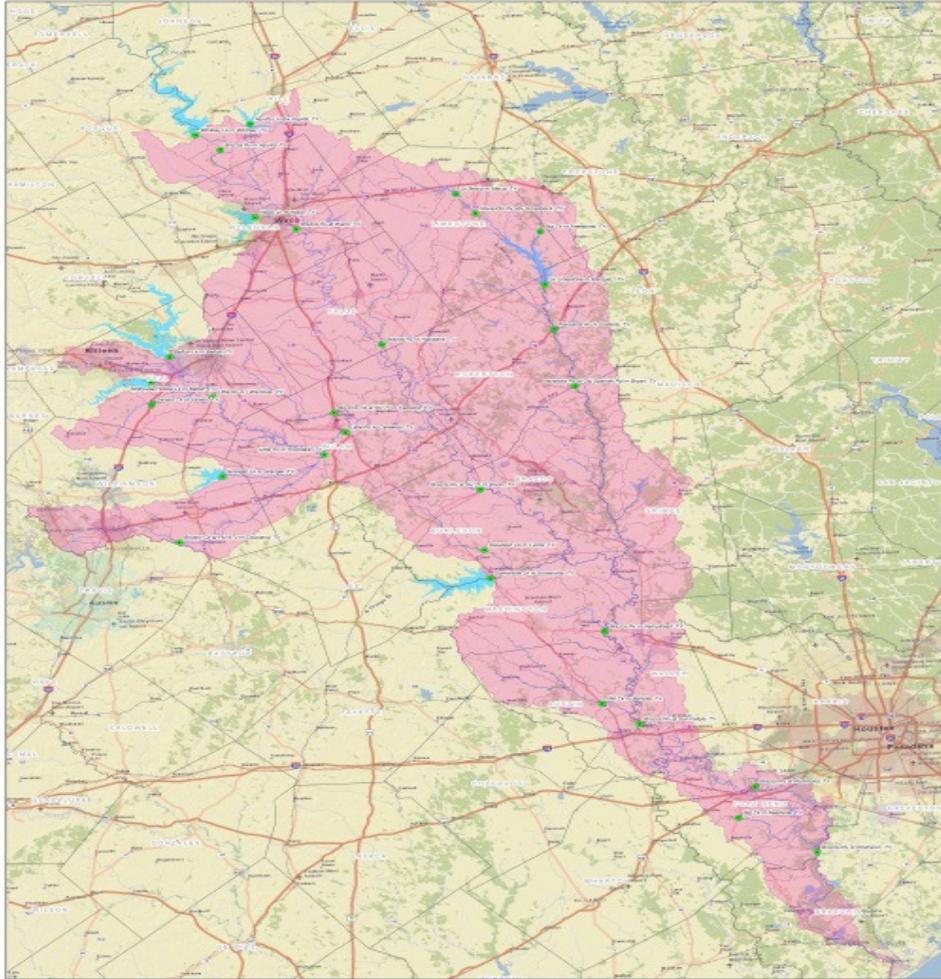


Goals of the Study

- * 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

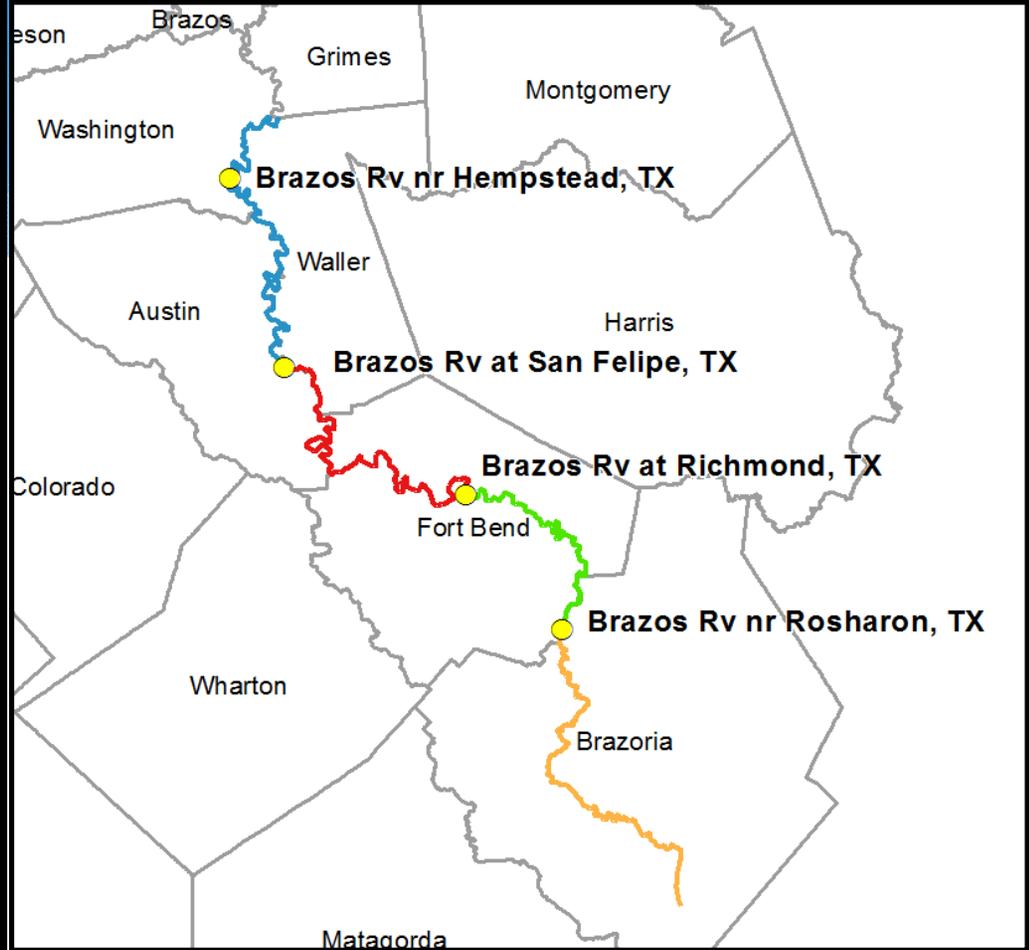


BASIN STATS:
 TOTAL NUMBER OF BASINS = 154
 MAX AREA = 126 SQ MI
 MIN AREA = 10 SQ MI
 AVG AREA = 64 SQ MI

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



0 5 10 20 30 40 Miles



Brazos
 Grimes
 Montgomery
 Washington
 Brazos Rv nr Hempstead, TX
 Waller
 Austin
 Harris
 Brazos Rv at San Felipe, TX
 Colorado
 Fort Bend
 Brazos Rv at Richmond, TX
 Wharton
 Brazos Rv nr Rosharon, TX
 Brazoria
 Matagorda



Where are We Today?

- * Combined Phase I and Phase II into a single project moving forward with 1 final report
- * Basin wide hydrology is 95% complete (Nov. 2015 Meeting)
- * Hydraulics are nearing completion for Fort Bend and Brazoria Counties
- * Hydraulics are in progress for Waller, Austin, & Washington Counties



Schedule

- * Phase II Field Surveys – Complete
- * Finalize Hydrology – March 2017
- * Hydraulics – April 2017
- * Alternatives Formulation – August 2017
- * Flood Damage Analysis Modeling – November 2017
- * Environmental Constraints Analysis – January 2018
- * Draft Report – January 2018
- * Final Report – March 2018



May-June 2016 Flood

CBS/AP / May 31, 2016, 3:50 PM

Amid deadly floods, Texas' Brazos River crests at record 54 feet

24 Comments / f Share / T

Last Updated May 31, 2016 6:3

RICHMOND, Texas -- Residents were bracing for more flooding high crest just two years after it



More flooding in Houston as Brazos River swells

AP BY: Associated Press
POSTED: 9:00 PM, May 31, 2016



Print Close

Texas residents brace for more flooding after torrential rains kill six

Published May 30, 2016

Associated Press

Deadly deluge: Texans "not prepared for 8 or 9 feet of water"

32 Comments / f Share / T Tweet / Stumble / @ Email

The deluge of rain that's pummeled Southeastern Texas has sent rivers surging to levels not seen in decades.

The rising Brazos River has forced the evacuation of hundreds from Simonton to Richmond and is expected to hit a record eight and a half feet above flood stage.

An area that's no stranger to flooding has still found itself overwhelmed, reports CBS News correspondent Manuel Bojorquez.

"Yeah, you're prepared but you're not prepared for eight or nine feet of water," said one resident.



Four days of torrential rains have caused flooding now blamed for six deaths along the Brazos. The Brazos River Authority says every single one of the 11 reservoirs fed by the swollen river are already 95 to 100 percent full.

Dozens of people in Fort Bend County needed to

for more flooding on
years after it had run dry

er would crest at 53.5 feet
s record and topping a

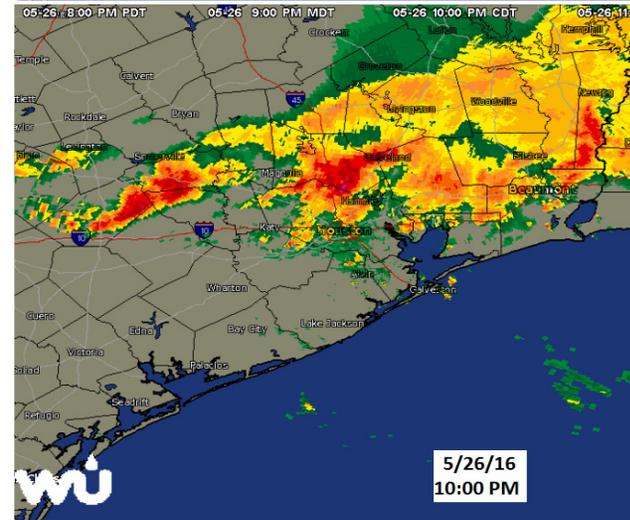
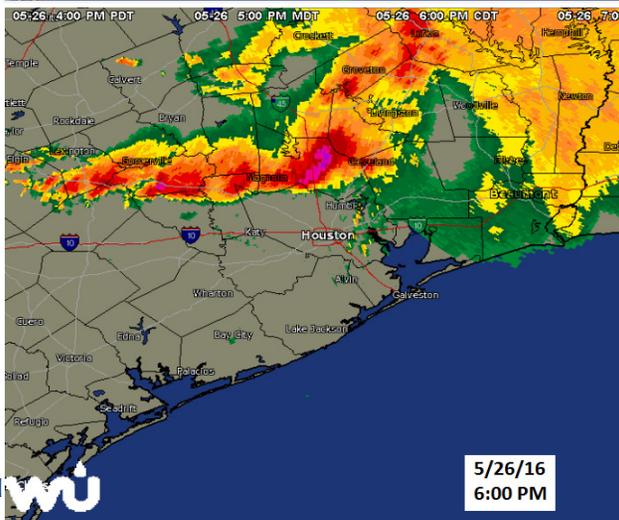
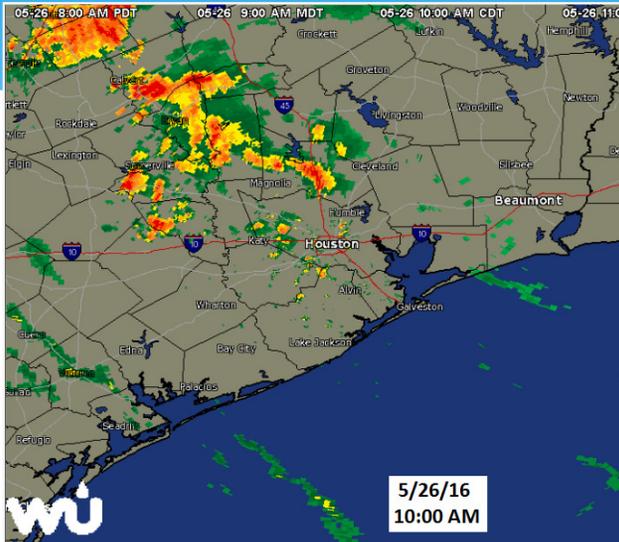
the Brazos, which runs
shows all 11 of the

in the Austin area near the
people reported missing



May 26, 2016 Radar

Source: Fort Bend August 19, 2016 Presentation www.wunderground.com

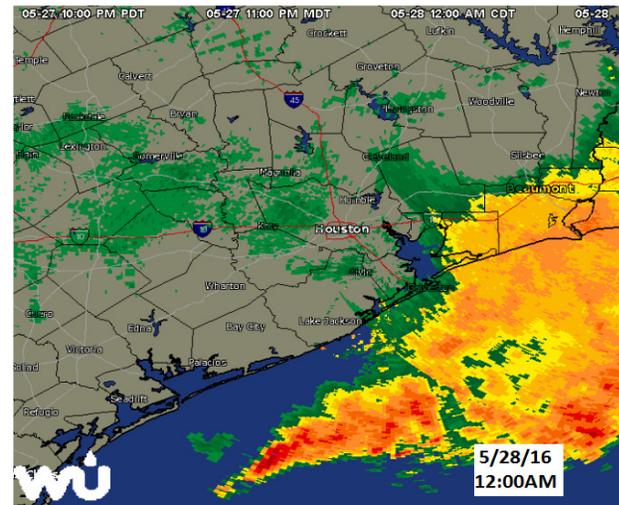
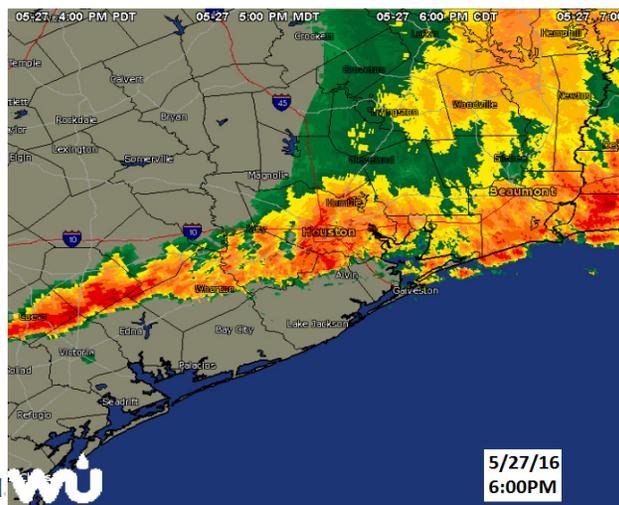


