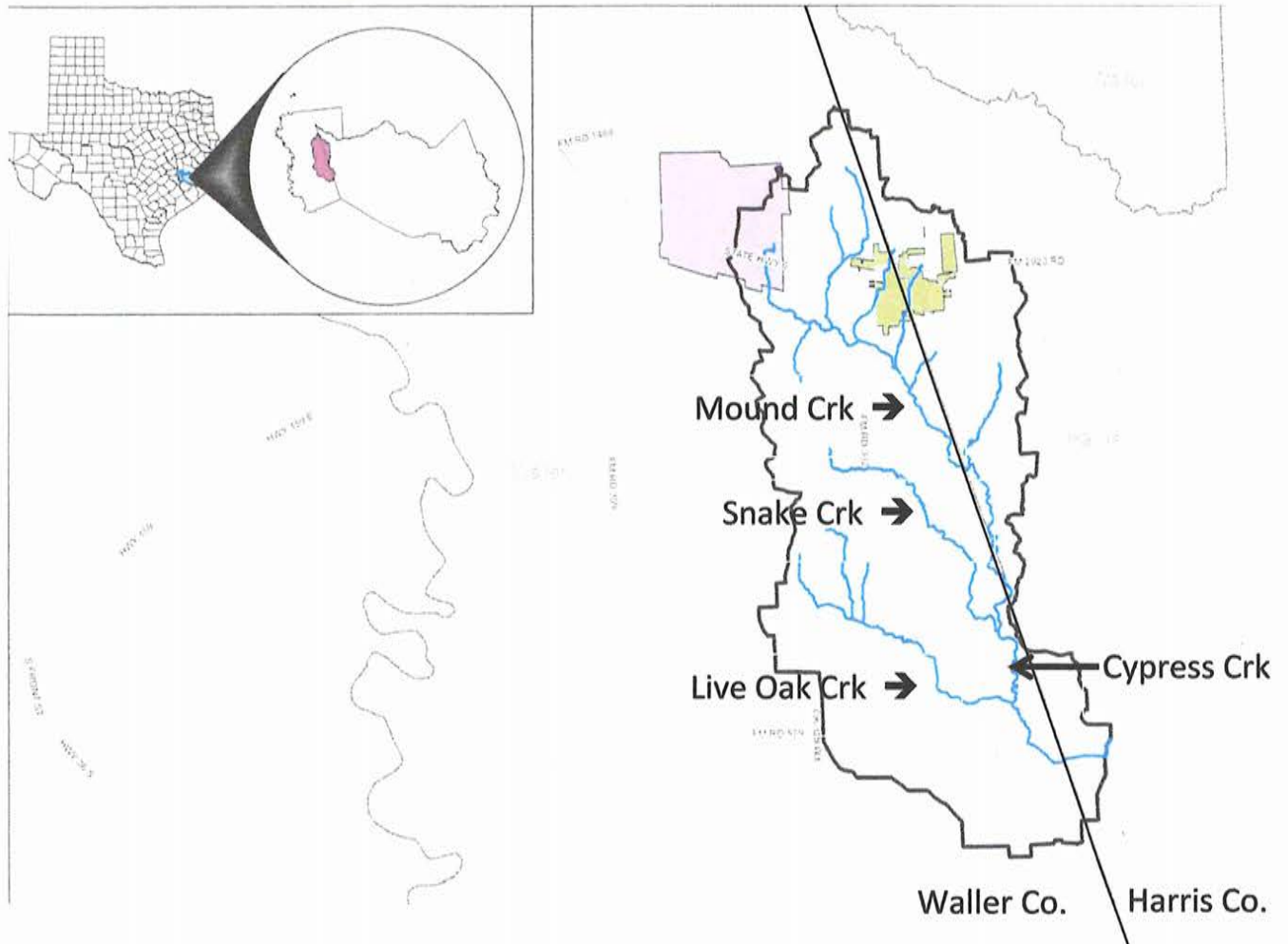


**HEADWATERS OF CYPRESS CREEK WATERSHED**  
**MOUND CREEK AND TRIBUTARIES**  
**WALLER/HARRIS COUNTIES**



**OVERFLOW & DOWNSTREAM**  
**COMMUNITY FLOODING**

**IT ALL BEGINS HERE**

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## CYPRESS CREEK FLOOD CONTROL COALITION

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Tel: 281-469-5161  
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### ***President's letter:***

June 29, 2018

***GALVESTON, Texas — Hurricane Harvey has become the first major hurricane in 12 years to hit the mainland United States, coming ashore Friday night in Texas as a Category 4 storm with 130-mph winds and threatening millions of people along the Gulf Coast with catastrophic flooding and torrential rains. (August 25, 2017)***

The Cypress Creek Watershed is the largest in land area among all Harris County's 22 major watersheds. It has changed immensely during the past 40 years from an agriculture landscape of rice fields and pastures to one of the most aggressive urban development areas in the Texas Gulf Coast.

This change has included a massive increase in stormwater drainage -- in both volume and rate of runoff. Although brought to the attention of our government authorities many times, major inadequacies' in regulatory criteria have not been corrected due to lack of political will and a significant lack of funding. Land Development leaders have not taken steps to resolve inadequate practices for economic reasons.

It is said the Cypress Creek Watershed has become the area's "Poster Child" for ever-worsening, insufficient mitigation, and storm -crippling disasters. This has not been an immediate phenomena- - - it has developed over decades. There are three primary reasons:

1. Increasing storm rainfall (amount and frequency) aka "Climate change"
2. Detention facilities less than required to the extent of reaching critical mass.
3. Drainage regulations which fail to achieve the "No Adverse Impact" requirements to obtain new development permit applications approval.

Funded entirely with voluntary donations made by a few watershed MUDs, several years of investigations of (1) Harris County land development flood mitigation drainage criteria and, (2) flood plain modeling have been completed by independent technical engineering experts contracted by the Cypress Creek Flood Control Coalition. The findings / conclusions have identified / determined changes are needed.

...continued on next page ...

The Hurricane Harvey presidential declared National Disaster is a clear and loud call for change  
- - - change which always takes time.

- How long did it take to build - - -
  - Noah's fabled Ark? (Less than 75 years!)
  - The Cypress Creek's fabled "3rd Reservoir" Ark? ( 78 years since 1940 and counting)
- How long was the - - -
  - Fabled flood? (300 days!)
  - Cypress Creek / Katy Prairie untamed floods? ( Centuries)
- How long was - - -
  - Noah in the Ark? (377 days!)
  - Cypress with no Ark? (to be continued next year).

The extensive storm damages from the 2017 Harvey storm, the 2016 Tax Day and Memorial Weekend storms, and the 2015 storms that visited our communities could have been less. The residents were victimized, however, due to reasons which can/must be resolved by its citizens and devoted elected representatives. Replace apathy with leadership with all coming together on a forward path of non-partisan funding, sounder development regulations and devoted systems engineering of our regional drainage systems.

A handwritten signature in cursive script, reading "G. D. Smith". The signature is written in black ink on a white background.

*NOTE: Not every chart or map in this Report will have dialog associated with it. They are placed within the Index as "Maps...Misc" and a few other places within the Report as a handy repository for reference in the future as issues develop.*



## **2017 MILESTONES/HIGHLIGHTS**

BECAME PARTNERS IN BAYOU CITY INITIATIVE & IN HOUSTON STRONG ORGANIZATIONS

DOCUMENTING AND SEARCHING FOR HARVEY FACTS

WORKED WITH OTHER ORGANIZATIONS ON CONGRESSIONAL FUNDING PACKAGE AFTER HARVEY

UPDATED CHART ON HCFCD 5 YR PLAN FOR CAPITAL IMPROVEMENTS

WA 21 COMPLETED BUT PLACED ON HOLD WAITING ON RESULTS OF LAN STUDY FOR LIL CYPRESS CREEK

INCREASED BOARD MEMBERS TO TEN

PRESENTATION BY ERWIN BURDEN OF HCFCD ON LITTLE CYPRESS FRONTIER PROGRAM

RENEWAL OF RELATIONS WITH USACE IN GALVESTON ON 7-18-17 AFTER LONG HIATUS. HISTORIC MILESTONES PRESENTED BY CCFCC.

POSITIVE EXCHANGE OF INFORMATION WITH KATY PRAIRIE CONSERVANCY MARY ANNE PIACENTINI

NEGATIVE DECISION OF TEXAS SUPREME COURT IN KERR VS. HCFCD

FEDERAL LAWSUIT FILED BY TIRZ 17 NEIGHBORHOOD (MEMORIAL) VS. CITY OF HOUSTON

DR. OLIVERSON, STATE REP DIST. 130, REQUESTS MEETING WITH CCFCC ON FLOODING ASSISTANCE FOR UPCOMING LEGISLATIVE SESSION

KATRINA RAINED 6.5 TRILLION GAL WATER. HARVEY RAINED 15 TRILLION GAL

9450 HOMES FLOODED IN CYPRESS CREEK AND LITTLE CC WATERSHEDS DURING HARVEY

EXTENSIVE WORK WITH REGULATORS ON DISASTER FUNDING PACKAGE

CCFCC MEETS AGAIN WITH USACE TO DISCUSS CURRENT CORP PROJECT TO REVIEW HCFCD REGS

GOVERNOR ABBOTT VETOES HB 2334 WHICH GAVE HCFCD POWER TO FINE DEVELOPERS FOR NON – COMPLIANCE

2015 CYPRESS CREEK OVERFLOW MANAGEMENT PLAN DEAD ON VINE WITH NO ACTION

CCFCC/HCFCD LONG-STANDING DRAINAGE CRITERIA ISSUES NOT RESOLVED

## **Mission Goals/Mission Statement**

### **Mission / Vision Statement**

Protecting people, property, and the environment from increasing flood risks occurring in the Cypress Creek Watershed through mitigation, preservation and education.

### **Core Values**

#### **Advocate for public and property safety through---**

- Engineering evaluation / analysis, identification and reporting of methodology to achieve flood damage risk reductions and seeking enforcement of the Harris County's Flood Plain Management Regulations "No Adverse Impact" requirements.
- Adequate capital improvement funding levels and timing by government and private sector as required to achieve a "No Adverse Impact" across the Watershed's landscape.

**Analysis of government land development permit criteria and advocate responsible development** through engineering research evaluation and sharing resulting information with responsible government authorities, and land development decision makers.

**Be stewards of the Cypress Creek watershed** by promoting environmental preservation of forest and wildlife habitat and quality of life trail, park and greenway floodplain enhancements.

