LOWER BRAZOS RIVER FLOODPLAIN PROTECTION PLANNING STUDY

Hempstead, Texas

March 15, 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

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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

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Lower Brazos River Floodplain Protection Planning Study
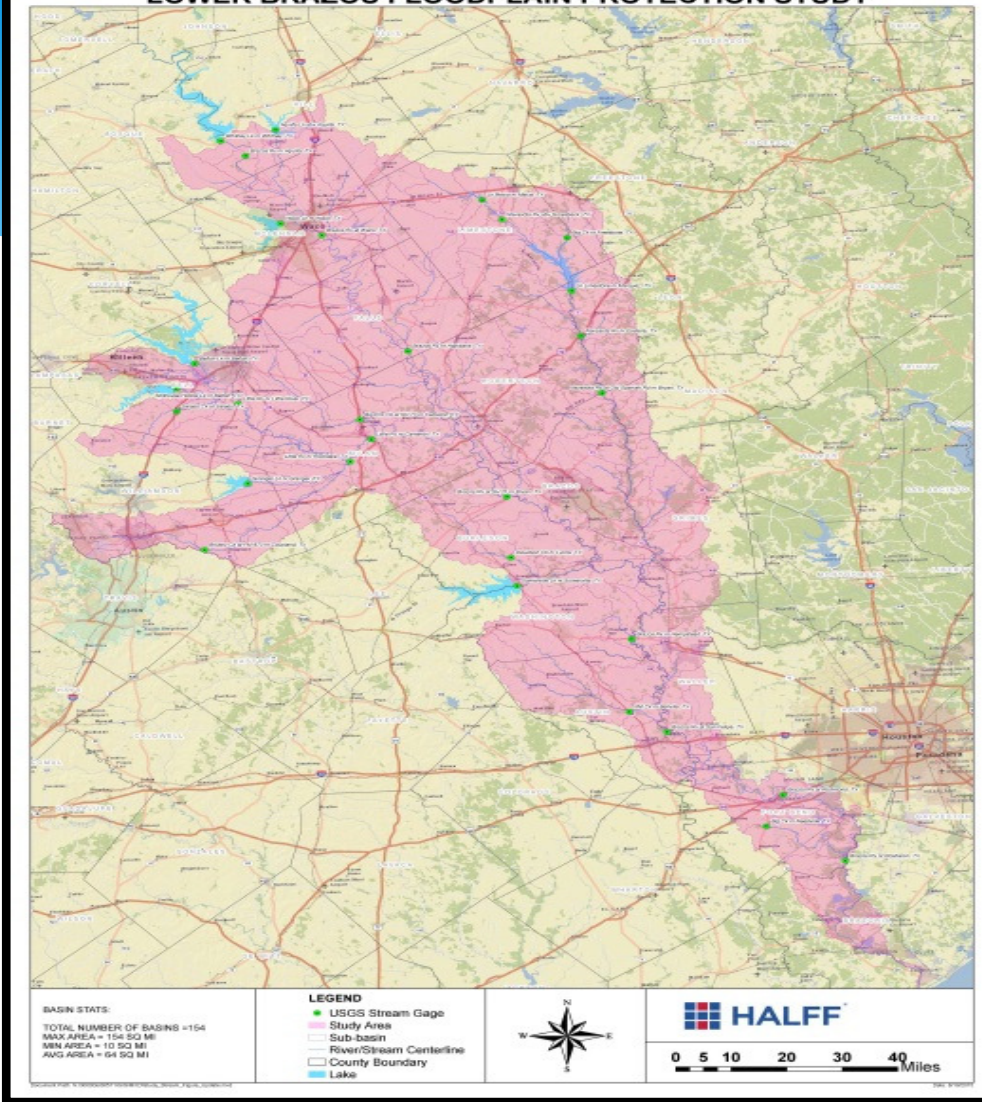
Where are We Today?

* 15 months into Phase I
* Phase II contract pending
* Combine Phase I and Phase II into a single project moving forward with 1 final report
* Basinwide hydrology is 95% complete (Nov. 2015 Meeting)
* Hydraulics are in progress for Fort Bend and Brazoria Counties

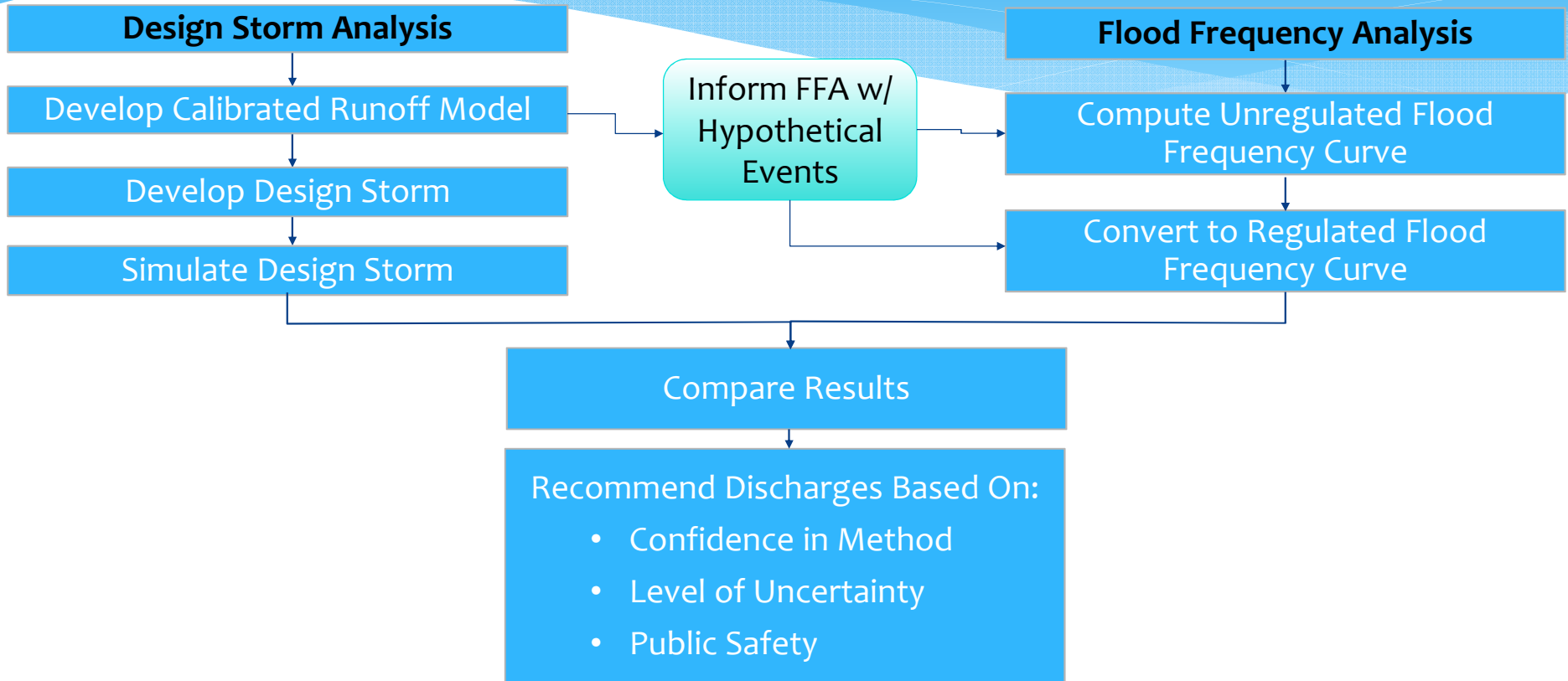Lower Brazos River Floodplain Protection Planning Study

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Schedule

* Phase II Field Surveys – May 2016
* Phase II Terrain Development – June 2016
* Finalize Hydrology – October 2016
* Hydraulics – March 2017
* Alternatives Formulation – August 2017
* Flood Damage Analysis Modeling – November 2017
* Environmental Constraints Analysis – January 2018
* Draft Report – January 2018
* Final Report – March 2018

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Hydrologic Modeling Update

Hydrologic Modeling Methodology

Design Storm Analysis

- Develop Calibrated Runoff Model
- Develop Design Storm
- Simulate Design Storm

Inform FFA w/ Hypothetical Events

Flood Frequency Analysis

- Compute Unregulated Flood Frequency Curve
- Convert to Regulated Flood Frequency Curve

Compare Results

Recommend Discharges Based On:
- Confidence in Method
- Level of Uncertainty
- Public Safety

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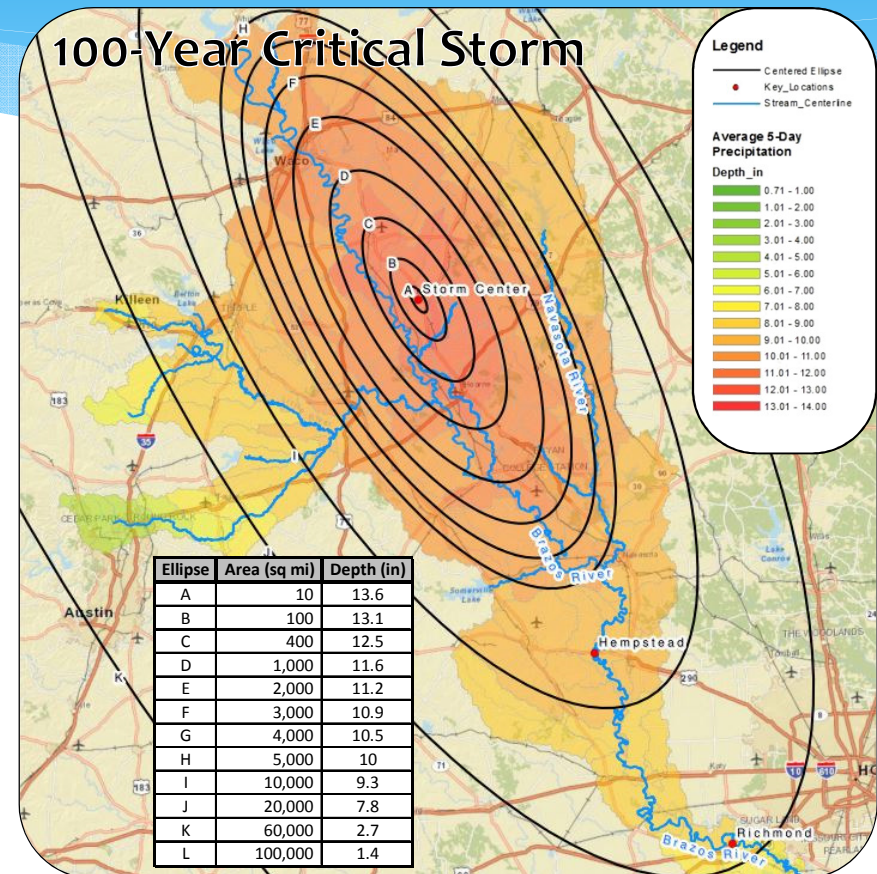# Hydrologic Model