Lower Brazos River Floodpl

HALFF®

May 27, 2016 Radar

Source: Fort Bend August 19, 2016 Presentation www.wunderground.com



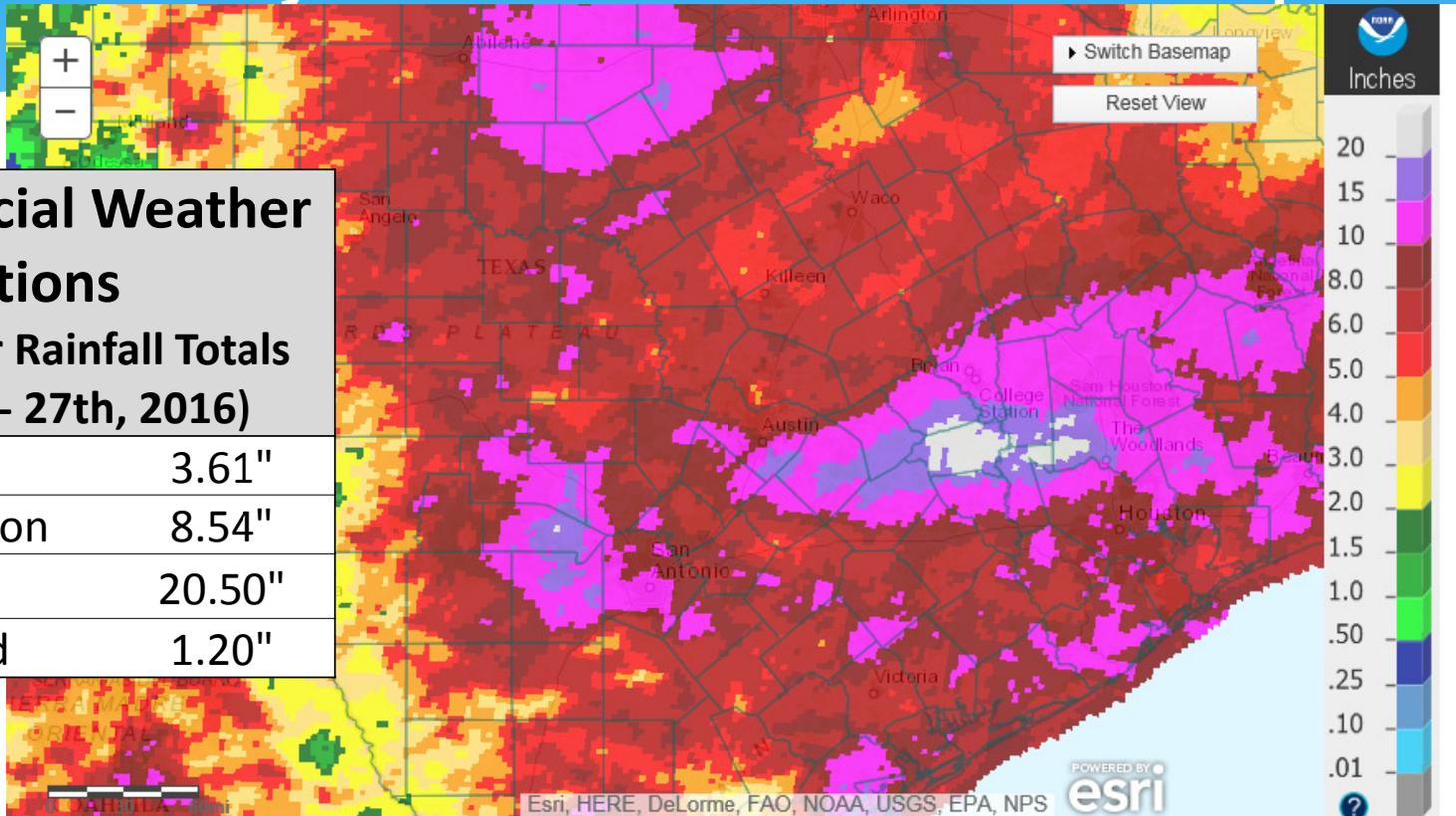
Lower Brazos River Floodpl



Authority

HALFF[®]

NOAA May 2016 Observed Precipitation



NWS - Official Weather Stations

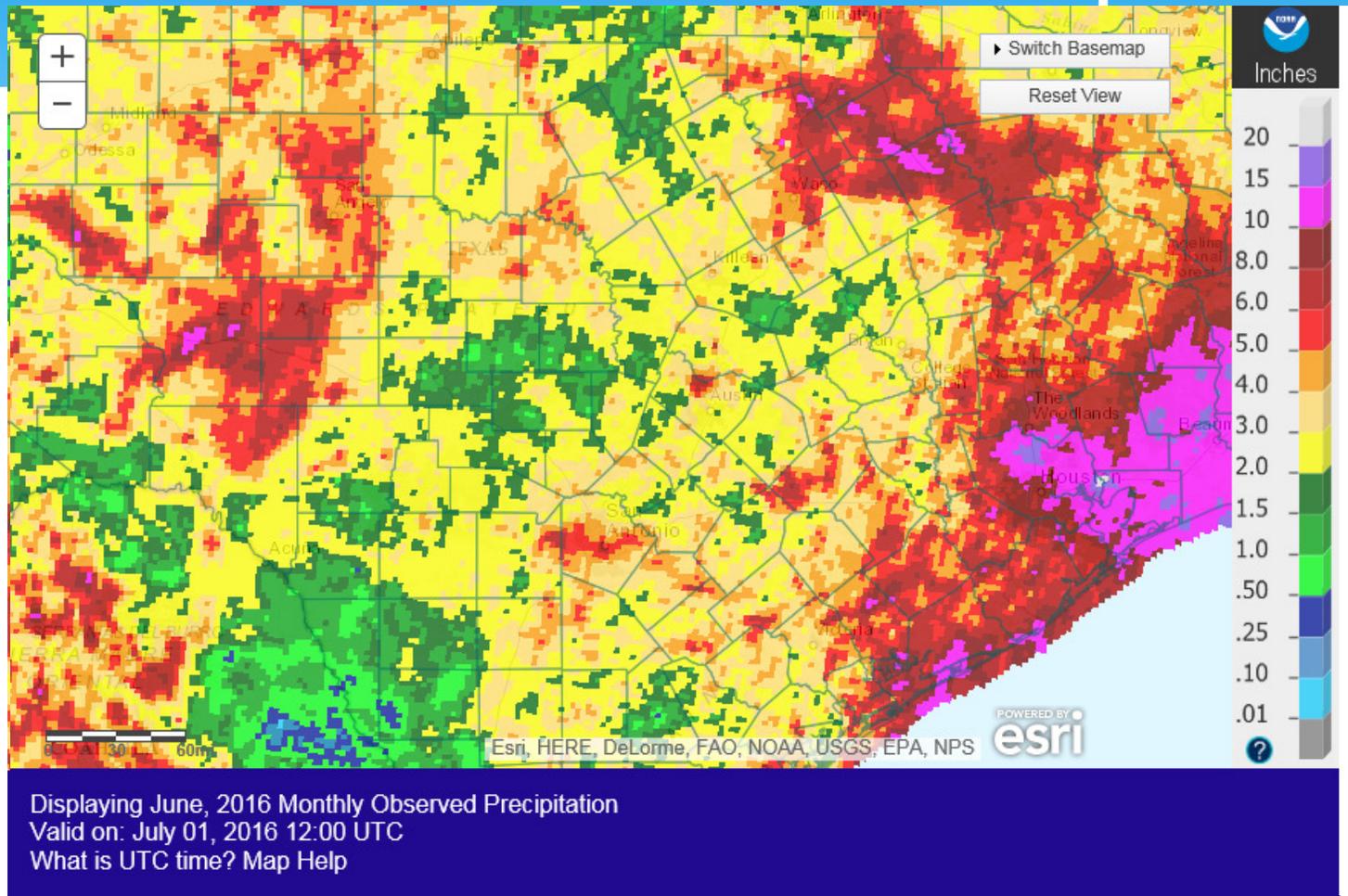
Max 24-Hour Rainfall Totals (May 26th - 27th, 2016)

Waco	3.61"
College Station	8.54"
Brenham	20.50"
Sugar Land	1.20"

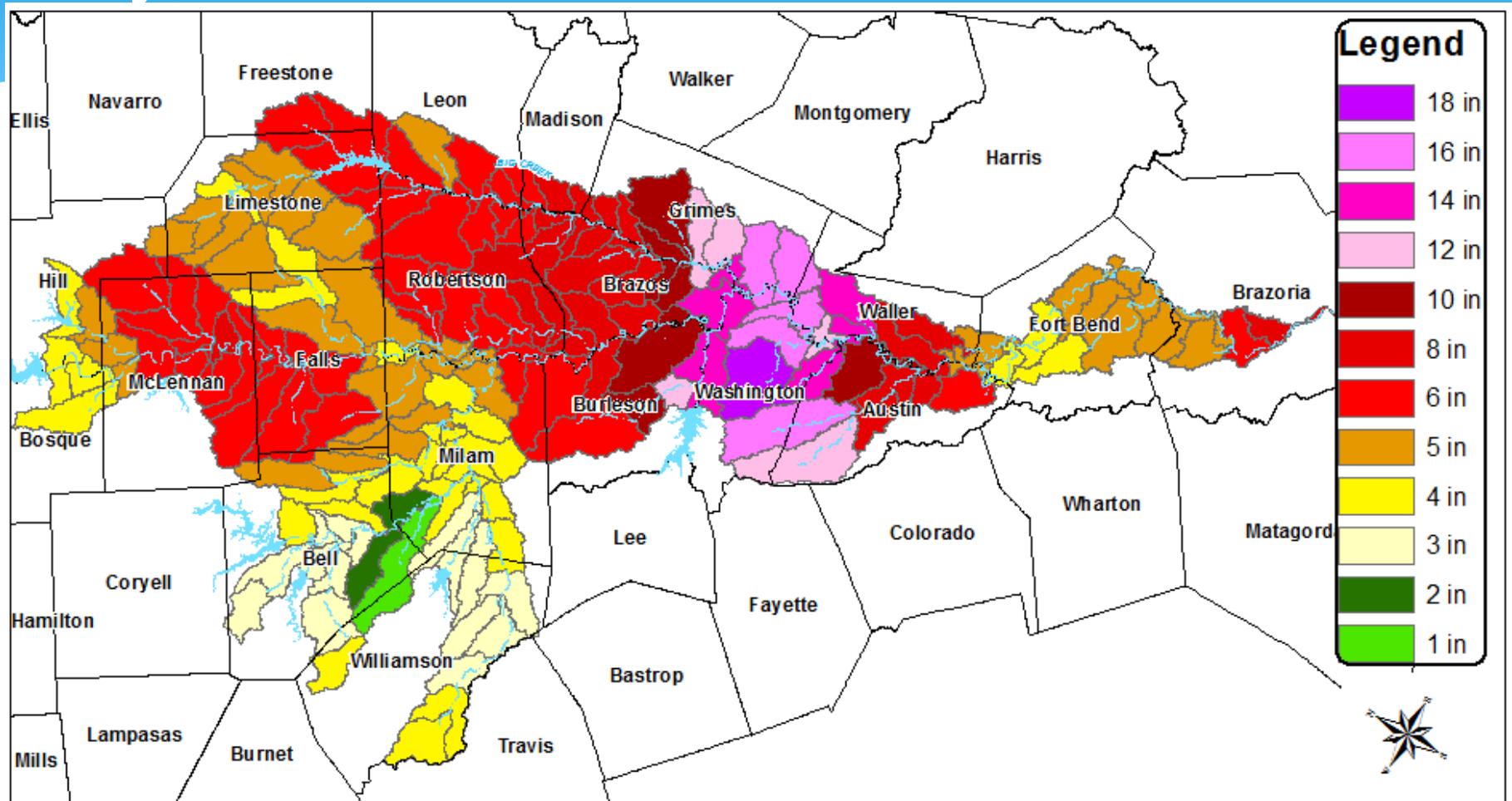
Displaying May, 2016 Monthly Observed Precipitation
 Valid on: June 01, 2016 12:00 UTC
 What is UTC time? Map Help



June 2016 Observed Precipitation

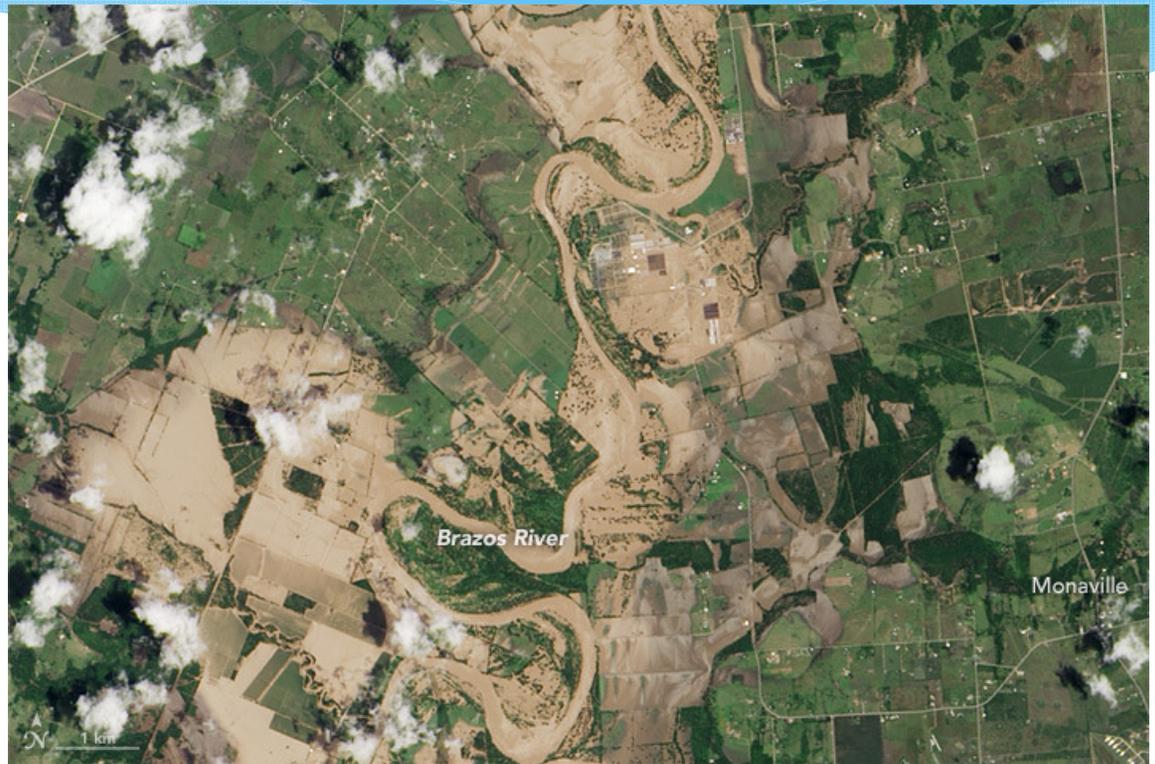


May/June 2016 HMS Model Rainfall



May-June 2016 Flood Data

- * High Water Mark Survey
- * Georeferenced Flood Photos
- * Fort Bend County Sheriffs Office
- * Fort Bend County
- * Velasco Drainage District
- * Twitter
 - * Photos from Space Station
- * YouTube Videos
 - * Drone Flights
- * Facebook Photos