**Promote out-of-box thinking by regulatory authorities** to totally cure the causes of repeated flooding events rather than temporary fixes.

**Emphasize Benefit/ Cost ratios be included in all Government Studies and Proposals** of past and future flooding events.

## **Watershed Facts**

### **THE CYPRESS CREEK WATERSHED CONSISTS OF SEVERAL WATERSHEDS AND SUB-WATERSHEDS.**

#### **Upper Cypress Creek Watershed (Overflow Flooding—It All Begins Here)**

The most westerly portion of the CC watershed is located in Waller County, drains over 79 square miles and consists of the Mound Creek sub watershed with its several tributaries and 47 sub basins. The tributaries of Mound Creek are the East, Middle, West and South Forks of the main Creek, the Snake Creek, Live Oak Creek with its tributaries, and Little Mound Creek on the far East of the area. Drainage is from North to South into the confluence with Cypress Creek. A map of the Upper Cypress Creek Watershed is included on Page 9.

A 2012 Flood Protection Planning Study by the firm Halff & Associates for the Cities of Waller and Prairie View developed a detailed breakdown of all the tributaries and 47 sub-basins for hydraulic and hydrologic modeling of the watershed (See map on Page 10).

Infrastructure revisions and small detention basins were recommended at the head waters of East Mound, Middle Mound, and Main Mound Creeks to mitigate flooding events in the Cities of Waller and Prairie View. A 2,500 acre basin with 20,000 ac ft of storage situated at the confluence of Mound Creek and Cypress Creek was shown for further study with Harris and Fort Bend Counties in the then ongoing Overflow Study of Addicks Reservoir. (See Map on Page 11).

The August 2015 Cypress Creek Overflow Management Plan published by Harris County Flood Control District incorporated computer modeling of a 100 year storm, before the Tax Day event data was available, and indicated 1% frequency storm flow down Mound Creek into the headwaters of Cypress Creek amounts to 18,419 cfs or 28,846 ac. ft. of water drainage. The phenomena of this tremendous amount of drainage during large rainfall events has been known to exist since the early 1940's when the US Army Corp of Engineers gave it the name "Overflow" and constructed the Addicks Reservoir to capture the Overflow before it could enter the lower elevation Buffalo Bayou watershed and inundate the City of Houston. (See Map on Page 13).

Overflow across the divide between Cypress Creek and Addicks watersheds was 23,355 ac.ft. in the 2015 Study compared to 65,000 ac.ft. that crossed during Hurricane Harvey. The Overflow Study (Plan 5) recommended a detention basin of 26,500 ac. ft. of storage on the Katy Prairie to mitigate flooding across the divide and down Cypress Creek but current flooding experience from the Tax Day and Harvey storms show such a basin to be inadequate to stop the Overflow.

Both the Cities of Waller and Prairie View expect their populations to increase rapidly in the future as development of the area occurs. It is expected that runoff from these areas will only increase as development expands unless steps are taken now and while acreage is available at reasonable prices for upfront flood mitigation actions.

### **CYPRESS CREEK WATERSHED**

The Cypress Creek (CC) watershed, the largest of the 22 watersheds in Harris County, drains an area of about 267 square miles. Page 14 depicts the extent of drainage area which includes some overlap in Waller County. CC has several tributaries that contribute to the overall flow down the creek which need to be recognized in any studies or mitigation efforts on flooding. In the western portion of the creek, there are 5 tributaries, some of them have been given identification numbers by HCFCD, and have floodway and floodplain areas that take up considerable drainage area. A blowup map of these tributaries is shown on Page 12. As shown, the floodways and floodplains depict a considerable contribution to the overall flow down the creek, and more importantly, contribute to the volume of Overflow water that has to be dealt with during large storms. CCFCC has recommended to HCFCD that gauges be installed on one or more of these tributaries to achieve a determination of the actual volume of water the creek must handle during large storms.

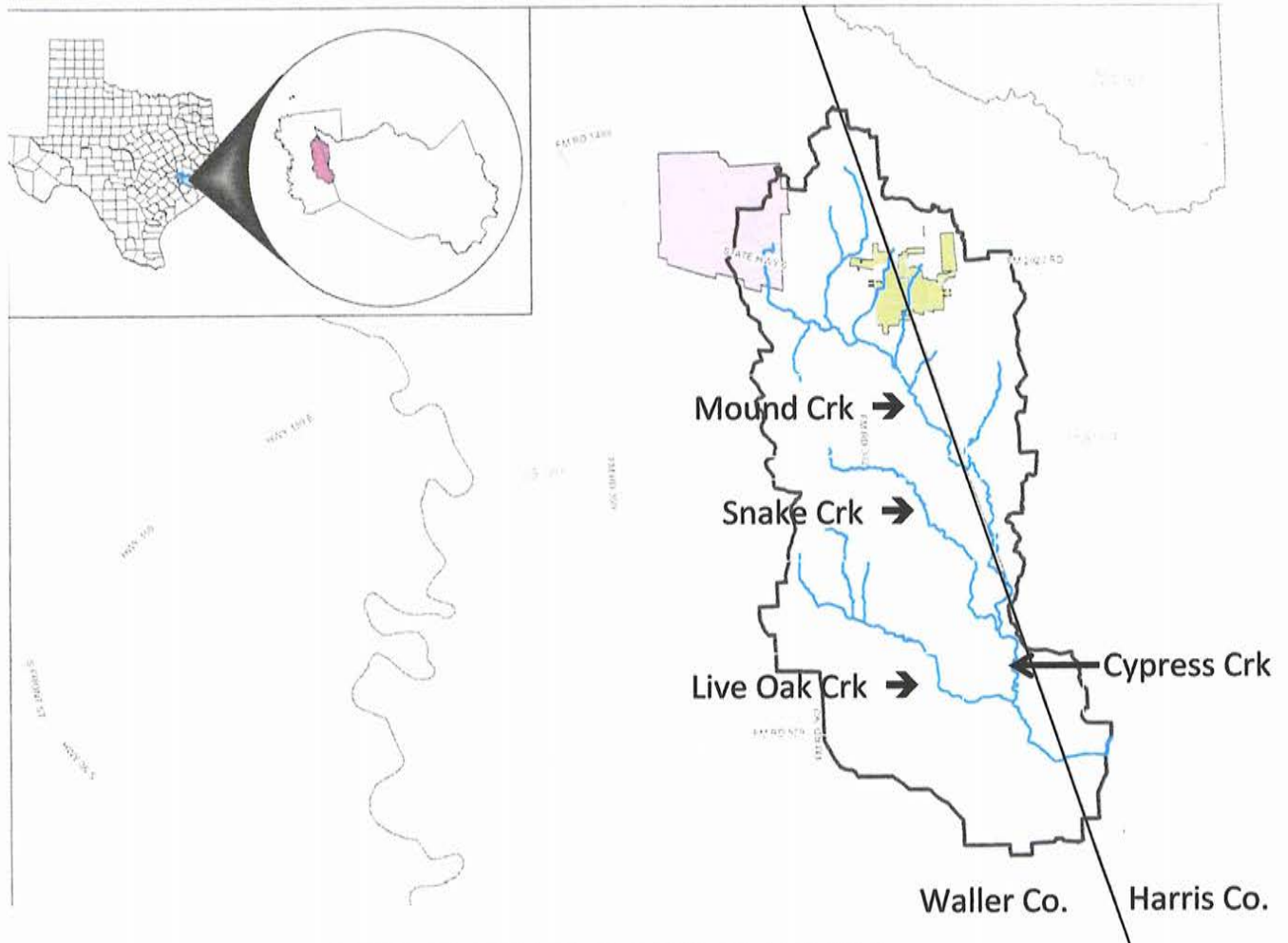
Page 13 shows the natural CC Over flow direction during various sized large storms. It is significant that, even with the presence of Addicks/Barker reservoirs, runoff drainage across the CC/Addicks divide invades several of the Bayous in the County during the larger storm events.

Pages 14-15 are taken from the HCFCD website and show various details of the CC watershed.

### **LITTLE CYPRESS CREEK WATERSHED**

The Little Cypress Creek (LCC) watershed is the largest of the tributaries of the main CC draining about 50 square miles. While the area is developing at a rapid pace, it still has rural locations that have potential for flood mitigation sites. Pages 16-19 are taken from the HCFCD website and show a map of the tributary and other watershed facts. LCC is undergoing a Frontier Program which is an organized effort by HCFCD to incorporate regional drainage infrastructure in advance of land development. Several regional detention basins are being constructed now and others planned.

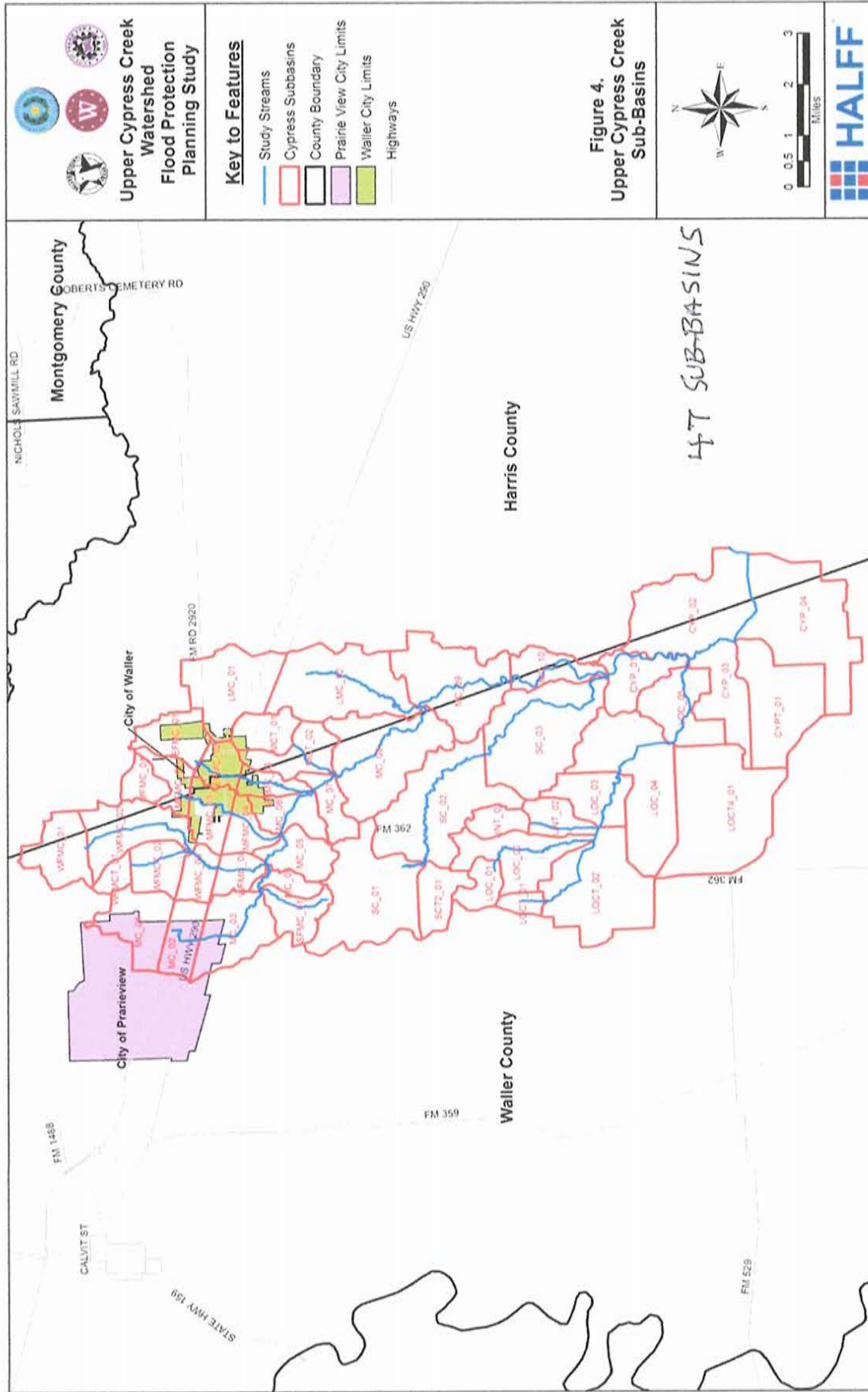
**HEADWATERS OF CYPRESS CREEK WATERSHED**  
**MOUND CREEK AND TRIBUTARIES**  
**WALLER/HARRIS COUNTIES**