* Base HEC-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)
* Extensive Calibration
  * 17 Calibration Zones
  * 8 Calibration Storms
  * UH and Routing Parameters

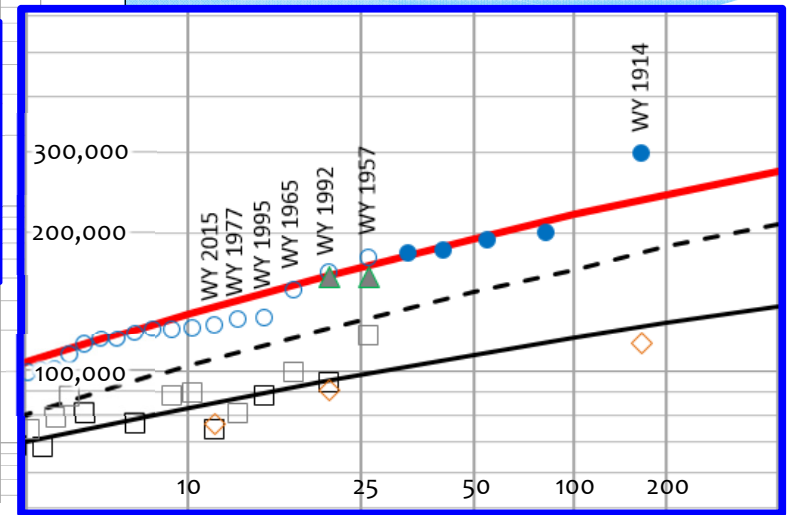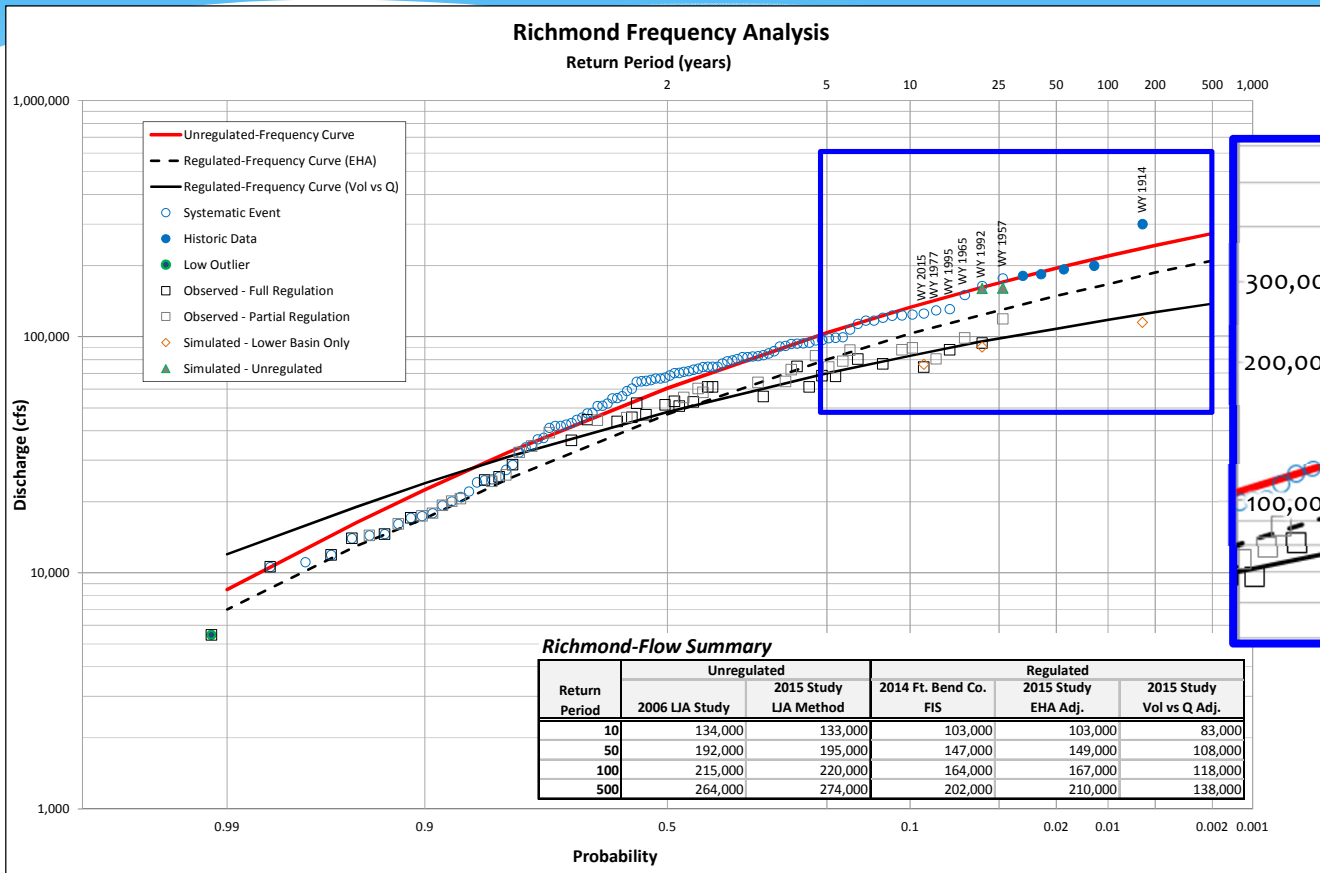Brazos River Authority

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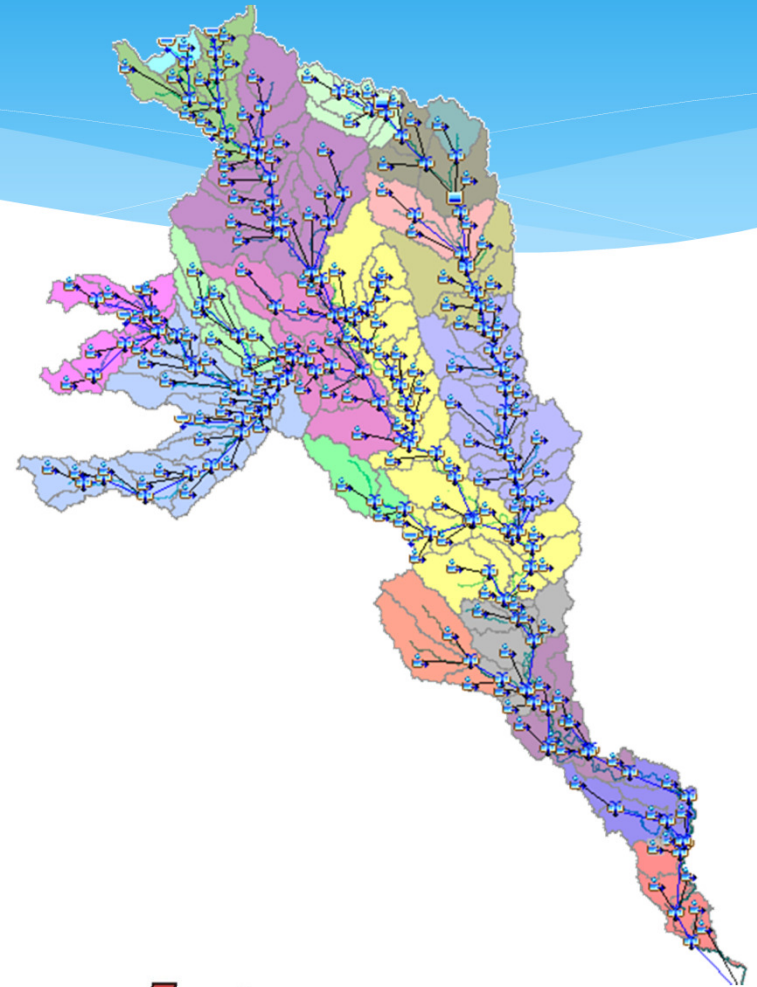
Design Storm Analysis

* **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"

100-Year Critical Storm

Legend
- Centered Ellipse
- Key_Locations
- Stream_Centerline

Average 5-Day Precipitation
Depth_in
- 0.71 – 1.00
- 1.01 – 2.00
- 2.01 – 3.00
- 3.01 – 4.00
- 4.01 – 5.00
- 5.01 – 6.00
- 6.01 – 7.00
- 7.01 – 8.00
- 8.01 – 9.00
- 9.01 – 10.00
- 10.01 – 11.00
- 11.01 – 12.00
- 12.01 – 13.00
- 13.01 – 14.00

Ellipse	Area (sq mi)	Depth (in)
A	10	13.6
B	100	13.1
C	400	12.5
D	1,000	11.6
E	2,000	11.2
F	3,000	10.9
G	4,000	10.5
H	5,000	10
I	10,000	9.3
J	20,000	7.8
K	60,000	2.7
L	100,000	1.4

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Flood Frequency Analysis

Richmond Frequency Analysis

Richmond-Flow Summary

Return Period	Unregulated		Regulated		
	2006 LJA Study	2015 Study LJA Method	2014 Ft. Bend Co. FIS	2015 Study EHA Adj.	2015 Study Vol vs Q Adj.
10	134,000	133,000	103,000	103,000	83,000
50	192,000	195,000	147,000	149,000	108,000
100	215,000	220,000	164,000	167,000	118,000
500	264,000	274,000	202,000	210,000	138,000

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Conclusions

Return Period	2009 Waller Co. FIS Hempstead Discharge (cfs)	2015 Study Hempstead Discharge (cfs)	2014 Ft. Bend Co. FIS Richmond Discharge (cfs)	2015 Study Richmond Discharge (cfs)
10-year	110,000	**107,000** (-3,000, -3%)	103,000	**86,000** (-17,000, -17%)
50-year	182,473	**148,000** (-34,473, -19%)	147,000	**122,000** (-25,000, -17%)
100-year	206,962	**170,000** (-36,962, -18%)	164,000	**139,000** (-25,000, -15%)
500-year	260,000	**223,000** (-37,000, -14%)	202,000	**178,000** (-24,000, -12%)

Reasons for the Changes

* Routing

* Additional analyses in 2015 (design storm and gauge frequency analysis)

* 1984 conversion of unregulated to regulated discharges for the frequency analysis

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Hydraulic Modeling Update

Phase I & II Study Limits

* Hydrology Calibration Updates
  * Phase I
    * Richmond to Rosharon
   * Hempstead to San Felipe
  * Phase II
    * San Felipe to Richmond