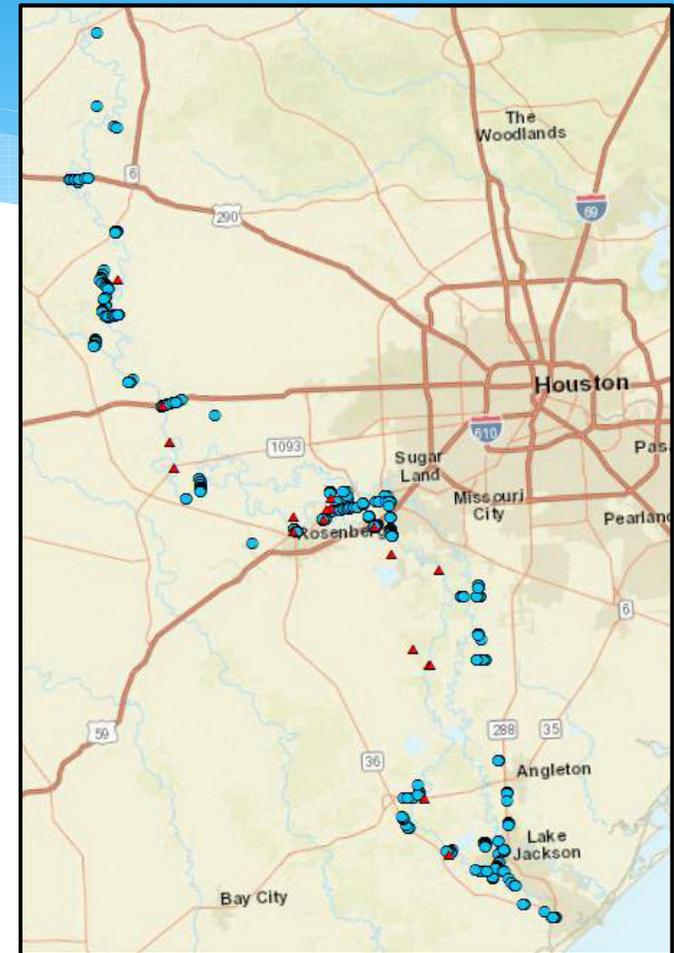


- * Source: NASA Space Station Photo Posted on Twitter 5/28/2016
- * Waller/Austin Co.



Halff Flood Photos & Survey

- * Halff made several field visits to document the May/June 2016 flood event
- * 18 High Water Mark Survey points
- * 850 Flood Photos of the Brazos River
 - * Georeferenced location of photos
 - * Time Stamp with Date and Time



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
 - * 78 Years of Record



Hempstead Flood Photos



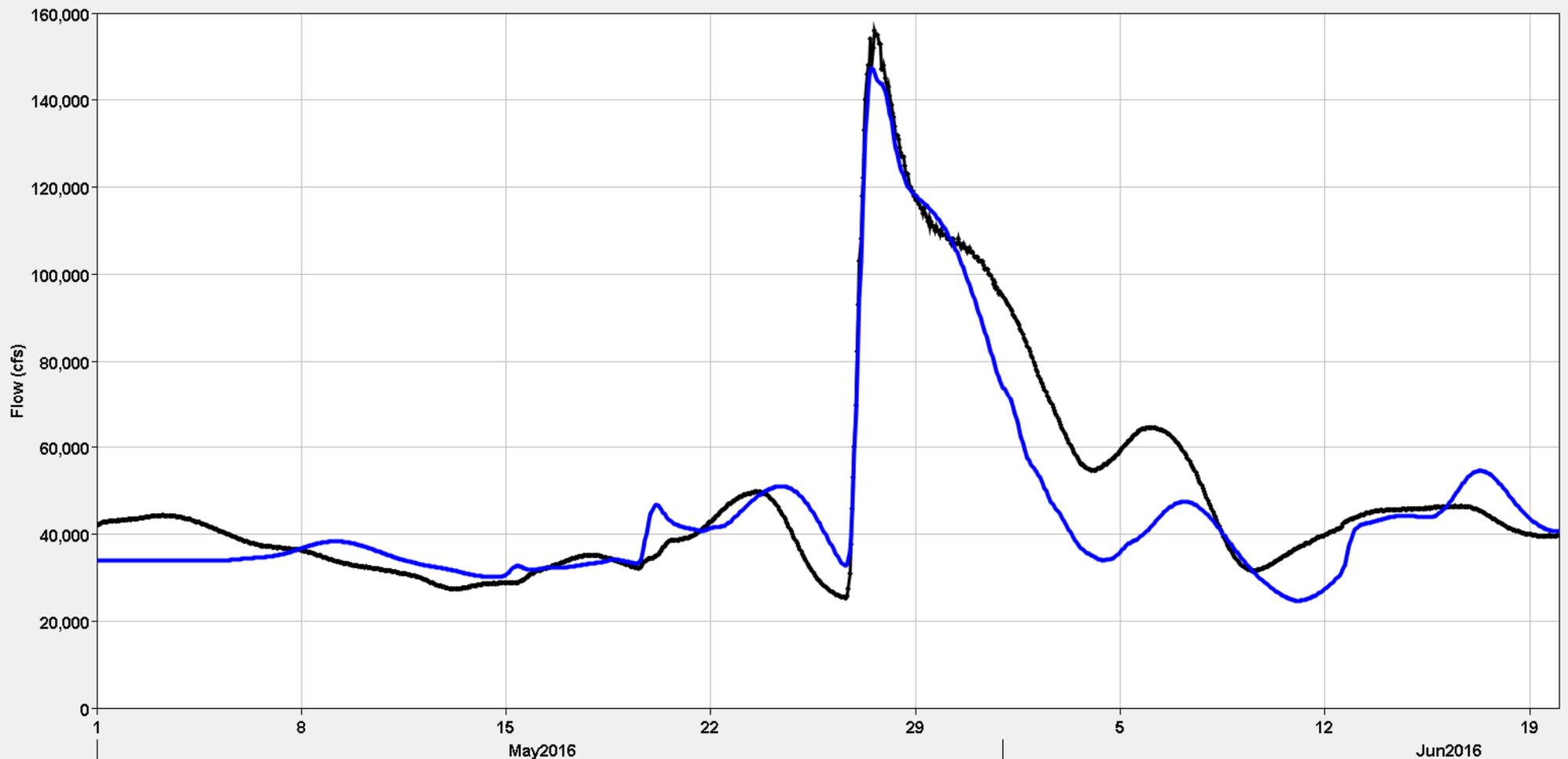
SH 159 – June 3, 2016



FM 529– June 3, 2016



HEMPSTEAD GAGE RESULTS



Legend (Compute Time: 20Oct2016, 15:05:49)

— OBSERVED FLOW

— Run:2016MAR_2016JUN Element:J_Hempstead Result:Outflow



May-June 2016 Gage Discharge Timeline

May 27

- **14:00 -Hempstead Gage Peaks at 156,000 cfs**
- 21:00 – Mill Creek Gage Peaks at 89,000 cfs

May 28

- 18:00-San Felipe Gage Peaks at 143,000 cfs

June 1

- 11:00 – Richmond Gage Peaks at 102,000 cfs

Jun 4

- 13:00 – Rosharon Gage Peaks at 112,000 cfs

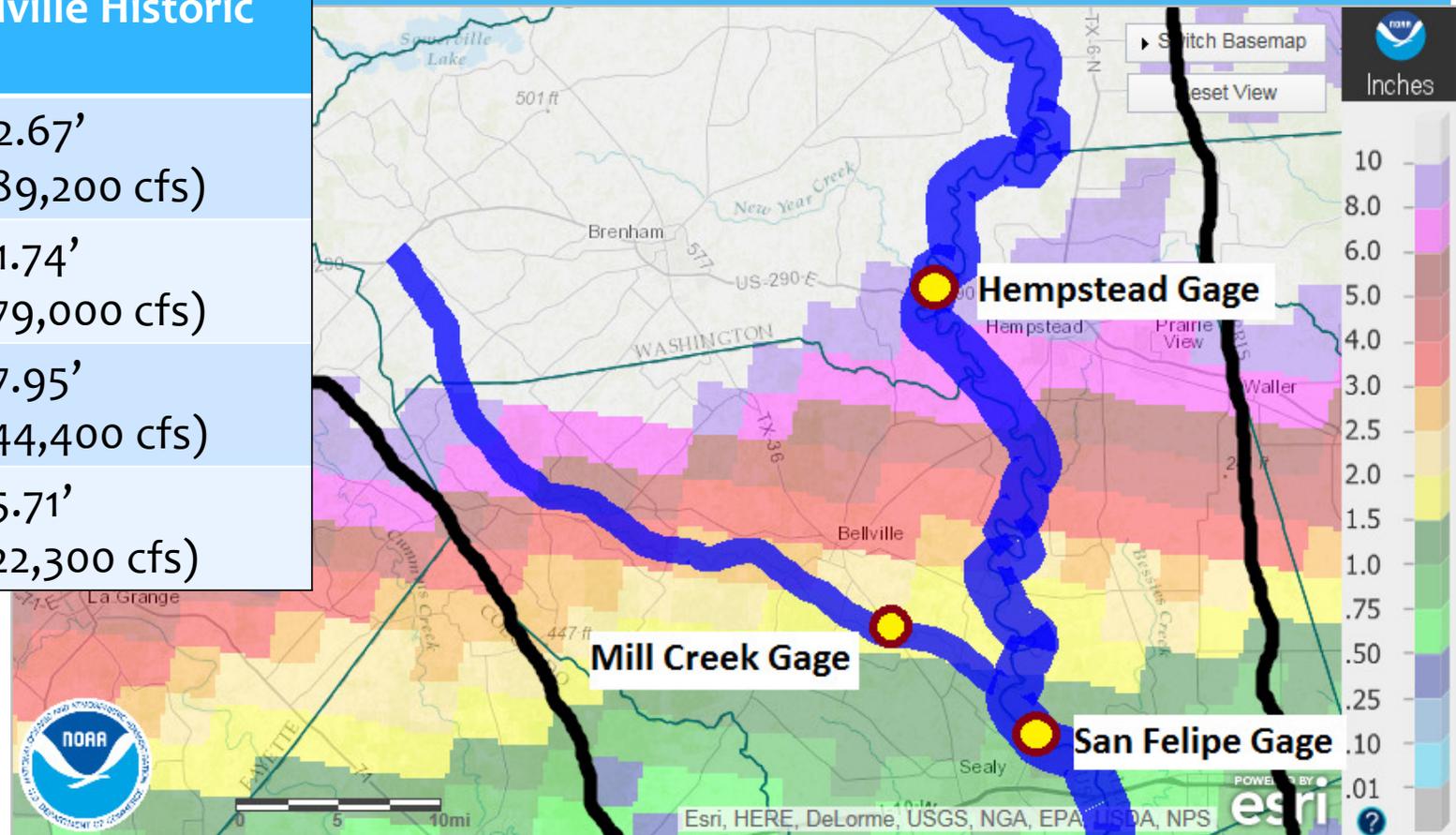


Mill Creek Between Sealy/Bellville

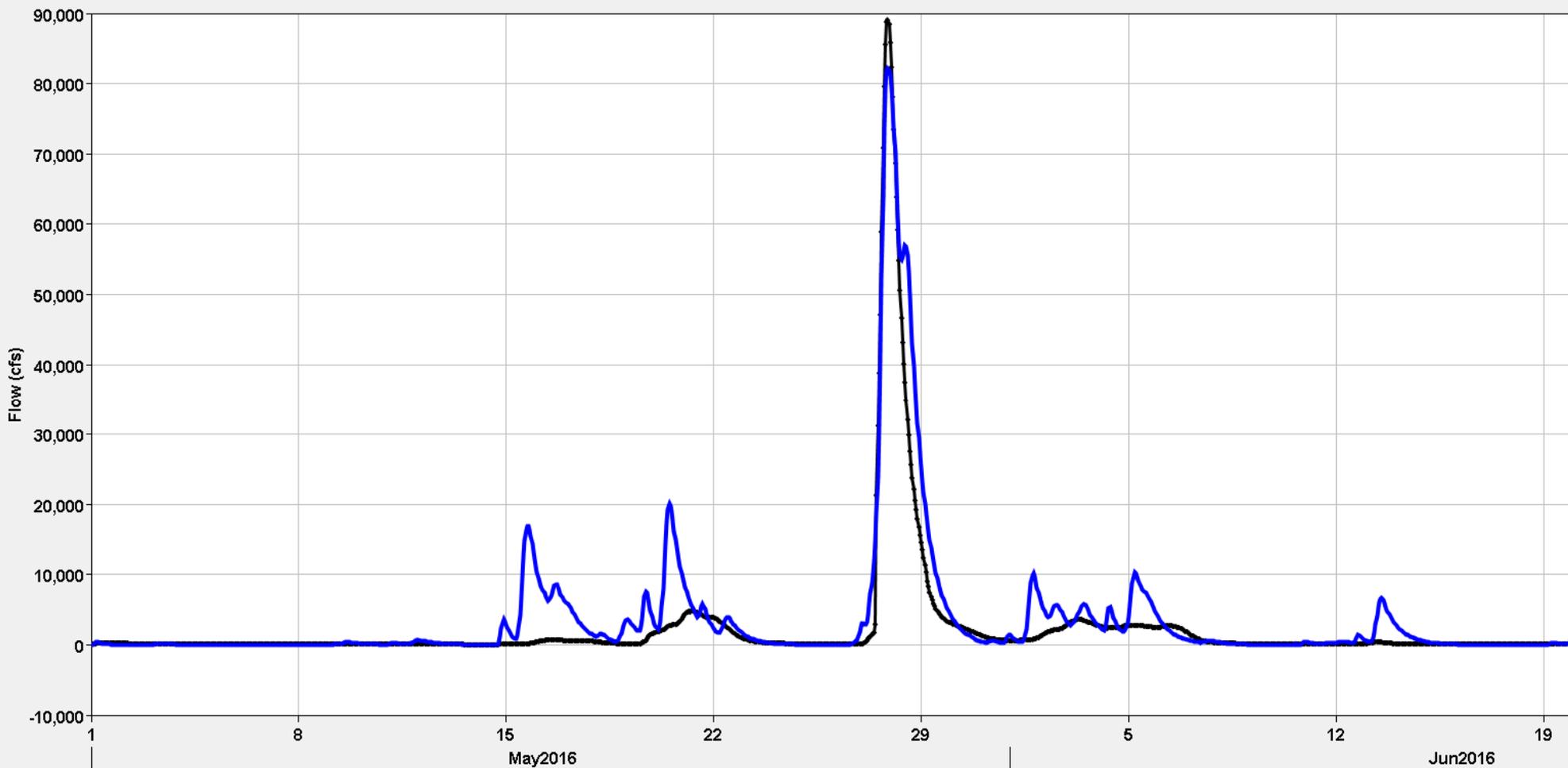
Mill Creek near Bellville Historic Crests since 1964