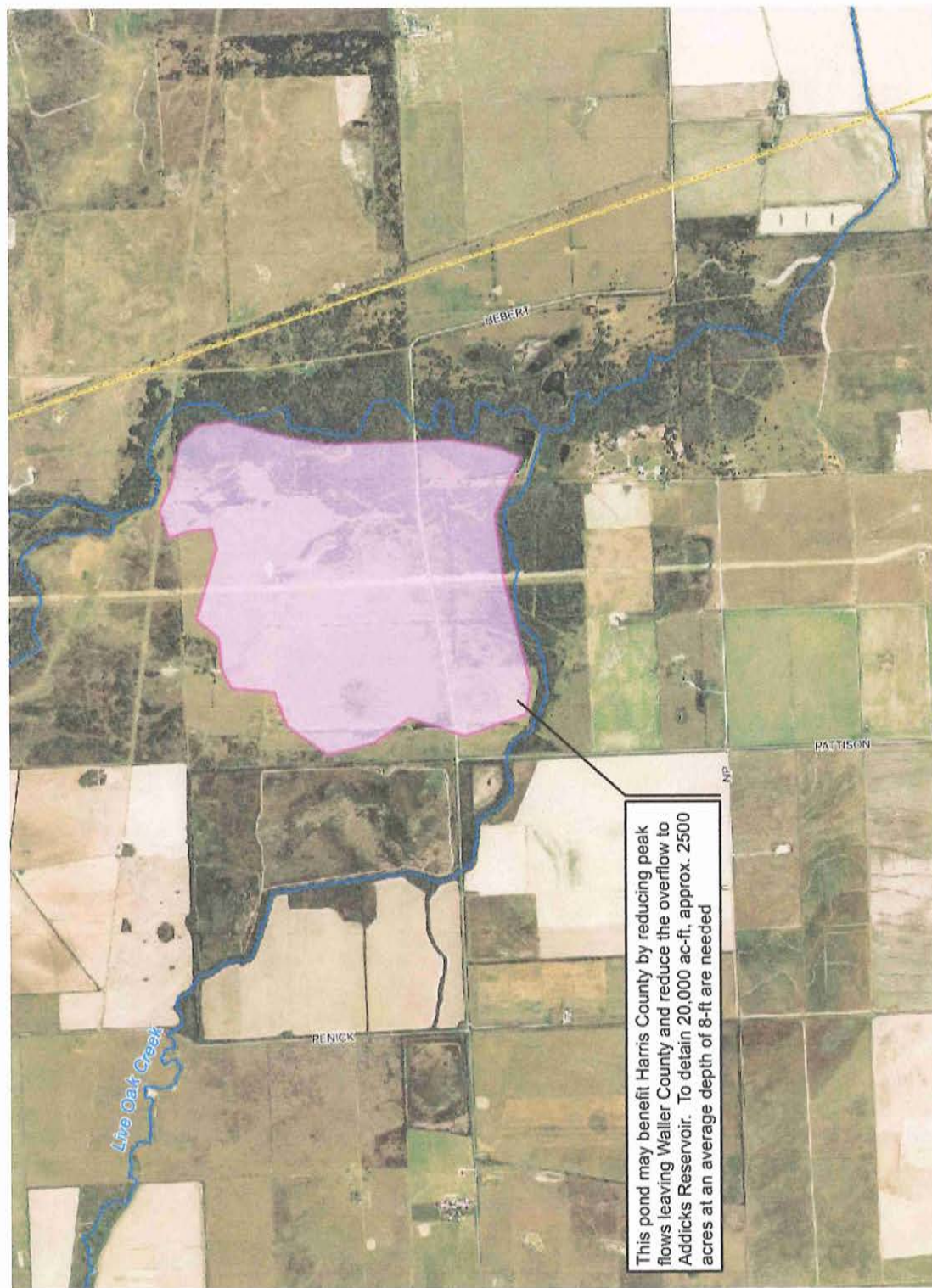


**OVERFLOW & DOWNSTREAM**  
**COMMUNITY FLOODING**

**IT ALL BEGINS HERE**



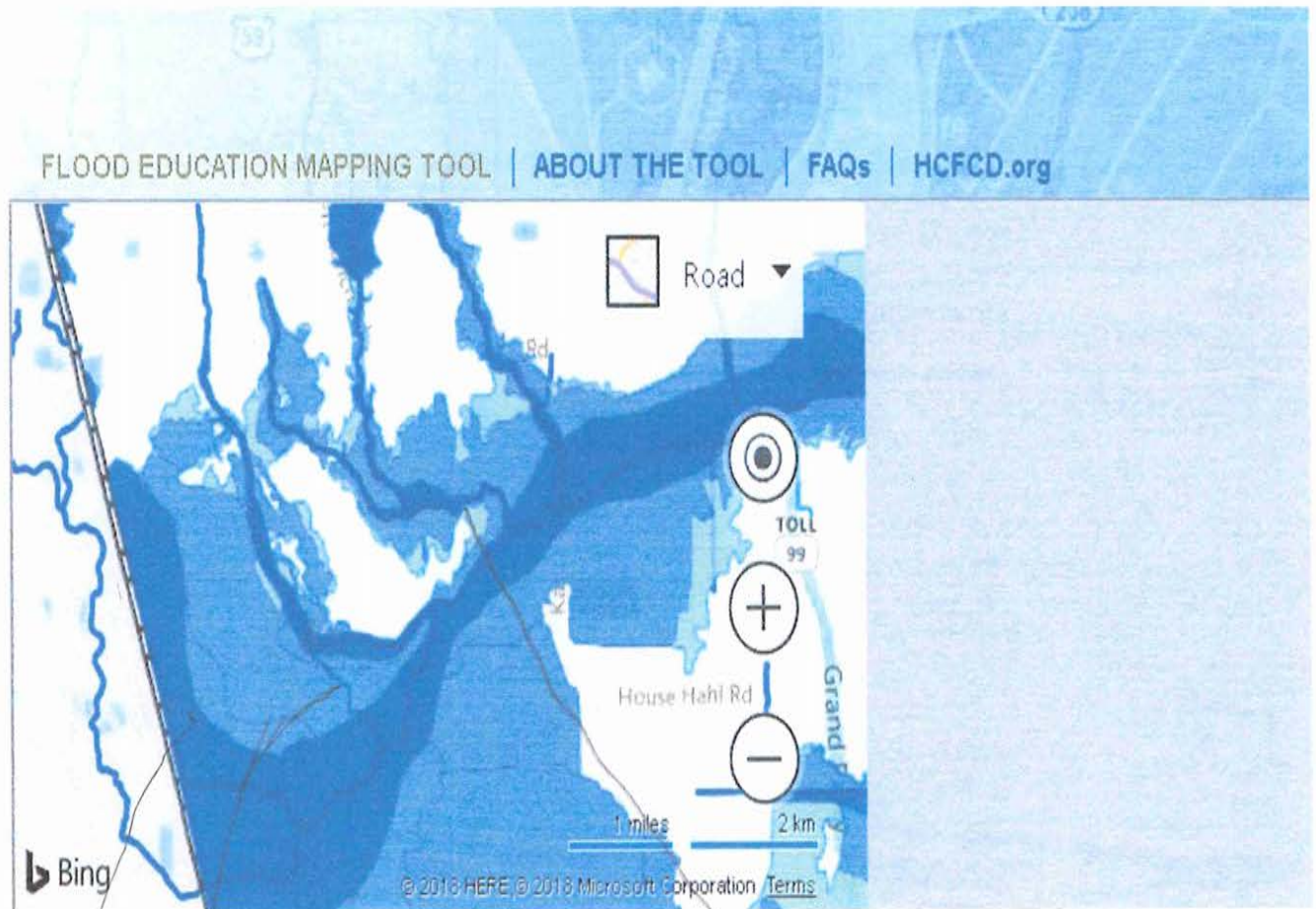




**Figure B14: Proposed impoundment location to help reduce Cypress Creek overflow to Addicks Reservoir**



HARRIS COUNTY TRIBUTARIES  
UPPER CYPRESS CREEK WATERSHED

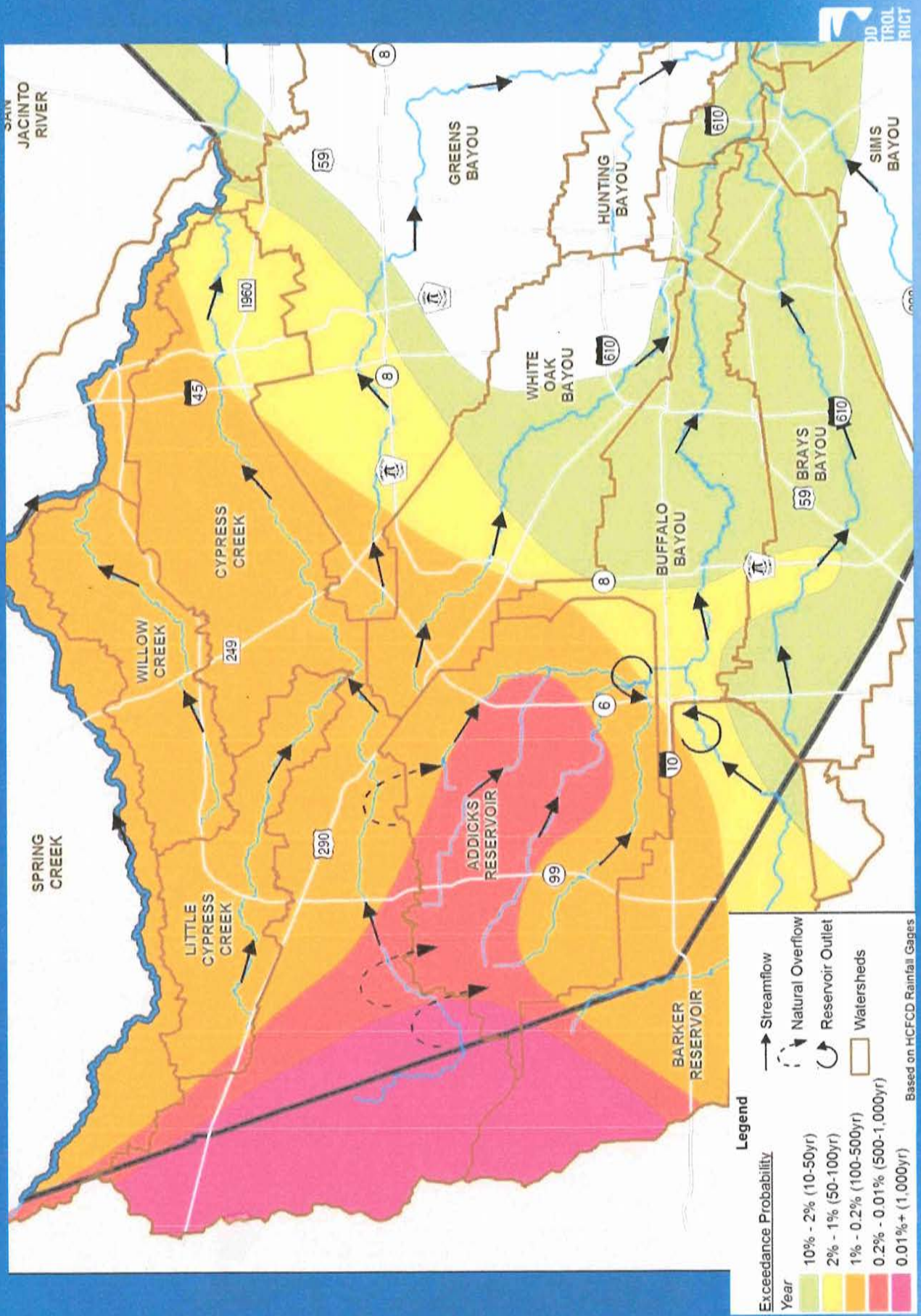


**HCFCD NAMES TO TRIBUTARIES:** Left to Right:

K 162-00-00, K 172-00-00 (Lower) Trib/ K 172-00-00, Rock Hollow/ K 160-01-00 T 1.63 to Rock Hollow/ K - 160-00-00 Rock Hollow, K 15 Trib to CC, Un-named at GP



# Natural Cypress Creek Overflow



Source: The Bay by Lindner





# Cypress Creek Watershed

## What is a watershed?

A watershed is a geographical region that drains to a common bayou, creek or other waterway.

## Watershed Overview

The Cypress Creek watershed is located in northwest Harris County and extends into Waller County. Rainfall within the 267 square miles of the Cypress Creek watershed drains to the watershed's primary waterway, Cypress Creek (K100-00-00). There are 250 miles of open waterways in the Cypress Creek watershed, including Cypress Creek and its major tributaries, such as Little Cypress Creek (L100-00-00), Turkey Creek (K111-00-00), Dry Gully (K133-00-00) and Mound Creek (K166-00-00). Based on the 2010 U.S. Census, the estimated population of the Harris County portion of the Cypress Creek watershed is 347,334. The western portion of the watershed is historically rural farmland, while the eastern and central portions have developed rapidly in the past 20 to 30 years. The Cypress Creek watershed has a diverse environment with animal species ranging from the American alligator to the bald eagle. The watershed upstream of Highway 290 is part of the well-known Katy Prairie ecosystem.

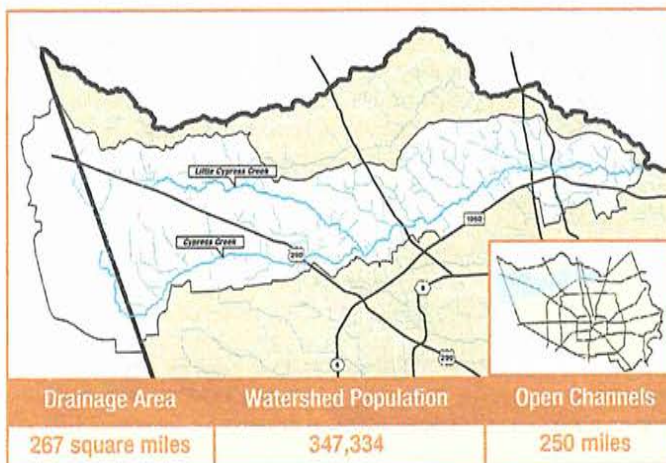
## Active Studies

**Cypress Creek Overflow Management Plan** – The Addicks Reservoir watershed occasionally receives a significant amount of natural stormwater overflow from the Cypress Creek watershed during heavy rainfall events. To understand and manage this overflow, a study has been initiated that will result in policies, technical criteria and guidelines to reduce flood risks that are acceptable to area interests and reflect the unique hydrologic conditions in the area. The study area includes upper Cypress Creek (upstream of Highway 290) and the drainage areas upstream of Addicks and Barker reservoirs, including Langham Creek, Bear Creek and South Mayde Creek. Approximately 60 square miles of the upper Cypress Creek watershed originate in Waller County and drain into Harris County. The Flood Control District and Harris County have received a grant from the Texas Water Development Board to partially support this study effort. Two public meetings were held in August 2012 and November 2013, with a third scheduled in September 2014. See [www.hcfd.org/cypresscreekoverflow](http://www.hcfd.org/cypresscreekoverflow) for further information.

## Active Capital Projects

In the past 20 years, the Harris County Flood Control District has spent nearly \$37 million on capital projects in the Cypress Creek watershed. The completed capital projects include channel improvements along various tributaries, erosion repairs along Cypress Creek, home buyouts and floodplain preservation acquisitions, and improvements to existing stormwater detention basins.

