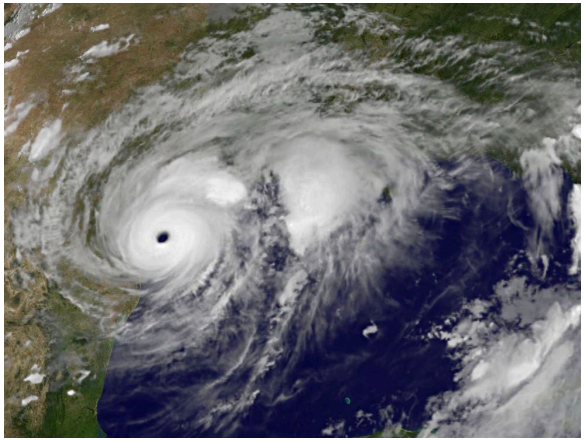
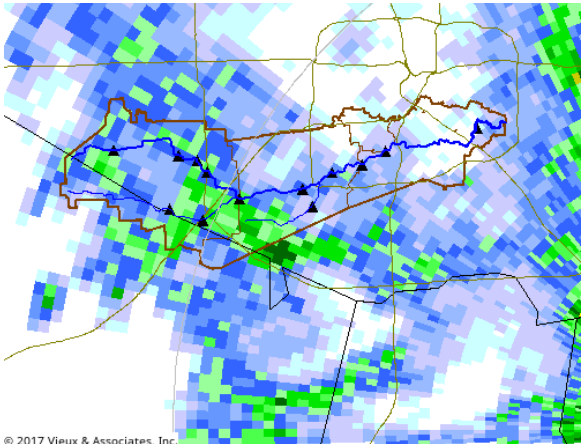
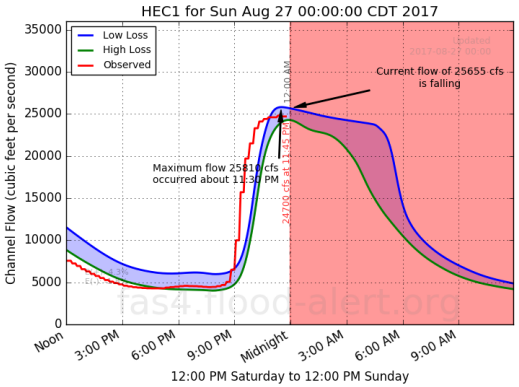
FAS5
FLOOD ALERT SYSTEM

October 2020

Flood Alert System (FAS5)
Texas Medical Center Training







Philip Bedient, PhD, PE | Andrew Juan, PhD | Toby Li, MS Student

TMC TEXAS MEDICAL CENTER

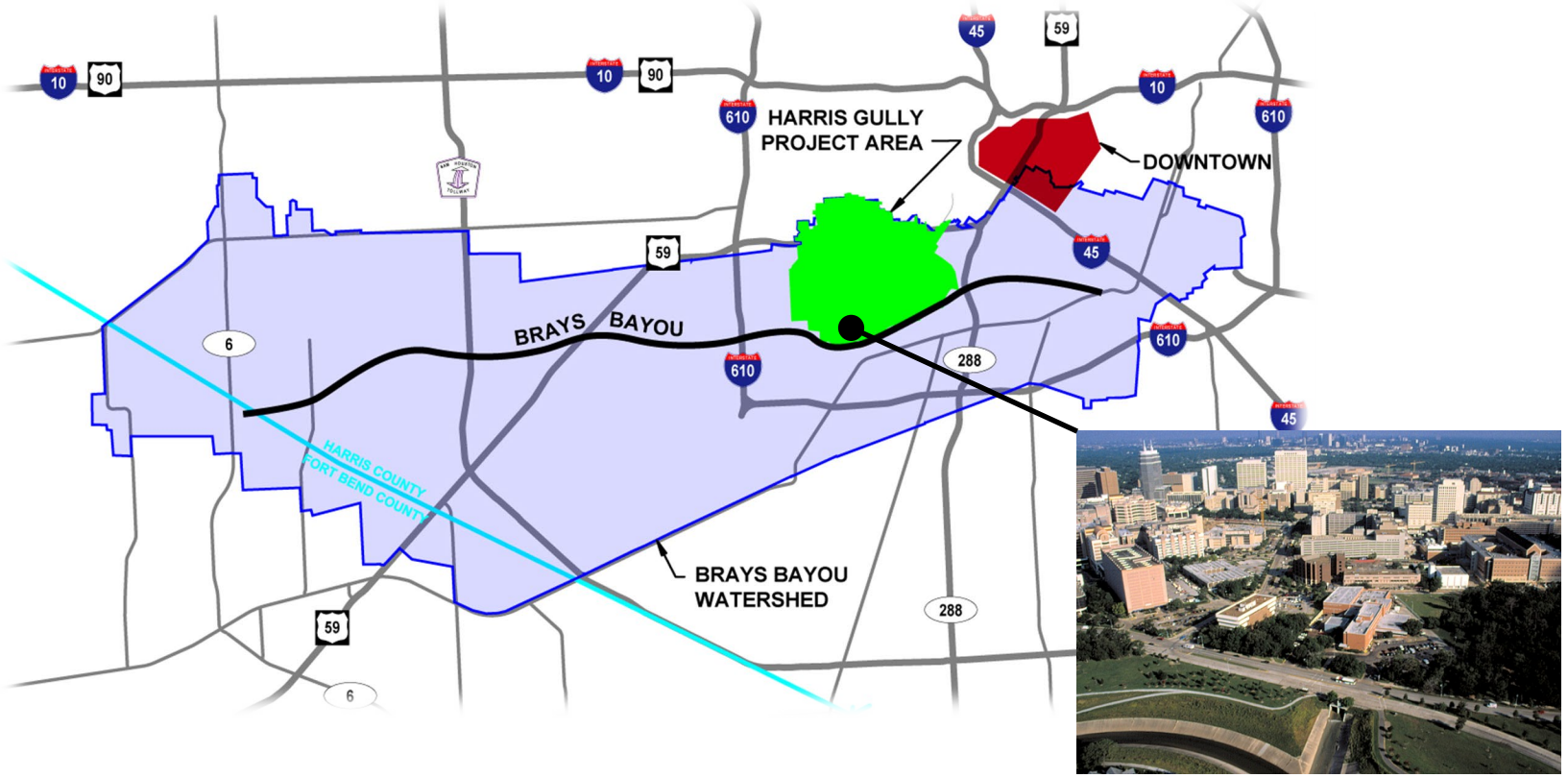
RICE

Contents

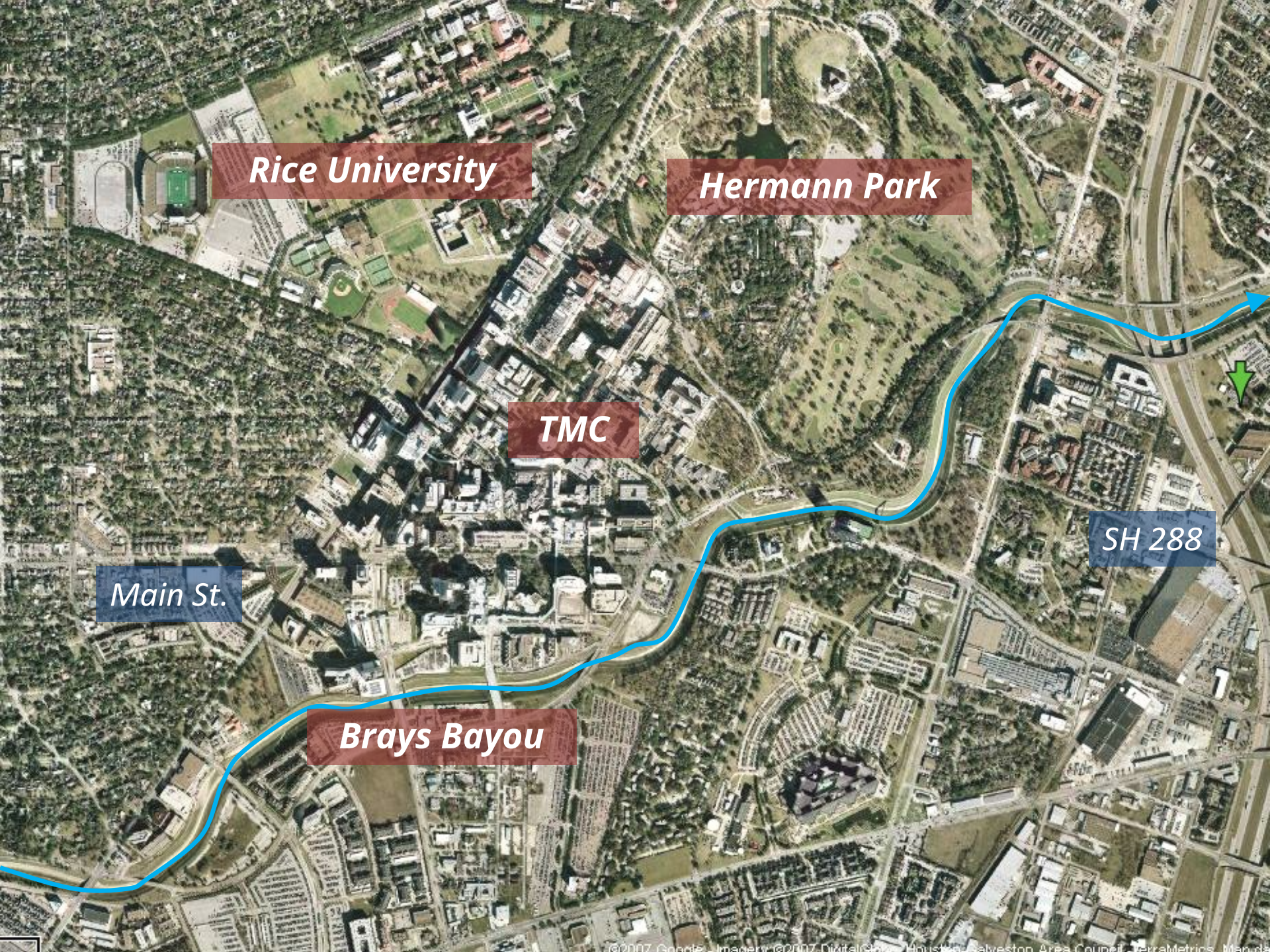
Development of FAS (1997–2020)

