

2015 MEMORIAL DAY FLOOD IN HARRIS COUNTY, TEXAS

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Abstract

After weeks of intermittent rainfall across Harris County, a slow moving line of thunderstorms moved into Harris County from central Texas during the evening hours of May 25, 2015. Very heavy rainfall began around 8:30 p.m. across the northern portions of Harris County, while additional thunderstorms developed over central Fort Bend County and moved into Harris County from the southwest. A period of thunderstorm cell training occurred from 10:00 p.m. to 1:00 a.m. from Fort Bend County into north-central Harris County where the cells merged with the line of storms moving southward from northern Harris County. Thunderstorm cell mergers continued over central and southwest Harris County for several hours resulting in widespread significant flooding.

A “Flash Flood Emergency” was issued by the National Weather Service for Harris County at 10:52 p.m. on the 25th for the first time ever (although this is a relatively new terminology). The worst rainfall was focused across the western portion of Harris County from the northwest side of the City of Houston to Addicks, Sharpstown, and Richmond in central Fort Bend County.

Hundreds of water rescues were performed by various agencies during the height of the rainfall on the 25th and 26th. Rescues were mainly motorists stranded on area freeways and roadways, and after daylight on the 26th, the Houston Fire Department responded to many requests for assistance from residents in flooded homes.

Seven fatalities were directly related and one additional fatality was indirectly related to the flooding. Three fatalities resulted from the capsizing of a Houston Fire Department rescue boat in Brays Bayou and three were related to submerged vehicles. No flood-related fatalities were reported in homes or businesses.

A federal disaster declaration was issued for Harris County on May 30th and covered the period from May 4th to June 8th.

May 25-26 Rainfall

Duration – The heaviest rainfall occurred from the northwest side of the City of Houston from Heights Blvd. southwest to near Beltway 8 and I-10, and then southwest into Fort Bend County. All of the rainfall occurred within 12-hours with the heaviest rainfall rates observed in the 3-hour to 6-hour period.

Total Amounts – Total rainfall amounts averaged 3.0-4.0 inches across much of Harris County with totals of 4.0-6.0 inches from Humble to Jersey Village to Katy, and eastward to Galveston Bay. Rainfall totals of 8.0-10.0 inches were recorded on the northwest side of the City of Houston southwest to Sugar Land. A maximum rainfall accumulation of 11.0 inches was recorded at Brays Bayou and Beltway 8. The rainfall intensity report and various rainfall distribution and flood information maps are available.

A CoCoRaHS observer 6.2 miles west of Downtown Houston recorded 10.03 inches of rainfall. Another observer 3.4 miles northeast of Richmond in Fort Bend County recorded 11.88 inches of rainfall.

An average rainfall of 5.3 inches occurred across Harris County in a 12-hour period which equates to 162 billion gallons of water.

Exceedance Probability – Rainfall on Brays, lower White Oak, Keegans, and Buffalo Bayous ranged between the 50% (2-year) frequency to well in excess of the 1% (100-year) frequency for the time periods of 15-min to 12-hours. The highest rainfall amounts occurred in the Buffalo and Brays Bayou watersheds for the 2-6 hour periods and are between the 1% (100-year) and 0.2% (500-year) frequency.

All other watersheds were less than the 4% (25-year) frequency.

Channel Flooding

Overbank conditions occurred on the following named primary channels (plus numerous tributaries in the watersheds):

Brays Bayou

Keegans Bayou

Buffalo Bayou (610 Loop to Downtown Houston) Spring Branch

White Oak Bayou (Heights Blvd. to Downtown Houston) Little White Oak Bayou

Halls Bayou

South Mayde Creek (downstream (east) of Fry Road)

West Fork of the San Jacinto River

East Fork of the San Jacinto River

San Jacinto River main stem (downstream (south) of Lake Houston)

Clear Creek

Carpenters Bayou (downstream (south) of I-10)

Armand Bayou

Willow Waterhole

Cypress Creek (I-45 downstream (east) to the San Jacinto River & upstream (west) of US 290)

Little Cypress Creek (near Becker Road)

Willow Creek

Spring Creek (headwaters (east) to FM 2978)

An HCFCD water level sensor installed in the bottom of the Arthur Storey Park detention basin (D500-06-00) on Brays Bayou at the Sam Houston Tollway recorded a water level rise of 16.5 feet between 11:00 p.m. May 25th and 1:00 a.m. May 26th. The peak elevation in the basin reached 66.0 feet at 2:45 a.m.