**Voluntary Home Buyouts** – Through voluntary home buyouts, the Flood Control District can purchase properties that are hopelessly deep in the floodplain, move the owners to higher ground and prevent future flood damages by removing structures from these properties. The Flood Control District has placed a major focus on voluntary home buyouts within the Cypress Creek watershed. Since 1985, the Flood Control District, acting alone and in various partnerships with the Federal Emergency Management Agency (FEMA), the U.S. Army Corps of Engineers (Corps) and Harris County, has acquired more than 300 flood-prone properties in the Cypress Creek watershed.



## Recently Completed Capital Projects

**Site Improvements and Wetlands Construction** – This project (K700-01-00-E001) created and restored approximately 95 acres of wetland habitat on the Katy Prairie near the intersection of Katy-Hockley and House Hahl roads. The area provides required mitigation for other projects that will impact native wetlands, specifically the Greenhouse Stormwater Detention Basin on Langham Creek (U500-02-00), at Greenhouse and Longenbaugh roads, and the John Paul's Landing Stormwater Detention Basin on a Bear Creek tributary, near the intersection of Katy-Hockley Cutoff and Sharp roads. The wetlands project, which included planting bog rush, swamp smartweed, duck potato, powdered thalia and maidencane, was completed in February 2014 and cost approximately \$203,000.

**Cypress Park Basin Improvements** – In 2013, the Flood Control completed excavation of a 50-acre stormwater detention basin at Cypress Park. This basin (K500-01-00) will store approximately 80 million gallons of stormwater to help reduce flooding risks and damages. It is located on the north bank of Cypress Creek near North Eldridge Parkway, adjacent to the Parc Lake subdivision. The total design and construction cost for the basin was approximately \$1.8 million.



## Completed and Routine Maintenance Projects

The Harris County Flood Control District oversees more than 2,500 miles (about the distance from Los Angeles to New York City) of bayous and creeks and routinely performs maintenance projects to repair bayous and stormwater detention basins that have experienced erosion, slope failure and sediment buildup. The Flood Control District also plants native grasses, wildflowers and trees to help reduce erosion and lower mowing costs along bayous and stormwater detention basins in the Cypress Creek watershed.

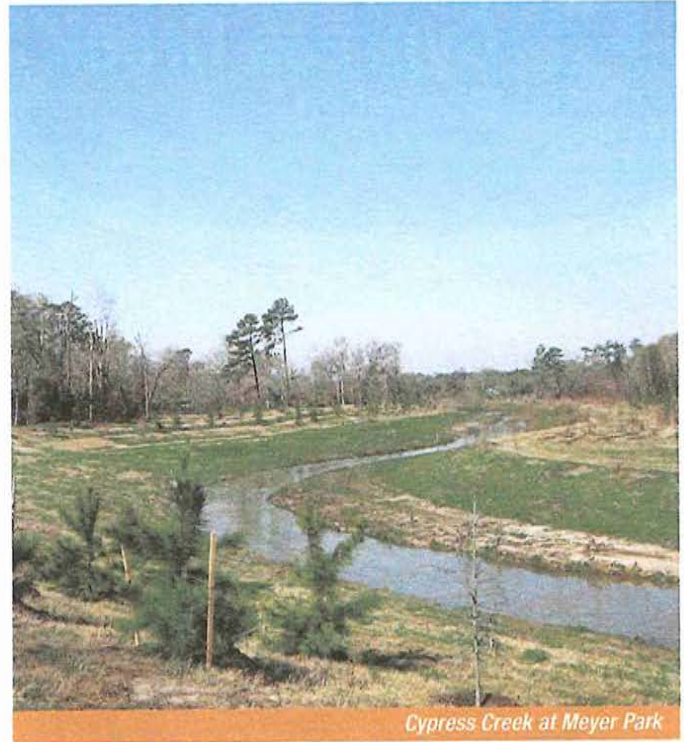
**Seals Gully Erosion Repairs** – In late 2014, the Flood Control District expected to complete a maintenance project in northwest Harris County along a tributary of Cypress Creek, formally identified as K124-00-00 and commonly called Seals Gully (or Bonds Gully). The project repaired severe erosion of the channel side slopes and also removed a failed and outdated drop structure located between Cypresswood Drive and Haude Road. The project maintains the channel's ability to carry stormwater.