1997	Developed for Brays Bayou (tested on >40 events since 1997)
2001	System tested on TS Allison
2003	System upgraded to FAS2
2005-2013	Core hydrologic model calibrated & improved
2009	Floodplain Map Library (FPML) implemented w/in Google Maps
2010	FAS2 upgraded to FAS3
2017	FAS3 upgraded to FAS4 & mobile site launched
2020	FAS4 upgraded to FAS5 (new site and system)

Brays Bayou and Harris Gully

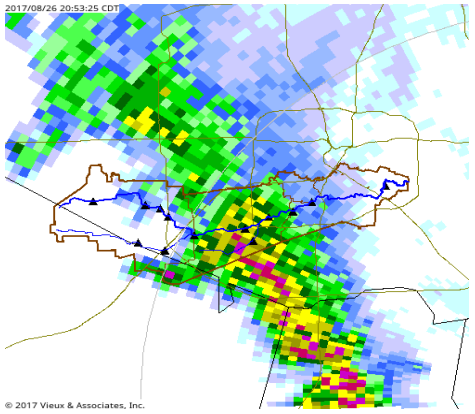


- 128 mi2 drainage area, Harris Gully is approx. 4.5 mi2
- Main channel is 31 miles long, draining to the Houston Ship Channel
- Flooding from severe storms: TS Allison (2001), Hurricane Ike (2008), 2015 Memorial Day Flood, 2016 Tax Day Flood, 2017 Hurricane Harvey, 2020 Beta


Rice University
Hermann Park
TMC
SH 288
Main St.
Brays Bayou

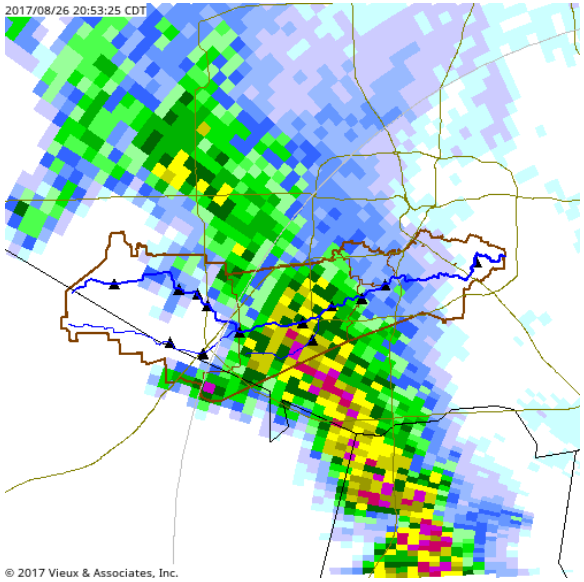
Needs for Inland Flood Protection

- Rapidly moving weather systems - explosive rainfalls
- Urban developments exceeded the original design capacity of the channels
- Severe street flooding occurs during routine rainfalls
- Many older areas are very prone to floods
- Timely flood information for traffic re-routing and TMC operations
- Damage costs continue to increase



GIS and NEXRAD Radar Rainfall

- Watershed analysis within GIS
- Satellites & sensors providing meteorological data
- NEXRAD and CASA NetRAD radar systems
- LiDAR – advanced topography and DEM
- Advanced hydrologic/hydraulic modeling systems



What does FAS do?

- Increase lead time for flood warning
- Provide accurate real-time radar rainfall estimates (1998-2017)
- Google Earth/Maps technologies integrated
- Radar rainfall can be visualized over the watershed and individual sub-basins
- Provide frequent information updates via the website
- Provide communication – emergency response and operations

Fas5.org

How it Works

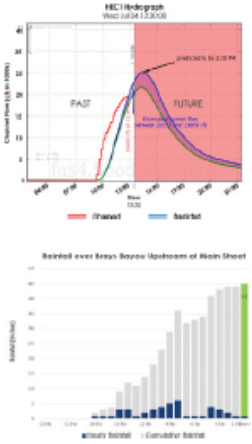
Data Acquisition

- Radar rainfall (NEXRAD)
- Flow & stage gauge data
- Bayou camera water level

Hydrologic / Hydraulic Analysis

- Hydrologic & hydraulic models (HEC-HMS & HEC-RAS)
- Floodplain mapping

Real-Time Flood Warning Data



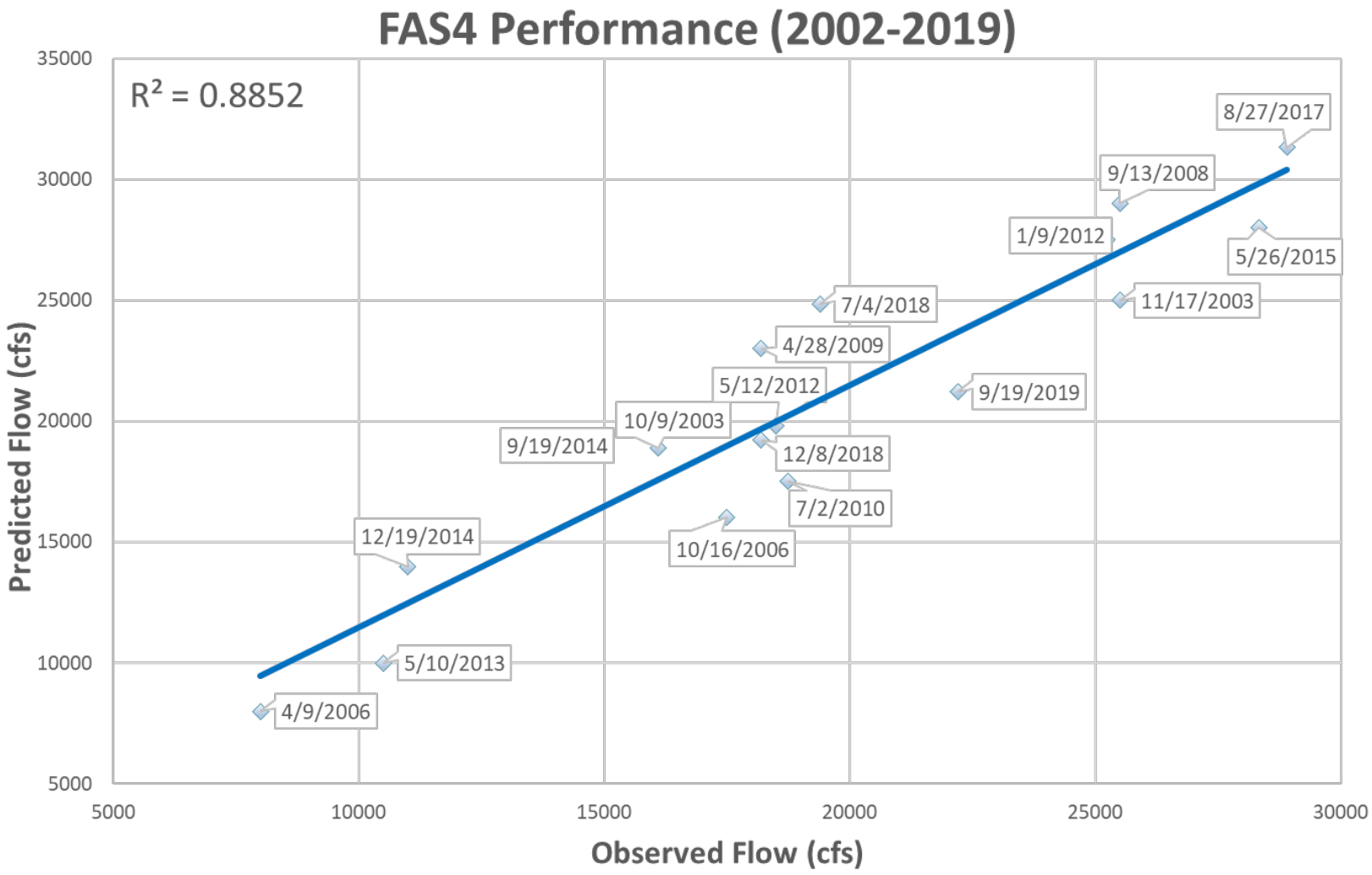
- Real-time rainfall and flow hydrographs at watch points
- Floodplain map library (FPML)

Communication

- Establish warning thresholds
- Automatic communication via text, email and the FAS website

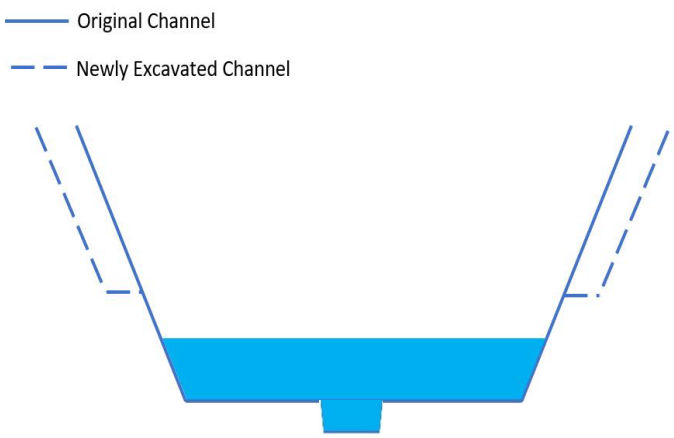
- **Data every 5 min ingested into hydrologic model**
- **FAS5 was completely rebuilt in early 2020**

FAS4 Performance (2002-2019)