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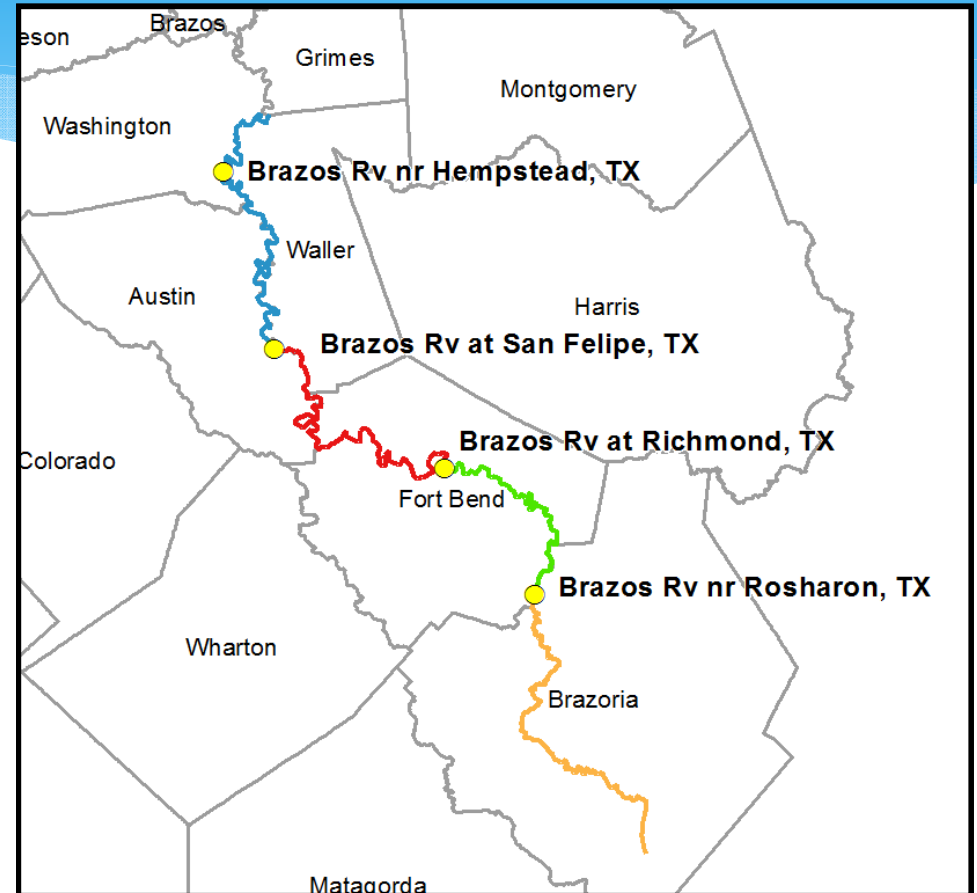
Fort Bend Unsteady HEC-RAS

* Incorporate the Fort Bend 2015 HEC-RAS FIS Model
  * Reviewed the steady state model
  * Converted from steady state to unsteady model
  * Calibrate to the 1991, 1998, 2007, 2010, 2013, and 2015 storm event from Richmond to Rosharon USGS Gages
    * Phase II will calibrate section in Fort Bend County from San Felipe to Richmond USGS Gages

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Fort Bend Steady State Mapping Issues

* Overflow at US 90A and FM 359 to Pecan Grove Levee

* Overflow from Fort Bend and Brazoria County Line at the South Texas Water Company Canal to the confluence location between Cow Creek and Brazos River

* Brazos River and Oyster Creek overflow at Flat Bank Creek and Sienna Plantation Diversion Channel
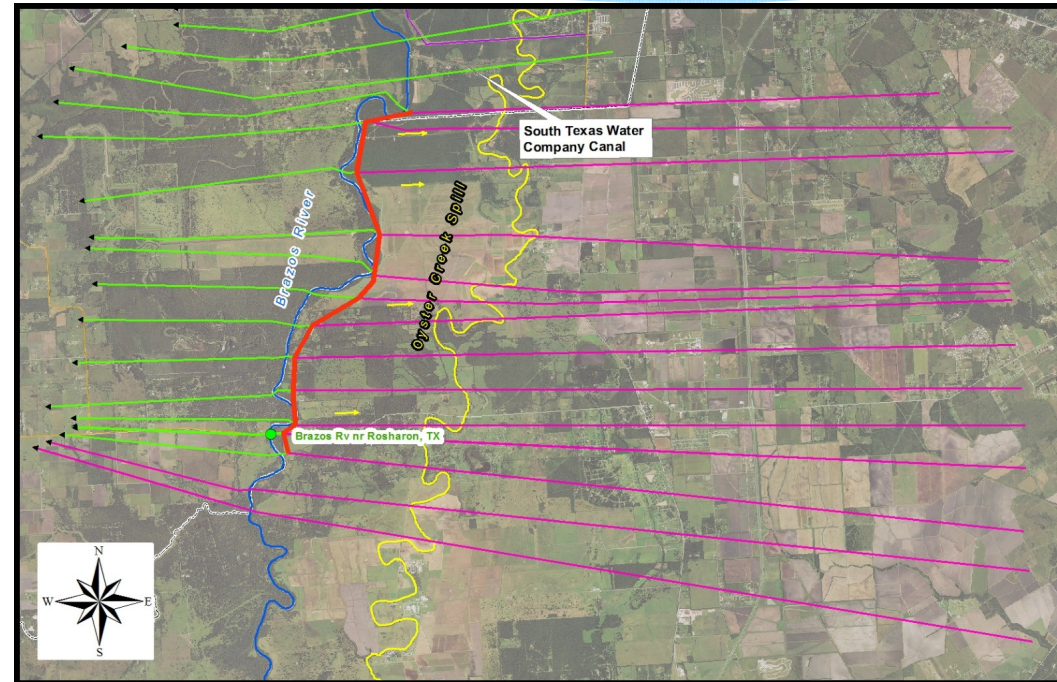
HEC-RAS Unsteady Calibration

* Calibration involved adjusting the following parameters:
  * Channel Manning's "n" Roughness Coefficient
  * Overbank Manning's "n" Roughness Coefficient
  * Lateral Weir Adjustments (mainly for large flow events)
    * Adjust weir coefficients

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Low Flow Calibration Events

* 4 Low Flow Events that are generally within the channel banks
    * October 17, 1998 to November 1, 1998
    * June 19, 2007 to July 31, 2007 (HW Marks at 8 Locations)
    * September 1, 2010 to October 9, 2010
    * October 12, 2013 to November 21, 2013

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6/19/2007 - 7/31/2007 ROSHARON USGS GAGE
OBSERVED FLOW VERSUS COMPUTED FLOW

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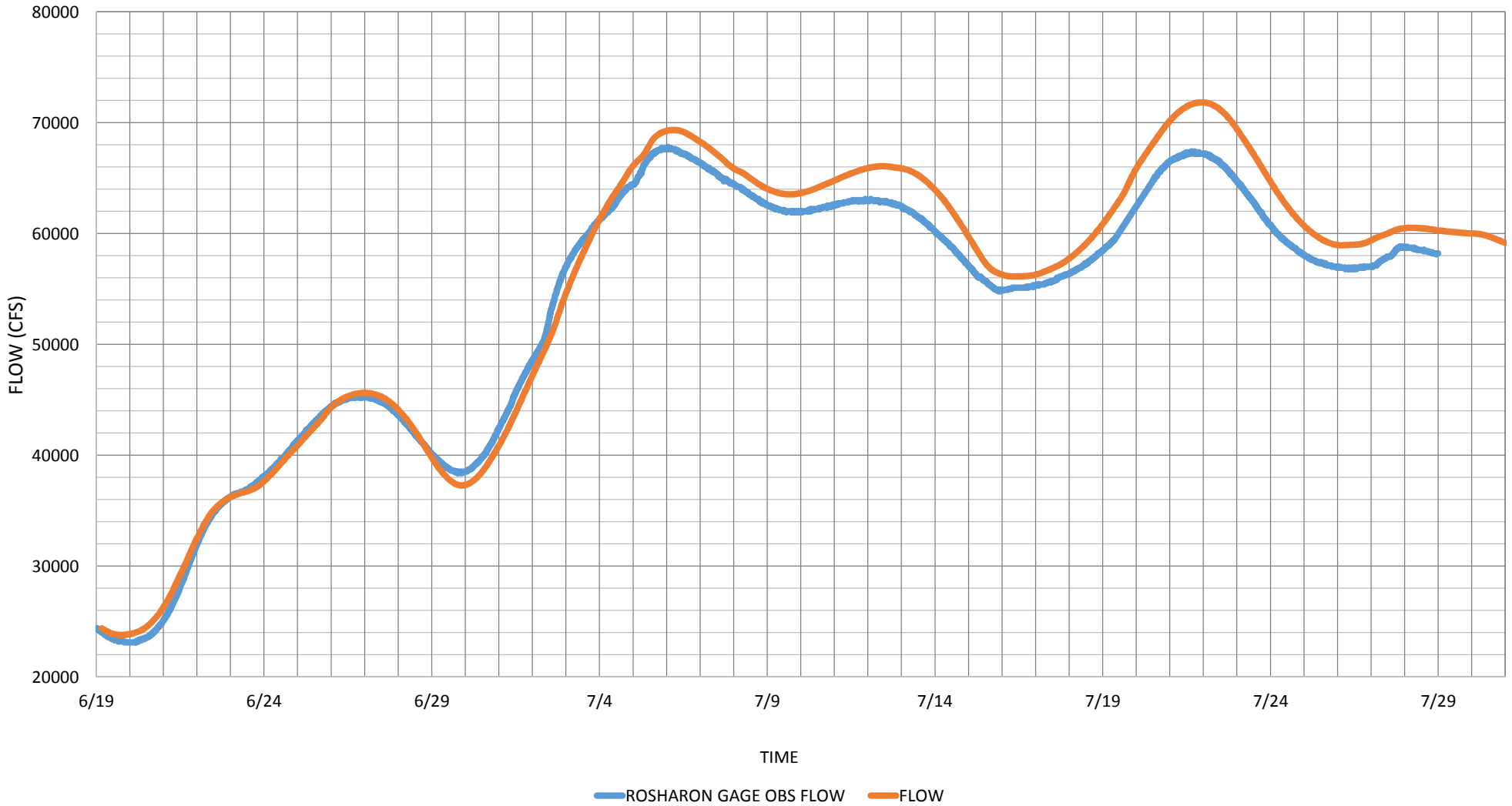
2007 UNSTEADY AND STEADY HEC-RAS PRELIMINARY RESULTS

Chart axes: ELEVATION, FT (vertical, -20 to 80); BRAZOS RIVER STATION, FT (horizontal, 0 to 200,000)