**Cypress Creek Channel Restoration Project** – In 2013, the Flood Control District completed the final phase of a maintenance project to repair severe erosion along Cypress Creek (K100-00-00) from Champion Forest Drive to Stuebner-Airline Road. The first phase, which used natural stable channel design techniques to repair erosion along a bend in the creek adjacent to Meyer Park, was completed in 2006. The second phase focused on the creek from Latson Road to Stuebner-Airline. Both phases included the construction of gentle side slopes and a channel "bench" or plateau to help prevent and control future erosion. In advance of this project, a Native American campsite was found along the banks. In accordance with state and federal laws, archeologists excavated portions of the area and recovered more than 2,000 artifacts, such as stone tools and pieces of pottery, which are now curated at the Texas Archeological Research Laboratory at the University of Texas in Austin. Following completion of this cultural resources investigation, construction began to repair the severe erosion within the Phase II project limits. Total cost of both phases was more than \$3 million. Following construction, the Flood Control District also posted educational signs describing the archeological finds along Cypress Creek. The signs are located near the pond in the southeast corner of Meyer Park.

**Mowing and vegetation maintenance** – The Flood Control District performs routine cyclical maintenance, including mowing of land along bayous, creeks and stormwater detention basins in the Cypress Creek watershed. The Flood Control District also performs selective clearing of invasive trees and vegetation.

## What We Do

The Harris County Flood Control District was initially created in 1937 to serve as a local partner to the U.S. Army Corps of Engineers to build projects that reduce flooding risks and damages from major bayous and creeks in Harris County. While the District still fulfills that role, its responsibilities and capabilities have expanded over the years. The mission of the Flood Control District is to provide flood damage reduction projects that work, with appropriate regard for community and natural values. The Flood Control District accomplishes its mission by devising flood damage reduction plans, implementing the plans and maintaining the infrastructure.



Cypress Creek at Meyer Park

**Tree and wildflower plantings** – In recent years, the Flood Control District has planted hundreds of trees in the Cypress Creek watershed. In the 2013-2014 planting season alone, more than 700 trees were planted on Cypress Creek (K100-00-00) in Meyer Park. In the 2011-2012 season, the Flood Control District planted along Dry Gully (K145-00-00) and a tributary formally identified as K111-07-00. In earlier years, nuttall oak, green ash and southern magnolia were just a few of the tree species planted along the stormwater detention basin formally identified as K545-04-00. The Flood Control District also planted several species of wildflowers, including showy primrose, Texas bluebonnet and bird's eyes, along, Faulkey Gully (K142-00-00) and a tributary formally identified as K131-03-00.

## Active Maintenance Projects

### Erosion Repairs on a Cypress Creek tributary, Rockgate to Cypressgate

– In June 2014, the Flood Control District began construction on a maintenance project along a tributary of Cypress Creek, formally identified as HCFCD Unit K105-00-00, from Rockgate Drive to Cypressgate Drive in north Harris County. This project will repair erosion, remove excess sediment, install buried riprap to armor the channel against further erosion, and replace failed outfall pipes.

*For more information about the Cypress Creek watershed, its studies and projects, or the Flood Control District, please visit our website at [www.hcfcd.org](http://www.hcfcd.org). For more information on a particular study or project, please call the Harris County Flood Control District's Project and Study Information Line at (713) 684-4040.*





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## PROJECTS & STUDIES

[MULTI-WATERSHED \(HTTP://WWW.HCFCF.ORG/PROJECTS-STUDIES/MULTI-WATERSHED/\)](http://www.hcfcf.org/projects-studies/multi-watershed/)

[ADDICKS RESERVOIR \(HTTP://WWW.HCFCF.ORG/PROJECTS-STUDIES/ADDICKS-RESERVOIR/\)](http://www.hcfcf.org/projects-studies/addicks-reservoir/)

[ARMAND BAYOU \(HTTP://WWW.HCFCF.ORG/PROJECTS-STUDIES/ARMAND-BAYOU/\)](http://www.hcfcf.org/projects-studies/armand-bayou/)

[BARKER RESERVOIR \(HTTP://WWW.HCFCF.ORG/PROJECTS-STUDIES/BARKER-RESERVOIR/\)](http://www.hcfcf.org/projects-studies/barker-reservoir/)

[BRAYS BAYOU \(HTTP://WWW.HCFCF.ORG/PROJECTS-STUDIES/BRAYS-BAYOU/\)](http://www.hcfcf.org/projects-studies/brays-bayou/)

[BUFFALO BAYOU \(HTTP://WWW.HCFCF.ORG/PROJECTS-STUDIES/BUFFALO-BAYOU/\)](http://www.hcfcf.org/projects-studies/buffalo-bayou/)

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[CEDAR BAYOU \(HTTP://WWW.HCFCF.ORG/PROJECTS-STUDIES/CEDAR-BAYOU/\)](http://www.hcfcf.org/projects-studies/cedar-bayou/)

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[GREENS BAYOU \(HTTP://WWW.HCFCF.ORG/PROJECTS-STUDIES/GREENS-BAYOU/\)](http://www.hcfcf.org/projects-studies/greens-bayou/)

[HUNTING BAYOU \(HTTP://WWW.HCFCF.ORG/PROJECTS-STUDIES/HUNTING-BAYOU/\)](http://www.hcfcf.org/projects-studies/hunting-bayou/)

[JACKSON BAYOU \(HTTP://WWW.HCFCF.ORG/PROJECTS-STUDIES/JACKSON-BAYOU/\)](http://www.hcfcf.org/projects-studies/jackson-bayou/)

[LITTLE CYPRESS CREEK \(HTTP://WWW.HCFCF.ORG/PROJECTS-STUDIES/LITTLE-CYPRESS-CREEK/\)](http://www.hcfcf.org/projects-studies/little-cypress-creek/)

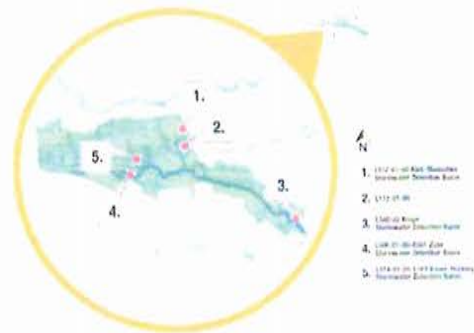
Completed Projects (<http://www.hcfcf.org/projects-studies/little-cypress-...>)

## LITTLE CYPRESS CREEK FRONTIER PROGRAM

The Little Cypress Creek Frontier Program is one component of the Harris County Flood Control District's overall Frontier Program, which is an organized effort to plan for regional drainage infrastructure in advance of future land development.

The Little Cypress Creek Frontier Program focuses on the 52-square-mile Little Cypress Creek watershed in northwest Harris County. This area, which is experiencing rapid development with construction of the Grand Parkway, lacks sufficient natural drainage to accommodate expected growth. By collaborating with land owners and developers, the program is working to identify a large-scale, mutually beneficial plan for drainage that cost-effectively maximizes stormwater mitigation and water quality, as well as opportunities for public recreational amenities and open space. (</media/2046/little-cypress-creek-frontier-program2016-0527.jpg>)

This innovative approach is in contrast to typical efforts in which individual land owners and developers install drainage infrastructure that serves their site alone, resulting in smaller, isolated stormwater detention basins and minimum-width channels for stormwater management. By taking a regional approach, the Frontier Program protects existing developments and provides proper drainage access for newly developing properties.



Developers participate in the Frontier Program by paying a \$4,000-per-acre fee to develop in the watershed service area. Developers also participate by excavating a portion of regional drainage facilities and by dedicating property for right of way. The Little Cypress Creek Frontier Program will use impact fees primarily to acquire right of way along the channel and for stormwater detention basins.

The program calls for stricter stormwater detention requirements to mitigate runoff from new developments and will result in at least seven regional detention basins with a combined minimum storage of 14,000 acre-feet.

### MAJOR COMPONENTS

([click on map \(/media/2046/little-cypress-creek-frontier-program2016-0527.jpg\)](/media/2046/little-cypress-creek-frontier-program2016-0527.jpg))

Major components of the Little Cypress Creek Frontier Program plan include:

- **L500-02 Kluge Stormwater Detention Basin**  
This stormwater detention basin on a 146-acre site between Kluge Road and Longwood Trace Drive was completed in 2015. The basin holds more than 325 million gallons, or 1,000 acre-feet, of excess stormwater during periods of heavy rain.
- **L500-01-00-E001 Zube Stormwater Detention Basin**  
This stormwater detention basin is located on Harris County Precinct 3's existing Zube Park and an 84-acre site east of the park owned by the Flood Control District. Phase I construction was

[creek/completed-projects/](#)

Little Cypress Creek Frontier Program  
(<http://www.hcfcf.org/projects-studies/little-cypress-creek/little-cypress-creek-frontier-program/>)

Zube Park Stormwater Detention Basin  
L500-01-00 (<http://www.hcfcf.org/projects-studies/little-cypress-creek/zube-park-stormwater-detention-basin-l500-01-00/>)

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WILLOW CREEK ([HTTP://WWW.HCFCF.ORG/PROJECTS-STUDIES/WILLOW-CREEK/](http://WWW.HCFCF.ORG/PROJECTS-STUDIES/WILLOW-CREEK/))

completed in 2016. Phase II, which includes additional excavation and a weir connecting the basin to Little Cypress Creek, began construction in early 2017.

• **L112-01-00**

Conveyance improvements for this Little Cypress Creek tributary near Mueschke Road and the Grand Parkway are in design and are expected to go out for bid in 2018. Stormwater mitigation for this project will be provided by construction of HCFCF Unit L512-01-00.