May 27, 2016	22.67' (89,200 cfs)
April 18, 2016	21.74' (79,000 cfs)
July 13, 1973	17.95' (44,400 cfs)
June 21, 1993	15.71' (22,300 cfs)

Source:
Fort Bend
August 19, 2016
Presentation



MILL CREEK AT BELLVILE GAGE RESULTS



Legend (Compute Time: 20Oct2016, 15:05:49)

— OBSERVED FLOW

— HMS OUTFLOW



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Brazos Rv at San Felipe, TX

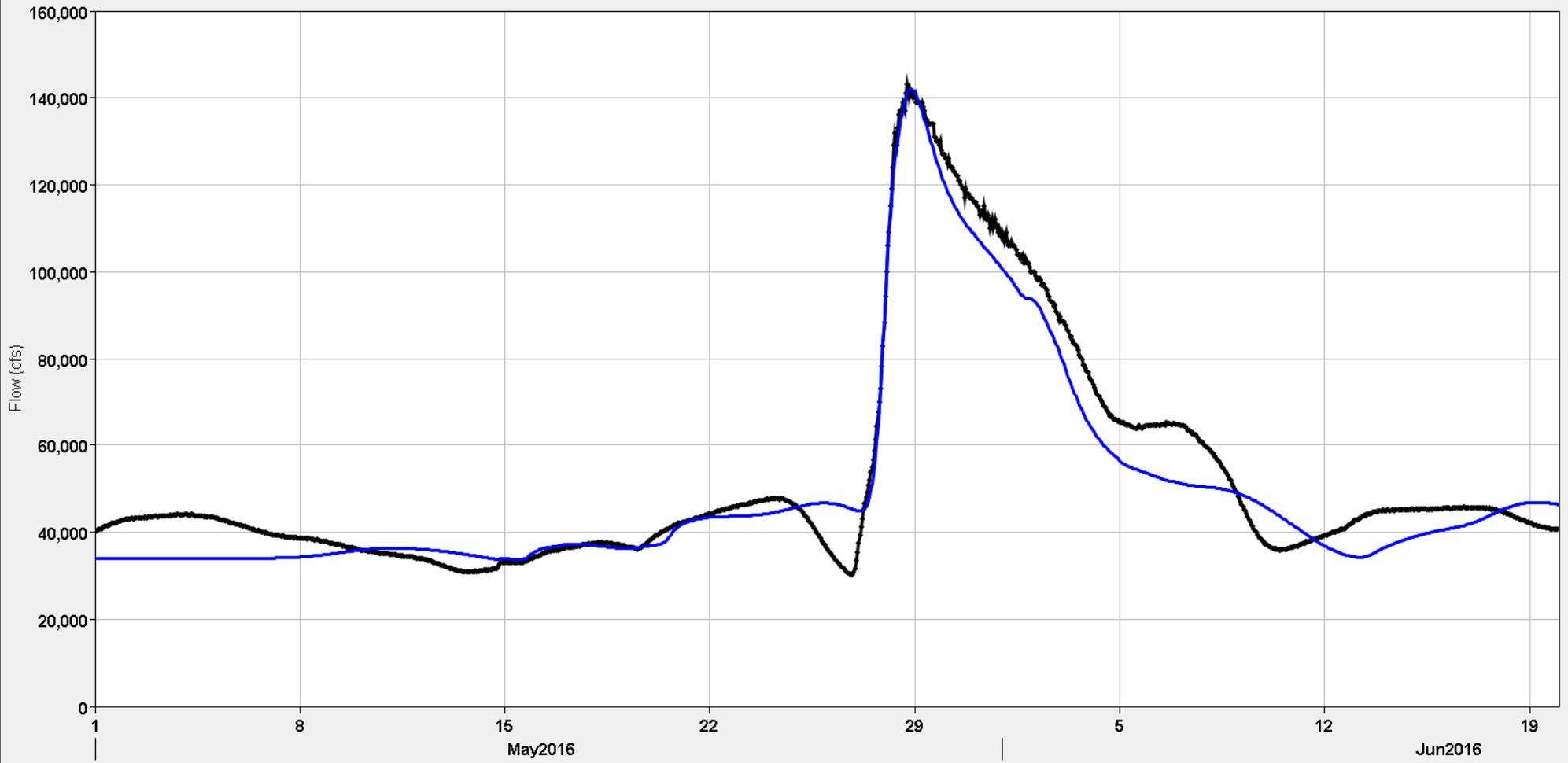
- * Austin County, TX
- * Located on FM 1458
- * Contributing Drainage Area = 44,670 sq mi
- * Gage Datum = 0 feet above NGVD88
- * Period of Record – August 2013 through Current Date
 - * 3 Years of Record



June 3, 2016 – FM 1458



SAN FELIPE GAGE RESULTS



Legend (Compute Time: 20Oct2016, 15:05:49)

— OBSERVED FLOW

— HMS OUTFLOW



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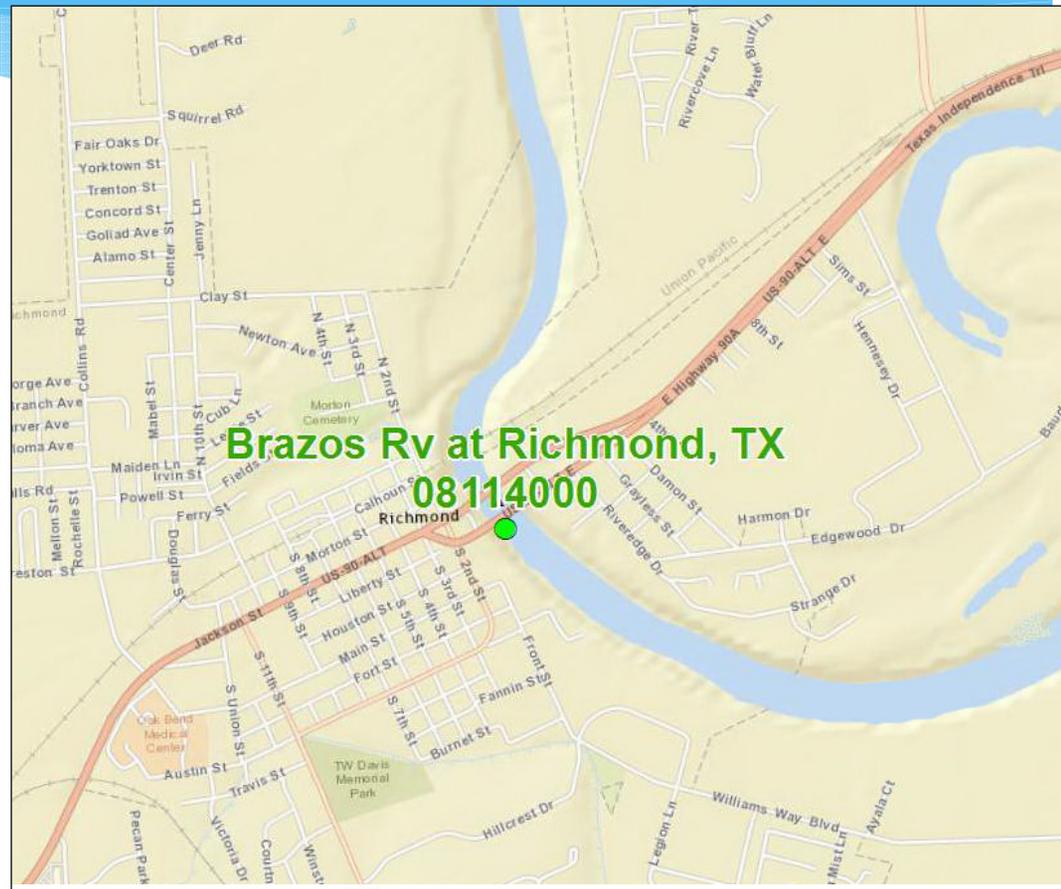
June 4

- 13:00 – Rosharon Gage Peaks at 112,000 cfs



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
 - * 94 Years of Record

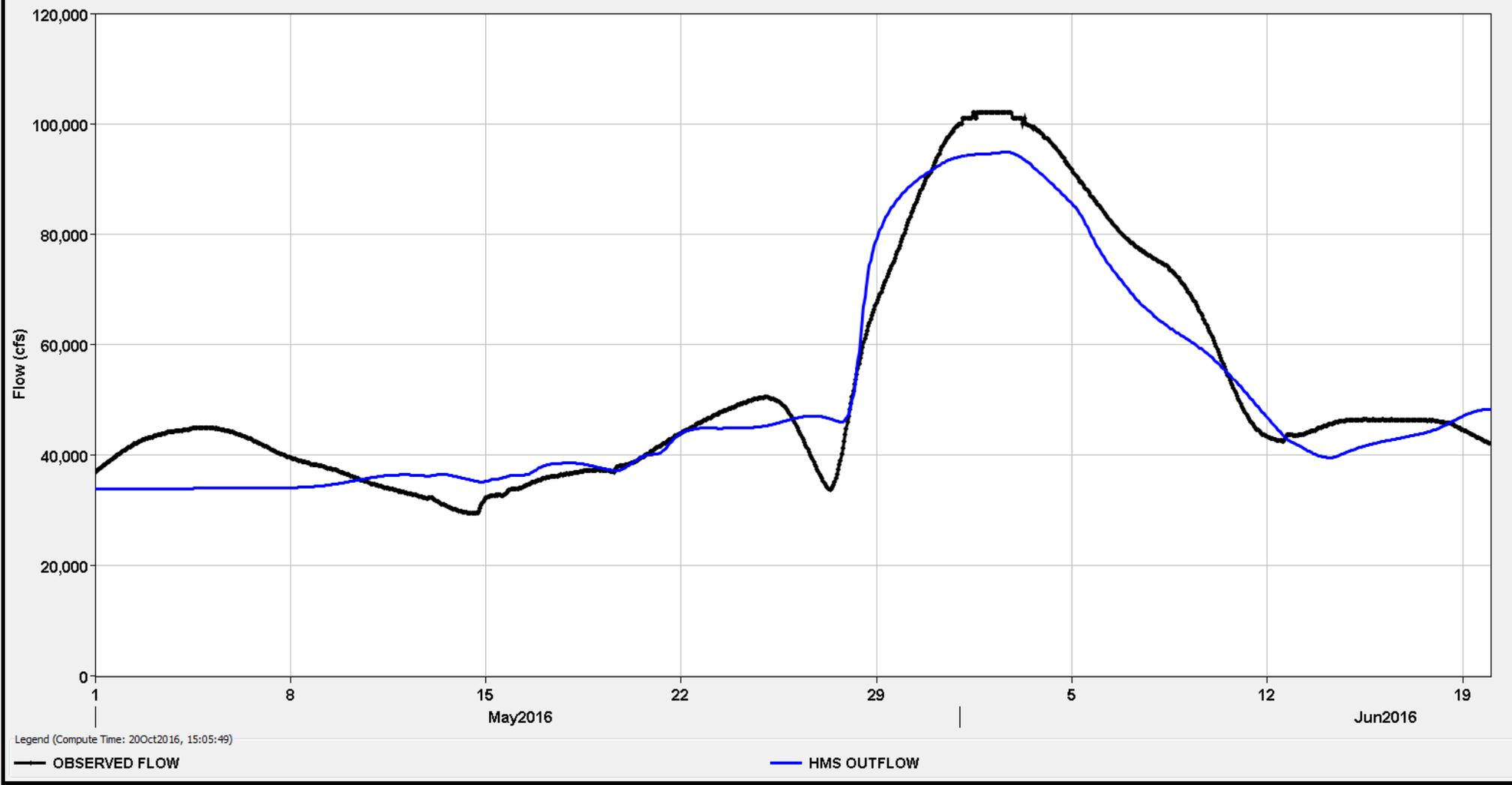


May 31, 2016 – US-90A



US 90 - Looking Upstream Along the Brazos Rv

2016 RICHMOND GAGE RESULTS



June 1, 2016 11:00-Richmond Gage

- * USGS @ US 90A
- * Gage Elevation
82.24-82.65 ft



Richmond Gage Comparison

May-June 2016 Storm Comparison

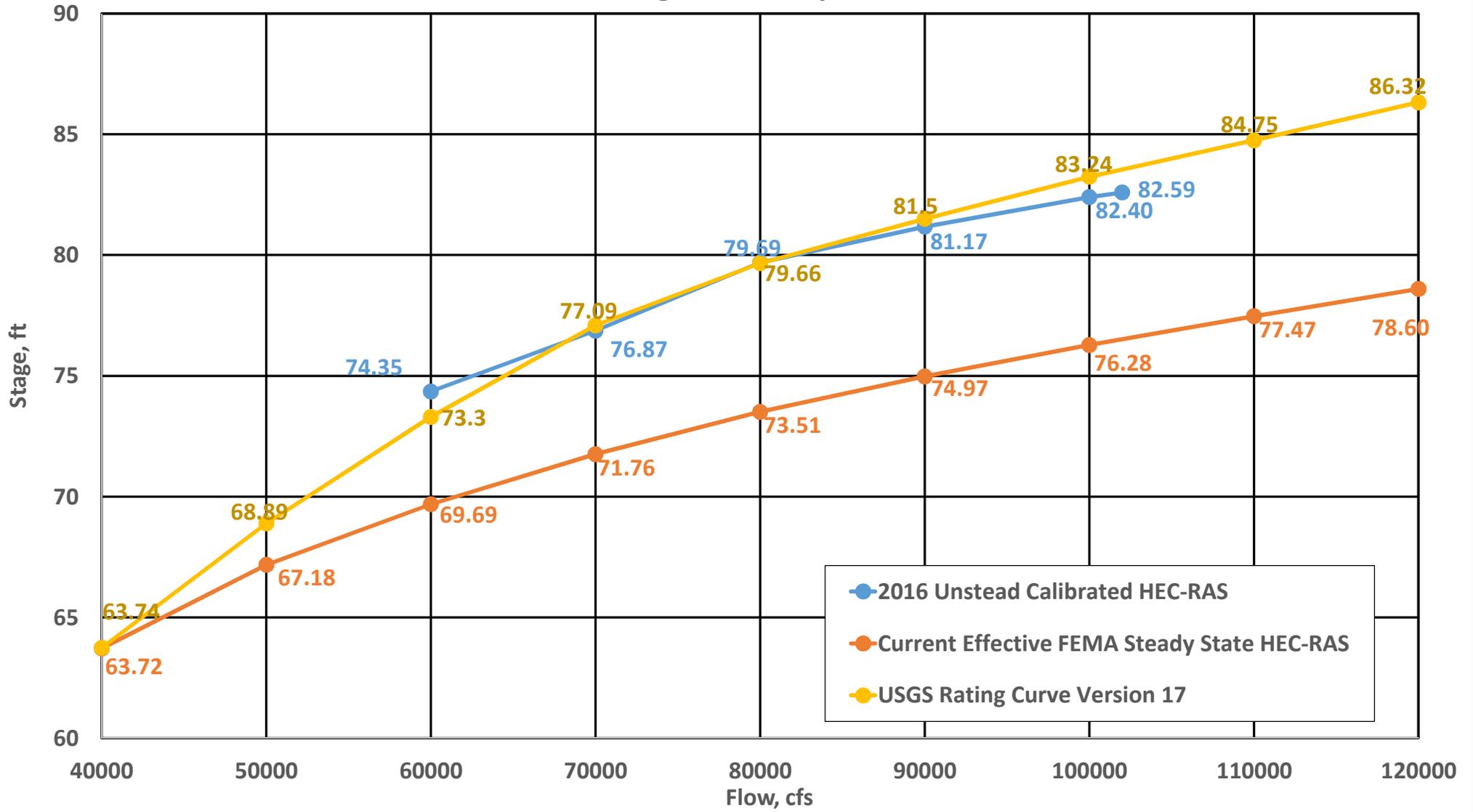
Description	May-June 2016 Event
USGS Peak Flow	102,000 cfs
2016 Calibrated HEC-HMS Model Flow	98,000 cfs
USGS Measured 2016 WSEL	82.64ft (54.7 ft+27.94 ft)
2016 Halff High Water Mark Survey	81.1 ft