Labels on chart: FM 1462; FM Rosharon USGS Gage; Start of Oyster Creek Split Flow; ATSF Railraod; SH 59; SH 99; Oyster Creek Split Flow Area

Legend: MIN CHANNEL ELEVATION — STEADY STATE HEC-RAS — UNSTEADY HEC-RAS

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10/17/1998 - 11/1/1998 ROSHARON USGS GAGE
OBSERVED FLOW VERSUS COMPUTED FLOW

Legend: ROSHARON GAGE OBS FLOW — FLOW

X-axis: TIME
Y-axis: FLOW (CFS)

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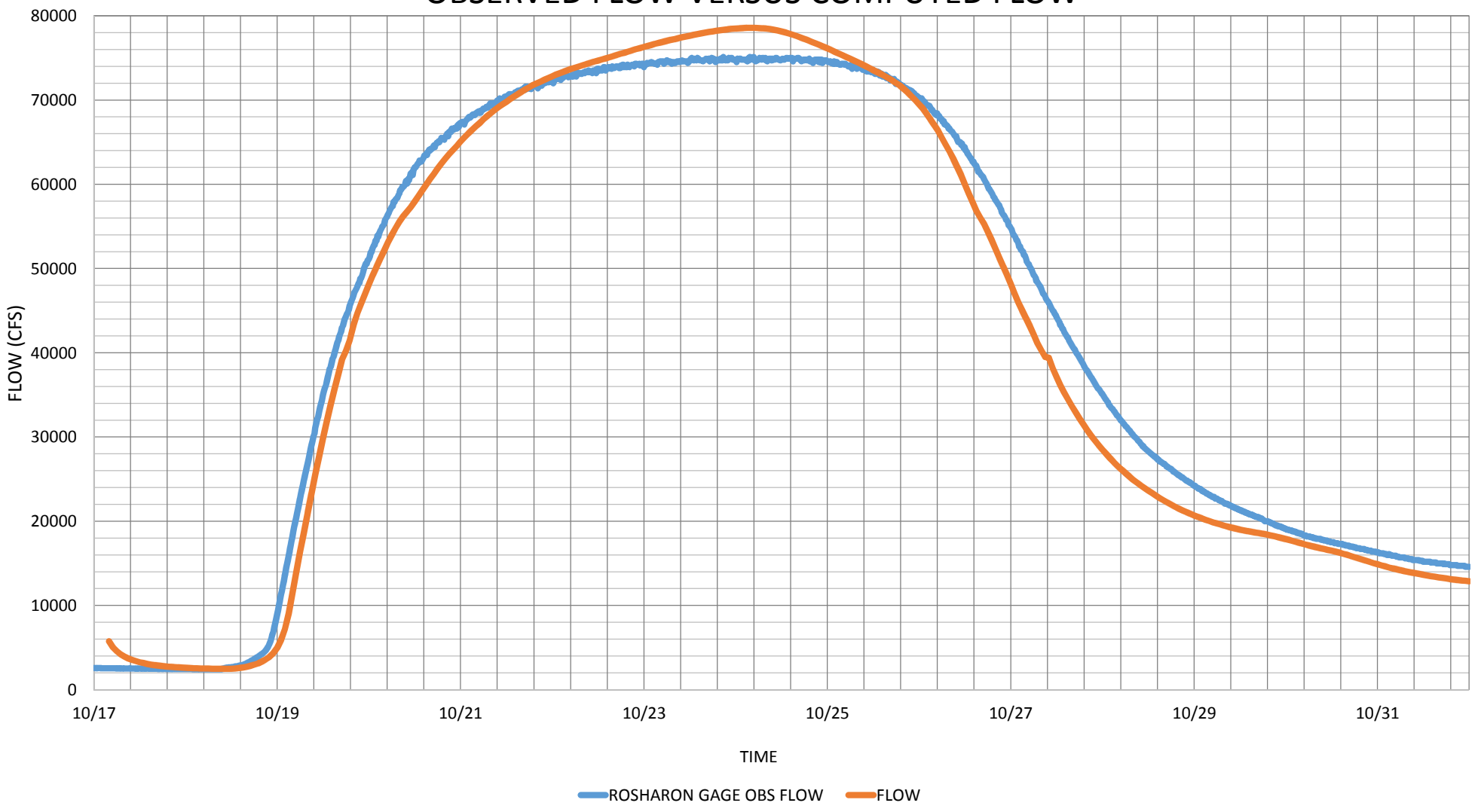
9/1/2010 - 10/9/2010 ROSHARON USGS GAGE
OBSERVED FLOW VERSUS COMPUTED FLOW

Lower Brazos River Floodplain Protection Planning Study
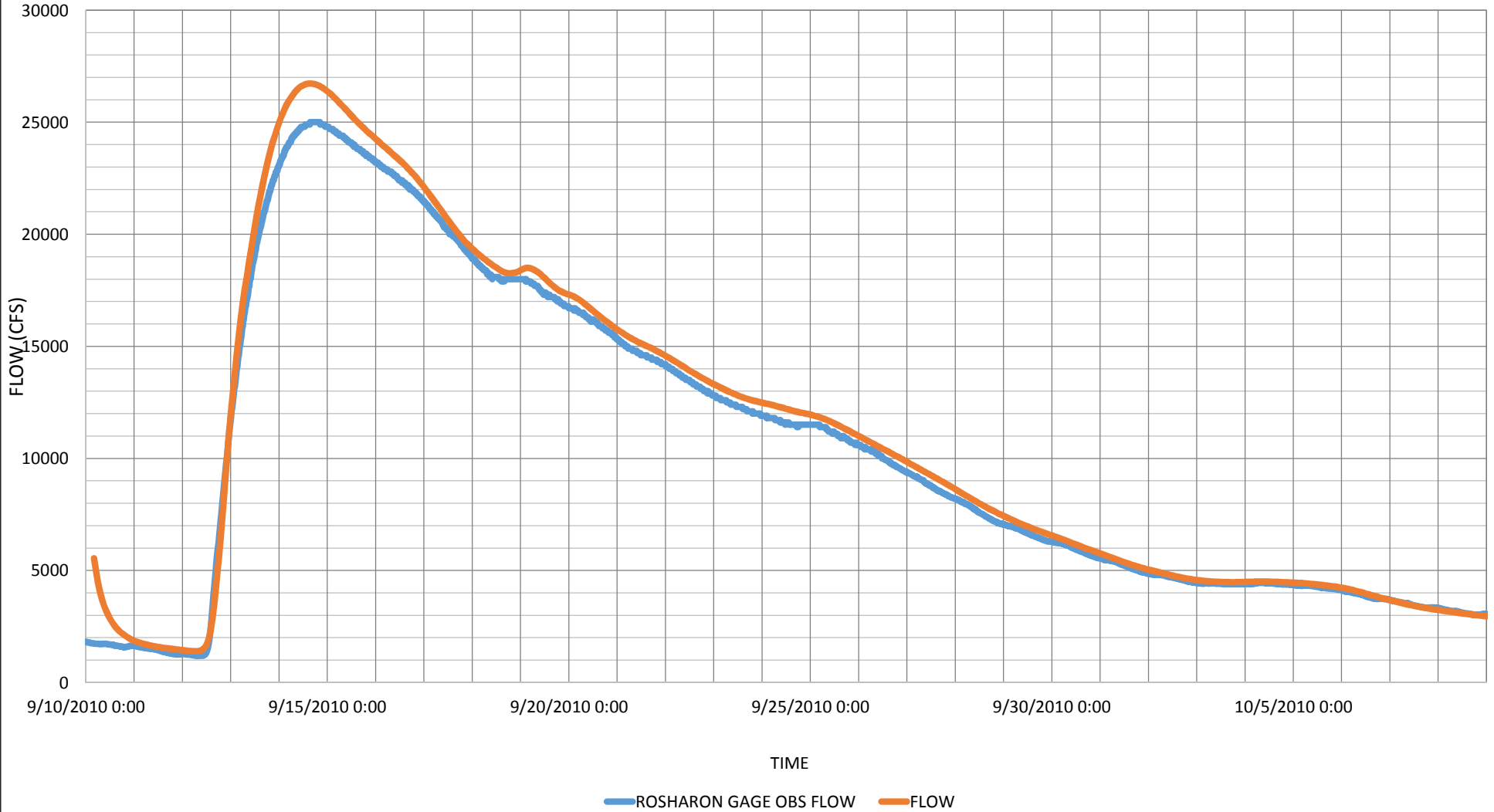
10/12/2013 - 11/21/2013 ROSHARON USGS GAGE
OBSERVED FLOW VERSUS COMPUTED FLOW

Lower Brazos River Floodplain Protection Planning Study
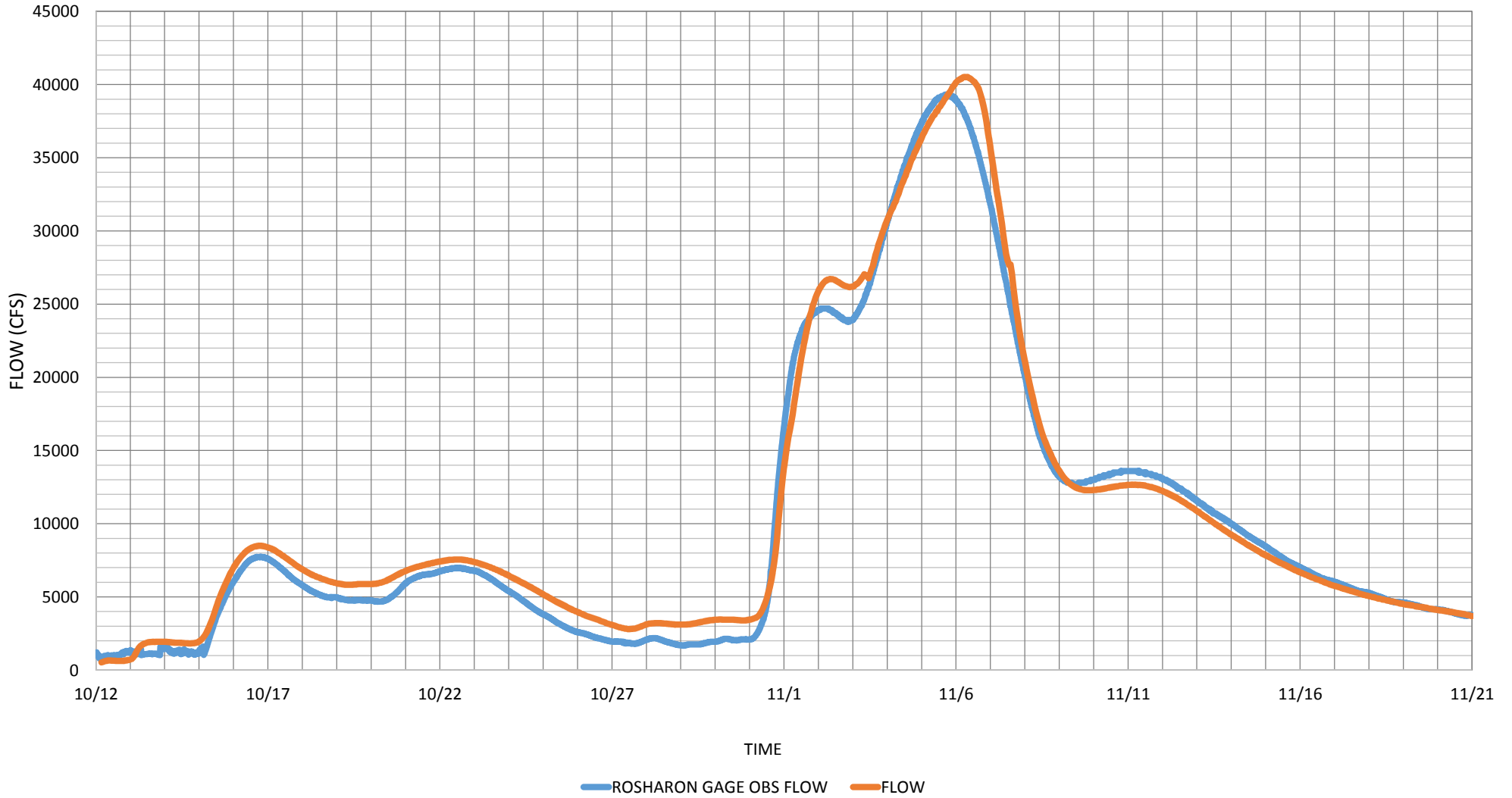
High Flow Calibration