• **L512-01-00 Kleb-Mueschke Stormwater Detention Basin**

This stormwater detention basin on a 106-acre site south of Kleb Woods is in design. The basin provides mitigation for improvements to HCFCF Unit L112-01-00.

• **L514-01-00-E001 Bauer-Hockley Stormwater Detention Basin**

This stormwater detention basin on a 101-acre site near Bauer-Hockley and Becker roads, west of the confluence of Little Cypress and Cypress creeks, has been previously excavated through excavation and removal contracts. A weir connecting the basin to a Little Cypress Creek tributary is in design.

• **Property acquisition** is underway for several components of the Little Cypress Creek Frontier Program Master Plan, including stormwater detention basins and future channel projects to increase stormwater storage and carrying capacity within the Little Cypress Creek watershed.

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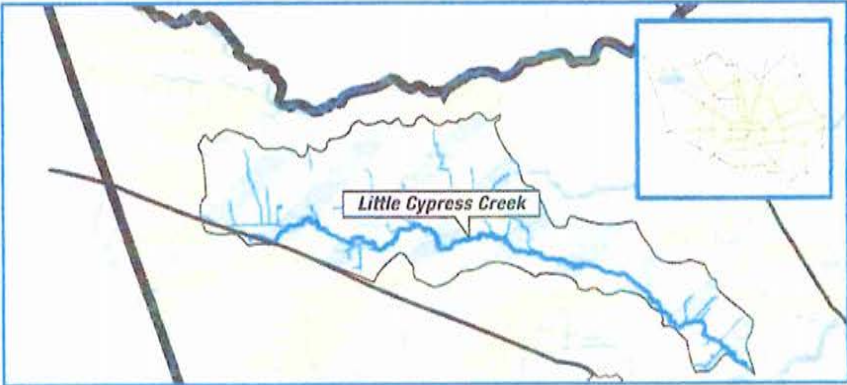
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Completed Projects (<http://www.hcfcd.org/projects-studies/little-cypress->

LITTLE CYPRESS CREEK

DRAINAGE AREA	WATERSHED POPULATION	OPEN STREAM MILES	PRIMARY STREAMS
50 Sq. Miles	28,879 (Harris County portion)	56	



WATERSHED OVERVIEW

Little Cypress Creek is usually considered the "22nd Watershed" within Harris County, although it is actually a subwatershed of the major Cypress Creek watershed. The Little Cypress Creek watershed encompasses a mostly rural, undeveloped area of northwest Harris County. Based on the 2010 U.S. Census, the estimated population of the Little Cypress Creek watershed is 28,879.



[creek/completed-projects/](#)

Little Cypress Creek Frontier Program  
(<http://www.hcfcf.org/projects-studies/little-cypress-creek/little-cypress-creek-frontier-program/>)

Zube Park Stormwater Detention Basin  
L500-01-00 (<http://www.hcfcf.org/projects-studies/little-cypress-creek/zube-park-stormwater-detention-basin-l500-01-00/>)

### **Tributary on Little Cypress Creek.**

Little Cypress Creek is not always delineated separately on Harris County Flood Control District maps. As far back as 1944, however, when the Flood Control District's unique internal unit numbering system was devised, it was given its own watershed letter – "L" – to help identify its associated tributaries and flood damage reduction projects. Cypress Creek is designated with the letter "K."

Little Cypress Creek comprises more than 15% of the larger Cypress Creek watershed, with a drainage area of about 50 square miles.

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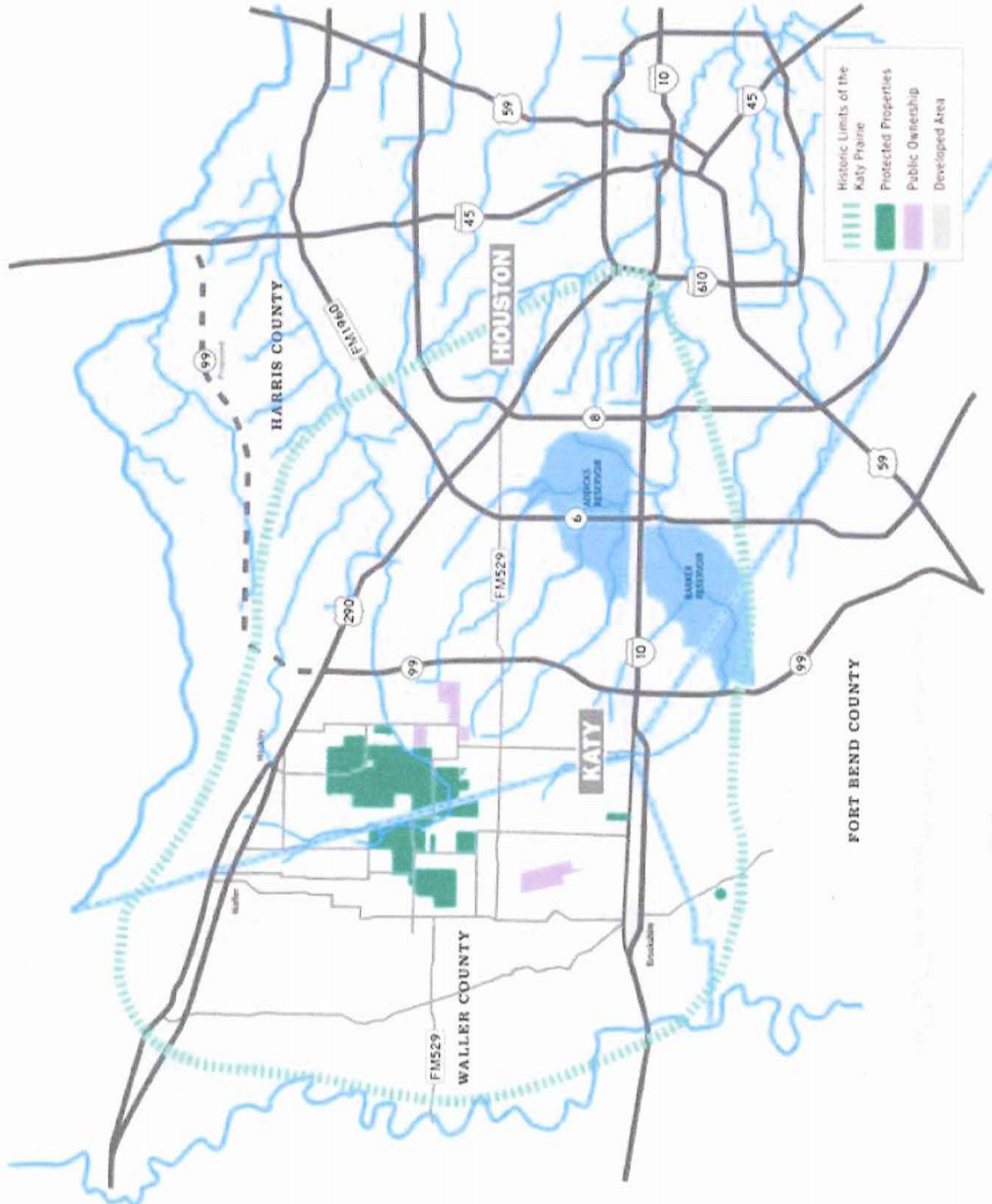
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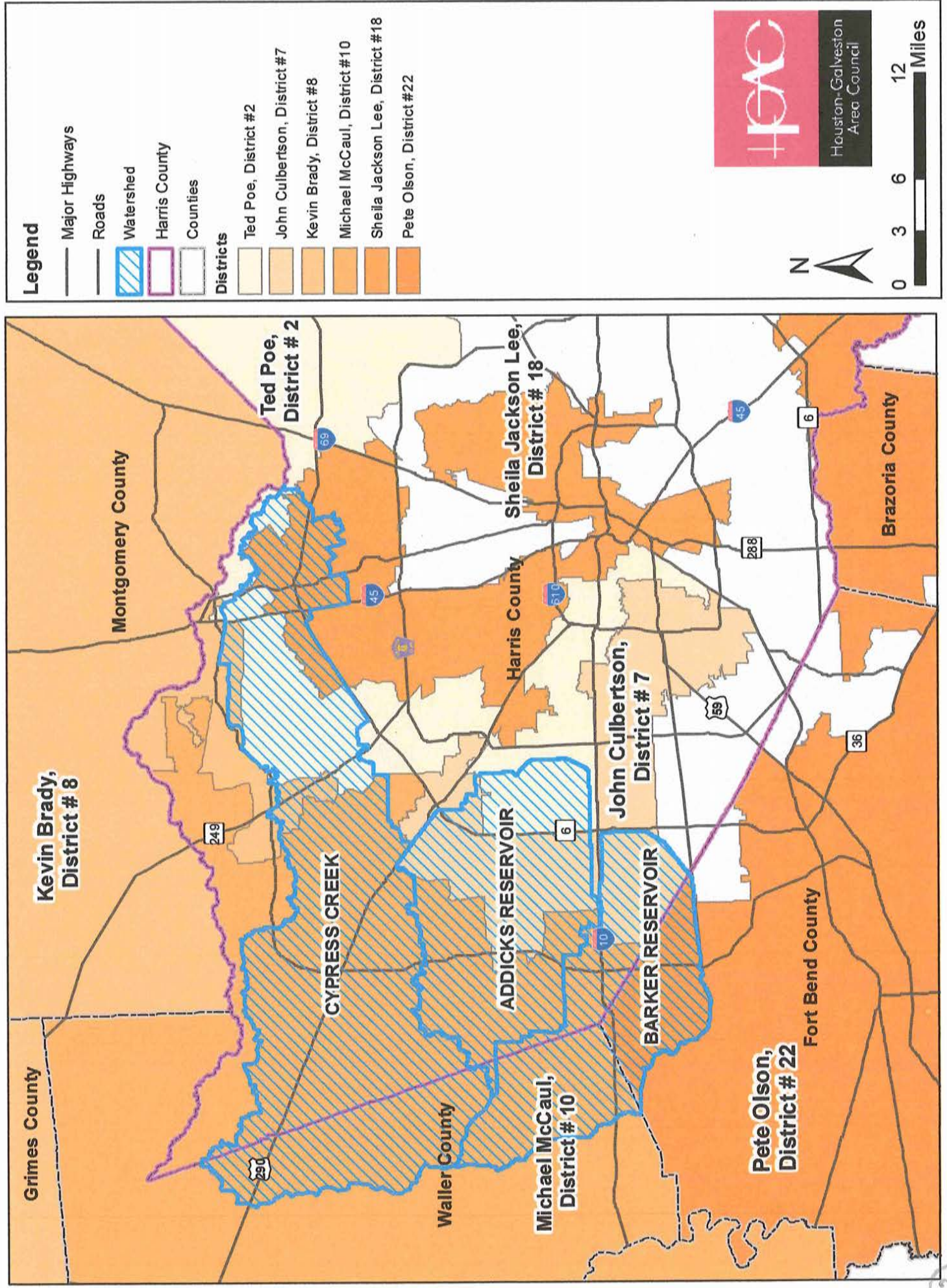