Fort Bend Current Effective Hydraulic Model

Frequency	Flow CFS	WSEL ft
10YR (10% ACE)	103,000	76.65
50YR (2% ACE)	147,000	81.34
100YR (1% ACE)	164,000	82.81
500YR (0.2% ACE)	202,000	85.20

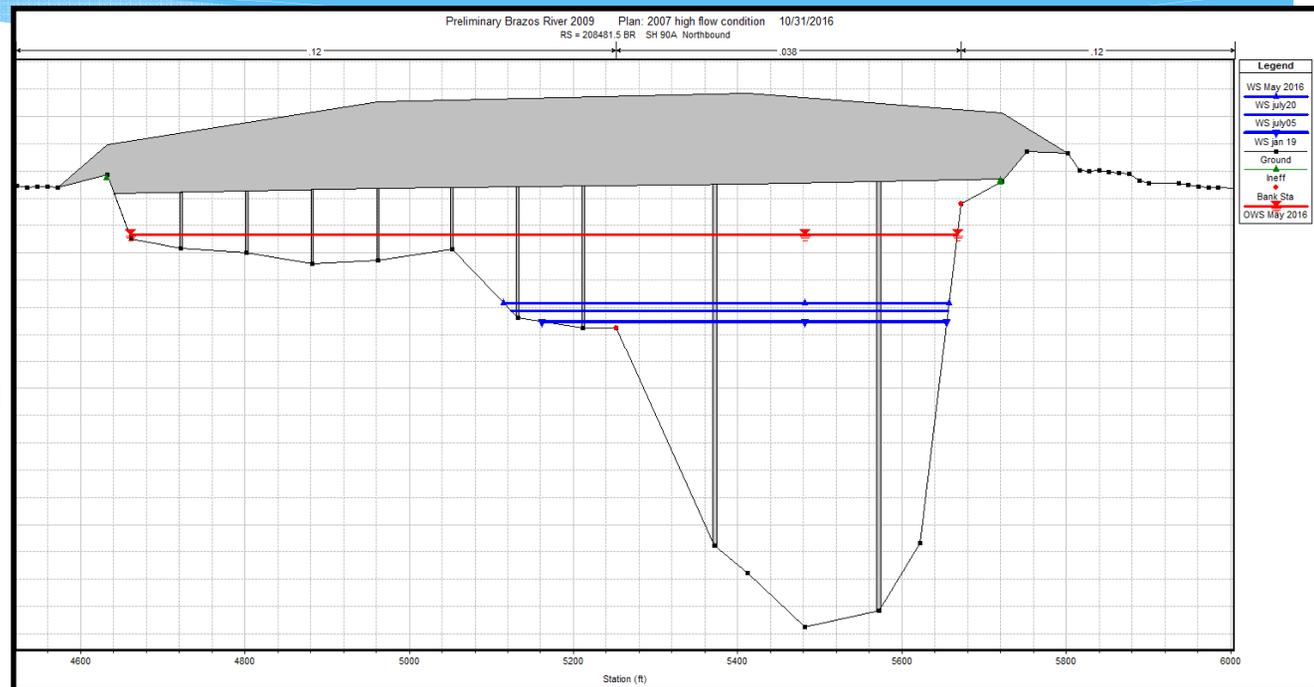


Rating Curve Comparison

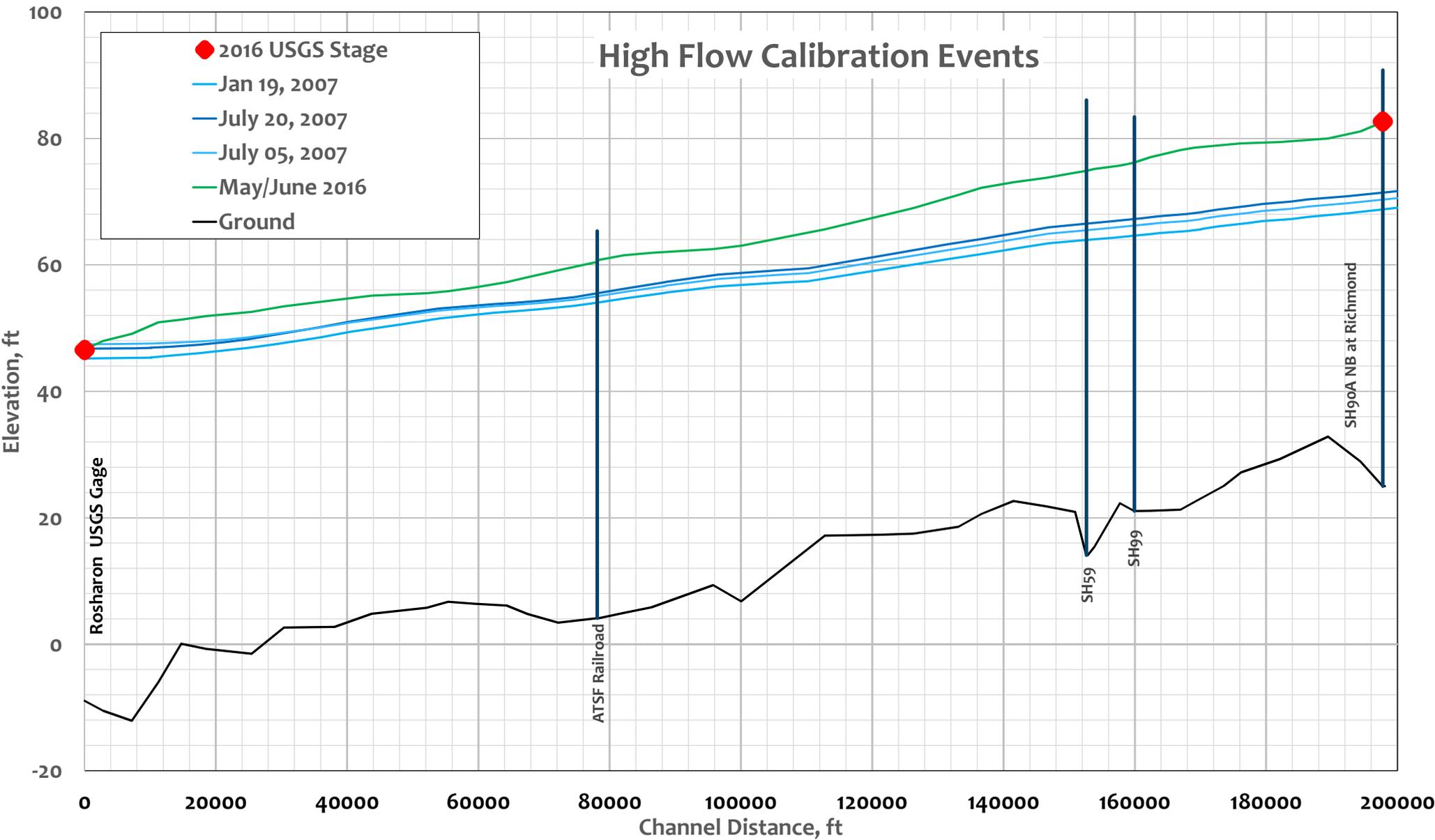


Steady State Mapping Assumptions

- * Overflow Areas
 - * Oyster Creek overflow
- * Downstream boundary condition from Brazoria Co. FIS for FEMA profiles
- * Low Flow Events Calibrate Well
- * Calibrated to 2007 High Flow Events
 - * July 20, 2007 = 72,100 cfs
 - * May-June 2016 Q = 102,000 cfs



High Flow Calibration Events



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June 4

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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 USGS Gage

- * Location: FM 1462 Fort Bend County
- * Gage Datum –
 - * USGS Website: 0.01 ft feet above NGVD29 (Adjusted)
 - * Channel Invert at gage: -8.93 ft
- * USGS Rating Curve computed on log/log scale
 - * Cannot have a negative datum
 - * Results in a 6-ft shift in reported data



June 1, 2016-Rosharon Gage

USGS Gage Elevation on 6/6/2016: 50.7-51.7 feet (46.6 feet with Datum Adjustment)



Drone footage along FM 1462 west of the Brazos River

June 6, 2016-Rosharon Gage

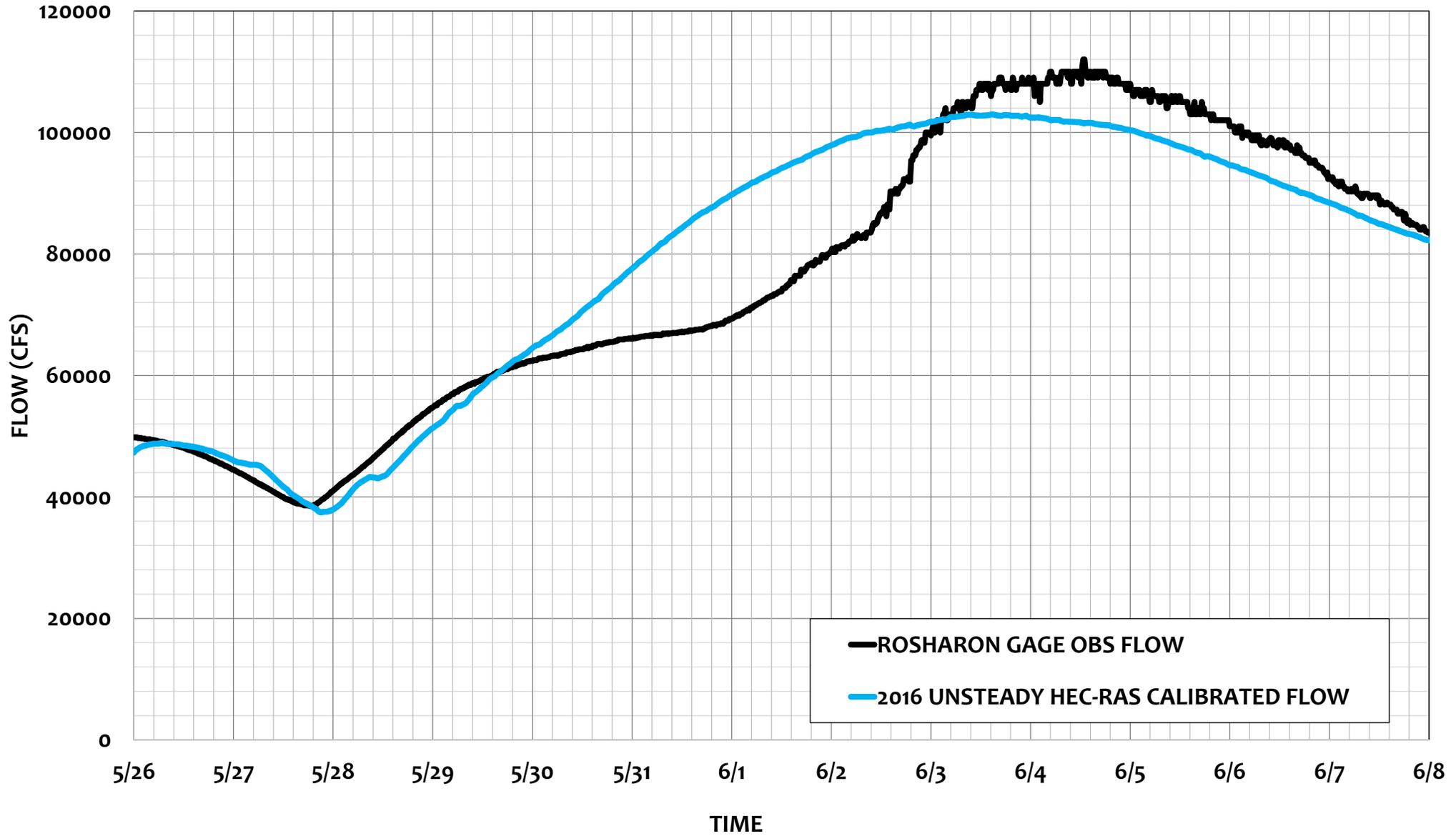
Along FM 1462 East of Brazos River near Majestic Oak Dr.

