

FORT BEND COUNTY HURRICANE HARVEY IMPACTS



Seven-Day Observed Precipitation (Inches) Ending Friday September 01, 2017 700 AM CDT

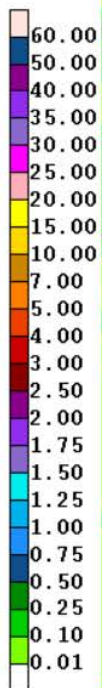
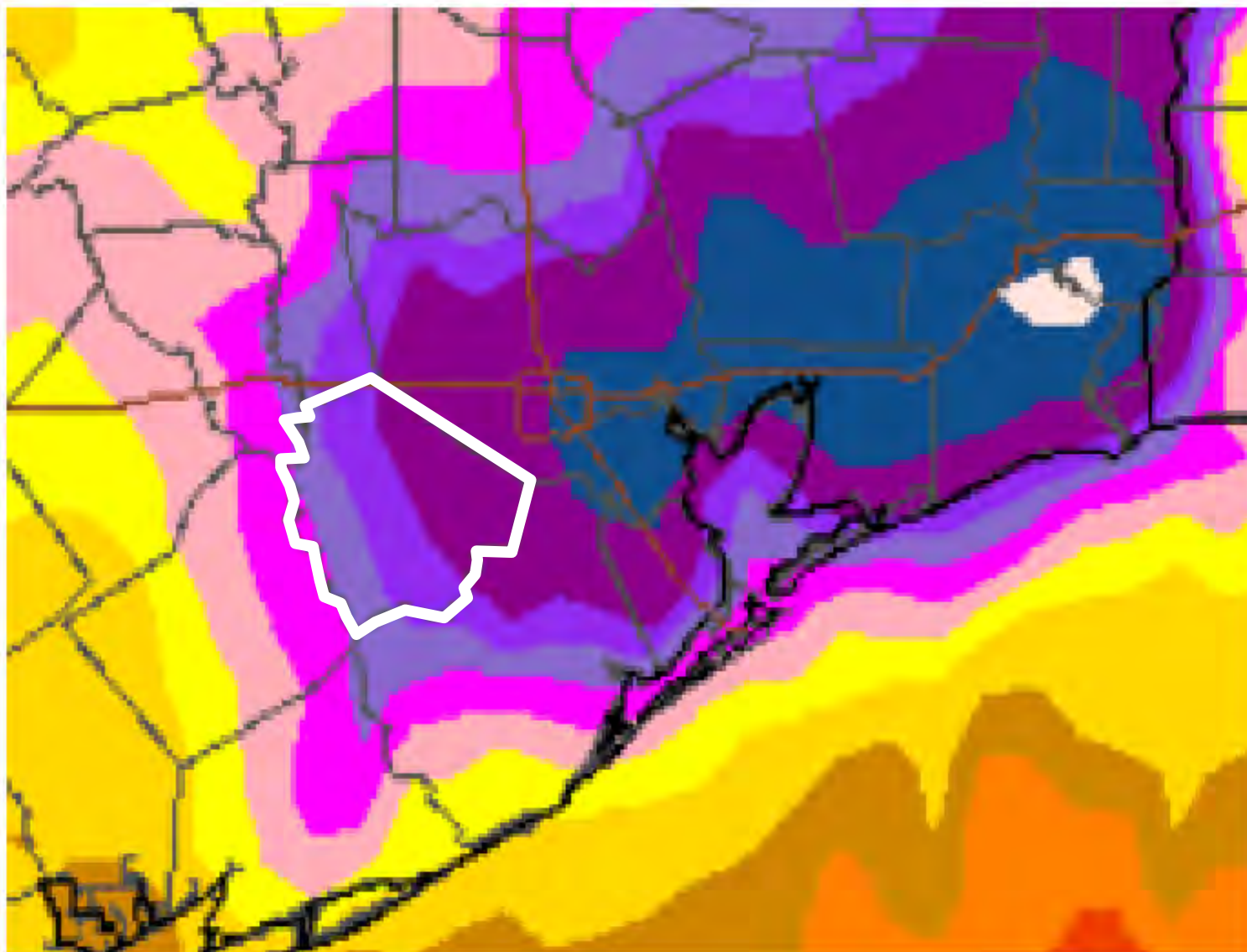
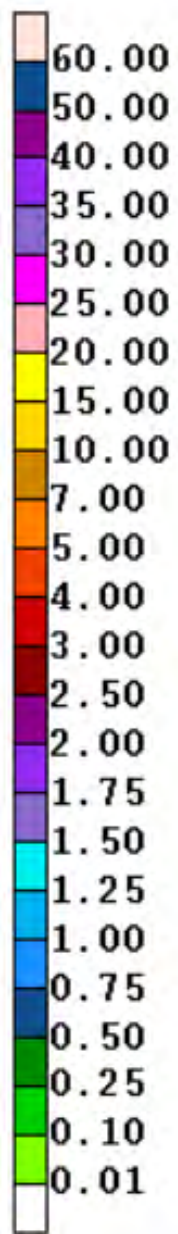


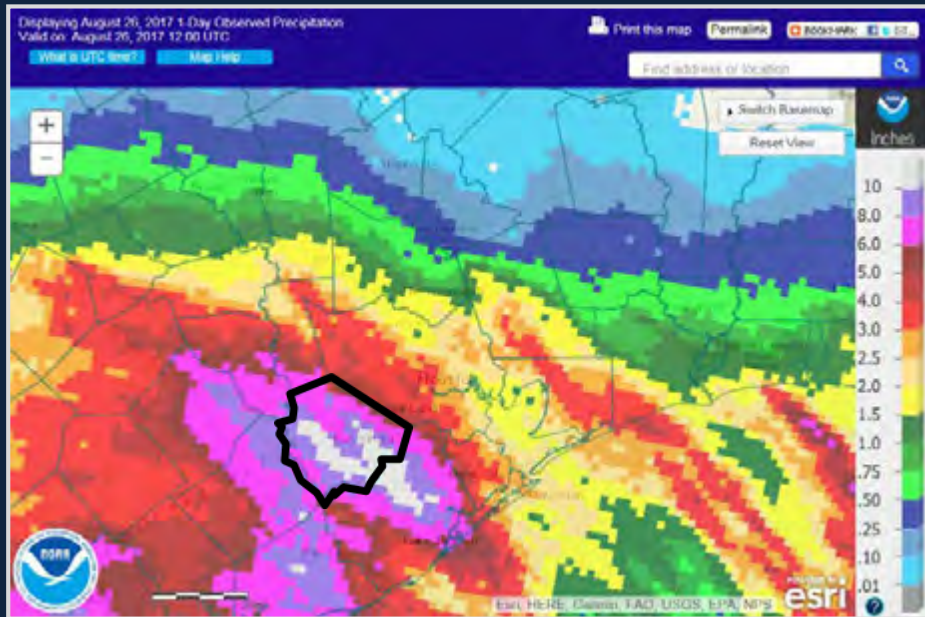
Image created by the
Weather Prediction Center
1019 PM EDT THU SEP 21 2017