Katy Conservancy Acreage

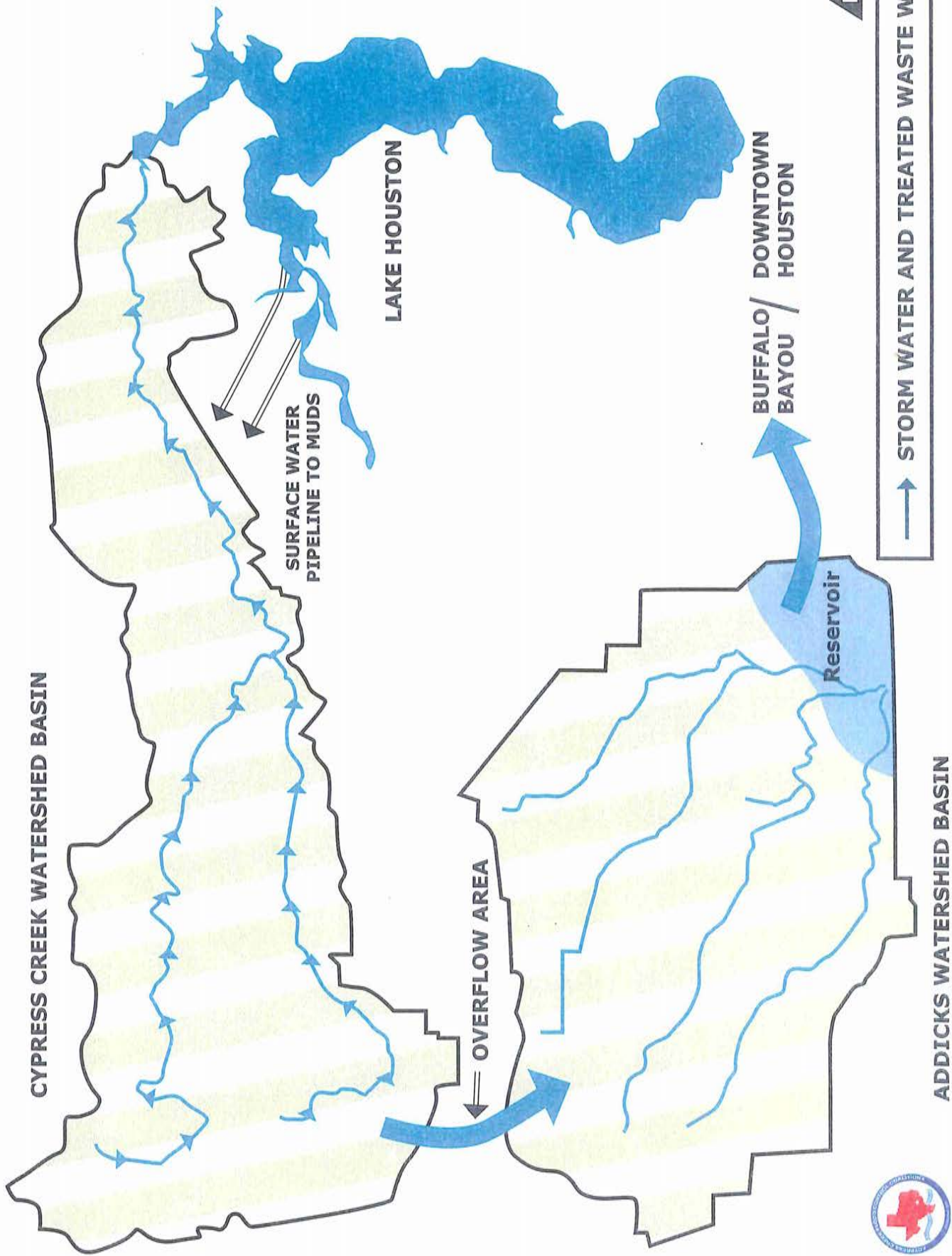


# Cypress Creek, Addicks & Barker Reservoir and Districts





# CREEK & TRIBUTARY | Watershed's Veins & Arteries



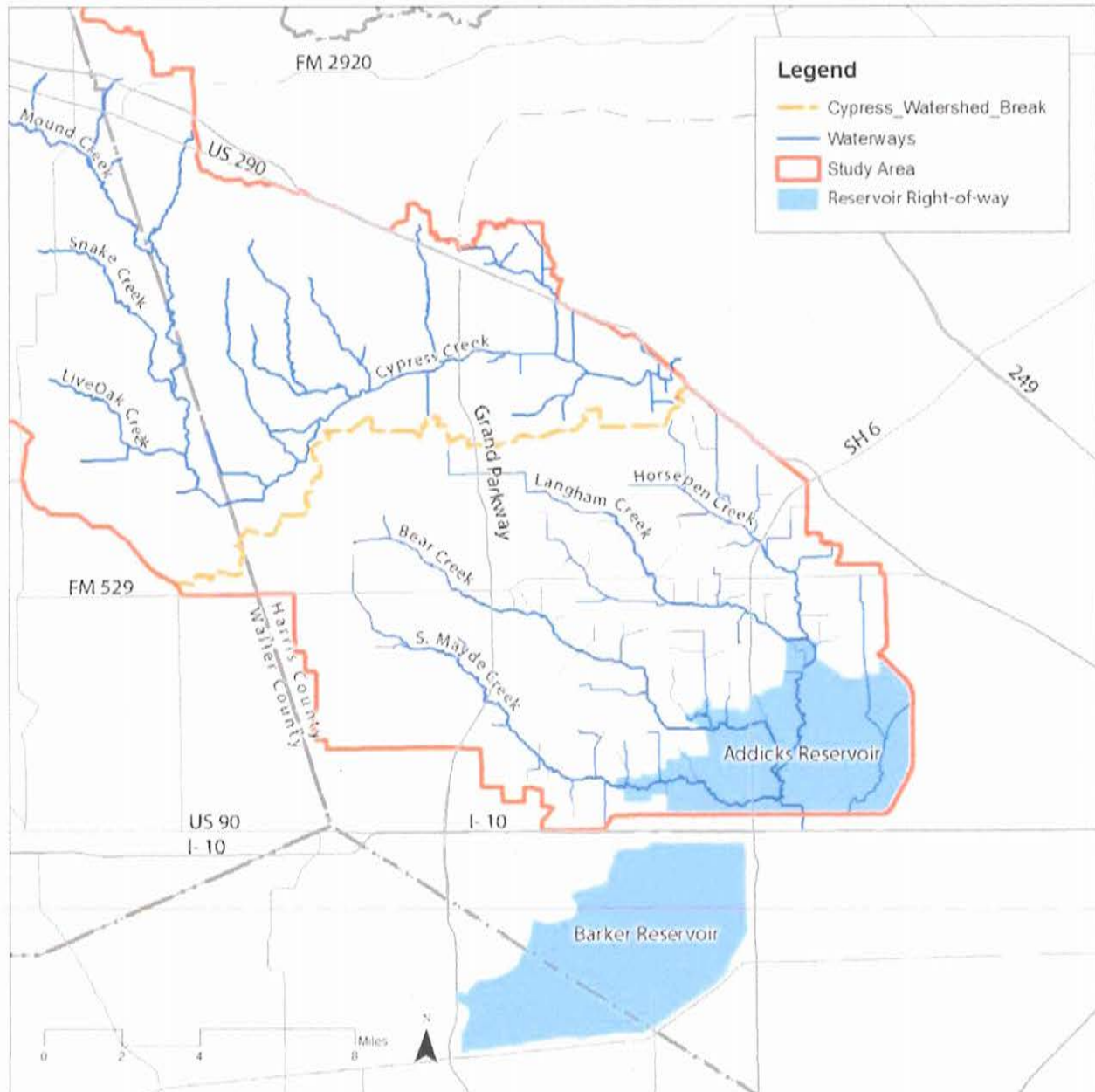
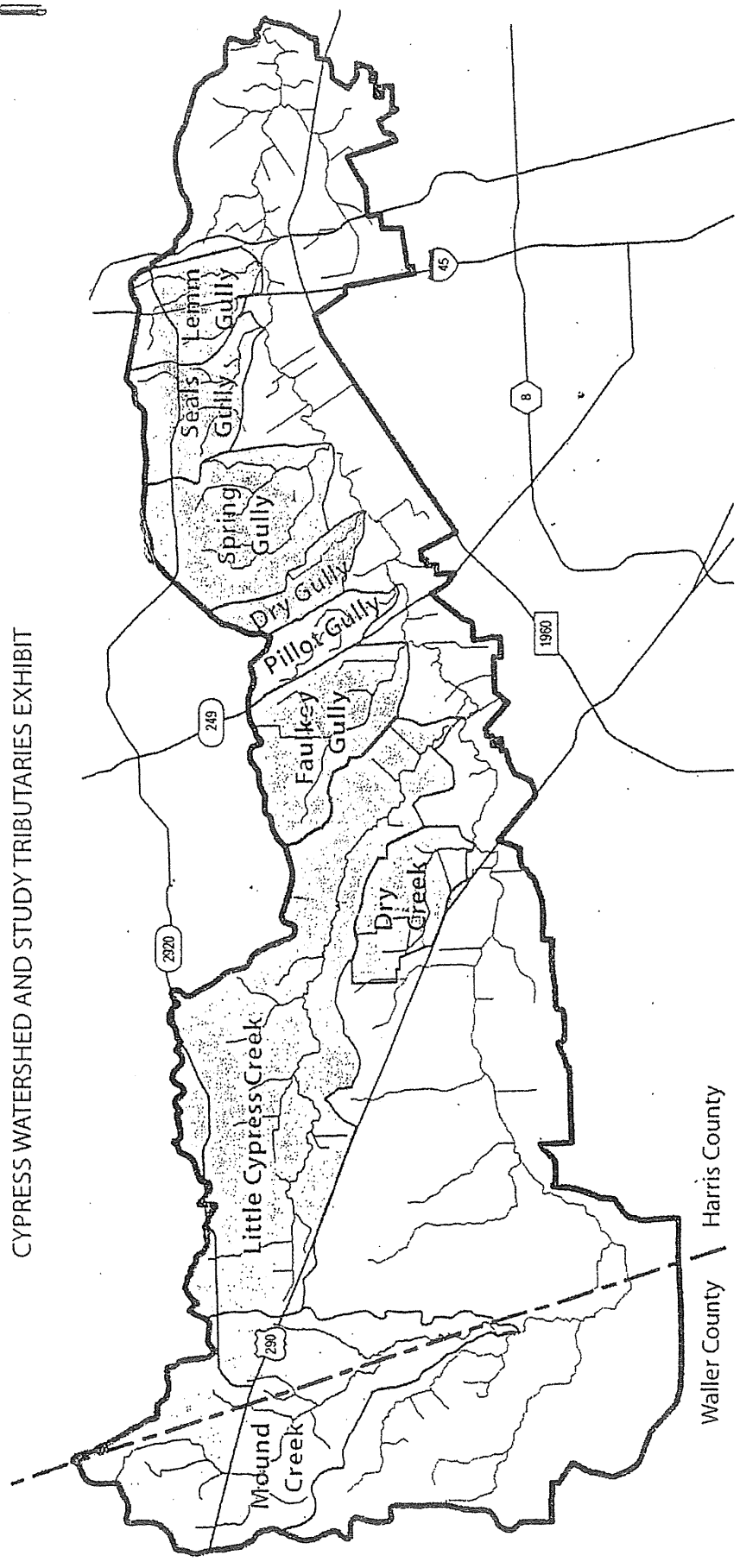