Picture taken on 6/6/2016 @ 15:00

Gage Elevation on 6/6/2016: 52.5 feet (46.25 feet with Datum Adjustment)



5/24/2016 - 6/16/2016 ROSHARON USGS GAGE
CALIBRATED HEC-RAS OBSERVED FLOW VERSUS COMPUTED FLOW



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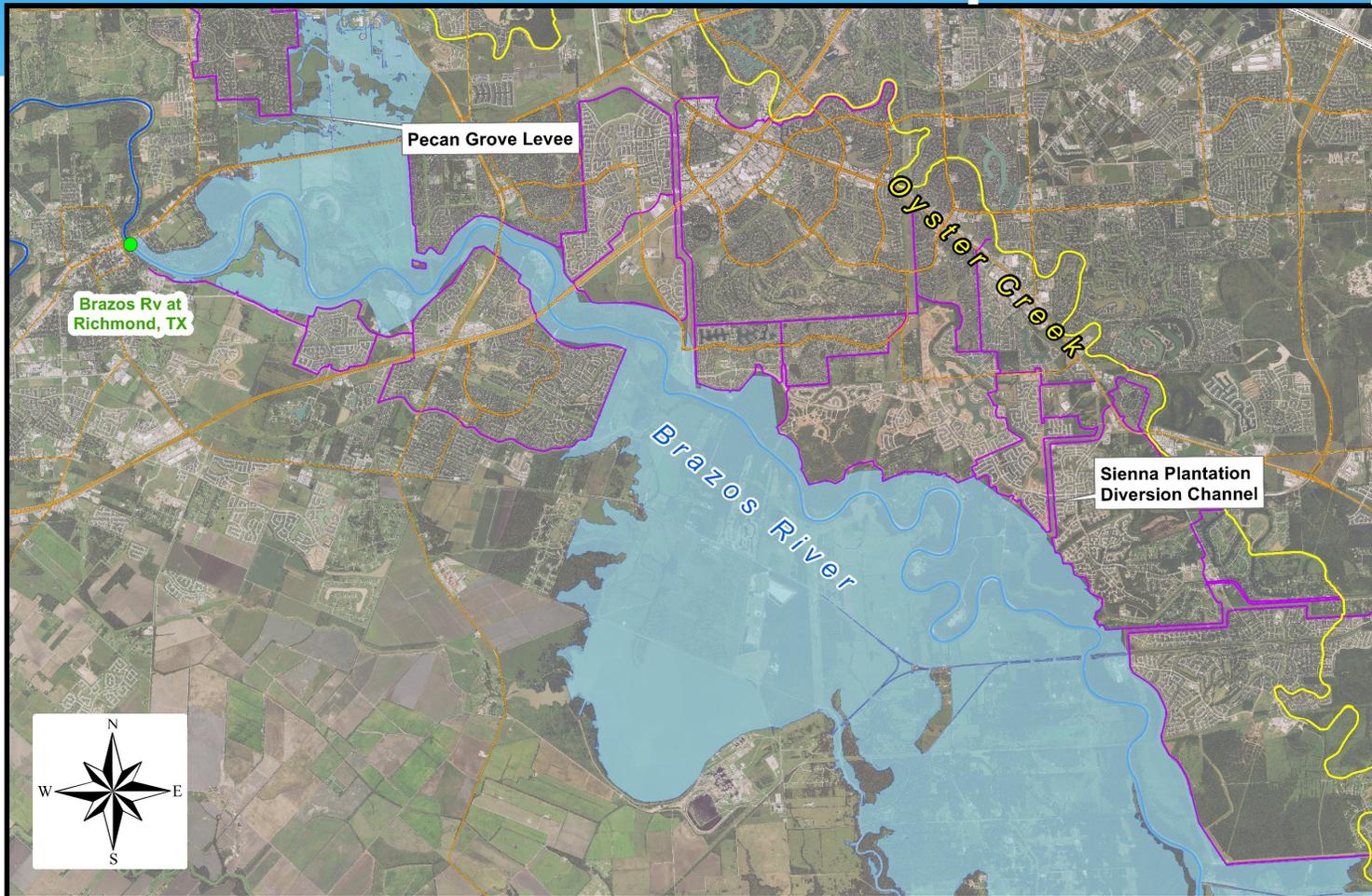
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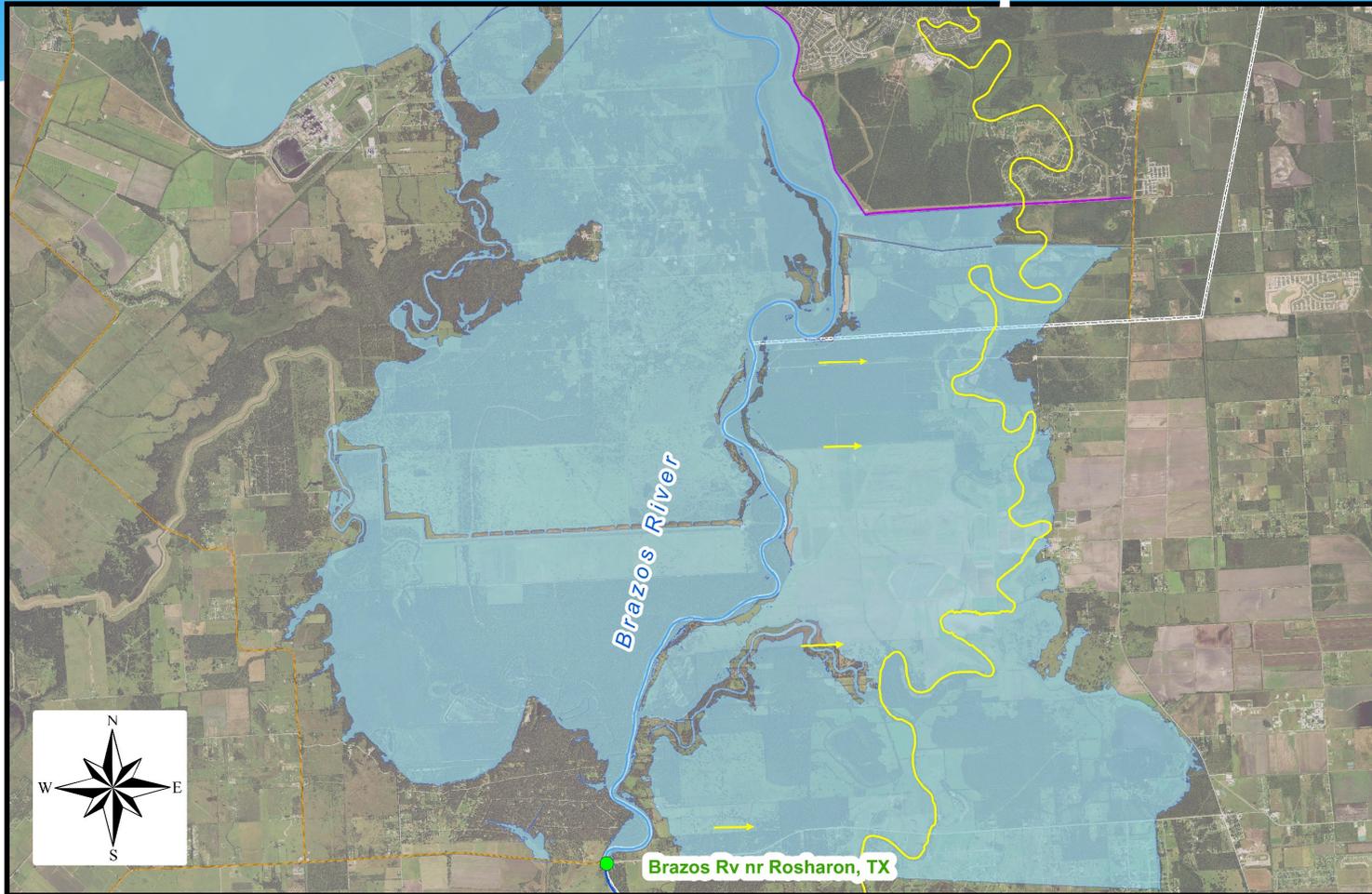
Fort Bend 2016 Floodplain Map



**Preliminary
Results**



Fort Bend 2016 Floodplain Map

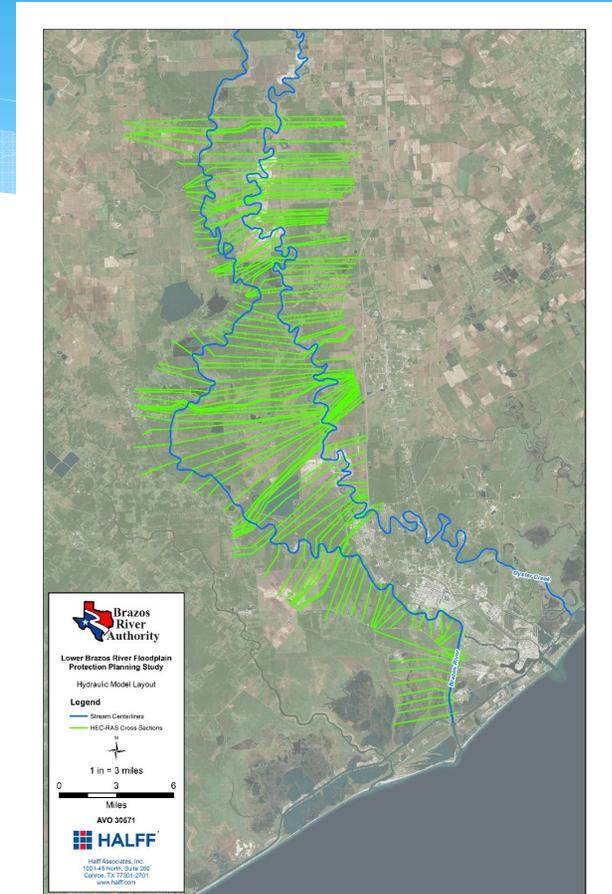


Preliminary
Results

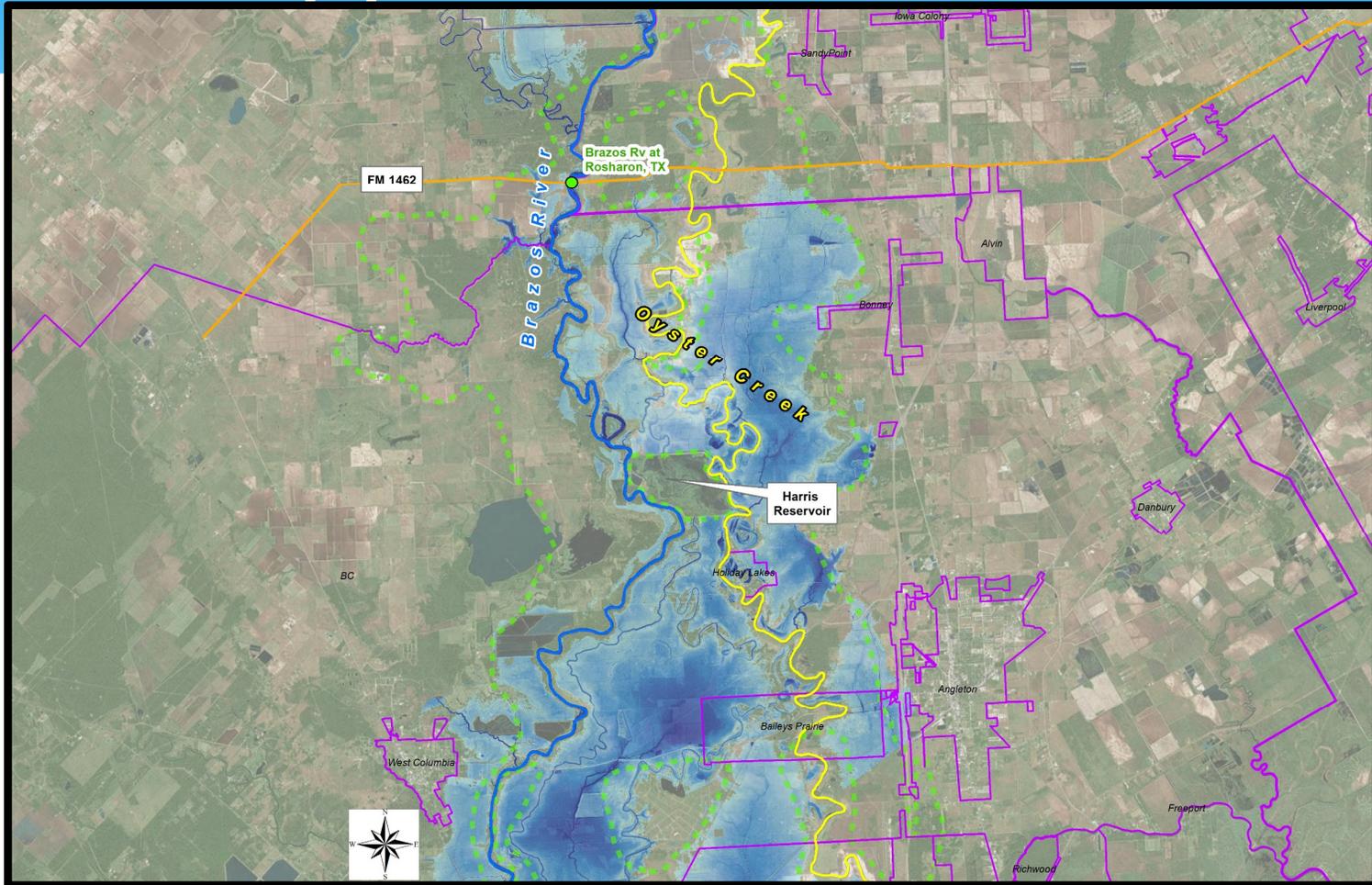


Brazoria Unsteady HEC-RAS

- * Developed the Hydraulic Model
 - * Model Cross Sections
 - * Updated terrain data with survey data
 - * Develop simulations with 1992, 2015 and 2016 flows
 - * Developed inundation mapping
 - * Continue calibration of model