Project Brays Flood Mitigation

EXAMPLE OF COMPLETED PORTION OF BRAYS BAYOU

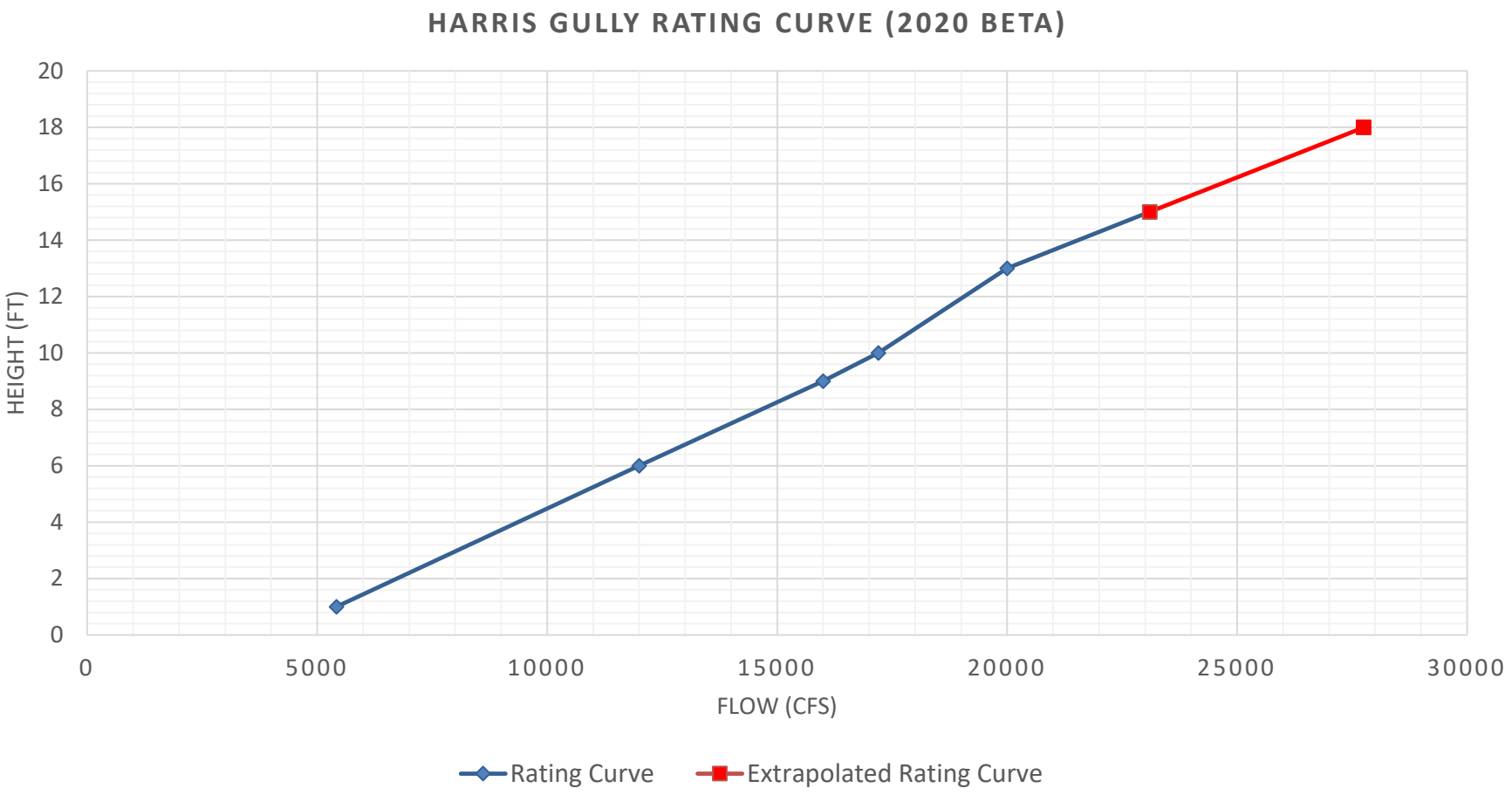


Project Brays Channel Improvement

Brays Bayou at TMC

TMC CULVERT - MAY 2015

Harris Gully Rating Curve



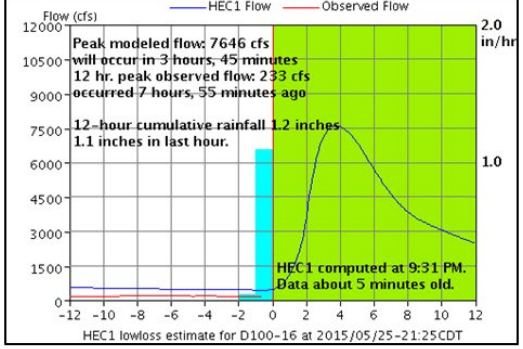
Developed using the Bayou Camera vs Flow

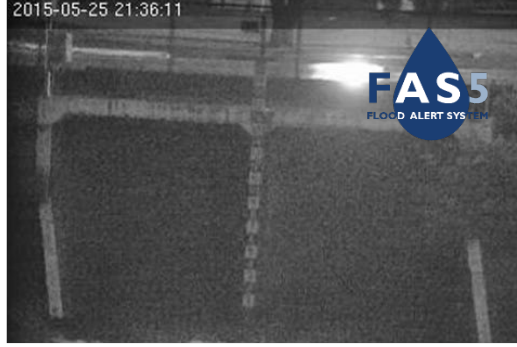
Memorial Day Flood (2015)

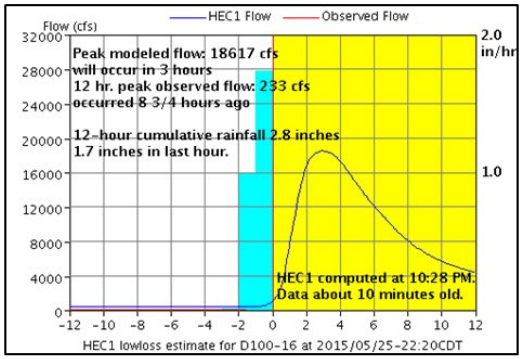
May 25, 10:20 p.m.
18,617 cfs. predicted to occur in 3 hours

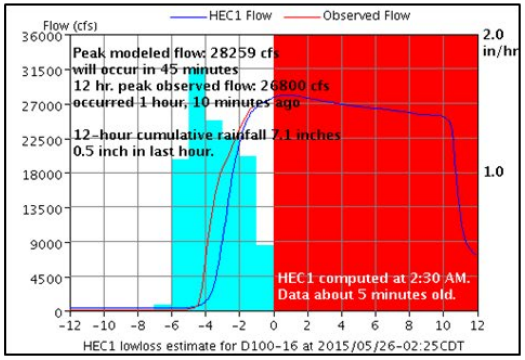
May 26, 2:25 a.m.
Near Peak of 28,259 cfs
Bayou Cam: 19.5 ft.
Note: 20+ ft. = Overtopping

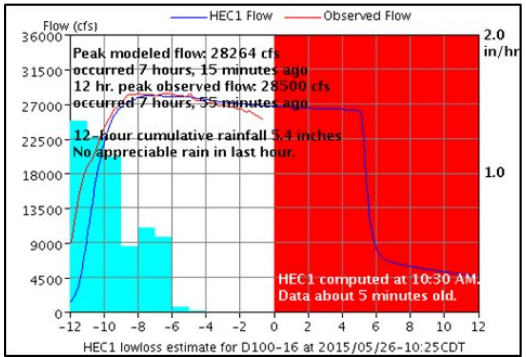
May 26, 10:33 a.m.
Bayou Cam: 15.8 ft.