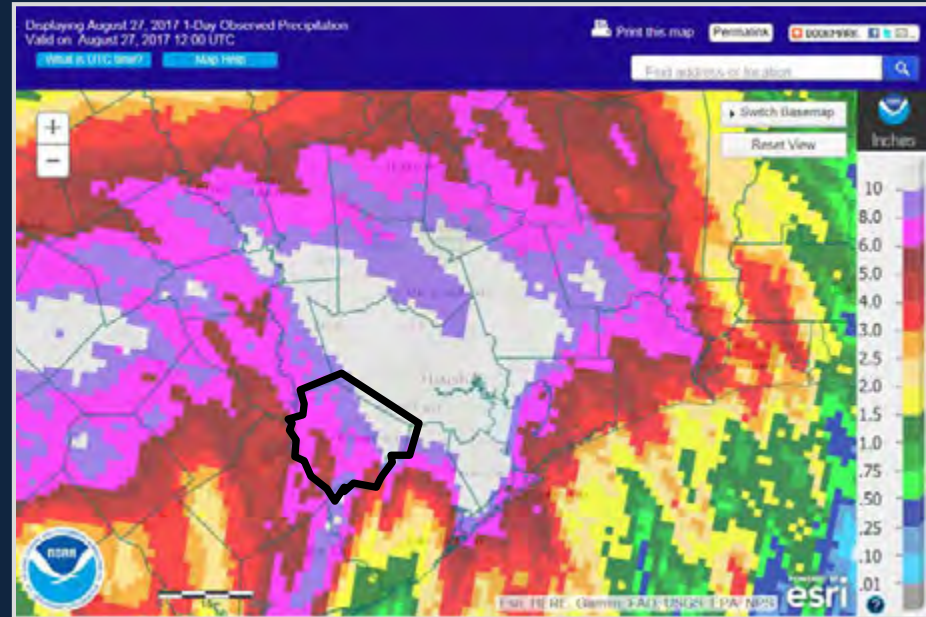
Max: 62.07 inches



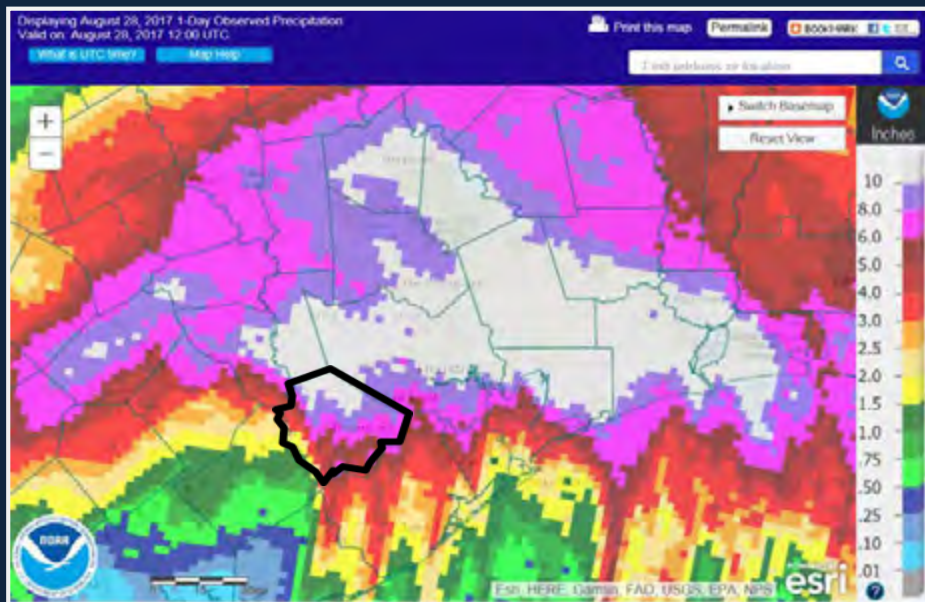
DAY 1



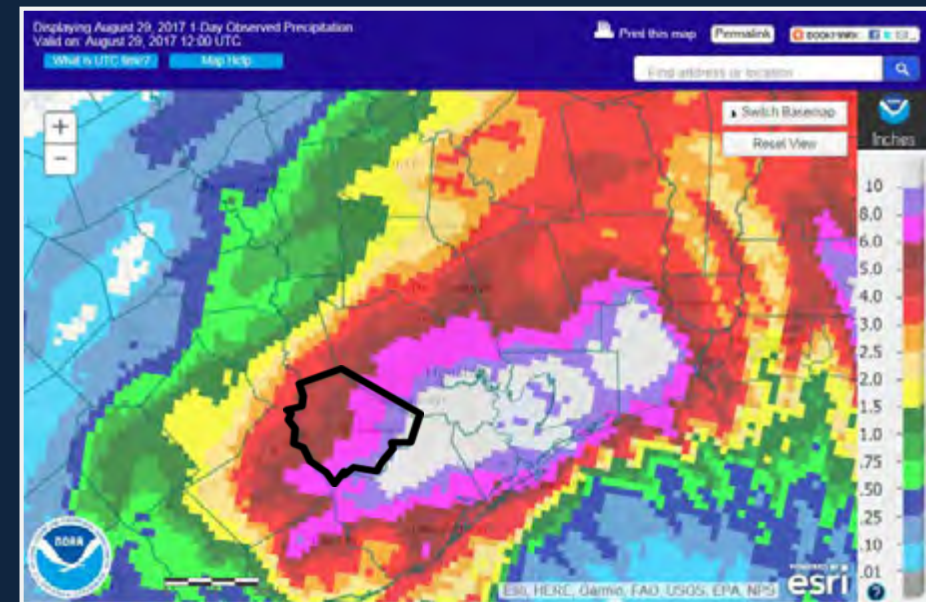
DAY 2



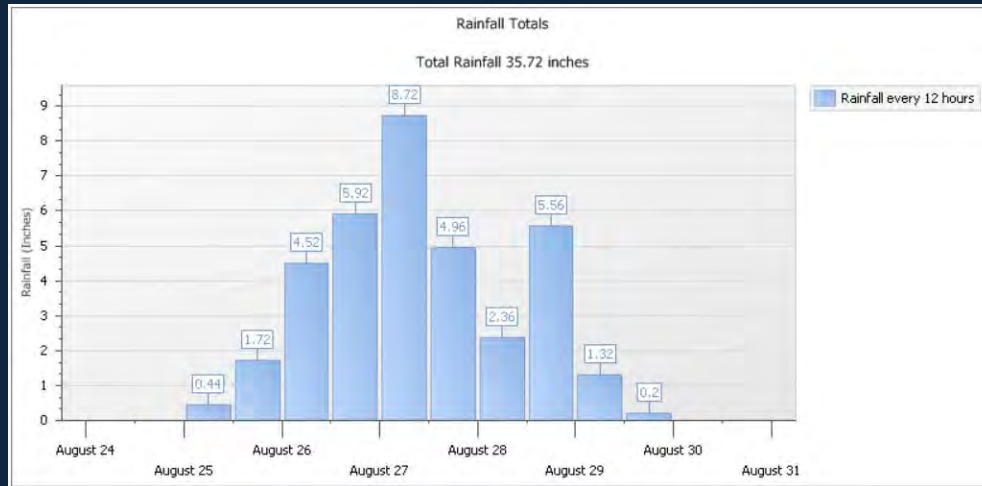
DAY 3



DAY 4



East Sugar Creek Ditch at Country Club Blvd.



Peak Rainfall Intensities:

12HR – 8.72"

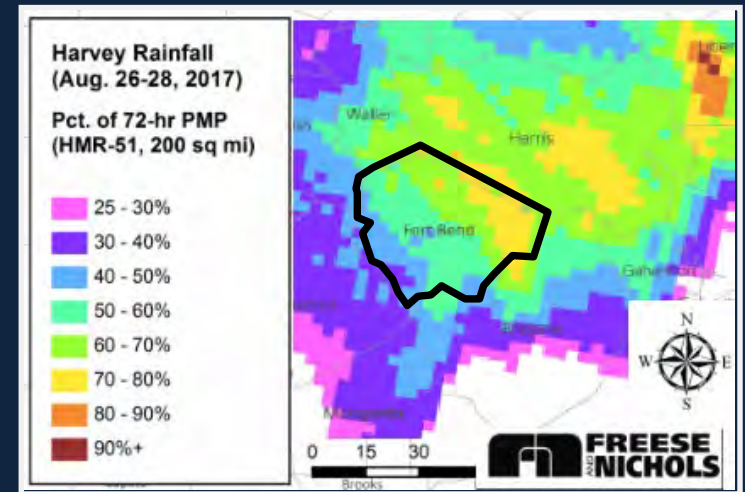
24HR – 14.64"

48HR – 24.12"

72HR – 32.04"

Houston Max Daily Rainfall Totals (July 1888 - July 2017)		
1	10.34"	June 25, 1989
2	9.92"	April 18, 2016
3	9.25"	Oct. 25, 1984
4	8.13"	June 8, 2001
5	8.04"	Oct. 28, 2002

PMP Analysis



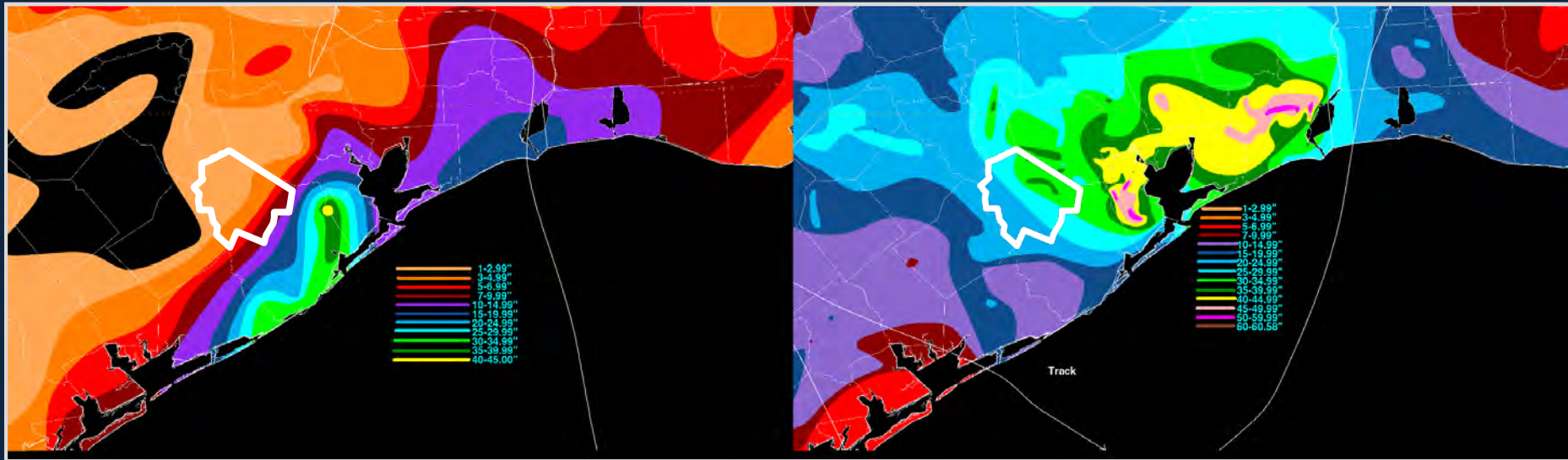
Probable Maximum Precipitation:

Defined by NWS as “theoretically, the greatest depth of precipitation for a given duration that is physically possible over a given storm area at a particular geographic region at a certain time of the year.”