* 2 High Flow Events that spill out of the main channel banks
  * May 25, 2015 to June 14, 2015
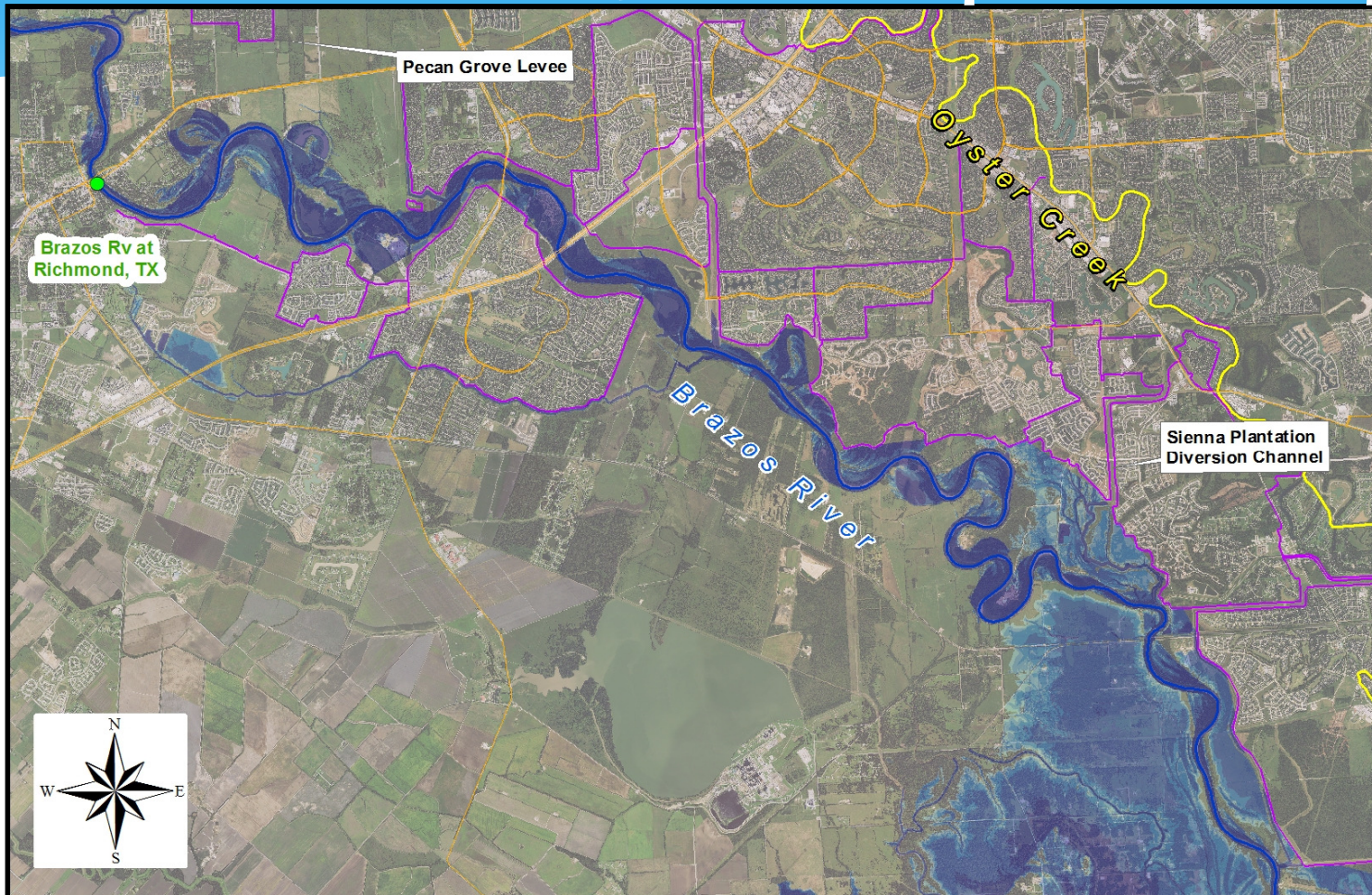 * December 21, 1991 to January 15, 1992

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5/25/2015 - 6/14/2015 ROSHARON USGS GAGE
OBSERVED FLOW VERSUS COMPUTED FLOW

Lower Brazos River Floodplain Protection Planning Study
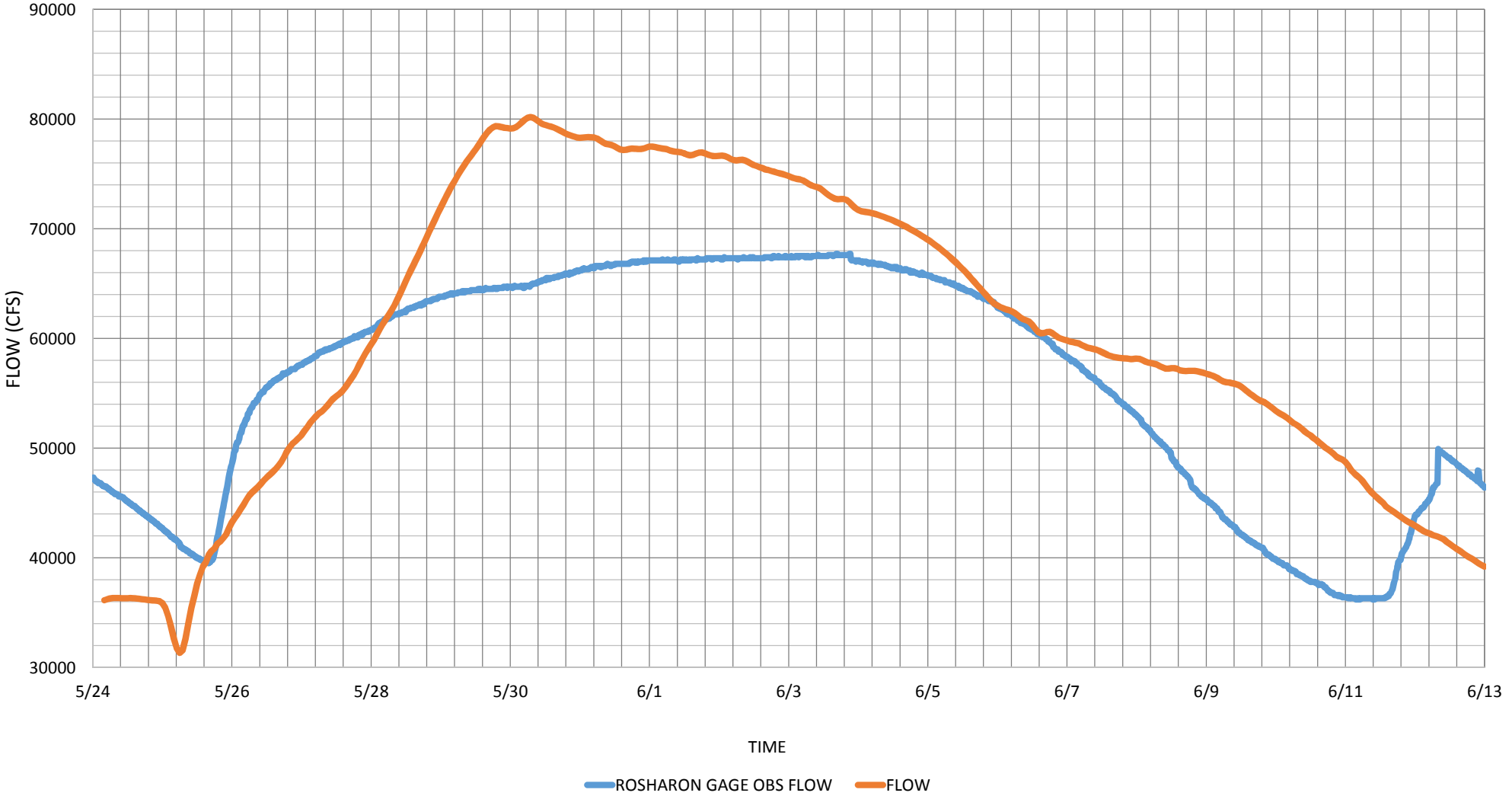
12/20/1991 - 1/15/1992 ROSHARON USGS GAGE
OBSERVED FLOW VERSUS COMPUTED FLOW
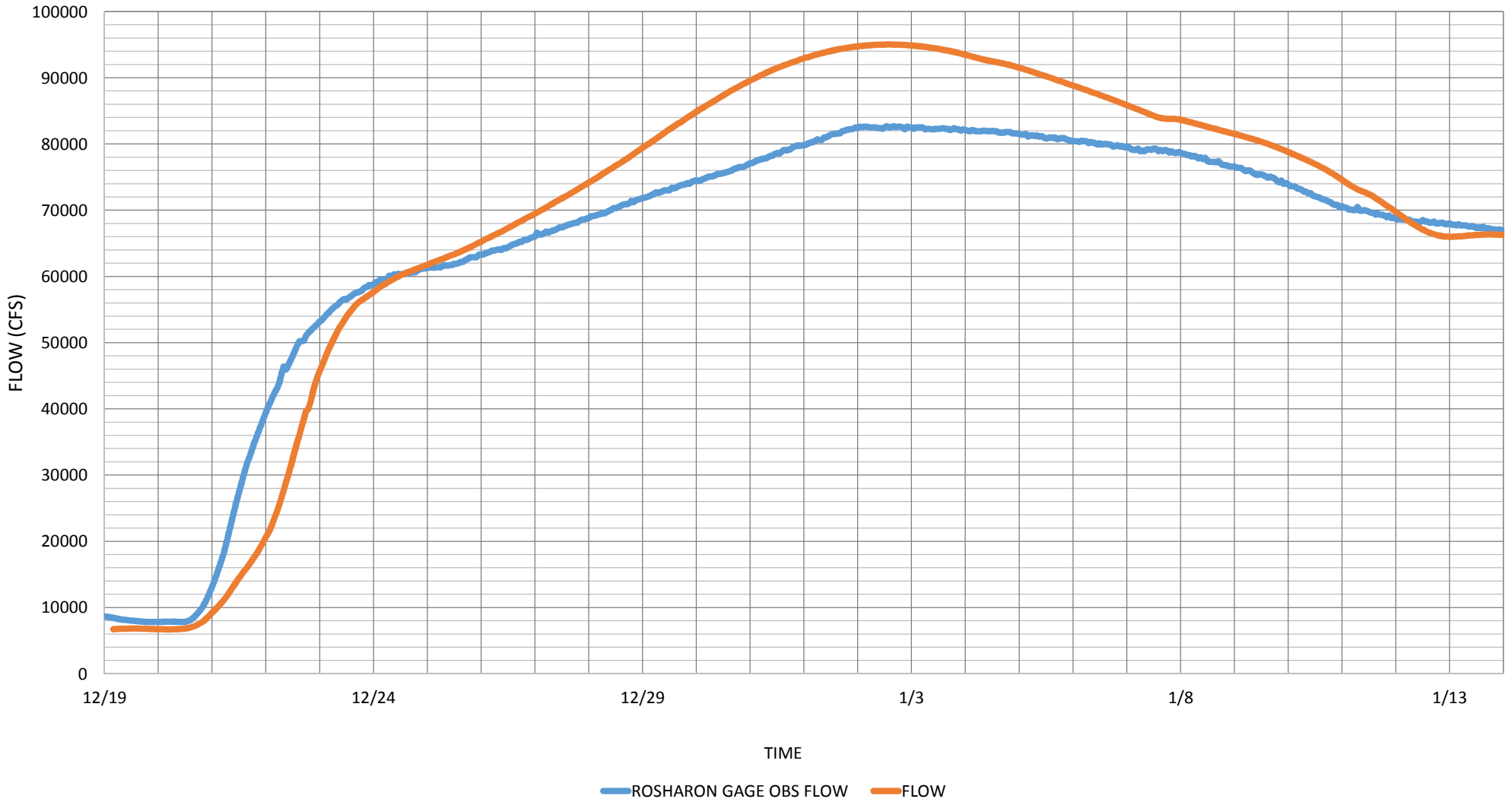
Legend: ROSHARON GAGE OBS FLOW — FLOW