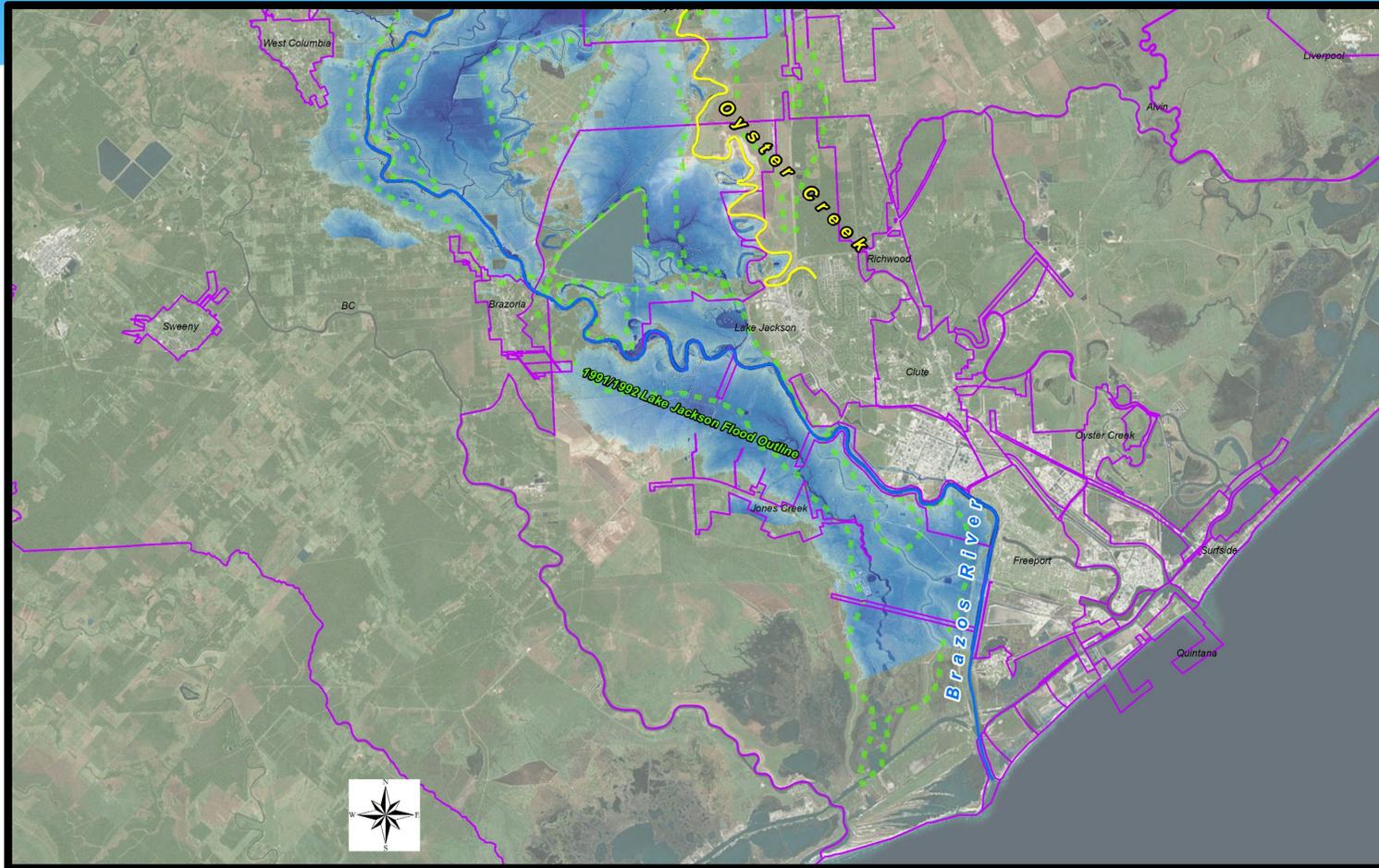
Upper Brazoria 1992



Preliminary
Results



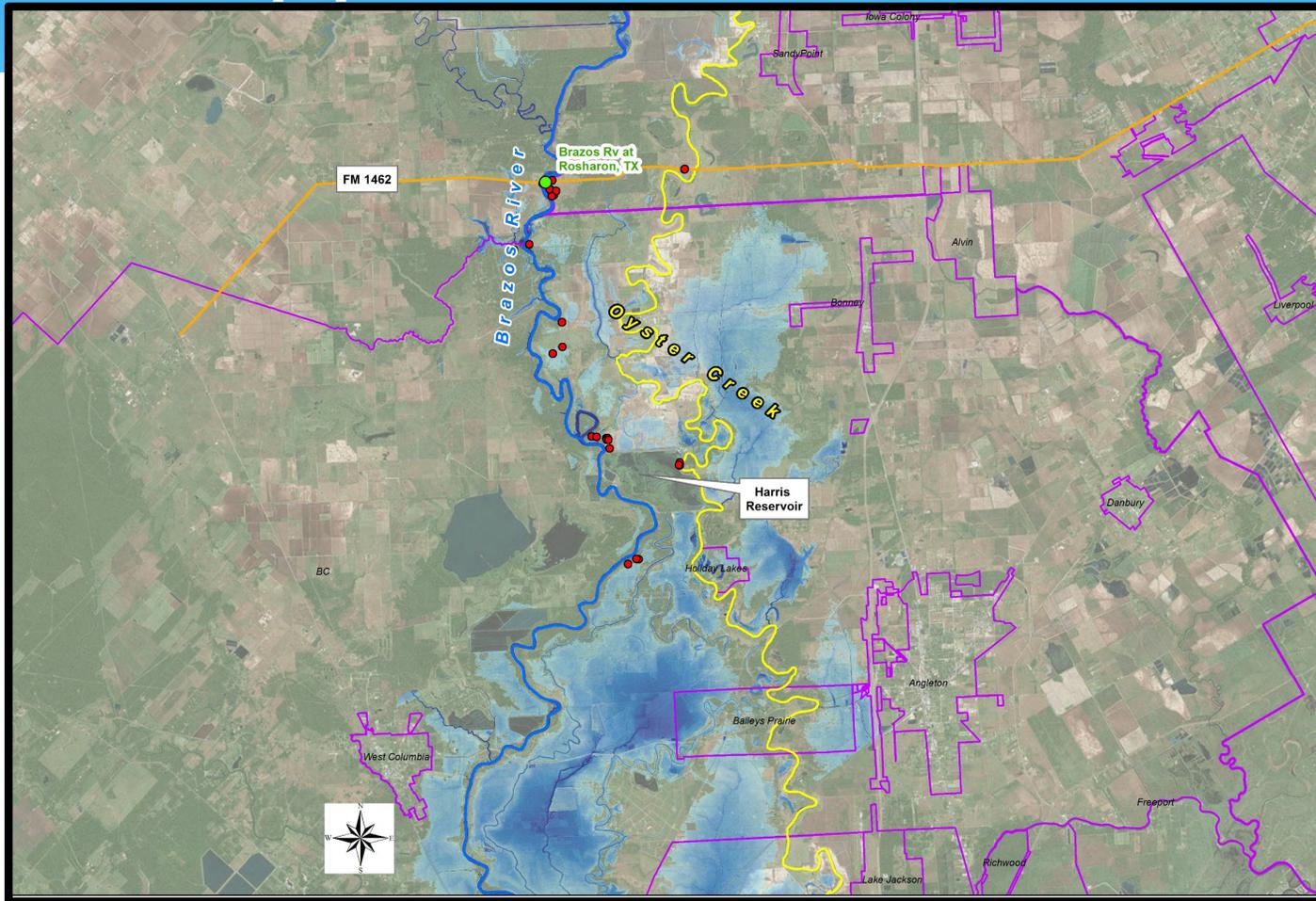
Lower Brazoria 1992



Preliminary
Results



Upper Brazoria 2015



Preliminary
Results



Upper Brazoria 2015



Photo provided by Steve Rosa



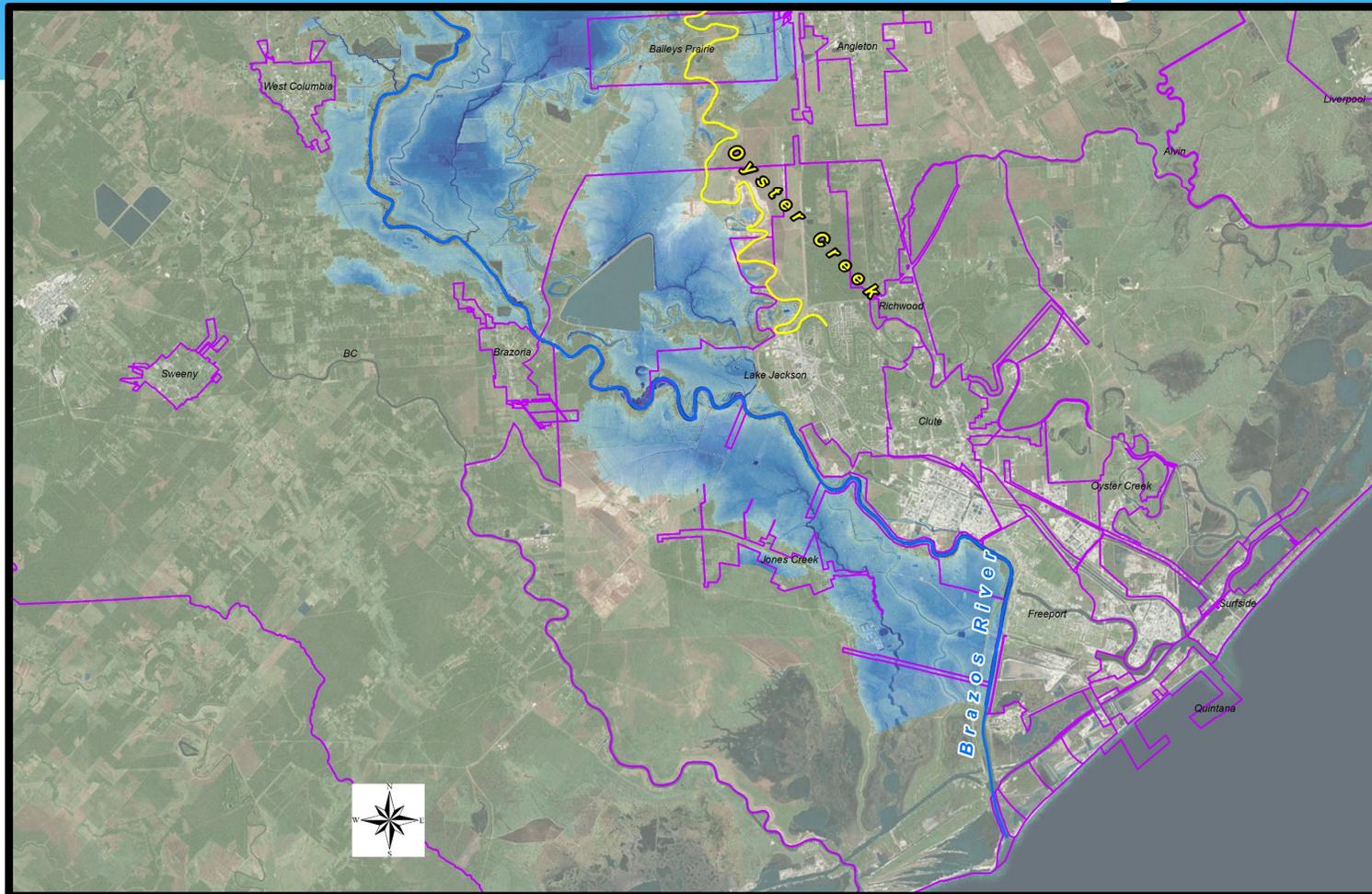
Upper Brazoria 2015



Photo provided by Steve Rosa



Lower Brazoria 2015

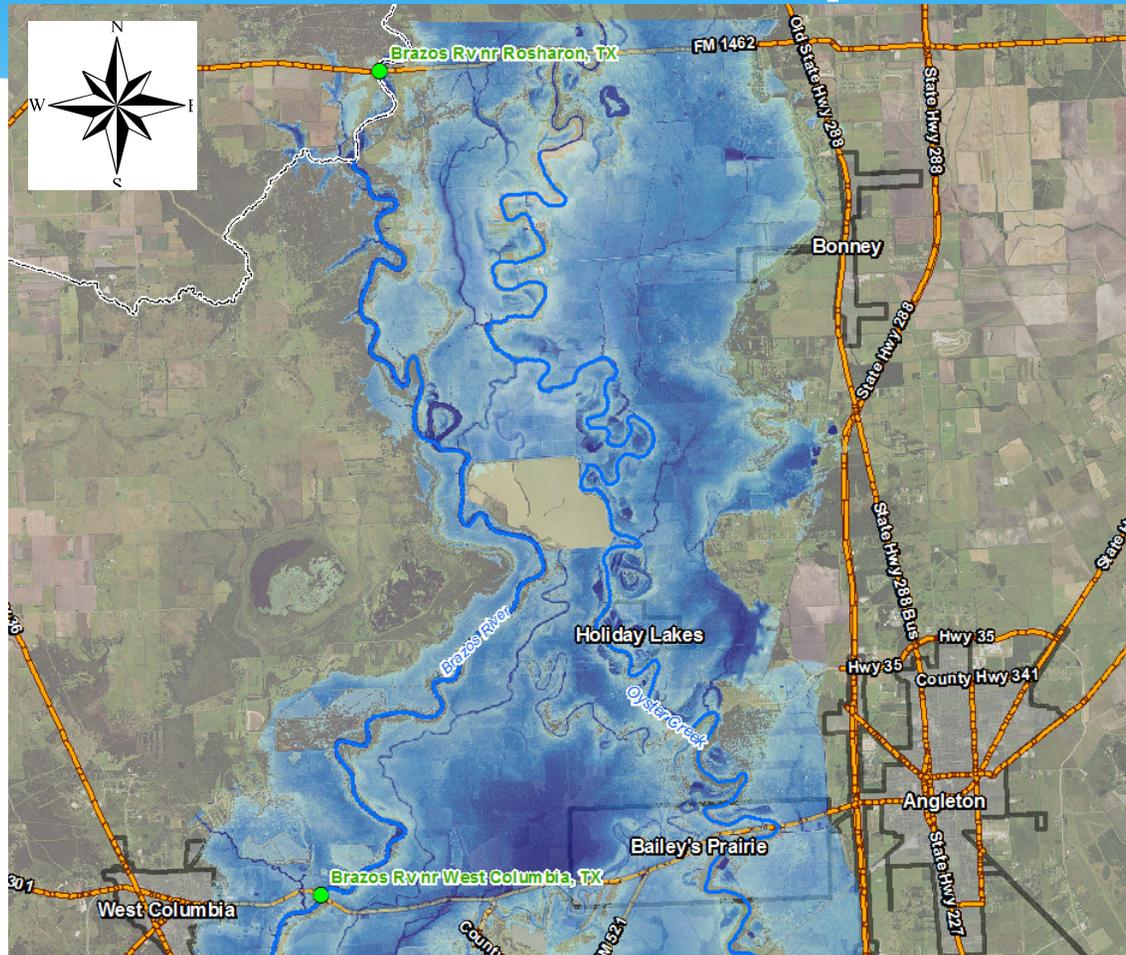


**Preliminary
Results**



Brazoria 2016 Floodplain Map

**Preliminary
Results**

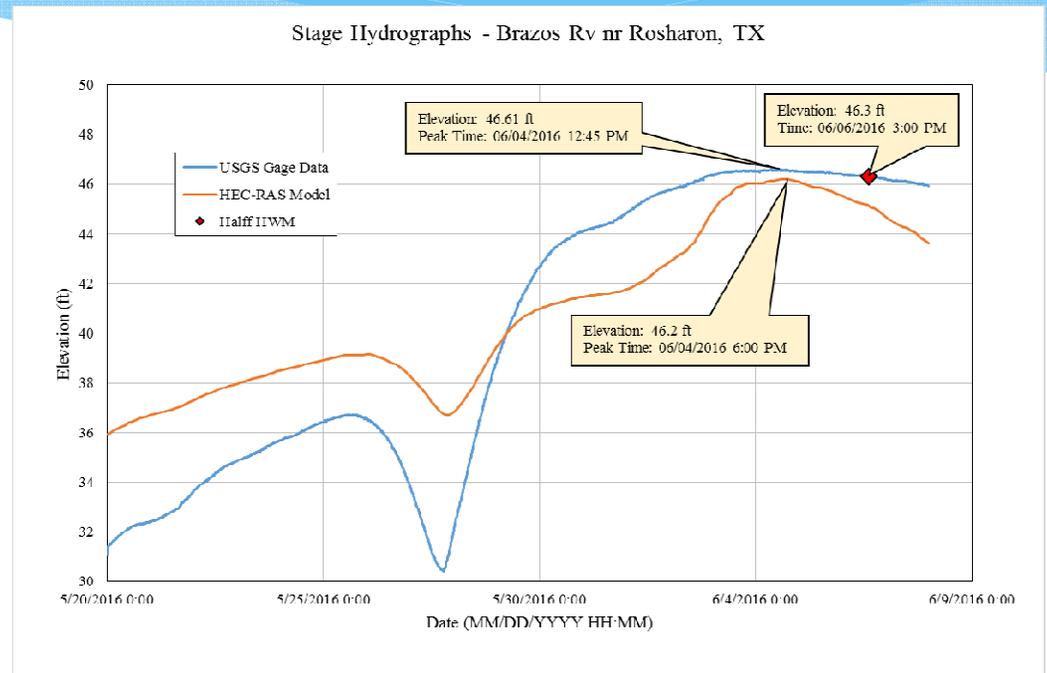


Brazoria 2016 Floodplain Map

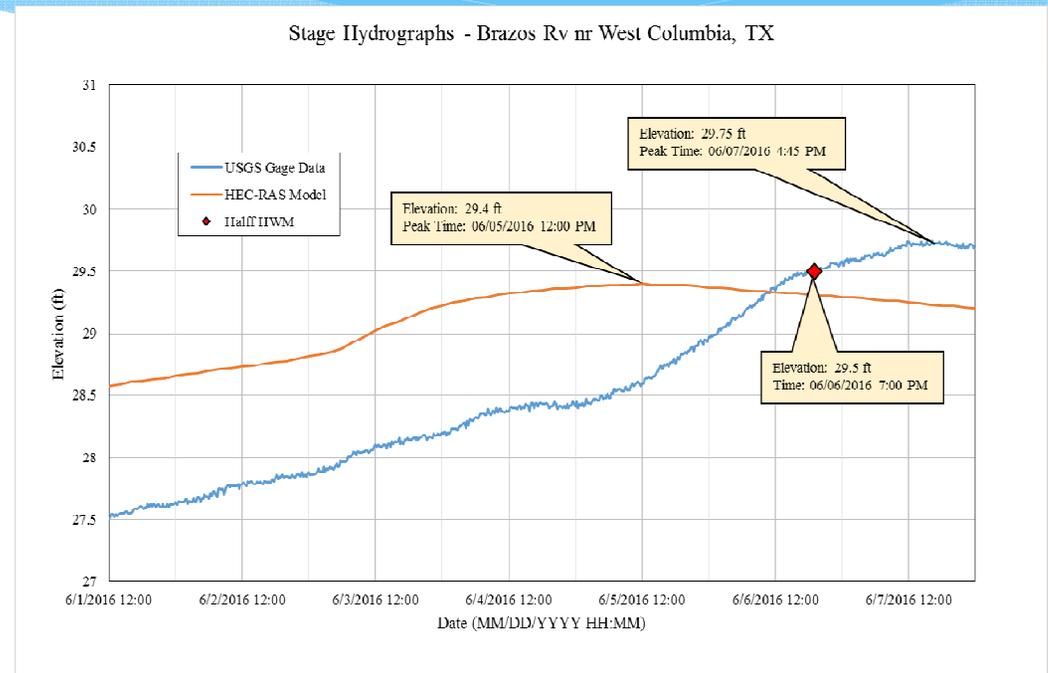
**Preliminary
Results**



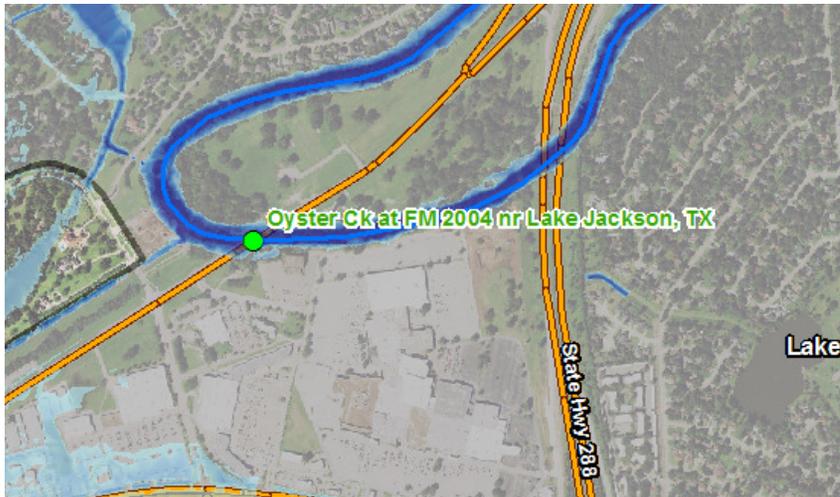
Brazoria 2016 Stage Hydrograph Comparisons



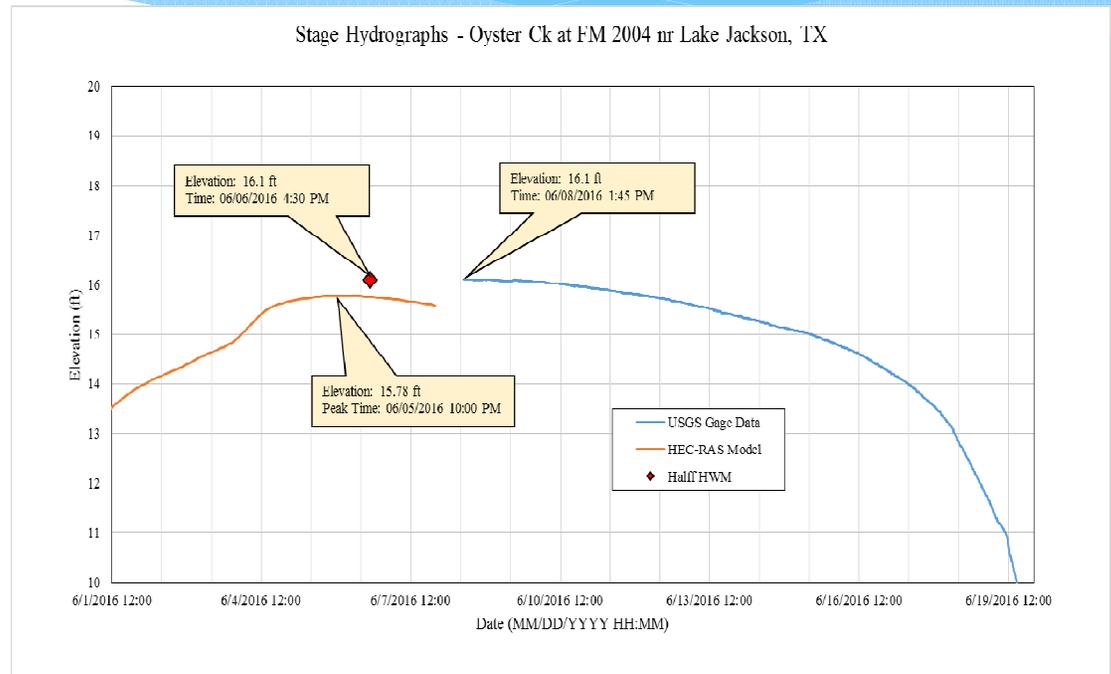
Brazoria 2016 Stage Hydrograph Comparisons



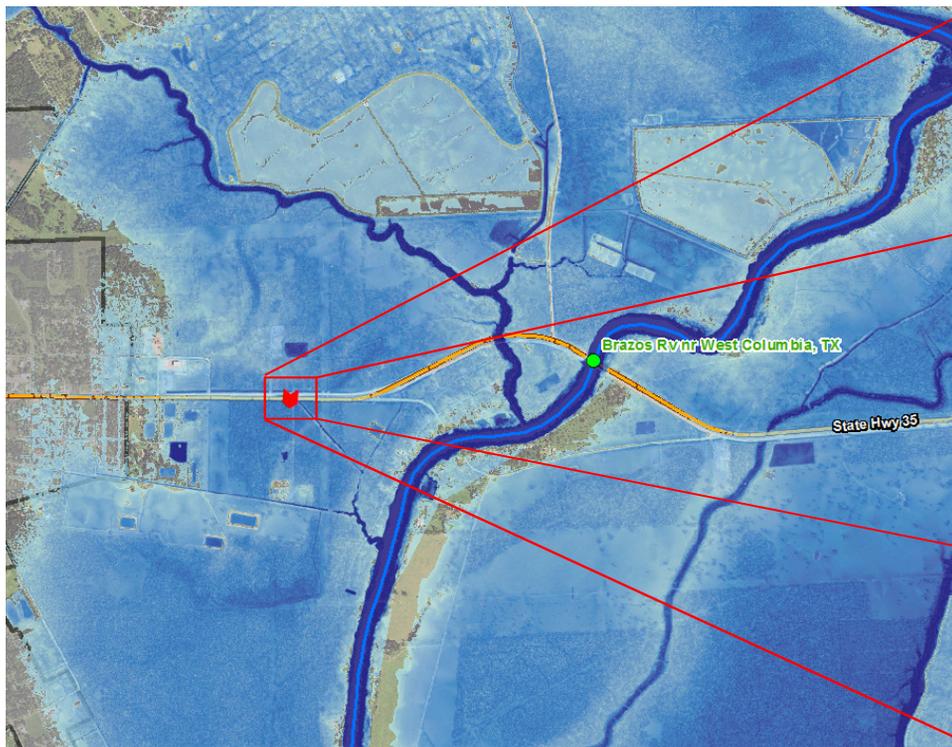