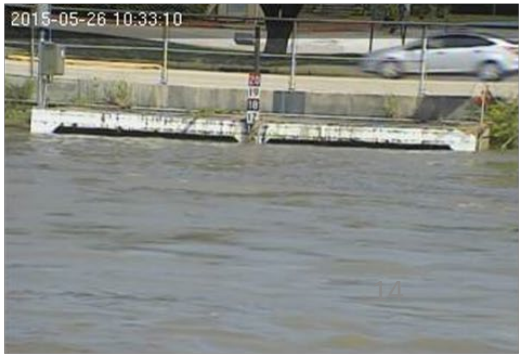






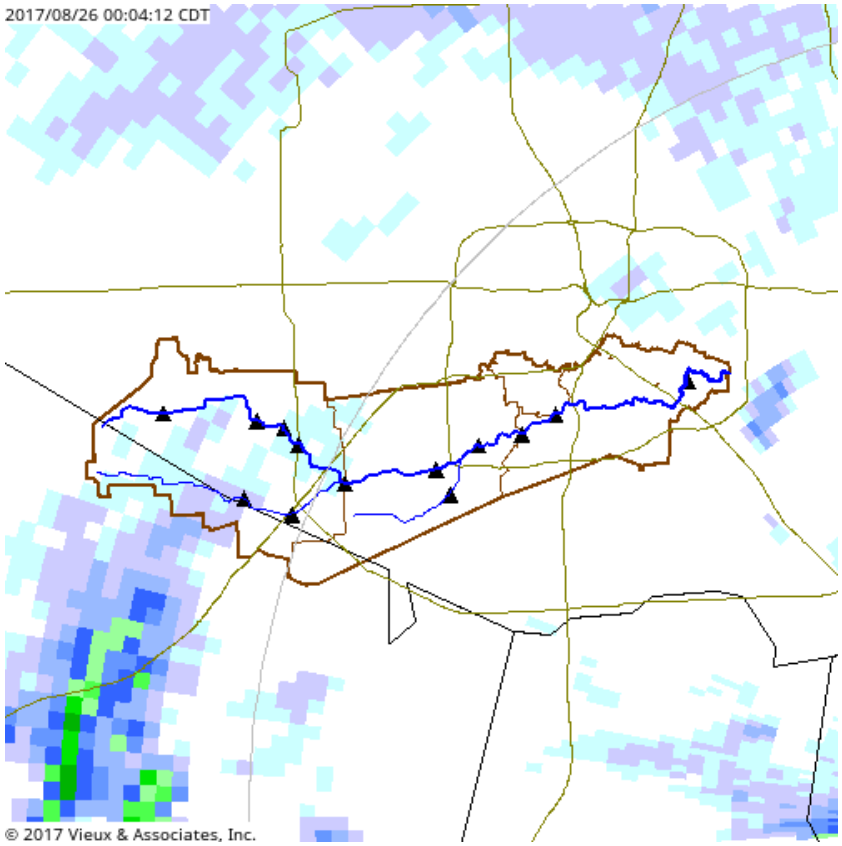


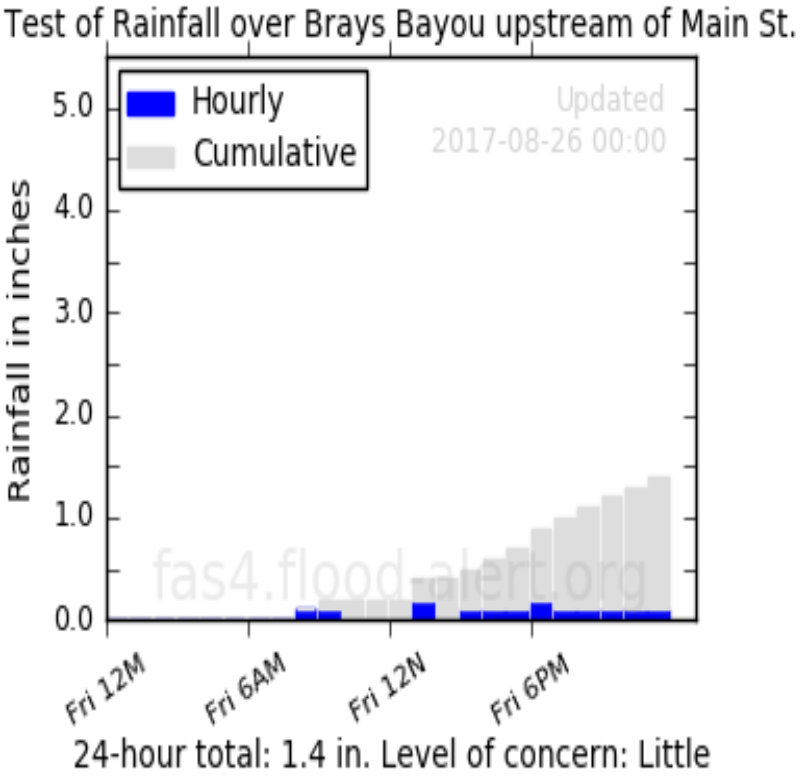




FAS4 Radar and Rainfall Delivered

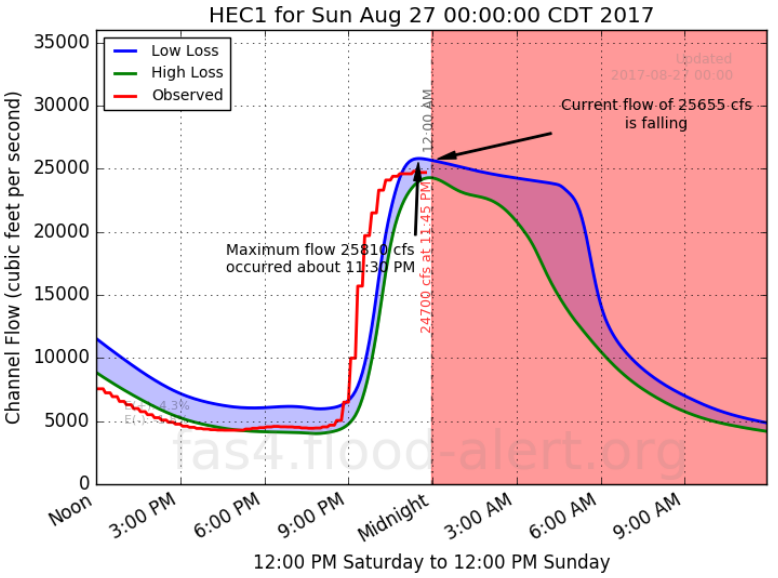
AVERAGED EVERY 5 MIN OVER BRAYS FOR HARVEY

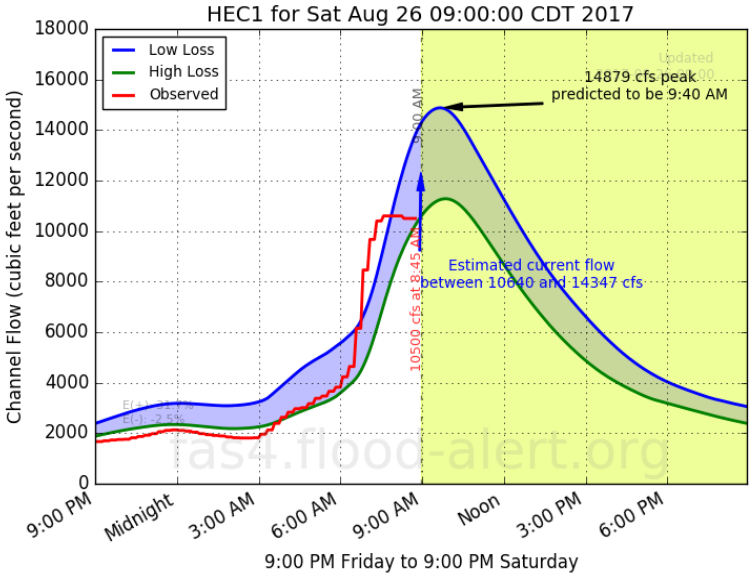


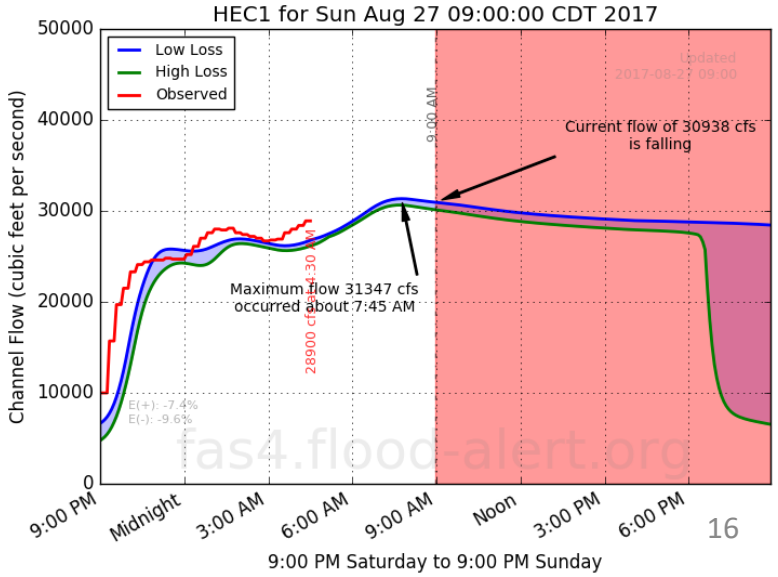


FAS4 Performance during Harvey

- High and Low Prediction based on Infiltration
- Note that Brays response – table top shape