Claudette – June 1979

vs

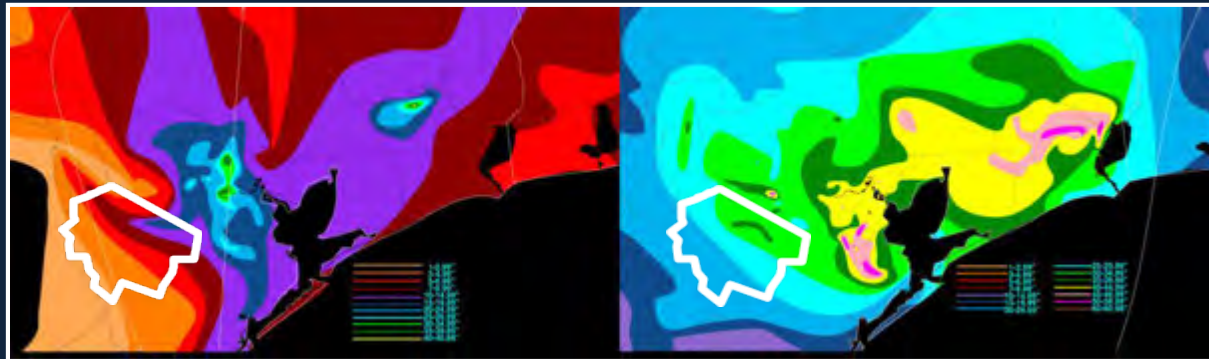
Harvey – August 2017



Allison – June 2001

vs

Harvey – August 2017



Source: NWS WPC – Comparison of Hurricane Harvey Total Precip. to TS Claudette & TS Allison

Challenges:



Challenges:

Colorado Pouring into San Bernard River

Post Hurricane Harvey



West Gulf
River Forecast Center

FROM ONE RIVER...

Colorado River at Wharton:

Water rose high enough to
go above the natural
Colorado Watershed



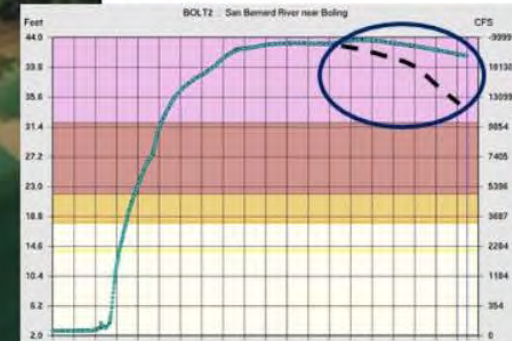
This caused the hydrograph
to “flatten out” as water
didn’t continue to rise but
pour into San Bernard
watershed



TO ANOTHER

San Bernard River nr Boling:

Water was high from local
rainfall upstream but stayed
high much longer then gages
upstream

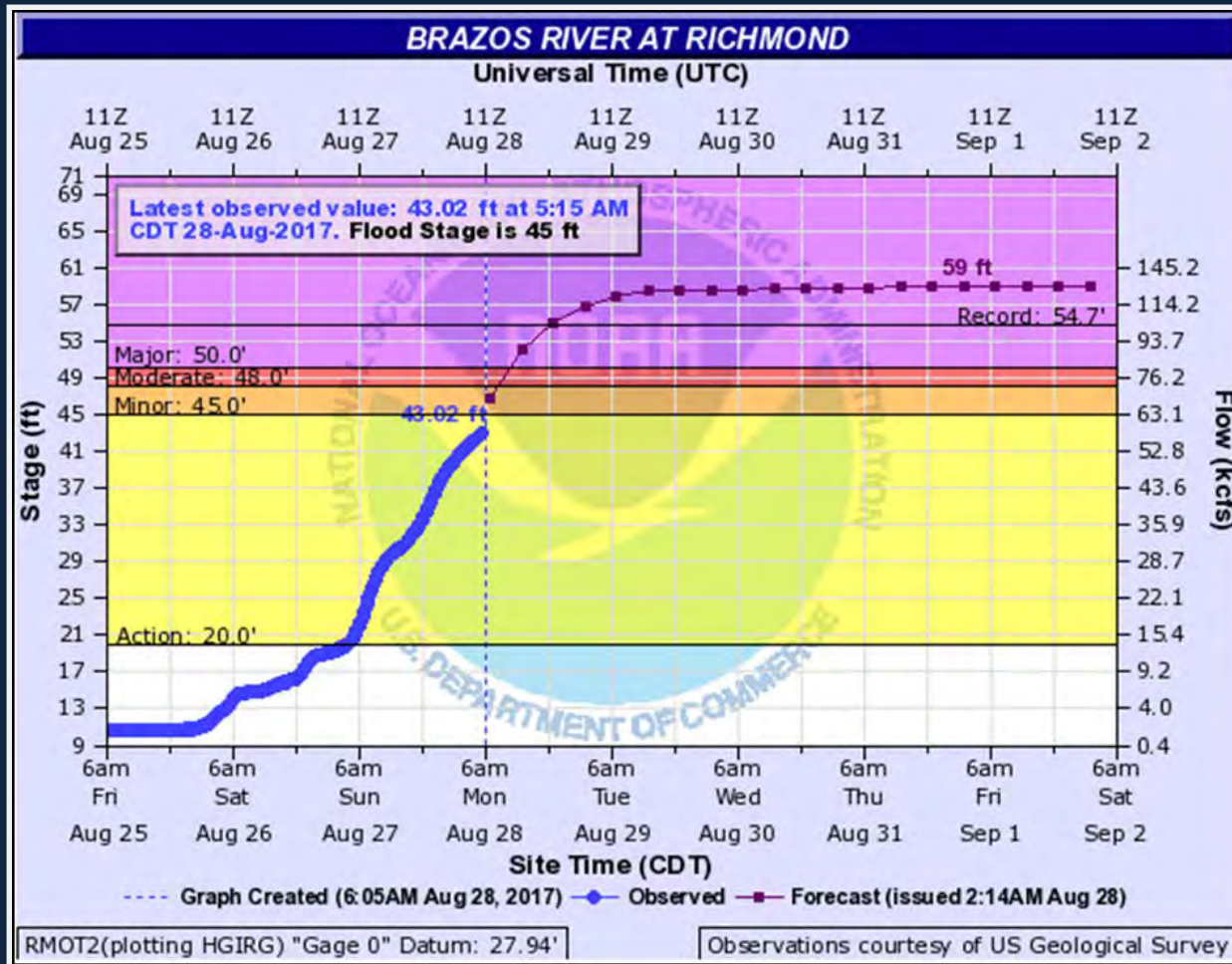


This caused the hydrograph
to extend out longer as
water from the Colorado
kept levels higher for a
couple of days

9/3/2017 12:14 PM

www.weather.gov

Challenges:



8/27/17

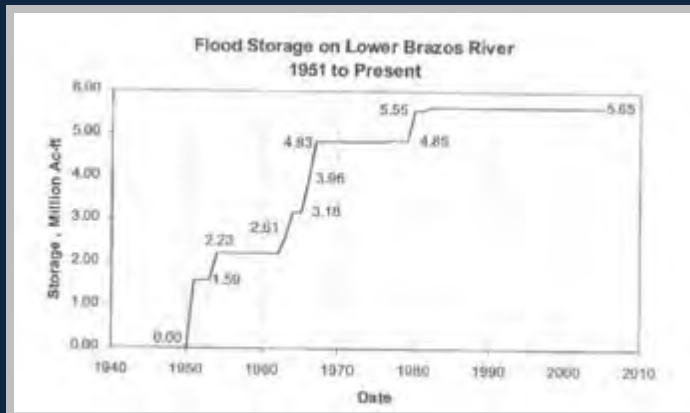
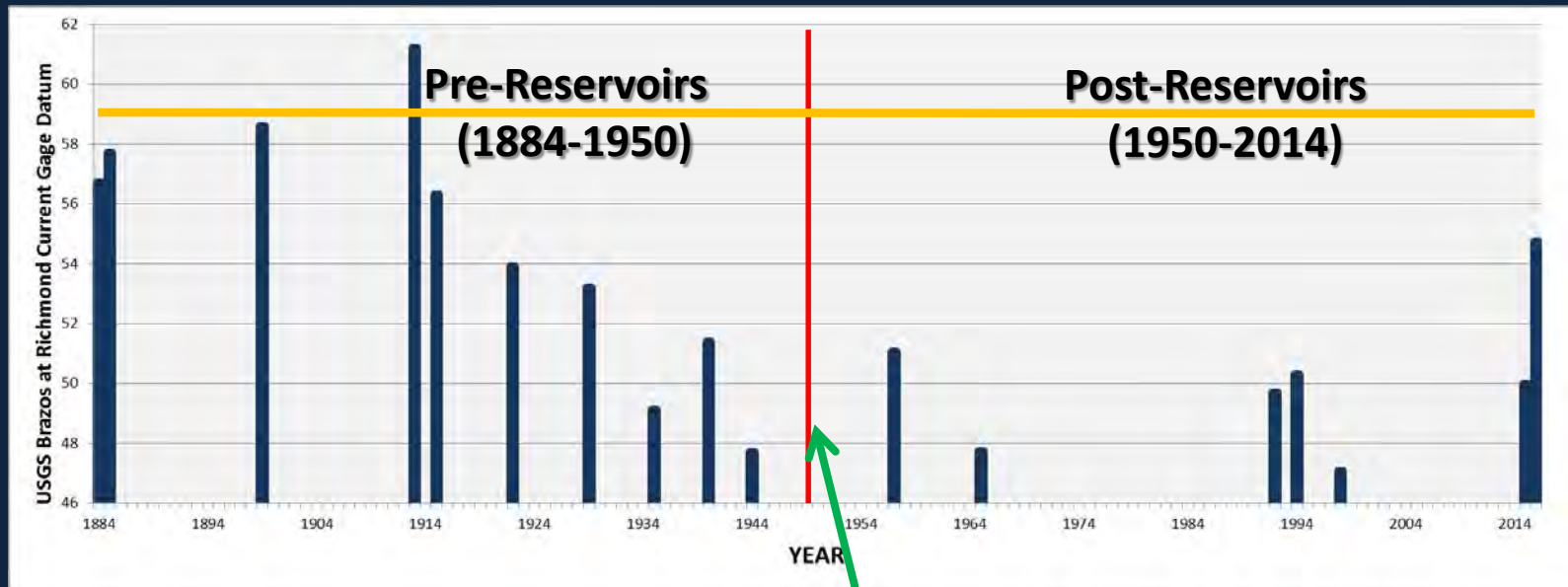
Brazos River
Forecast of
59' at
Richmond



Brazos River at Richmond – Looking Downstream

May 30, 2015, 4PM - Gage Elevation 48.76'

Appx. Brazos at Richmond Elevations Above 47' (USGS Gage Datum Stage)



Beginning around 1950 approximately 5.6 million acre-feet of flood control storage has been constructed in the upstream Brazos River watershed.

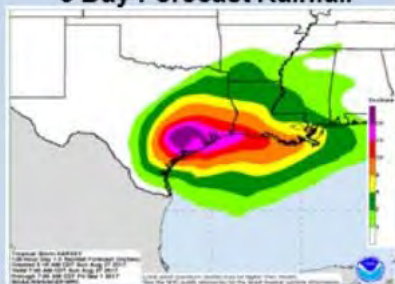
What Goes In A River Forecast?

Forecast and Current Rain Goes Into a Model Taking Current Conditions and Forecaster Knowledge to Create a River Forecast to Make a Flood Warning

Rain on the Ground



3 Day Forecast Rainfall



Soil Conditions



Lake Releases



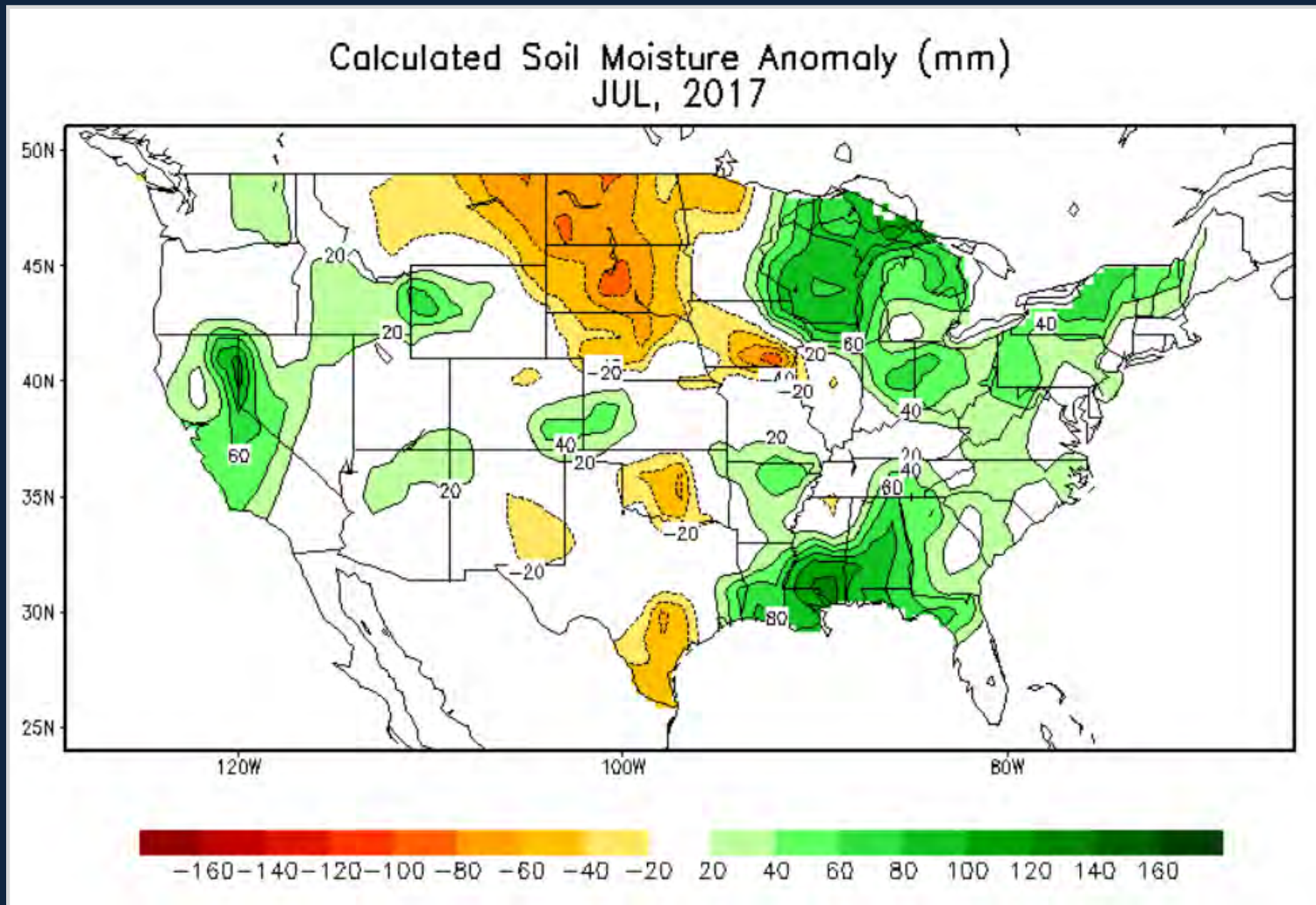
River Forecast



Flood Warning



Soil Conditions:



Upstream Brazos River Reservoirs

12 Reservoirs
5 Million Ac-Ft of Flood Storage

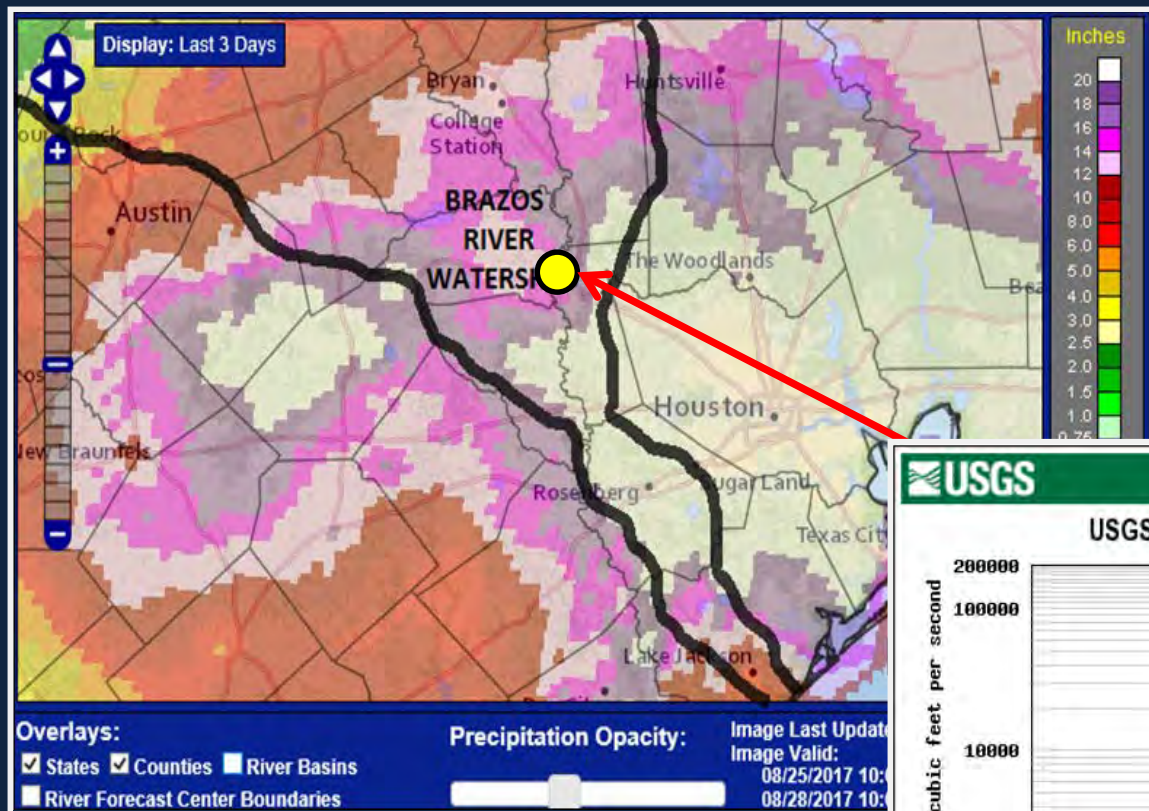


Lake Somerville
(Spring 2016)



- Upstream reservoirs all had full flood storage prior to Harvey, little to no releases
- Majority of rain fell downstream of reservoirs except for Lake Somerville
- Lake Somerville rose 17' over 5 days
- Two and a half "dry months" later there is still water in flood pool
- Current releases are 357 cfs (Harvey rainfall is still flowing down the Brazos River)

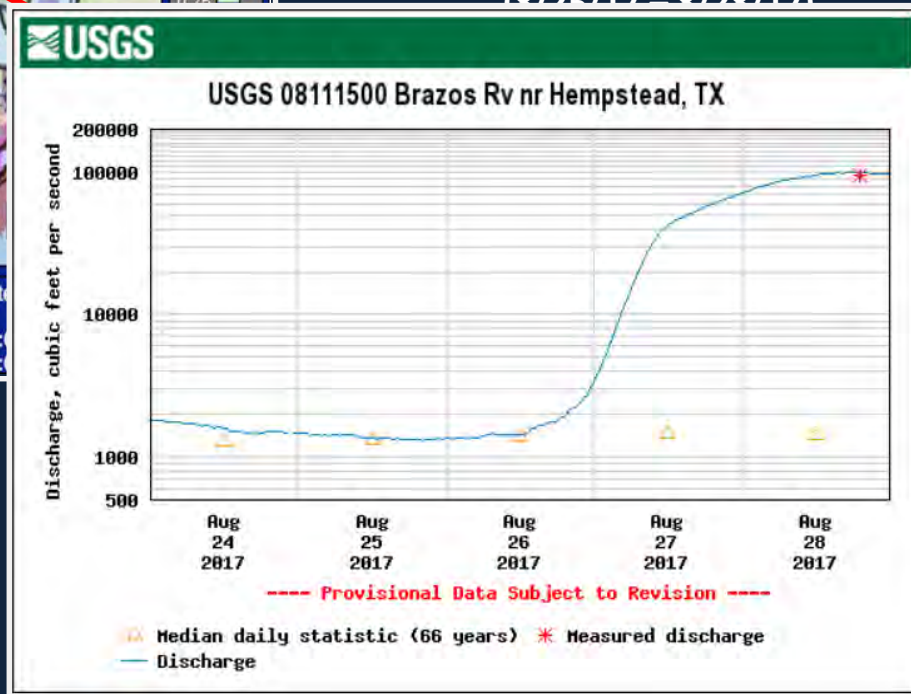
Rain on the Ground:



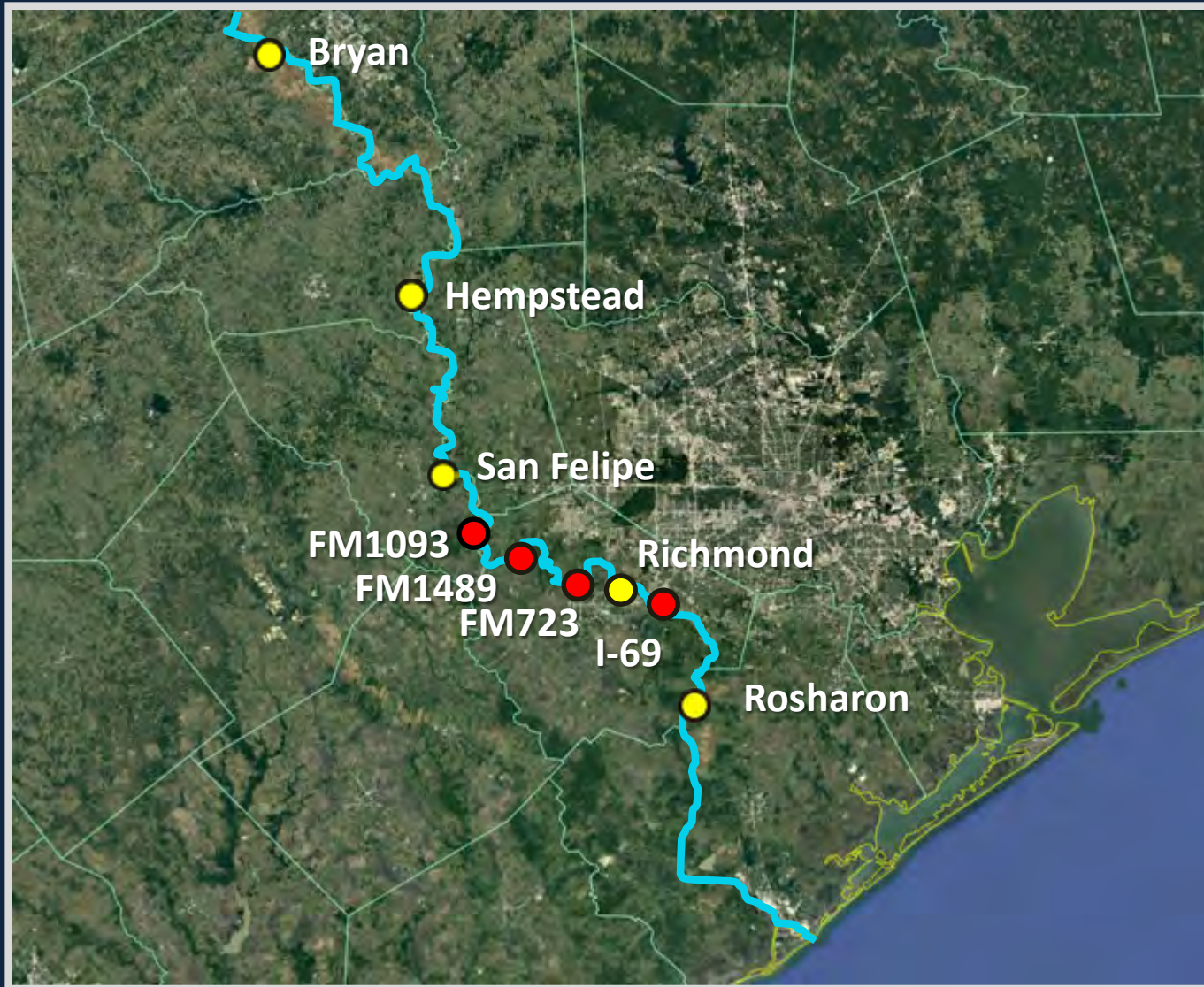
COLLEGE STATION MAXIMUM MONTHLY TOTAL PRECIP

NO.	MONTH	TOTAL
1	AUGUST 2017	21.02"
2	OCTOBER 1994	18.77"
3	JANUARY 1991	15.60"
4	JUNE 1905	15.03"
5	SEPT. 1889	14.86"

College Station Rainfall total
(8/25/17 - 8/28/17)