Brazoria 2016 Stage Hydrograph Comparisons



Stage Hydrographs - Oyster Ck at FM 2004 nr Lake Jackson, TX



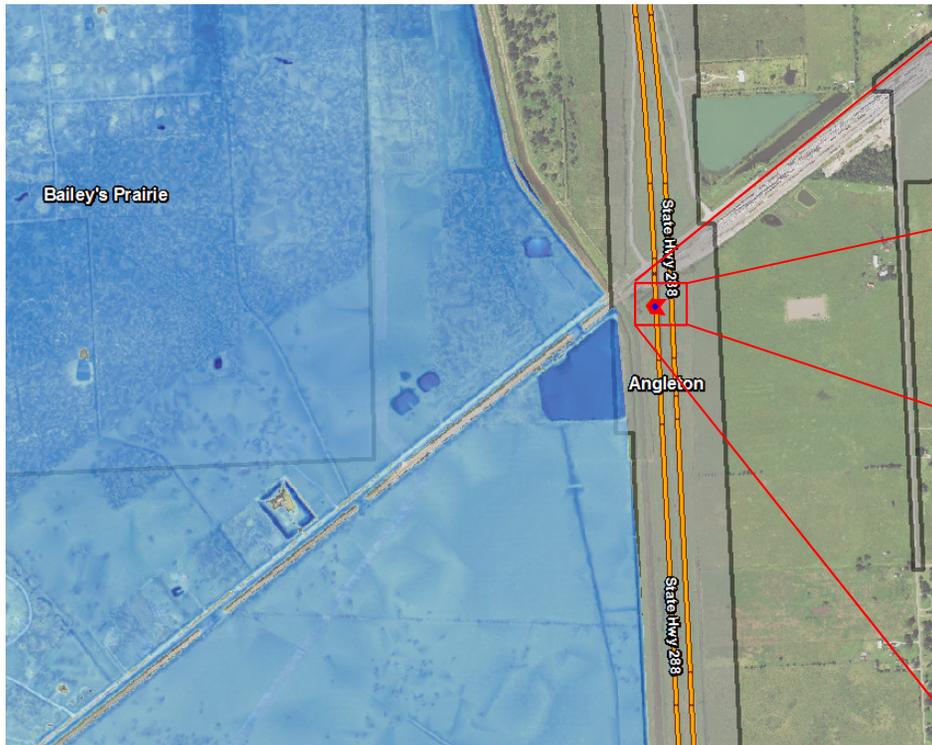
Brazoria 2016 Photo Comparisons



Brazoria 2016 Photo Comparisons

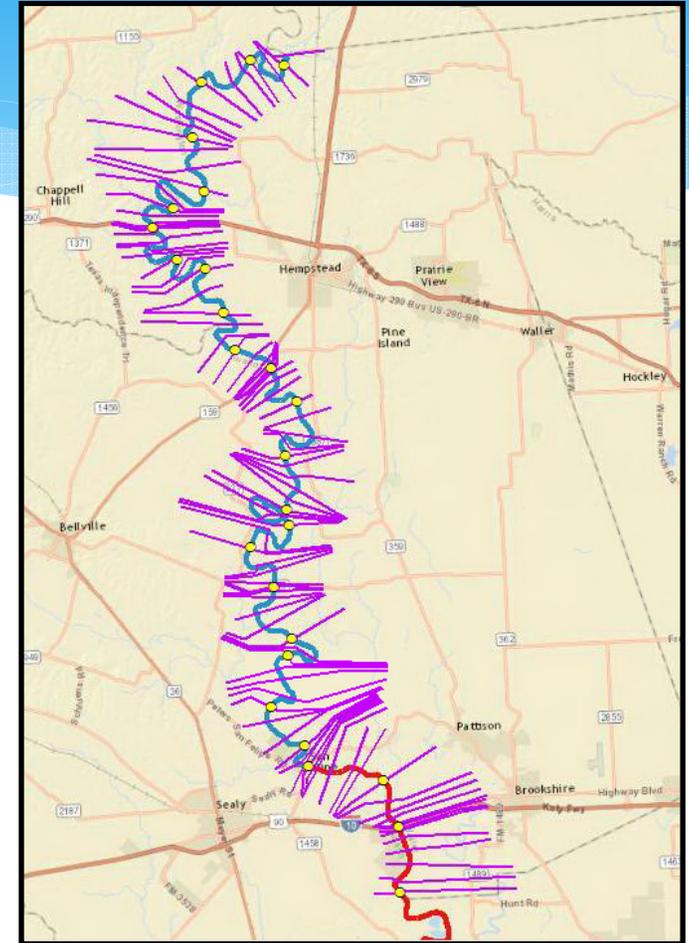


Brazoria 2016 Photo Comparisons



Austin/Waller Co. Hydraulic Models

- * Survey completed Oct 2016
 - * 5 Bridge Surveys
 - * 21 Cross Section Surveys
 - * Sonar through channel
- * Preliminary hydraulic modeling is underway



Next Steps

- * Complete development of the unsteady HEC-RAS model through Austin/Waller Counties
- * Calibrate HEC-RAS model through Austin/Waller Counties with May-June 2016, 2015, 2013, 2010, 2007, 2002, 1998, 1991
- * Route frequency flow hydrographs along main stem with unsteady HEC-RAS model
- * Finalize main stem frequency flows and WSELs (baseline conditions) from above Hempstead to Gulf of Mexico



Questions?