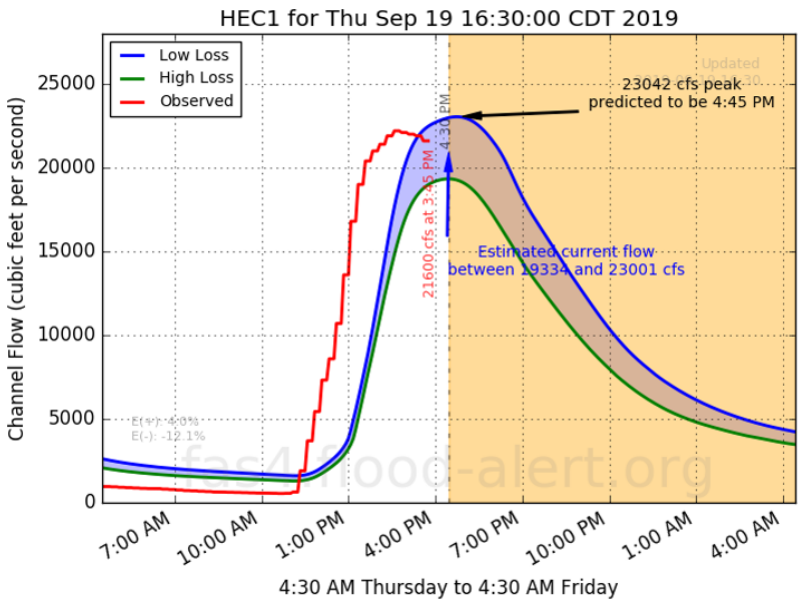






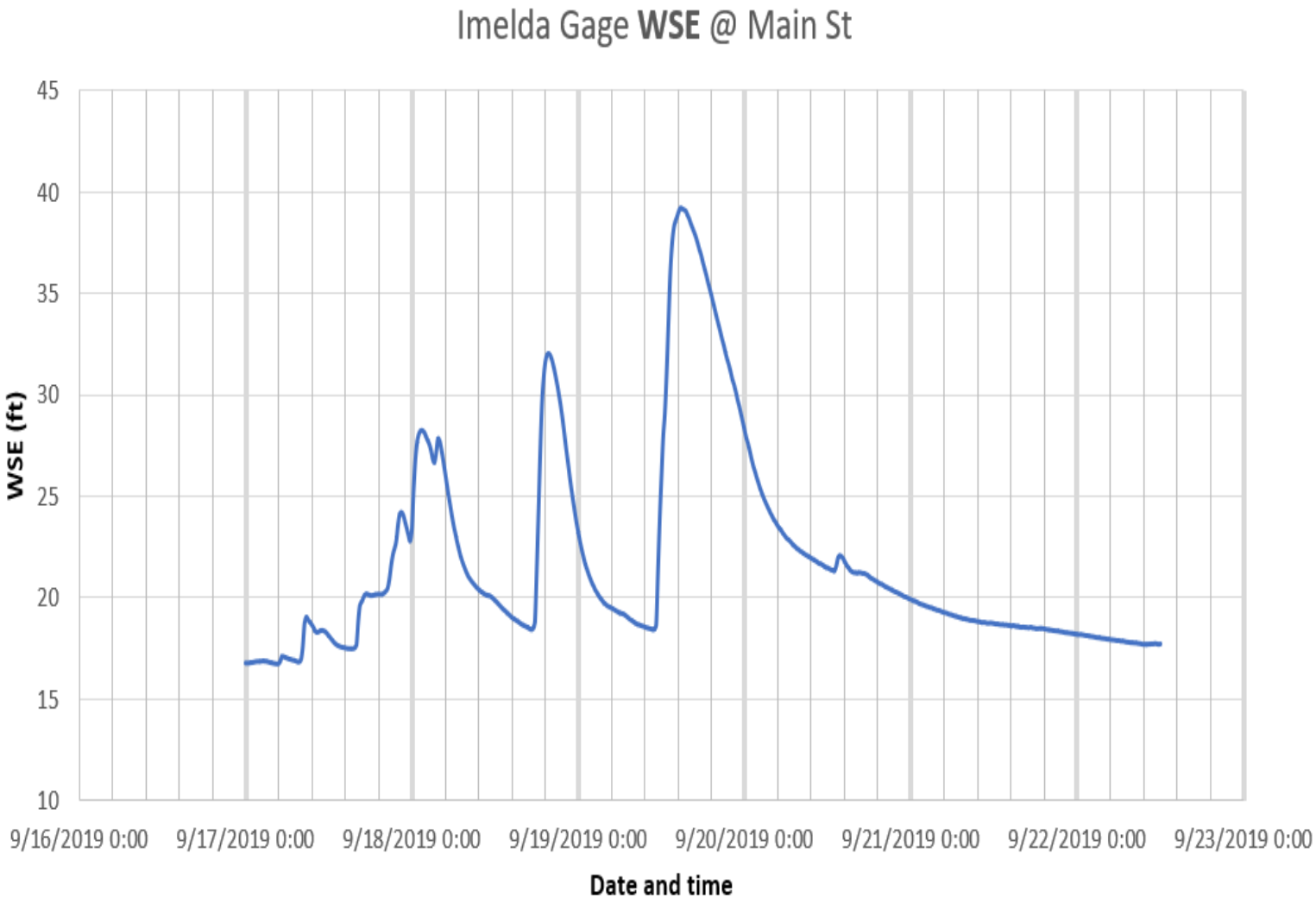
Tropical Storm Imelda, 2019

- Dates: September 16 – September 20, 2019
- Storm Duration: 3 days
- With some areas in Houston getting over 43 inches of rain, Imelda has caused five deaths and a total damage of over 5 billion dollars.
- TMC received 8.5 inches of rain in three days during Imelda.
- Water in Brays Bayou near TMC has reached a maximum height of 39 ft, in comparison to its normal height at 17 ft.

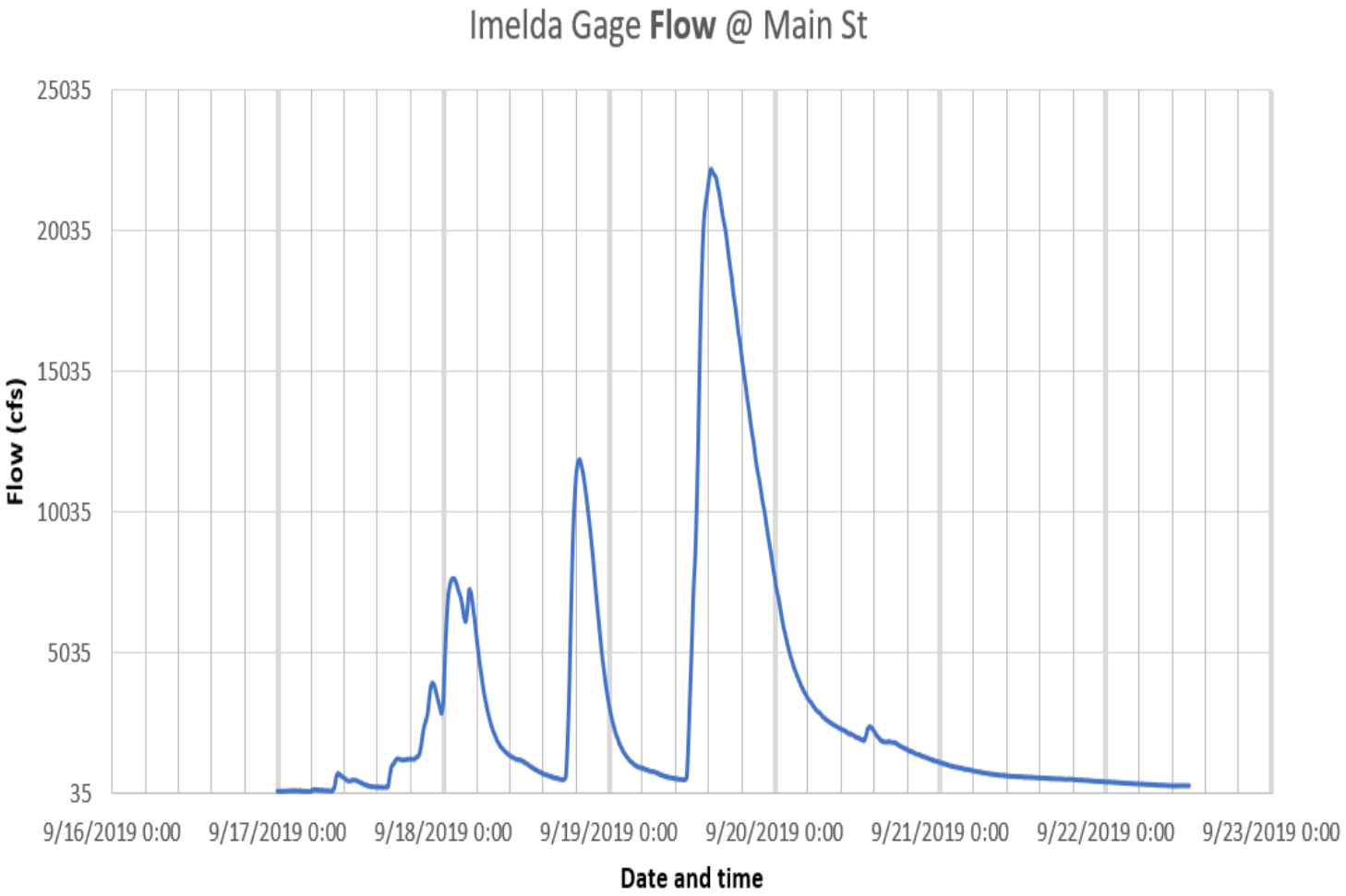


Interstate 59 during Imelda (Source: Houston Chronicle)