TIME (x-axis)
FLOW (CFS) (y-axis)

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Fort Bend 2015 Floodplain Map

Preliminary Results

Pecan Grove Levee

Oyster Creek

Brazos Rv at Richmond, TX

Brazos River

Sienna Plantation Diversion Channel

N
W E
S

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Fort Bend 2015 Floodplain Map

Preliminary Results

Brazos River

Oyster Creek Spill
Floodplain Not Mapped

N
W   E
S

Brazos Rv nr Rosharon, TX

Lower Brazos River Floodplain Protection Planning Study

Lower Brazos River Floodplain Protection Planning Study
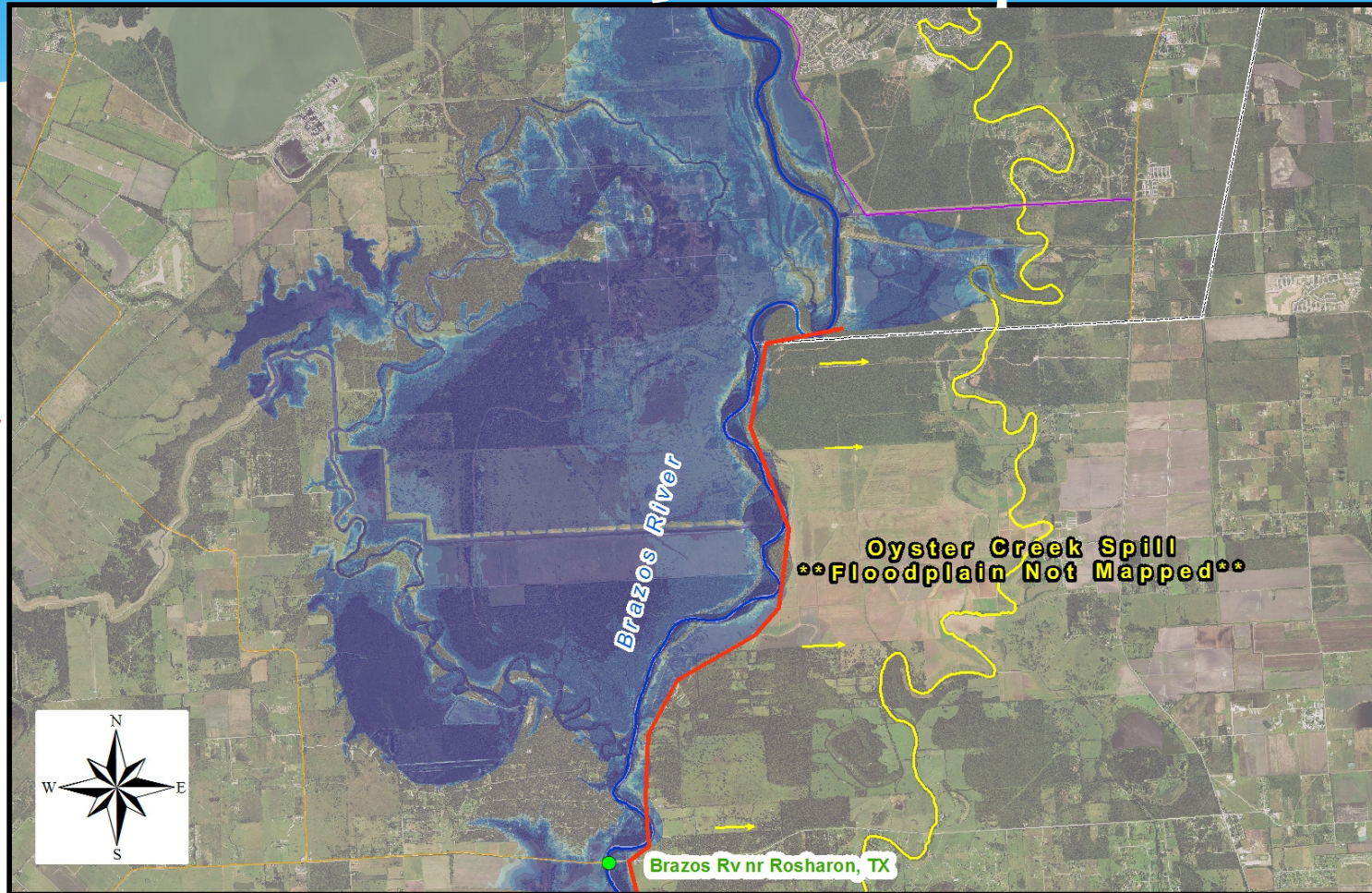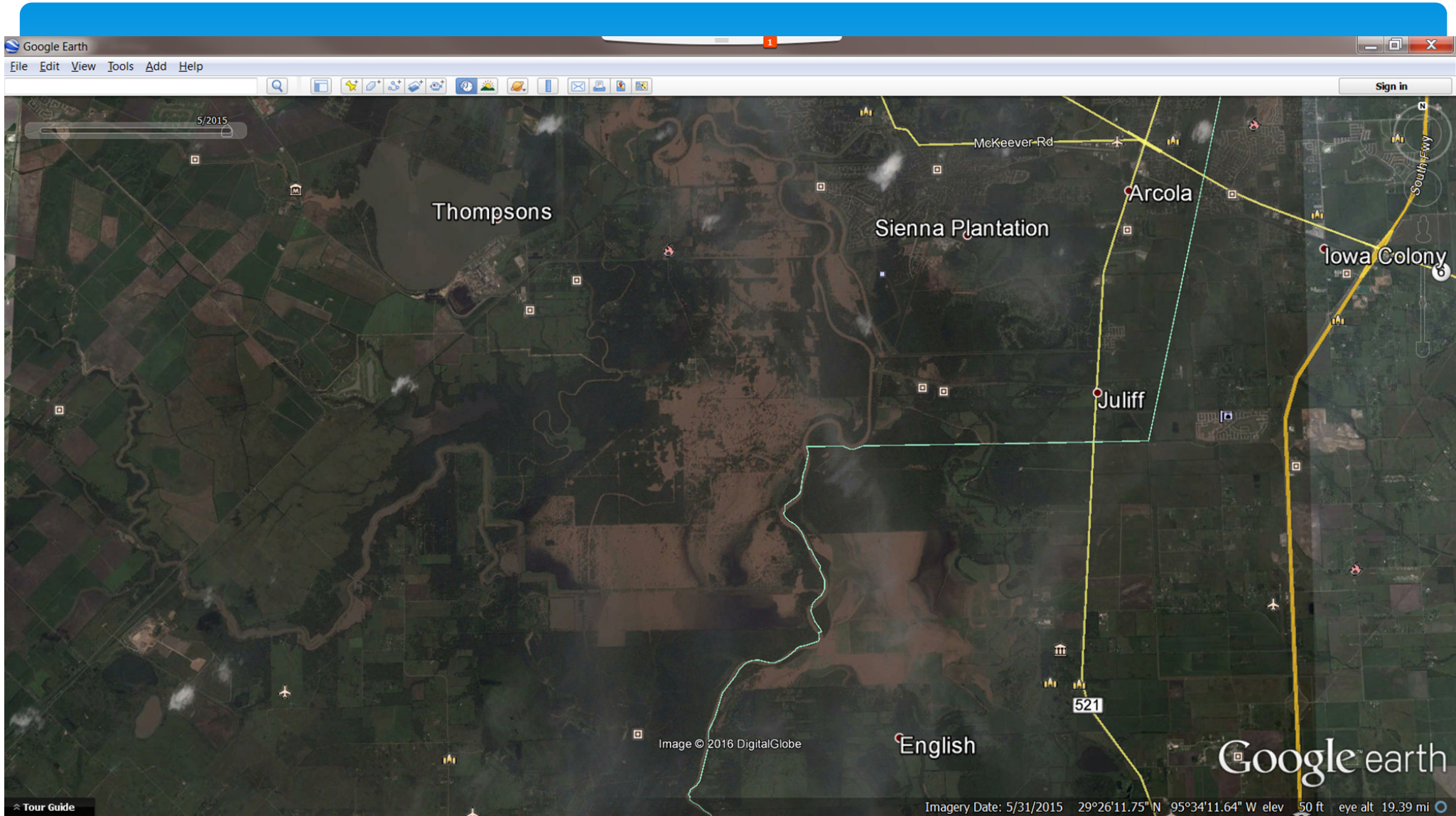
Hydraulic Models