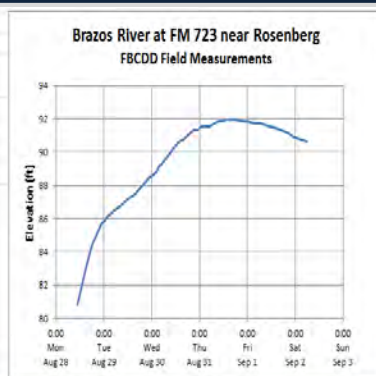
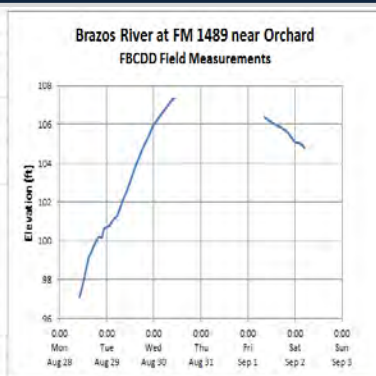
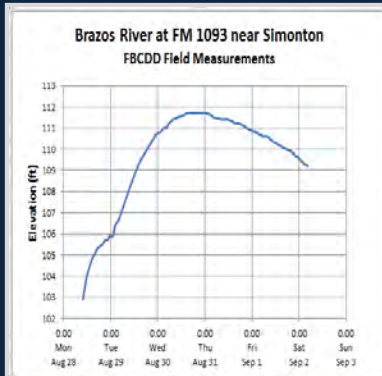
Stage/Flow Measurement Locations:



● USGS
Gage

● FBCDD
Field
Measurements

FBCDD Field Measurements



4 Additional Bridge
Locations to Supplement
USGS/NWS Forecast Data

Appx. 3-Hours between
Measurements

Field Measurements
related to FBCEOC

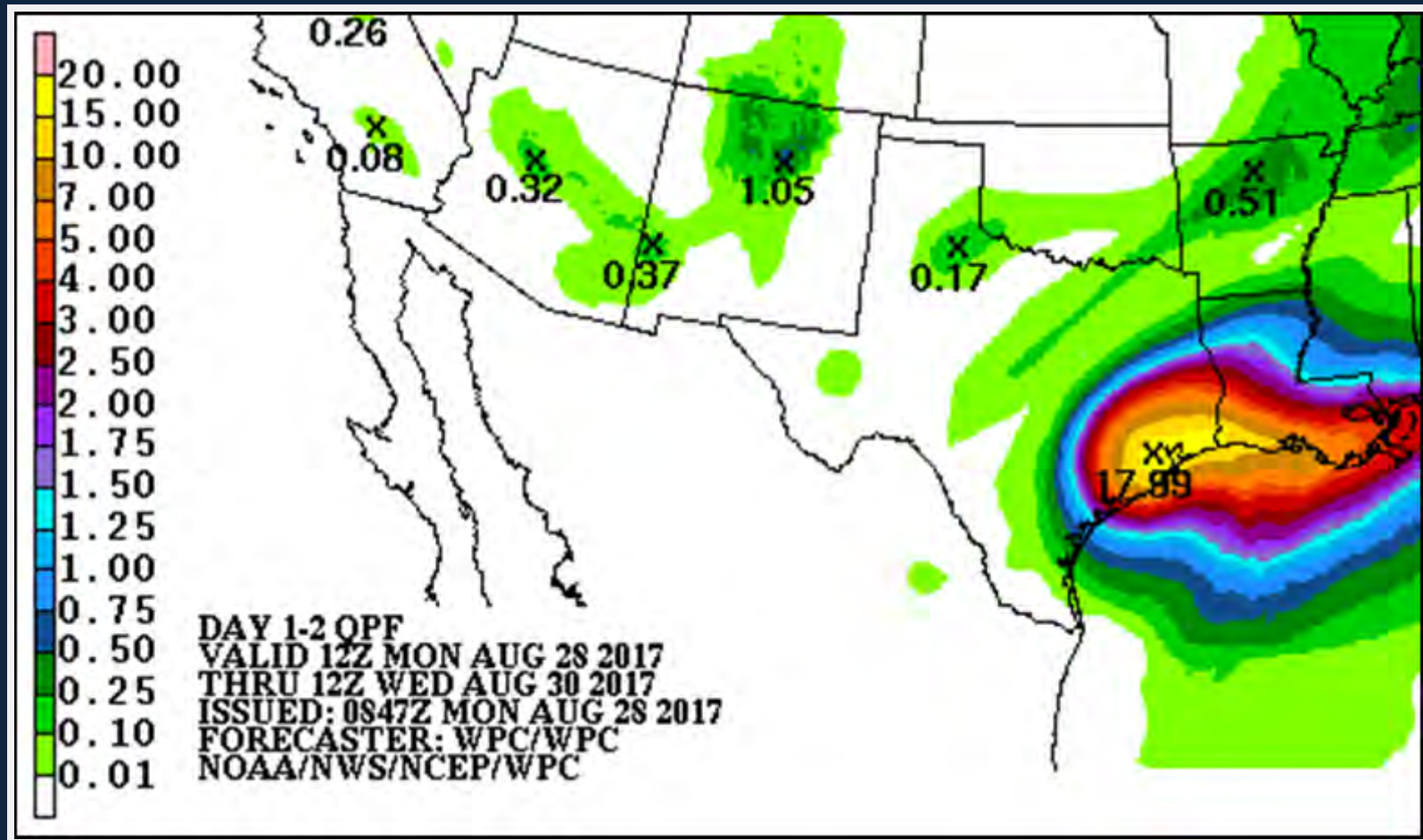
Input into Spreadsheet
and Emailed to WGRFC

FM 1093 near Simonton					
Appox. EL	Measurement	Date & Time	Change	Rate (ft/hr)	
Spring 2016 Peak = 111.01					
102.91	31.70	8/28/2017 9:50			
104.01	30.60	8/28/2017 11:55	1.10	0.53	
104.81	29.80	8/28/2017 14:30	0.80	0.31	
105.01	29.60	8/28/2017 15:45	0.20	0.16	
105.31	29.30	8/28/2017 17:15	0.30	0.20	
105.51	29.10	8/28/2017 19:50	0.20	0.08	
105.71	28.90	8/28/2017 21:20	0.20	0.13	
105.71	28.90	8/28/2017 22:25	0.00	0.00	
105.91	28.70	8/28/2017 23:39	0.20	0.16	
105.91	28.70	8/29/2017 1:12	0.00	0.00	
106.41	28.20	8/29/2017 2:22	0.50	0.43	
106.61	28.00	8/29/2017 3:51	0.20	0.13	
106.91	27.70	8/29/2017 5:03	0.30	0.25	
107.71	26.90	8/29/2017 8:00	0.80	0.27	
108.21	26.40	8/29/2017 9:50	0.50	0.27	
108.61	26.00	8/29/2017 11:25	0.40	0.25	
109.31	25.30	8/29/2017 14:25	0.70	0.23	
109.61	25.00	8/29/2017 16:05	0.30	0.18	
110.51	24.10	8/29/2017 21:54	0.90	0.15	
110.71	23.90	8/29/2017 23:05	0.20	0.17	
110.81	23.80	8/30/2017 1:10	0.10	0.05	
111.01	23.60	8/30/2017 3:02	0.20	0.11	

FM 1489 near Orchard					
Appx. EL	Measurement	Date & Time	Change	Rate (ft/hr)	
Spring 2016 Highest Measured Elev. = 106.50 (Inaccessible at Peak)					
97.10	35.10	8/28/2017 10:10			
98.00	34.20	8/28/2017 12:25	0.90		0.40
99.10	33.10	8/28/2017 14:45	1.10		0.47
99.40	32.80	8/28/2017 16:05	0.30		0.22
99.80	32.40	8/28/2017 17:45	0.40		0.24
100.20	32.00	8/28/2017 20:00	0.40		0.18
100.20	32.00	8/28/2017 21:35	0.00		0.00
100.60	31.60	8/28/2017 22:40	0.40		0.37
100.70	31.50	8/28/2017 23:56	0.10		0.08
100.80	31.40	8/29/2017 1:32	0.10		0.06
101.00	31.20	8/29/2017 2:45	0.20		0.16
101.20	31.00	8/29/2017 4:17	0.20		0.13
101.30	30.90	8/29/2017 5:22	0.10		0.09
102.20	30.00	8/29/2017 8:40	0.90		0.27
102.60	29.60	8/29/2017 10:20	0.40		0.24
104.40	27.80	8/29/2017 16:50	1.80		0.28
105.60	26.60	8/29/2017 22:17	1.20		0.22
105.90	26.30	8/29/2017 23:28	0.30		0.25
107.20	25.00	8/30/2017 8:45	1.30		0.14
107.40	24.80	8/30/2017 11:00	0.20		0.09
106.40	25.80	9/1/2017 8:15	-1.00		-0.02