Imelda Gage WSE @ Main Street

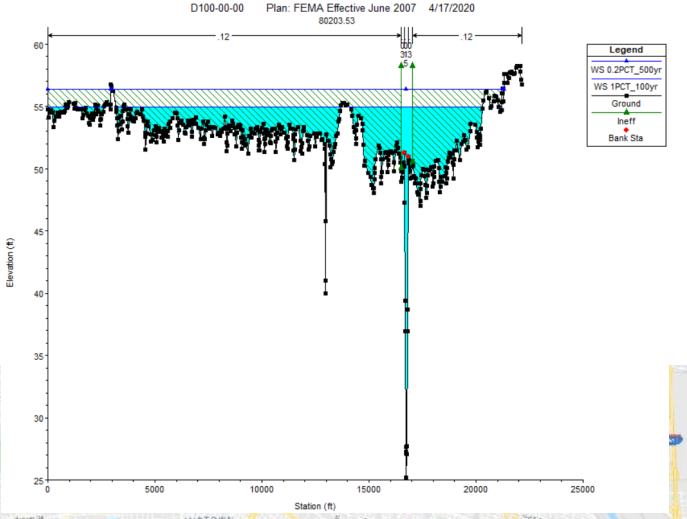


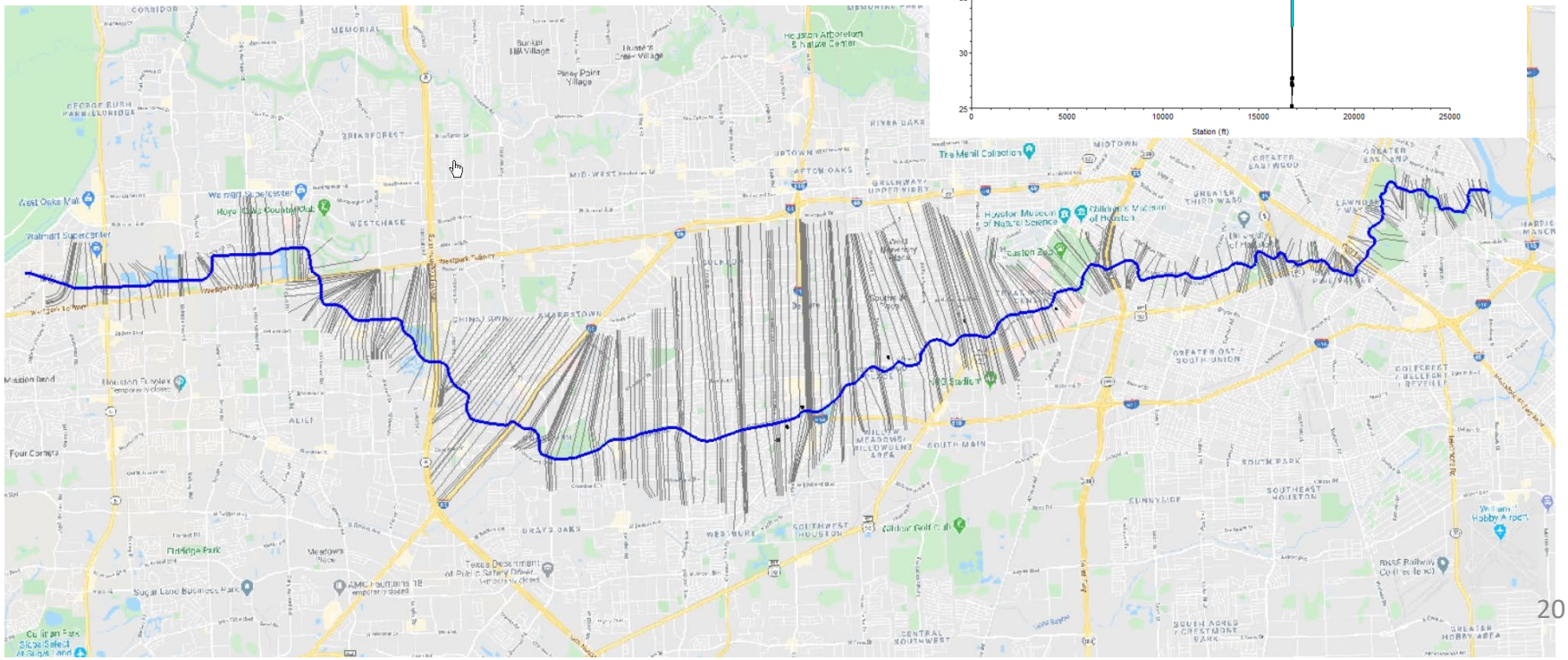
Imelda Gage Flow @ Main Street



Flood Hazard Modeling (HEC-RAS)

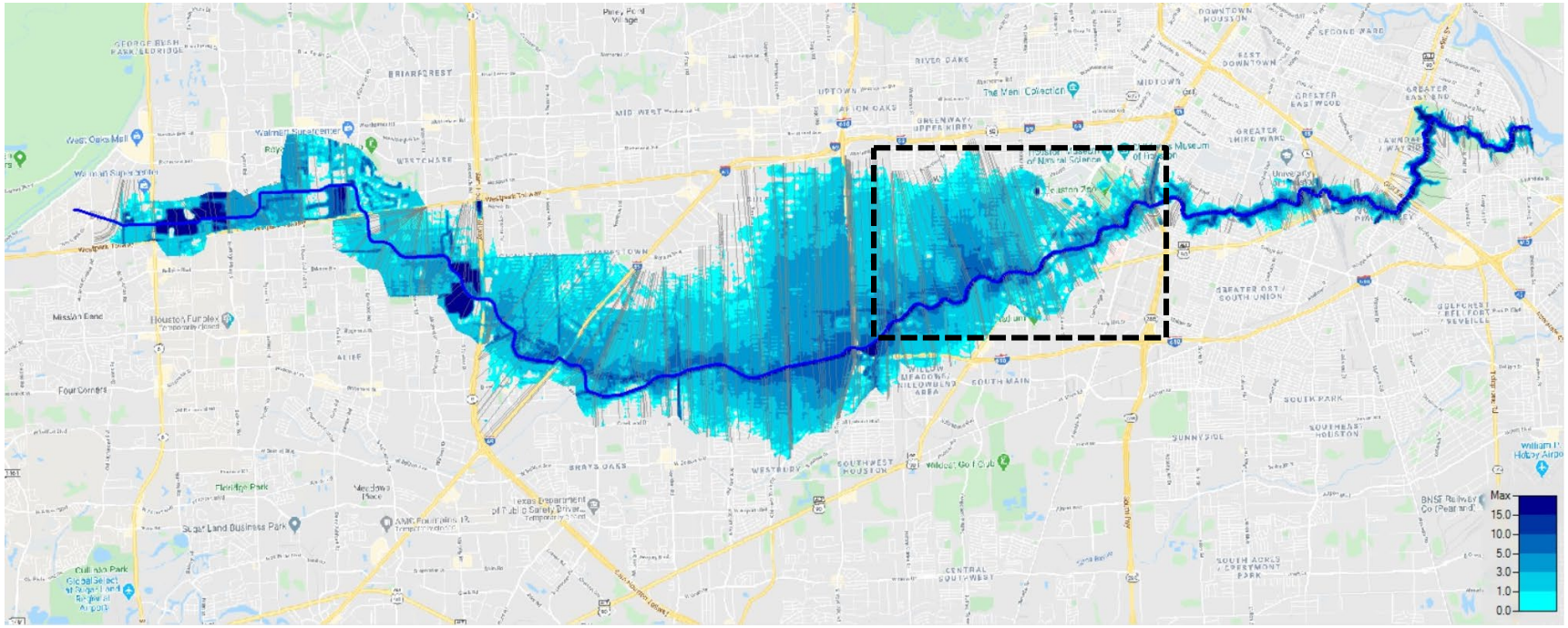
- HEC-RAS 1D models available for all studied bayous
- Computes peak flow (Qp) and water surface elevation (WSE) at each cross-section (400 cross sections).





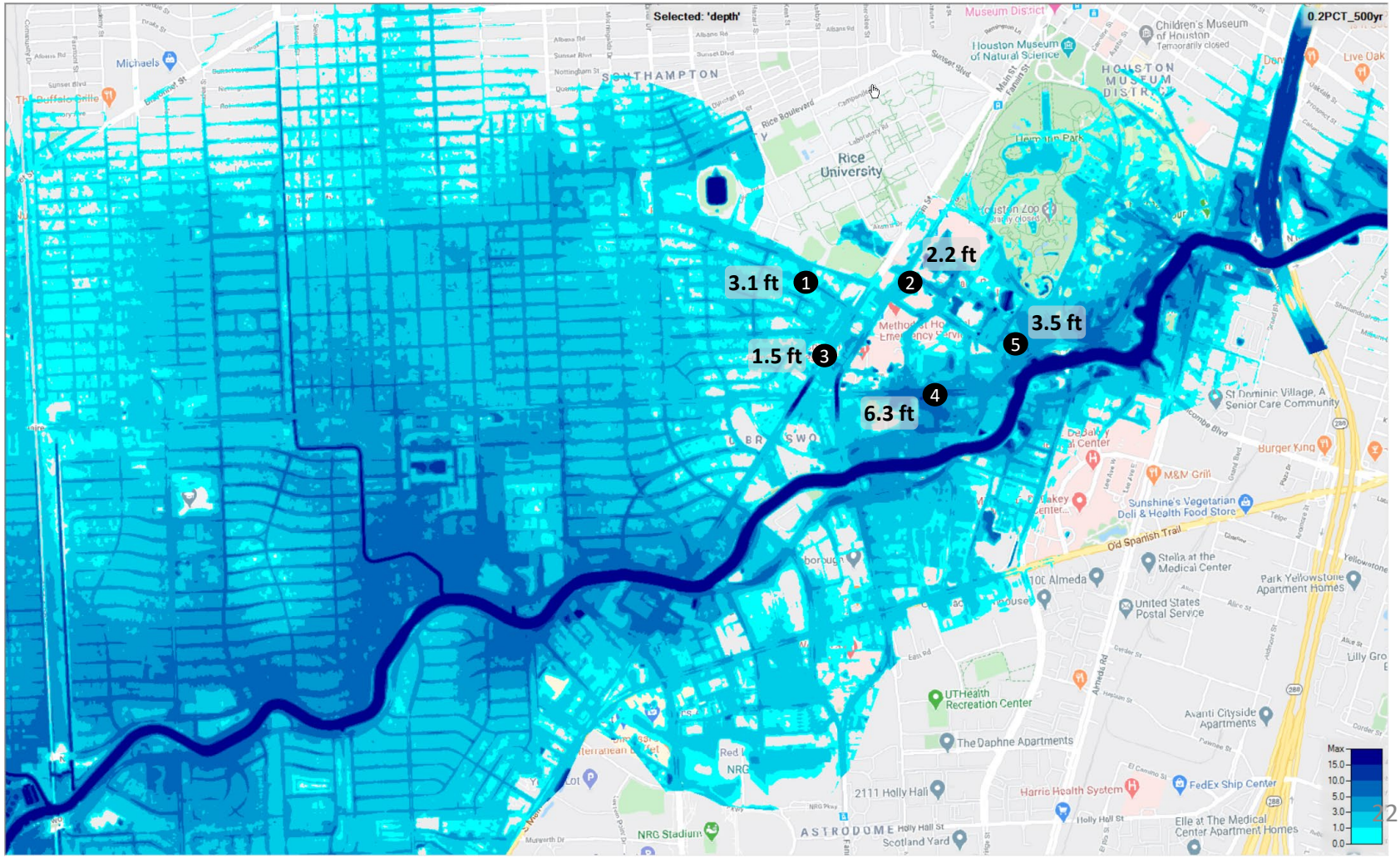
Brays Bayou (Modeled Flood Depth)

- Generates flood hazard maps (flood depth and flood elevation) by interpolating between cross-sections
- Estimated flood hazard at street level and designated watchpoints



Brays Bayou (Modeled Flood Depth)