* Additional work is on-going to calibrate the spill to Oyster Creek
  * Ditch H Study by FNI soon to be completed
  * 2015 Google Earth Photos of the spill
  * 2015 Drone Footage from the City of Sugar Land
  * 2015 High Water Mark Surveys and Pictures
  * Developed a 2D Rough Model of the Oyster Creek Spill
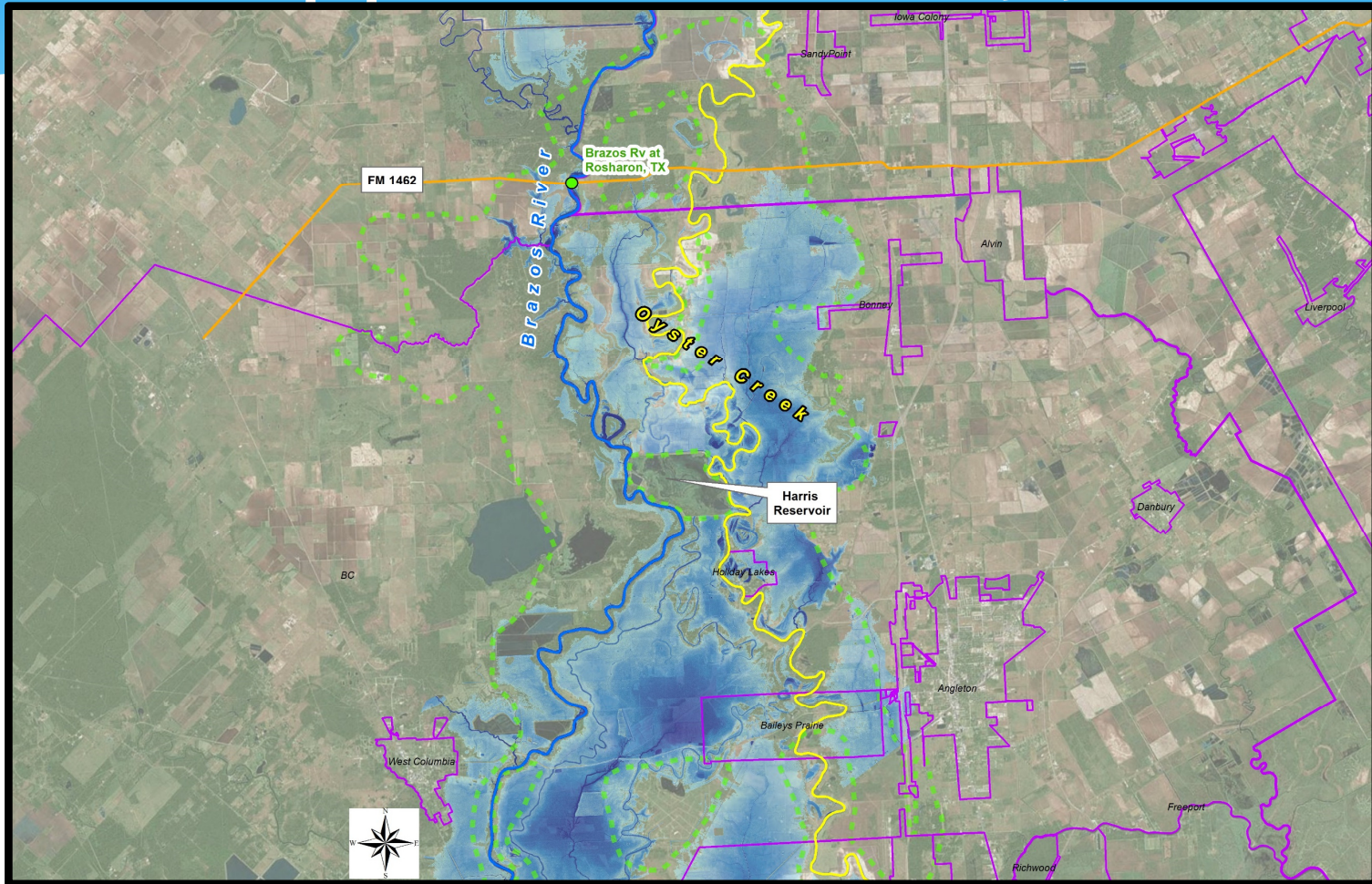* Combining the Fort Bend and Brazoria models

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Phase 1 Brazoria Unsteady HEC-RAS

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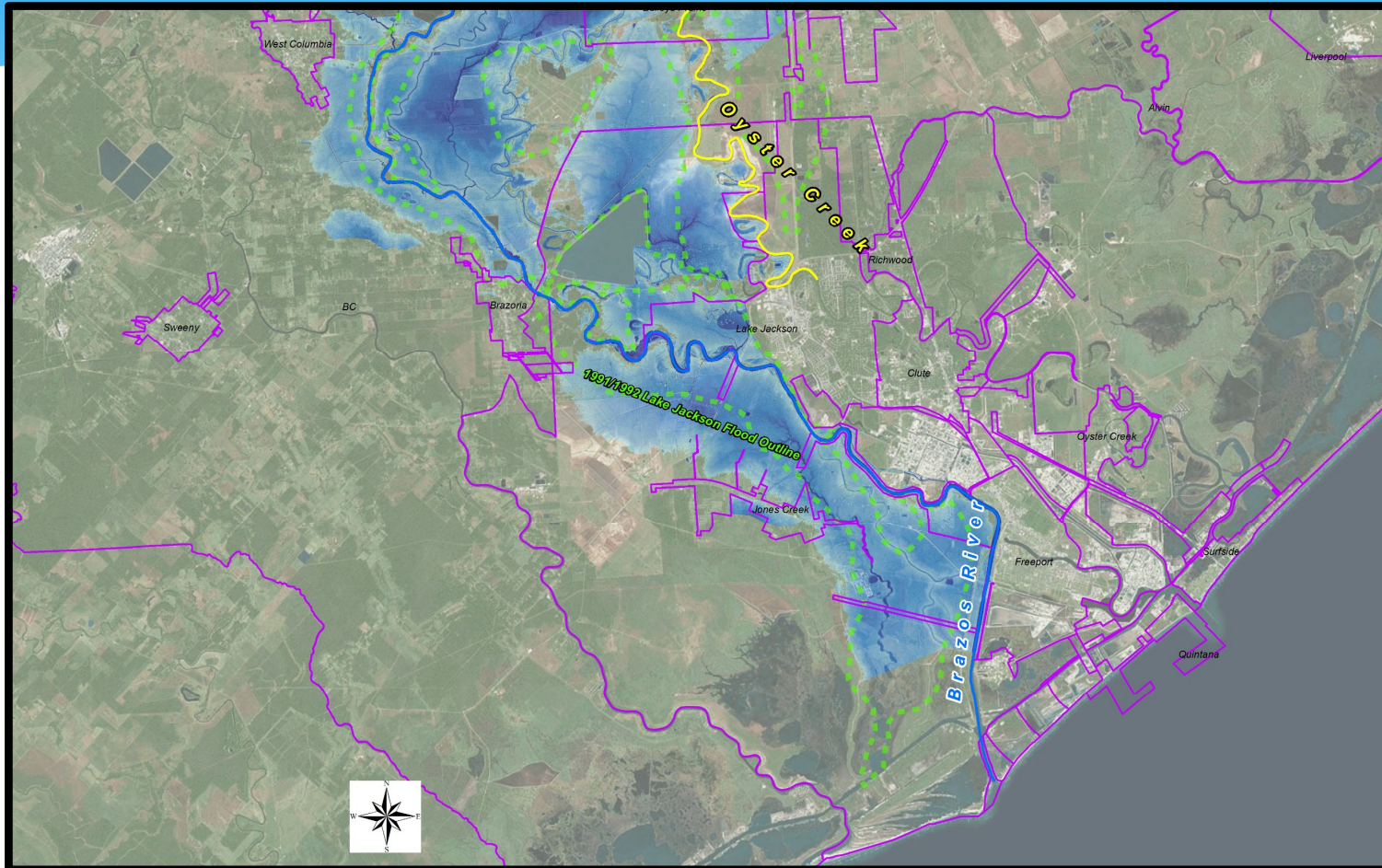 * Developed inundation mapping
  * Continue calibration of model
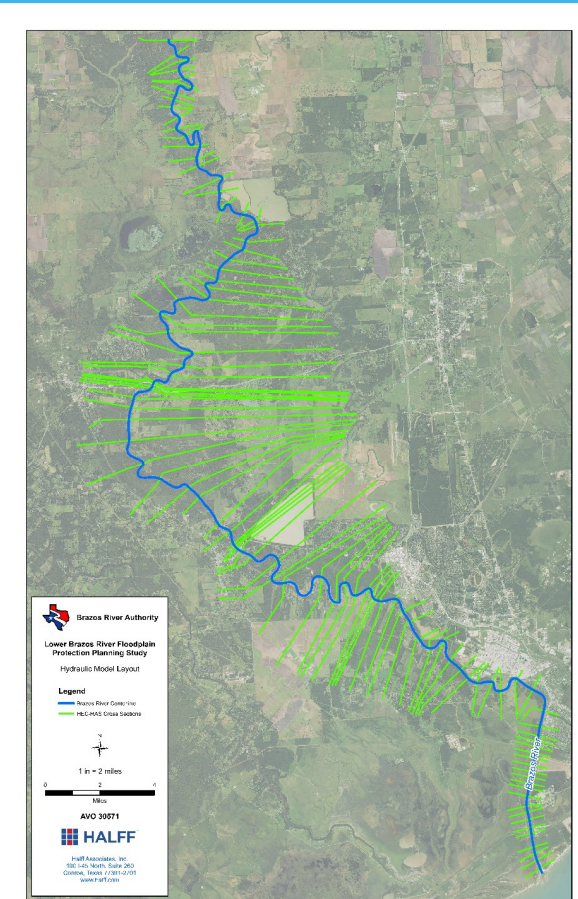
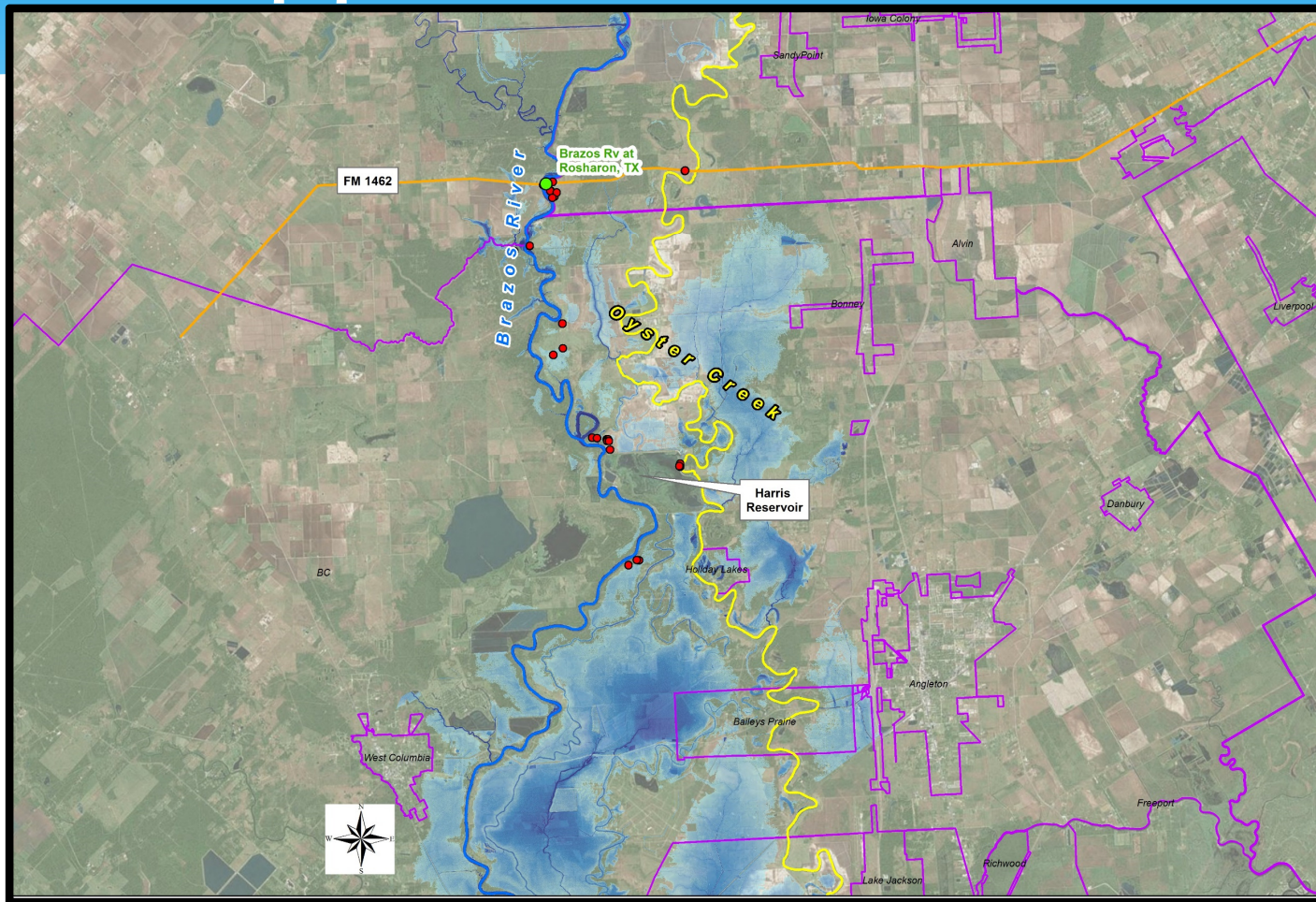# Upper Brazoria 1992