High Water Marks

A total of 114 high water marks were identified and surveyed along the following channels: Brays Bayou, Keegans Bayou, Buffalo Bayou, Hunting Bayou, Brickhouse Gully, and Little White Oak Bayou. Marks were also obtained along Poor Farm Ditch and Willow Waterhole, but no historical high water mark data is available for these channels as they were not marked in the past. High water marks were also obtained in HCFCD detention basins on upper Brays Bayou, Willow Waterhole, and in some of the flooded subdivisions along Brays Bayou.

The references in the paragraphs below to water level recurrence intervals and frequencies are based on the current effective FEMA Flood Insurance Study data. The terms used below regarding “record” flood levels relates to available HCFCD information, which generally is most detailed for the period starting in the early 1980s when HCFCD’s stream gaging system was started. The term does not indicate that it was the highest level ever observed, especially in watersheds that have significant flood damage reduction projects.

Buffalo Bayou:

“Record” high water levels were recorded along Buffalo Bayou from Woodway to Piney Point Dr. surpassing the previous record high water marks on April 28, 2009 and September 11, 1998 (Tropical Storm Frances). Water levels in this reach averaged at or above the 1% (100-year) level. Downstream of Woodway to Downtown Houston water levels were the second highest recorded behind Tropical Storm Allison (2001). Water levels in this reach averaged between the 10% (10-year) and 2% (50-year) frequencies. West of Gessner to Hwy 6, water levels were below both the April 2009 flood and the March 1992 flood and averaged between the 10% (10-year) and 2% (50-

year) frequencies. While similar to the April 2009 flood, the rainfall and highest water levels with the May 2015 flood were generally displaced slightly eastward of the April 2009 event resulting in lower water elevations on the upper end of Buffalo Bayou compared to April 2009.

Brays Bayou:

“Record” high water levels were recorded along Brays Bayou from South Post Oak upstream to US 59, exceeding the previous record high water marks in September 1983. Water levels in Brays Bayou averaged between the 10% (10-year) and 2% (50-year) frequencies between Calhoun and US 59. Water levels east of Calhoun to the confluence with the Houston Ship Channel and west of US 59 were below the 10% (10-year) frequencies. [Note: The effective FEMA flood levels do not reflect lower flood levels created by the recently completed Project Brays flood damage reduction features. The flood frequency numbers above will be higher (less frequent) when compared to flood levels updated to reflect the reduced risk provided by completed Project Brays features.]

Keegans Bayou:

“Record” high water levels were recorded along the entire length of Keegans Bayou. Water levels exceeded the previous record high water marks on November 17, 2003 by as much as 2.0 feet at various bridge crossings. From the confluence of Brays Bayou upstream to South Kirkwood water levels were at or above the 1% (100-year) frequency and at the Keegans and Dairy Ashford bridges were at or just below the 0.2% (500-year) frequency. West of Dairy Ashford to the headwaters water levels were between the 10% (10-year) and 2% (50-year) frequencies. Flow went over the top of the Dairy Ashford Bridge crossing for the first time.

Willow Waterhole (D112-00-00):

“Record” flood levels were recorded along Willow Waterhole from the headwaters to the confluence with Brays Bayou. High water marks exceeded the previous record high water marks on January 9, 2012 by 1.5-2.0 feet and water levels averaged at or above the

1% (100-year) level. The May 2015 flood is the highest known water levels in HCFCFCD’s limited data set along Willow Waterhole although historical high water marks are not available for Tropical Storm Allison or the September 1983 flood.

The table below lists the May 2015 high water marks and the previous “record” high water levels for the locations where HCFCFCD flood gages are installed.