MODELED FLOOD DEPTH AT CRITICAL INTERSECTIONS



FAS5 Website during Beta

SEP 22, 2020 AT 08:49

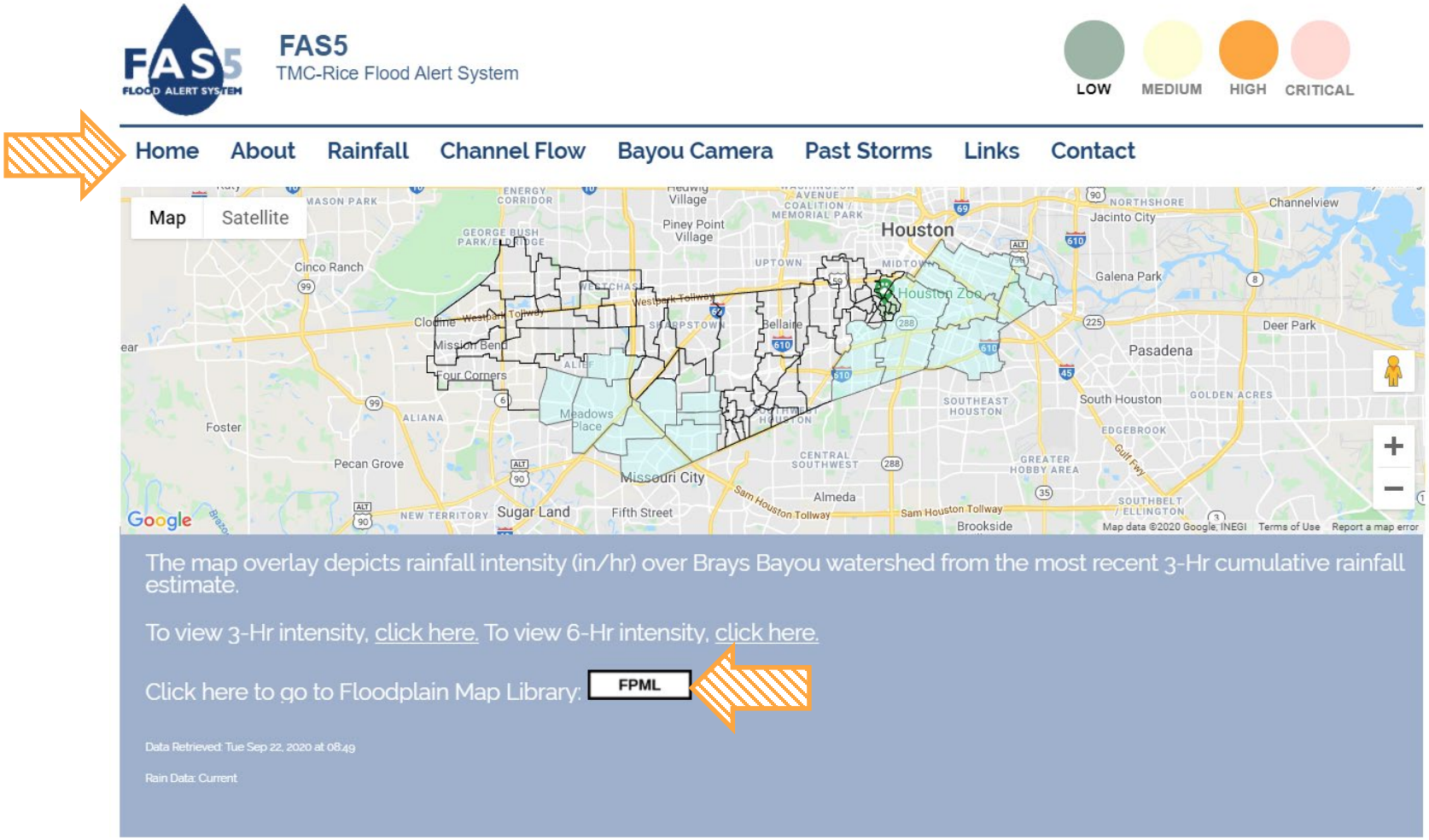


Figure 10

13 INCHES IN 24 HOURS OVER BRAYS BAYOU (FLOOD MAP)

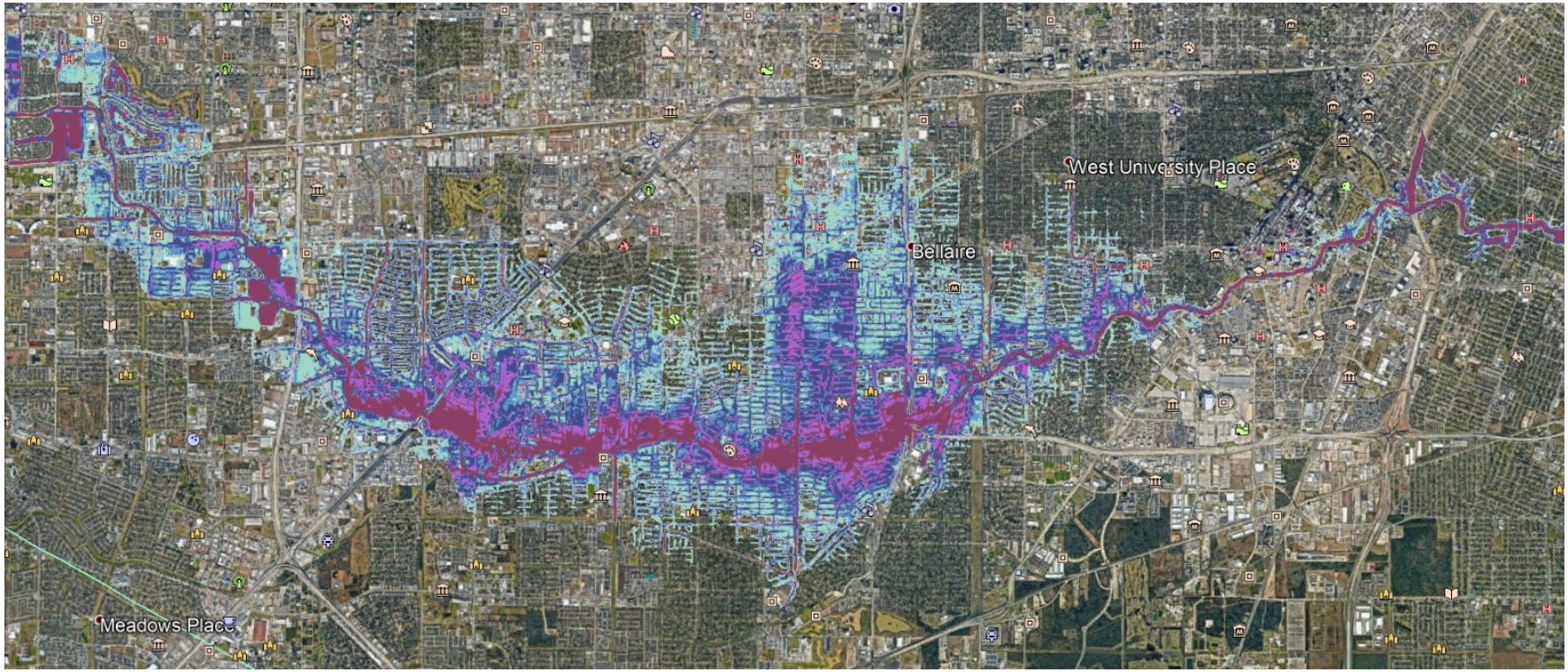
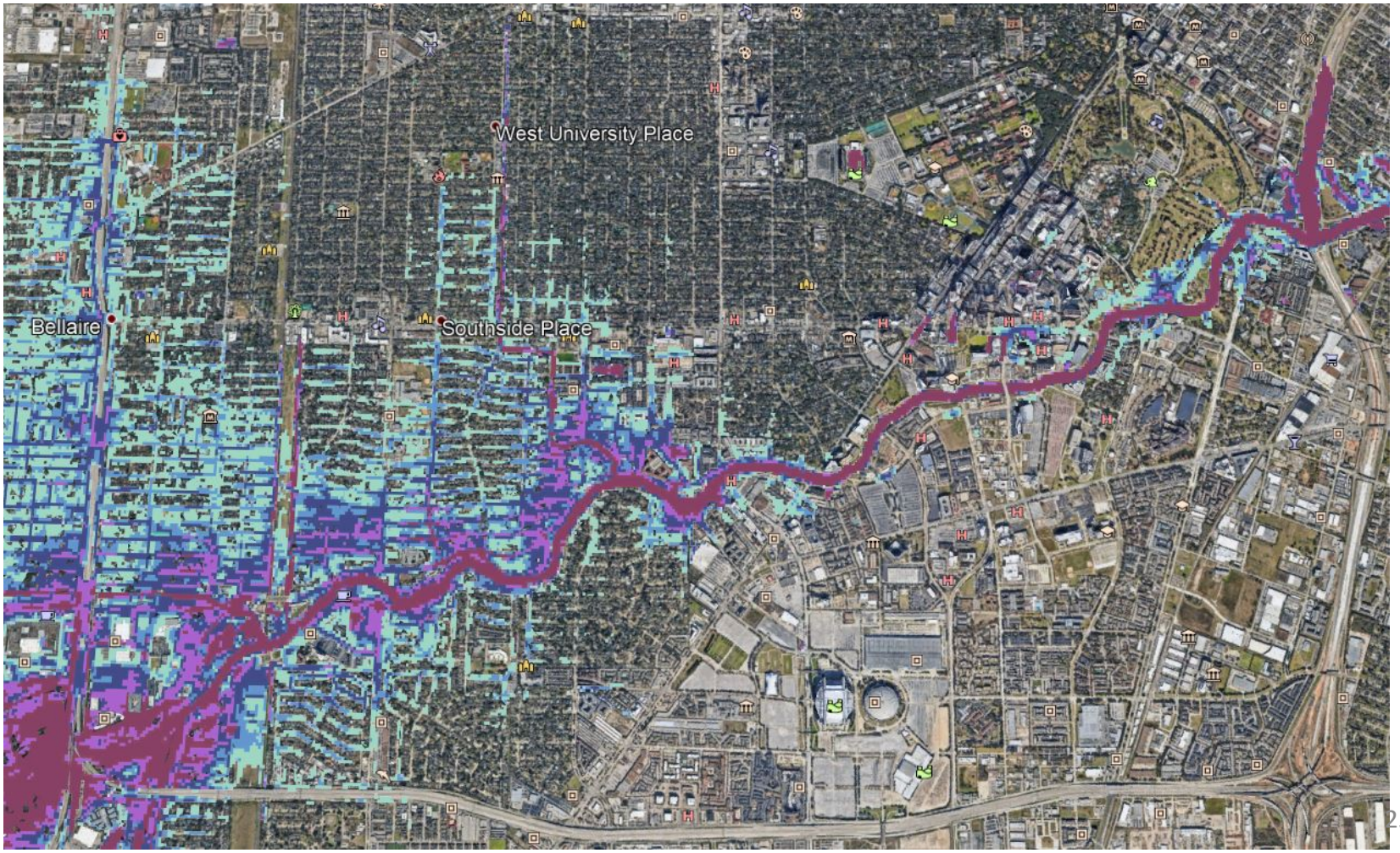