FM 723 near Rosenberg					
Appx. EL	Measurement	Date & Time	Change	Rate (ft/hr)	
Spring 2016 Peak = 91.45					
80.85	26.50	8/28/2017 10:45			
81.95	25.40	8/28/2017 12:55	1.10	0.51	
83.15	24.20	8/28/2017 15:15	1.20	0.51	
83.75	23.60	8/28/2017 16:35	0.60	0.45	
84.45	22.90	8/28/2017 18:10	0.70	0.44	
85.05	22.30	8/28/2017 20:23	0.60	0.27	
85.45	21.90	8/28/2017 21:57	0.40	0.26	
85.75	21.60	8/28/2017 23:00	0.30	0.29	
85.85	21.50	8/29/2017 0:19	0.10	0.08	
86.15	21.20	8/29/2017 1:50	0.30	0.20	
86.25	21.10	8/29/2017 3:05	0.10	0.08	
86.45	20.90	8/29/2017 4:35	0.20	0.13	
86.55	20.80	8/29/2017 5:43	0.10	0.09	
86.85	20.50	8/29/2017 9:10	0.30	0.09	
87.05	20.30	8/29/2017 10:50	0.20	0.12	
87.25	20.10	8/29/2017 12:45	0.20	0.10	
87.45	19.90	8/29/2017 15:20	0.20	0.08	
87.75	19.60	8/29/2017 17:25	0.30	0.14	
88.45	18.90	8/29/2017 22:35	0.70	0.14	
88.55	18.80	8/29/2017 23:52	0.10	0.08	
88.85	18.50	8/30/2017 2:27	0.30	0.12	
89.15	18.20	8/30/2017 3:35	0.30	0.26	

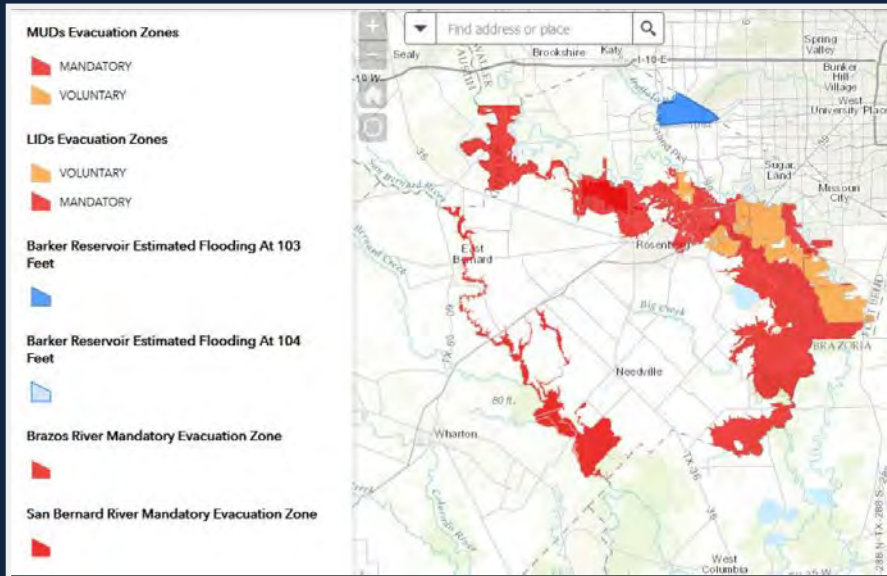
Forecast Rainfall:



SPECIFIC LEVEE CHALLENGES:

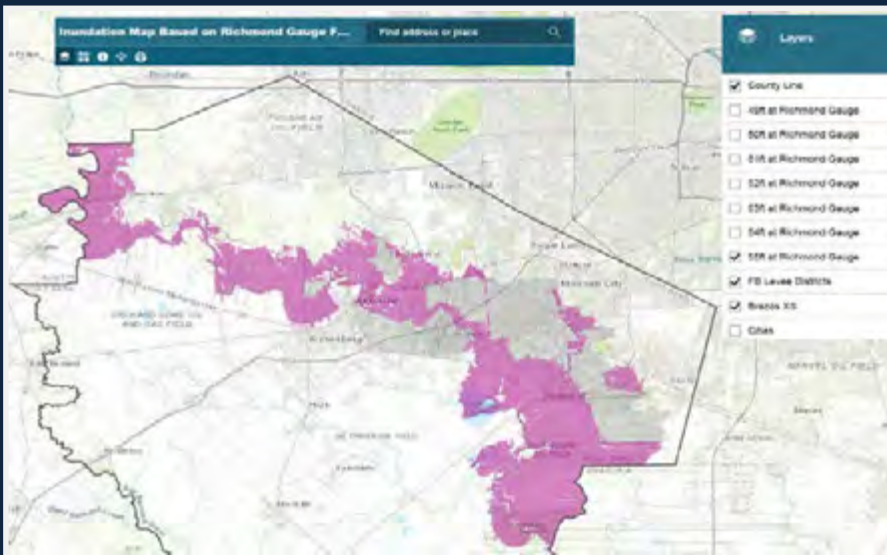
- Limited Evacuation Routes
 - Local Streets
 - Major Highways
- Very Quick Rise
- Watershed Overflows
- 59' Forecast extended beyond effective HEC-RAS Cross Sections
- Record Levels for Extended Duration
- Access to Levees due to High Water
- Minimal Amount of Levee Freeboard at Forecast Levels
- Amount of Information that Needed to be Conveyed
- Emergency Services





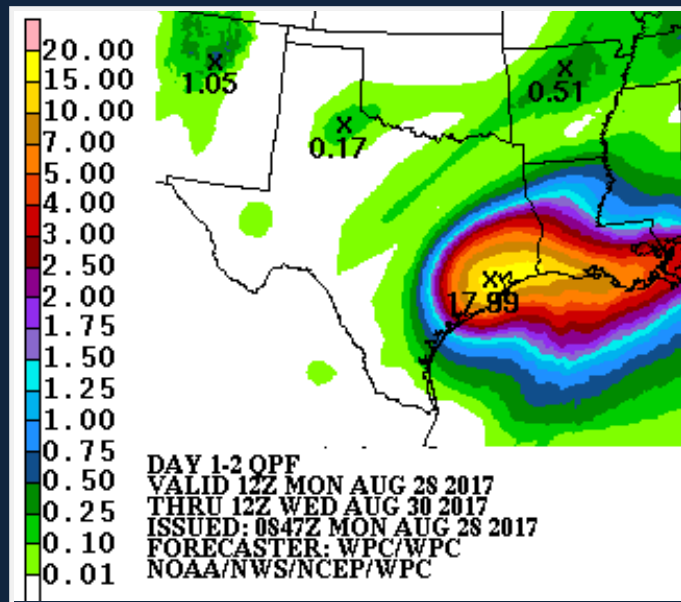
**COORDINATION WITH
OTHER JURISDICTIONS**

**EVACUATION ORDERS
ISSUED BASED ON BEST
AVAILABLE INFORMATION**



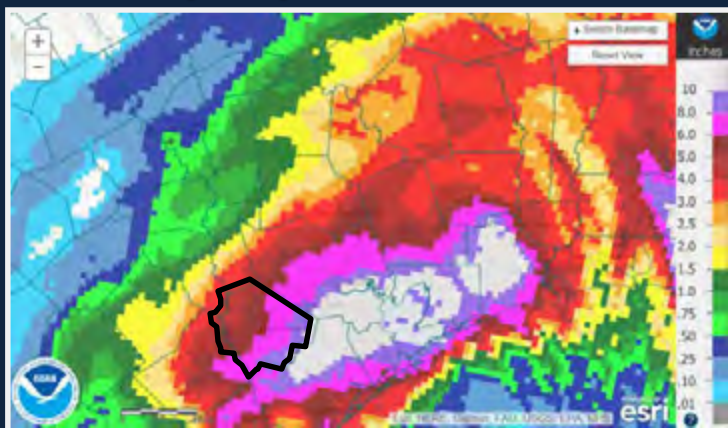
WEBSITE PRESENTING INUNDATION MAPPING RESULTS