Location	5-26-15 Crest	Previous “Record” Crest	Previous “Record” Date
Keegans Bayou at Roark	74.50	73.30	01-09-2012
Keegans Bayou at Keegans Road	80.80	78.90	01-09-2012
Keegans Bayou at Rocky Valley	85.50	Not Available	Not Available
Brays Bayou at South Main	42.90	42.90	06-09-2001
Brays Bayou at Stella Link	48.30	48.38	06-09-2001
Brays Bayou at Rice	52.90	52.51	09-09-1983
Brays Bayou at Gessner	61.70	61.40	09-09-1983
Willow Waterhole at Willowbend	51.70	49.10	01-09-2012
Buffalo Bayou at San Felipe	54.50	53.00	04-28-2009
Brickhouse Gully at Costa Rica	65.54	64.73	05-10-2007

House Flooding Estimates

Structure flooding resulted from both overbank channel flooding and street drainage systems (storm sewers and roadside ditches) being overwhelmed from the intense short term rainfall rates. In some instances, house flooding likely resulted from a combination of these two phenomena especially in the Brays Bayou, Little White Oak Bayou, Brickhouse Gully, and Keegans Bayou watersheds. The majority of the house flooding in the Buffalo Bayou watershed was likely from street drainage systems being overwhelmed.

The tables below show house flooding estimates by watershed and by jurisdiction based on information from damage assessment teams from the various jurisdictions and citizen reports during and immediately after the storm through Readyharris.org and the HCFCD phone bank (with duplicates removed). As jurisdictions and FEMA confirm individual house flooding, the estimates will change. Thanks are extended to the various jurisdictions and their damage assessment teams for their hard work in determining and confirming house flooding locations and water depths.

Watershed	House Flooding Estimates
Brays Bayou	1,185
Keegans Bayou	245
Willow Waterhole	295
Buffalo Bayou	270
Spring Branch	335
White Oak Bayou	130
Little White Oak Bayou	175
Brickhouse Gully	180
Halls Bayou	55
Hunting Bayou	35
Sims Bayou	30
Other	80
<i>Total</i>	<i>3,015</i>

Jurisdiction	House Flooding Estimates
City of Houston	2,660
City of Bellaire	160
City of Pasadena	20
The Villages	65
Unincorporated Harris County	110
<i>Total</i>	<i>3,015</i>

Based on FEMA flood insurance claim data, approximately 3,320 homes may have flooded in addition to the totals listed above. There is no way to know how many other homes may have flooded that did not have flood insurance if the damages were not noticed by the jurisdictions and the owners did not report damage. The total flooded houses in Harris County may be in excess of 6,335.

Additionally, approximately 3,540 multi-family units and 92 commercial buildings were flooded in the City of Houston.

The number of requests to FEMA for Individual Assistance in Harris County is 10,860, which does overlap with some of the numbers above. Some of the requests are likely from homeowners whose house flooded who did not have flood insurance.

Based on historical house flooding information that was gathered by the various jurisdictions (but did not include flood insurance claims), the Memorial Day flooding resulted in the 4th largest number of flooded homes.

Flood Event	House Flooding Estimates*
June 2001 (TS Allison*)	73,000*
June 19, 2006	3,370
October 1994	3,248
May 25, 2015	3,015 w/o FEMA claims 6,335 w/ FEMA claims
April 28, 2009	2,305

*Note: Tropical Storm Allison values include only FEMA flood insurance claims. Other events do not include FEMA flood insurance claims unless noted.

Addicks and Barker Reservoirs

Due to the consistent and well above average rainfall in April and May 2015, and then the May 25-26 significant rainfall event, the reservoir levels came close to putting water on SH 6 and Westheimer Parkway. The Addicks water level was the 7th highest (95.51 feet on May 31st) and the Barker level was the 5th highest (91.87 feet on June 1st) on record.