Figure 10 – Zoomed In

13 INCHES IN 24 HOURS OVER BRAYS BAYOU (FLOOD MAP)

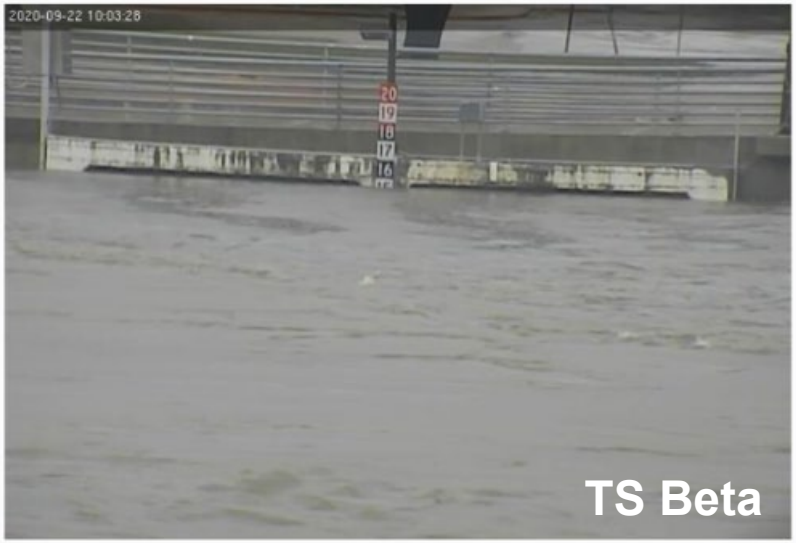


FAS5 Website: Gully Comparison

HARRIS GULLY CAM

Tue Sep 29, 2020 at 14:46

Tue Sep 22, 2020 at 10:03



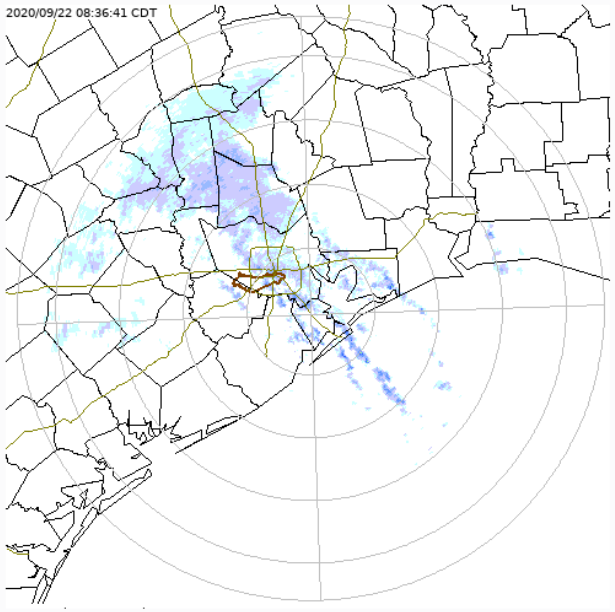
Bayou cameras provide vital water levels and visual confirmation during a flood event. The Harris Gully Gage was selected as the critical point to view gage activity for the Rice/TMC system. Gully levels are automatically communicated to TMC.

FAS5 Website during Beta

RAINFALL

Tue Sep 22, 2020 at 08:53

Radar Rainfall



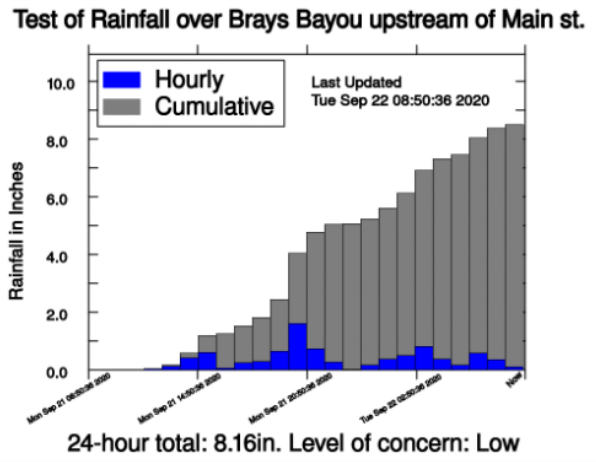
Zoom Selection

Regional | Eight Counties | Harris County | Brays Bayou

Radar Speed

Slow | Normal | Fast

Average Rainfall



Last 24 Hours

Levels of Concern	-3 Hr	-6 Hr	-9 Hr	-12 Hr
Low	4.0	4.8	5.7	6.8
Medium	4.0	4.8	5.7	6.8
High	4.0	4.8	5.7	6.8
Critical	4.0	4.8	5.7	6.8

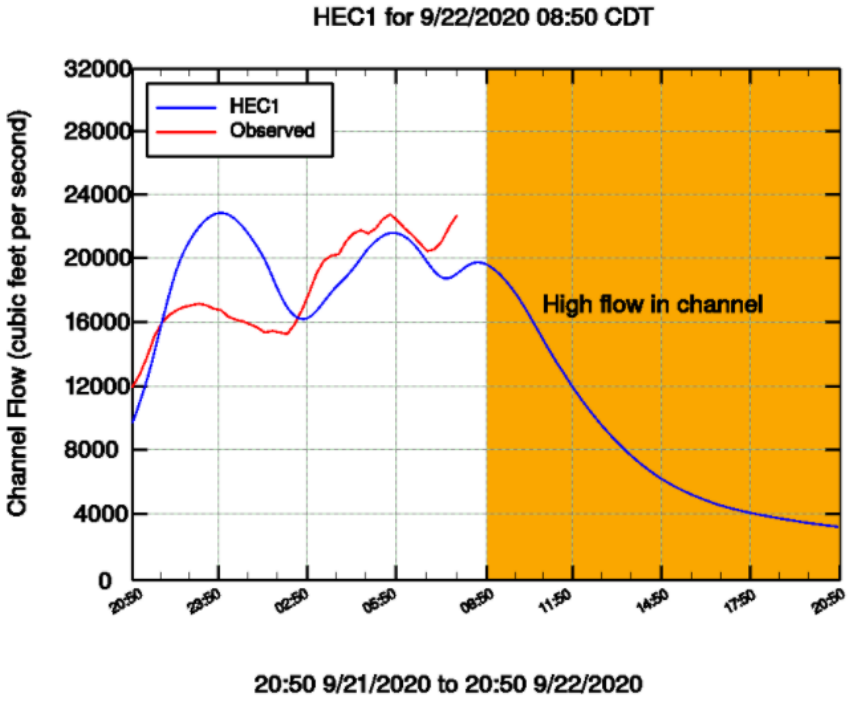
FAS5 Website during Beta

SEP 22, 2020 AT 08:53 & 10:02

CHANNEL FLOW

Tue Sep 22, 2020 at 08:53

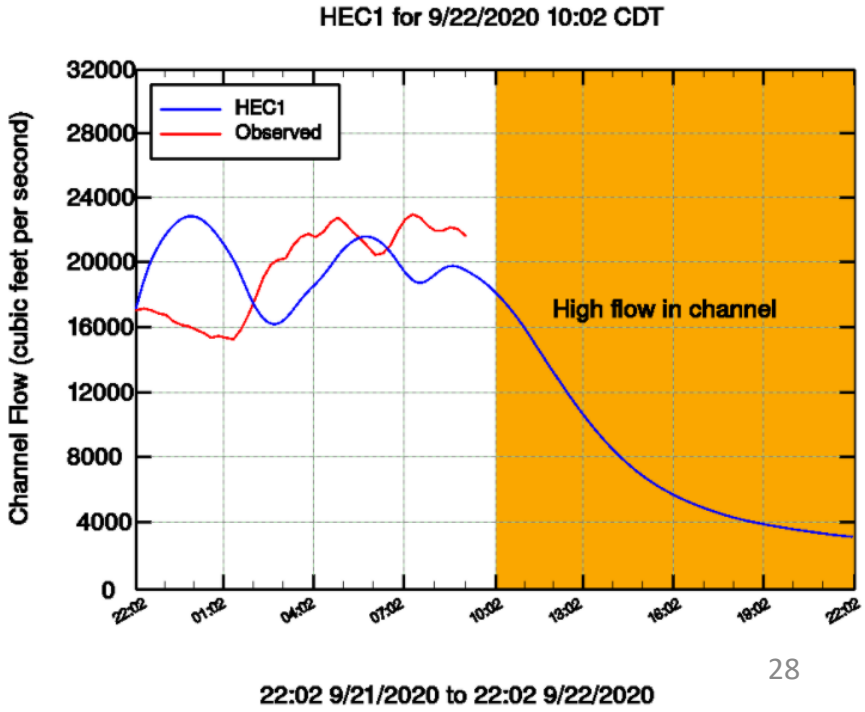
Hydrograph (HEC)



CHANNEL FLOW

Tue Sep 22, 2020 at 10:02

Hydrograph (HEC)



Conclusions

- FAS5 (fas5.org) is one of most reliable flood prediction tools around, with excellent performance for the past 20 years (prediction accuracy of R2 = 0.88).
- Software & Website was completely updated Feb - June 2020.
- Useful tool to inform TMC regarding the vulnerability from potential flood disasters as Houston infrastructure expands – could be linked to intersections and road inundation models.
- FAS4 mobile web app provides quick and easily accessible flood warning information on mobile devices (e.g., smartphones and tablets). (mobile.fas4.org)
- Future work needs to be done to upgrade FAS5 to include new channel
- FAS and Mobility needs to be linked for TMC access/emergency vehicles.