- Various elevations
- Address Search Tool

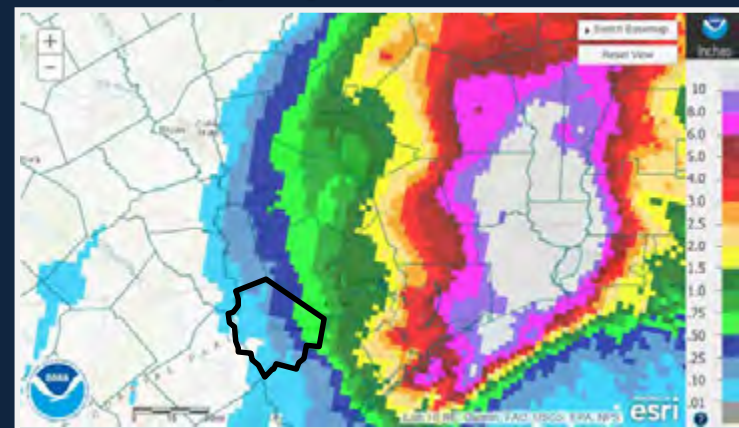


3-Day Forecast Rainfall Forecast 8/28/17

8/29/17 Rainfall



8/30/17 Rainfall





Brazos at Richmond Peak Elevation

**55.19' on
Friday, Sept. 1st at
1:00AM**

**Highest Elevation
since May 1915
(102 Years)**

Brazos at Richmond USGS Field Measurement Comparison

NO.	Date	Gage Height	Flow
1053	June 1, 2016	54.64'	106000 cfs
1066	August 31, 2017	54.97'	124000 cfs

Top 5 Flood Events at Critical Gage Locations

Gage:	San Bernard nr Boling (1955)		Big Creek nr Needville (1947)		Buffalo Bayou nr Katy (1978)		Mill Creek nr Bellville (1964)		Brazos at Richmond (1929)	
	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Stage
1	Aug. 31, 2017	58,900 cfs	June 26, 1960	10,400 cfs	Aug. 28, 2017	9,060 cfs	May 27, 2016	91,100 cfs	Aug. 2017	55.19'
2	Oct. 21, 1998	31,900 cfs	May 26, 2015	7,250 cfs	April 18, 2016	5,660 cfs	Apr. 18, 2016	74,800 cfs	May 2016	54.74'
3	June 28, 1960	21,200 cfs	Sept. 20, 1979	7,140 cfs	Aug. 8, 2017	3,850 cfs	Aug. 28, 2017	73,800 cfs	June 1929	53.20'
4	Nov. 14, 1985	20,600 cfs	Aug. 27, 2017	6,710 cfs	Feb. 21, 1994	3,780 cfs	June 13, 1973	44,400 cfs	Nov. 1940	51.40'
5	June 16, 1973	20,400 cfs	Nov. 11, 1985	6,490 cfs	Sept. 14, 2008	3,610 cfs	Nov. 1, 1981	36,600 cfs	May `1957	51.06'

- Harvey set new records at 3 of the 5 locations
- Harvey was a Top 4 Event at all 5 locations.
- 312 Total Years of Records at these 5 Locations
- 44% of the Flood Events (11 out of 25) have occurred since 2015
- 5 Separate Events over the Last 3 years:
 - Memorial Day '15
 - Tax Day '16
 - Memorial Day '16
 - Aug. 8th 2017
 - Hurricane Harvey

Hurricane Harvey / Fort Bend County Impacts

Estimated % FBC Land Area Inundated by Floodwater: 20%

Total Estimated Residents Impacted : 200,000

FBC Emergency Operations Total Phone Calls: 25,564

Total Number of Rescues : 9,945

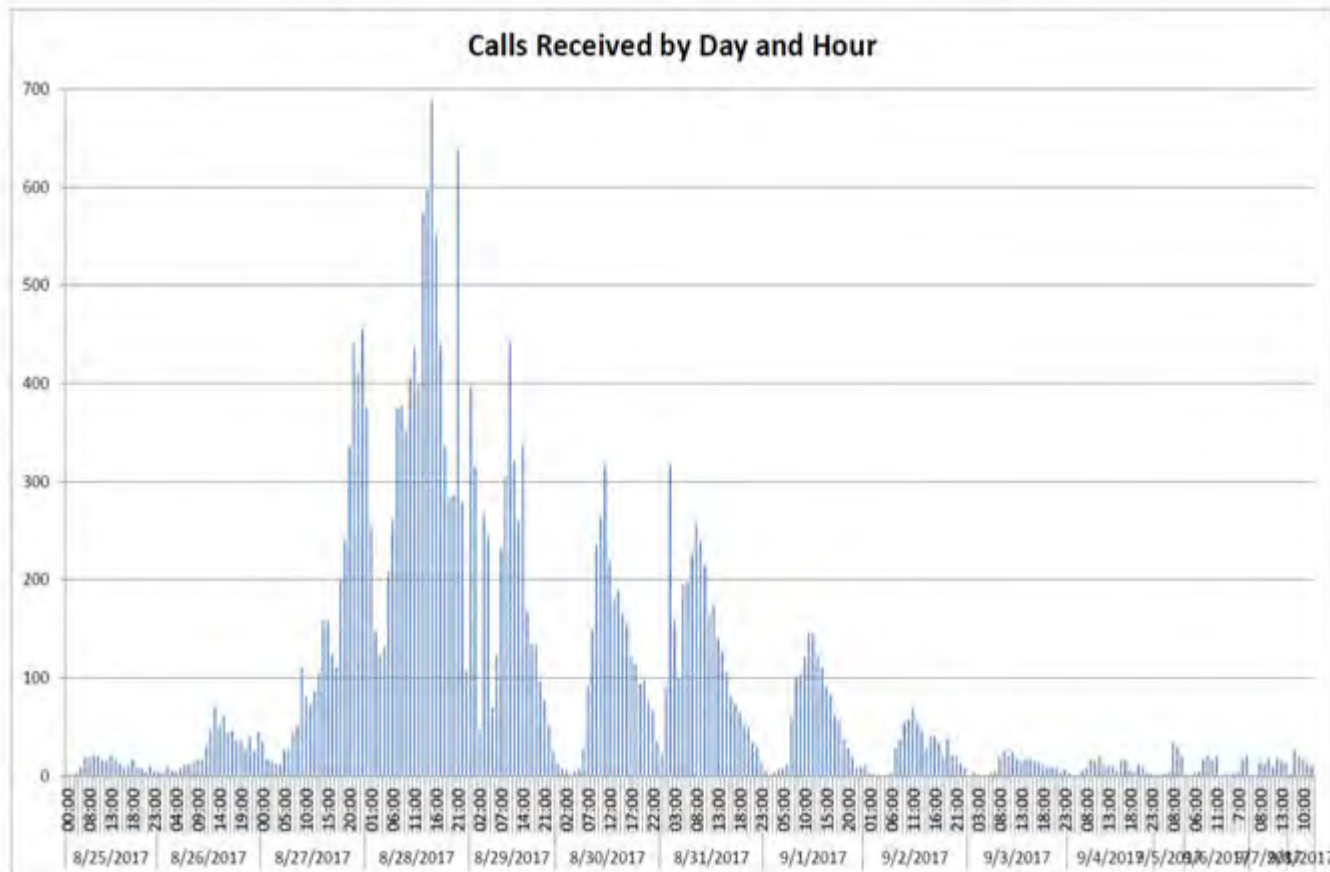
Fatalities Reported within Fort Bend County: 3

Number of Homes Damaged: 6,824

Source: Fort Bend County Office of Emergency Management, 10/27/17

Challenges:

Phone Bank Calls Received Metrics as of September 8th, 2017



**25,564 Total
Phone Calls to
Fort Bend County
Emergency
Operations Center**

**Approximately 700
in 1 Hour
(Monday
afternoon
8/28/17)**

**Mass
Communication**

Social Media

Maps

Incredible Rainfall totals...

FORT BEND:

NOAA - NWS RICHMOND WEATHER STATION Top 10 Daily Maximum Precipitation Totals		
1	11.03"	8/27/2017
2	9.32"	5/12/2012
3	8.58"	1/10/2012
4	8.19"	11/12/1985
5	7.72"	11/1/1959
6	7.60"	8/31/1981
7	7.51"	5/26/2015
8	6.93"	8/28/2017
9	6.68"	8/26/2017
10	6.60"	10/29/2002

Source:

FBCDD Analysis of
NOAA Online Weather Data (NOW Data)
Calendar Day Summaries –
Daily Maximum Precipitation

(Not a continuous period of record but
estimated 20,000+ days worth of daily rainfall
records)

REGIONALLY:

**“Harvey is head and shoulders
above all other multi-day rain
events that have ever occurred in
the continental United States”**

- Texas State Climatologist
John Nielsen-Gammon

**Total 5-day rainfall
averaged over 10,000 square miles**

- 1. 34.72" Harvey 2017**
- 2. 21.39" Texas 1899**
- 3. 20.50" Beulah 1967**
- 4. 18.37" Louisiana 1940**
- 5. 18.06" Texas 1994**

THANK YOU:



FORT BEND COUNTY OEM

FORT BEND COUNTY OFFICE OF EMERGENCY MANAGEMENT



US Army Corps
of Engineers.



CRASAR

CENTER FOR ROBOT-ASSISTED
SEARCH & RESCUE
TEXAS A&M ENGINEERING EXPERIMENT STATION



Brazos River
Authority



... along with many others too numerous to name!