The stormwater storage in the Corps of Engineers’ reservoirs helped reduce water levels downstream along Buffalo Bayou. The Corps of Engineers operates the reservoirs to maximize downstream flood protection on Buffalo Bayou. When rain is forecast, the gates are closed. Reservoir releases begin when flood flows at the Piney Point Road USGS gage are less than 2,000 cubic feet per second (cfs) and additional rain is not forecast. Under normal operations, reservoir gate releases are controlled to achieve a total discharge of 2,000 cfs at the Piney Point gage (note, the May flood event produced a peak flow at Piney Point of about 8,500 cfs. Gates on Addicks and Barker were closed at 3:00 p.m. May 23rd).

Because of the elevated water levels inside the reservoirs, the Corps made the decision to increase the combined releases to 3,000 cfs at the Piney Point gage to more quickly restore the flood holding capacity of the reservoirs. A combined release of 2,700 cfs from both Addicks and Barker began on June 1, 2015 resulting in a flow of 3,000 cfs at the Piney Point control gage. Due to subsequent rainfall events that added water to the reservoirs, combined with having to close the gates when rain was forecast, it took about 7 weeks to empty the reservoirs. The Corps only operated releases at the 3,000 cfs level for a total of about 13 days during the following 7 weeks.

Event	Addicks	Barker
Starting Storage May 24 th	~ 11,000 acre-feet	~ 11,000 acre-feet
Peak Storage ~ June 2 nd	~ 49,000 acre-feet	~ 48,000 acre-feet
Date Empty	July 11 th	July 12 th

Projects that Helped Reduce House Flooding

Capital projects and maintenance of the channels throughout the county helped reduce the risk of flooding and ensure the systems operated as designed. Completed buyouts also prevented flooding in many areas of the county. Major capital project efforts in the highest rainfall areas are discussed below.

Bravs Bayou:

Project Bravs (a partnership project with the Corps of Engineers) construction completed to date prevented the flooding of about 1,000 homes and businesses that would have otherwise flooded without the project work. For example, the 8.9 miles of channel conveyance improvements and 10 bridge replacements/ modifications downstream of Fannin Street helped lower flood levels from the mouth upstream though the Texas Medical Center. The excavation in the Eldridge, Old Westheimer, Arthur Storey Park, and Willow Waterhole regional detention basins held back a large volume of stormwater that otherwise would have rushed downstream. Those basins stored about 2.0 billion gallons of excess stormwater.

Sims Bayou:

Without the near-complete HCFCD and Corps of Engineers' Sims Bayou Federal Project and supplemental detention basins constructed by HCFCD, several hundred homes would have flooded along Sims Bayou during the May 25-26 storm event.

Addicks and Barker Reservoirs:

The U.S. Army Corps of Engineers' Addicks and Barker Reservoirs in western Harris County held back the Memorial Day Flood runoff from within the reservoirs and the upstream watersheds. The reservoirs' storage helped keep the water levels along Buffalo Bayou from being higher and potentially reaching flood levels.

Harris County Flood Control District Actions

- HCFCD Flood Watch team was activated from 6:00 p.m. May 23rd to 10:09 p.m. on May 30th.
- Clear Creek Second Outlet Gates were opened on May 23rd at 5:09 p.m. and closed on May 27th at 2:00 p.m. The gates were reopened on May 30th at 5:35 p.m. and closed on May 31st at 2:00 p.m.
- Conducted approximately 60 media interviews.
- Performed a helicopter reconnaissance flight the morning of the 26th over western and southwestern Harris County to document potential house flooding and performance of HCFCD facilities.
- Performed a helicopter reconnaissance flight the afternoon of June 1st over western and southwestern Harris County to document house flooding; look for HCFCD facility damage; document storage levels in the upper Cypress Creek watershed, Addicks Reservoir, and Barker Reservoir; and the 3,000 cfs flow in Buffalo Bayou.
- The HCFCD Flood Warning System alerted staff 89 times with rainfall alarms (set at 1 inch rainfall in 15-min) and 69 times with water level alarms (set at 3 feet below bank full) were reported from May 24th to May 26th.

- The only notable damage to HCFCD gages was a flood warning water level sensor on Buffalo Bayou at Milam St. that was destroyed by flood waters early on the morning of the 26th and was replaced and operational on May 27th.