Preliminary Results

Lower Brazos River Floodplain Protection Planning Study

Lower Brazoria 1992

Preliminary Results

Lower Brazos River Floodplain Protection Planning Study

Upper Brazoria 2015

Preliminary Results

Lower Brazos River Floodplain Protection Planning Study

Upper Brazoria 2015

Photo provided by Steve Rosa

Upper Brazoria 2015

Northwest Corner of Harris Reservoir

Photo provided by Steve Rosa

Lower Brazos River Floodplain Protection Planning Study

Lower Brazoria 2015

Preliminary Results

Lower Brazos River Floodplain Protection Planning Study
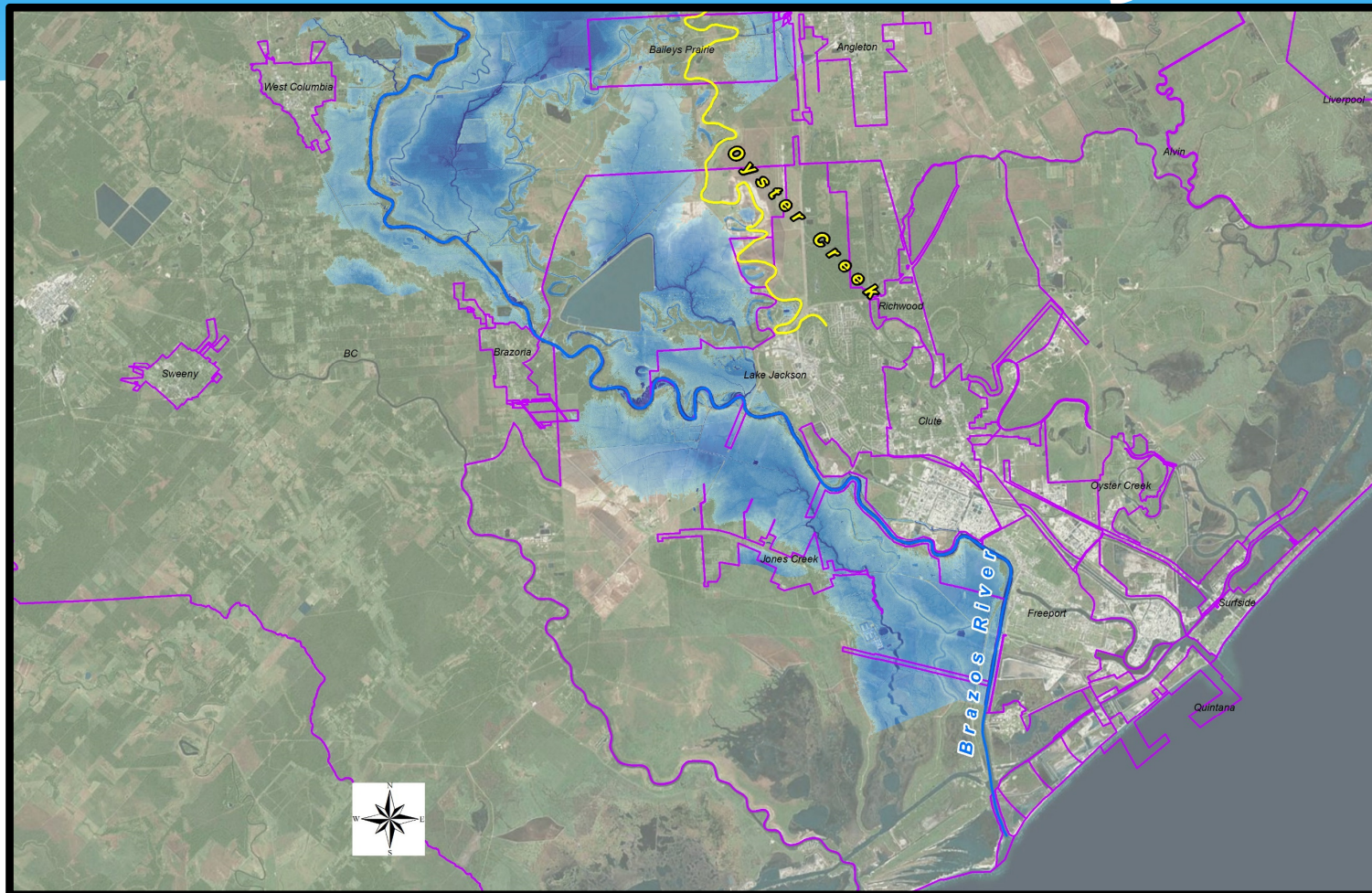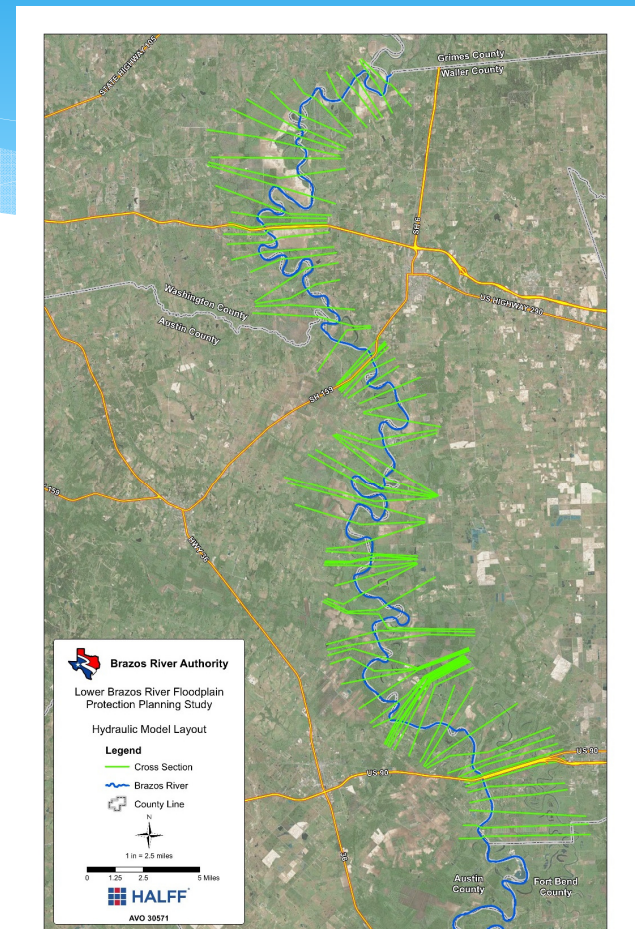
Phase 2 Unsteady HEC-RAS

* Develop the Hydraulic Model
  * Obtain Survey
  * Model Cross Sections
  * Develop terrain data with survey data
  * Calibration of model
  * Develop inundation mapping

Questions?