Figure 3.11 Addicks and Barker Reservoirs  
Source: 2015 CC Overflow Study

REGIONAL DRAINAGE PLAN AND ENVIRONMENTAL INVESTIGATION FOR  
 MAJOR TRIBUTARIES IN THE CYPRESS CREEK WATERSHED  
 CYPRESS WATERSHED AND STUDY TRIBUTARIES EXHIBIT

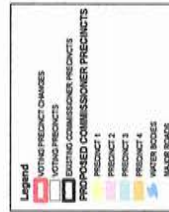
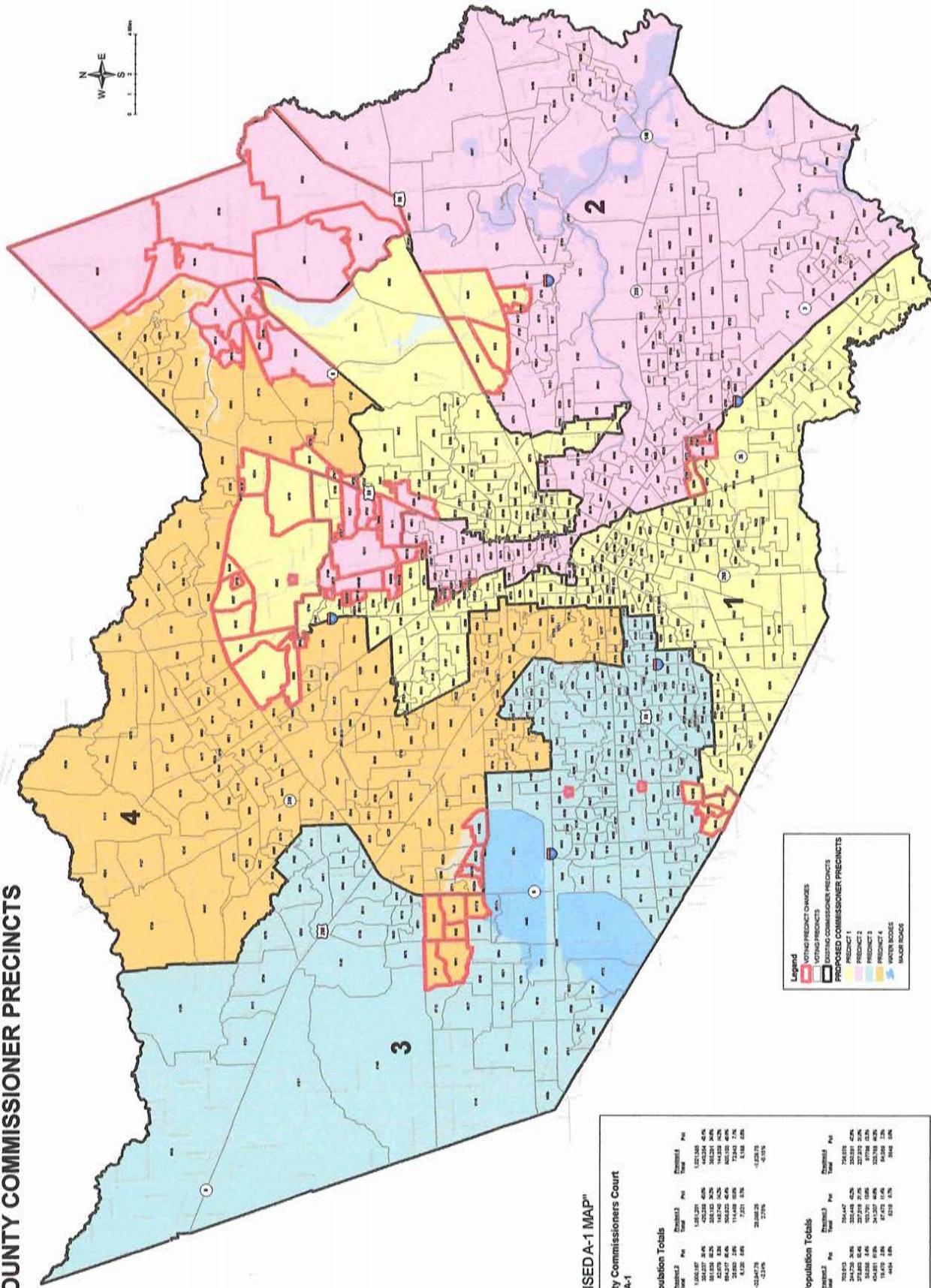
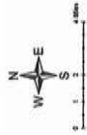


ENGINEERING CONTRACTOR/CONSULTANTS:

- BROWN & GAY: MOUND CREEK and DRY CREEK
- DODSON ASSOCIATES: LITTLE CYPRESS, FAULKNEY GULLY, PILLOT GULLY
- CIVIL TECH ENGR.: DRY GULLY, SPRING GULLY, SEAL'S GULLY, LEMM GULLY



# HARRIS COUNTY COMMISSIONER PRECINCTS



"REVISED A-1 MAP"

Harris County Commissioners Court  
Revised Plan A-1

## Population Totals

	Precinct 1	Precinct 2	Precinct 3	Precinct 4
Total	1,181,207	1,081,207	1,081,207	1,081,207
Population	1,181,207	1,081,207	1,081,207	1,081,207
White (Non-Hispanic)	714,483	714,483	714,483	714,483
Black (Non-Hispanic)	215,425	215,425	215,425	215,425
Hispanic (Non-Hispanic)	151,117	151,117	151,117	151,117
Asian	54,442	54,442	54,442	54,442
Other	5,740	5,740	5,740	5,740
Population %	42.8%	42.8%	42.8%	42.8%
Percentage %	42.8%	42.8%	42.8%	42.8%

## VA Population Totals

	Precinct 1	Precinct 2	Precinct 3	Precinct 4
Total	714,483	714,483	714,483	714,483
Population	714,483	714,483	714,483	714,483
White (Non-Hispanic)	438,425	438,425	438,425	438,425
Black (Non-Hispanic)	151,117	151,117	151,117	151,117
Hispanic (Non-Hispanic)	102,791	102,791	102,791	102,791
Asian	34,357	34,357	34,357	34,357
Other	4,003	4,003	4,003	4,003
Population %	42.8%	42.8%	42.8%	42.8%
Percentage %	42.8%	42.8%	42.8%	42.8%

Total Population 4,081,483  
Avg. Population 1,020,371

## **Rising Waters—Historic Flooding Hurricane Harvey/August 2017**

**Summary:** All rainfall records were broken in Harris County with the advent of Hurricane Harvey. Rainfall started on Friday morning August 28 and lasted through Monday August 28. The Hurricane made landfall near Port Aransas around 10PM on August 25, moved inland to near Victoria and then moved back in a Southward trek back offshore. From there it made a parallel run along the coast in an Eastward direction with inundating rainfall falling all along the Upper Texas Coast. The max peak rainfall over the day period for Harris County was 47.4 inches with some reports of as much as 51 inches just east of the County.

The toll from Harvey was devastating. Medical authorities confirmed 36 flood related deaths across Harris County. Damage assessments are still coming in and it is estimated that over 80,000 structures were flooded as well as 600,000 vehicles. Current damage estimates for Harvey range from 80-190 billion dollars.

### **Shared from the 2017-09-17 Houston Chronicle eEdition.**

“The amount of water that fell was unprecedented,” said Shane Hubbard, an associate researcher at the Space Science and Engineering Center at the University of Wisconsin-Madison.

Based on Hubbard’s analysis and Weather Underground statistics, the storm’s scope was enormous. Among the findings:

- The record 51.88 inch recording at Cedar Bayou, east of Houston, is the continental U.S. rainfall record, surpassing a mark set during Tropical Storm Amelia in 1978.
- The national record for a three-day rain total in a metro area is Hobby Airport Aug. 26-28, with 32.47 inches. Bush Intercontinental is third, over the same days, with 28.44 inches. The National Weather Service’s official rain gauges are at the airports.
- The area that received, on average, more than 40 inches of rain is slightly larger than the land mass of Puerto Rico.

The extent of significant rain is something officials are just starting to address, Hubbard said.

“Texas is a big place,” he said. “Sometimes the sheer size gets lost.”

According to his analysis, between Aug. 23 and Aug. 30 over an area of nearly 29,000 square miles received 20 inches or more of rain. That is larger than 10 U.S. states.

Hubbard noted the area hit by heavy rains is larger than West Virginia, Delaware and Rhode Island combined.

Using weather monitors, Hubbard mapped where rain was most and least concentrated as storms pounded the area. Though some specific spots received more or less rain, Hubbard's data showed a concentrated 28 inches of rainfall or more from Rosenberg to east of Beaumont.

Central and coastal areas received the most rain, with many spots receiving 50 or more inches.

274 Citizen Emergency Response Teams, which are composed of volunteers who have received special training, as well as the Cajun Navy from Louisiana and the Redneck Navy of Texas, a group of hunters and fishermen with their shallow water boats, poured into the area and responded to rescue efforts for hundreds of flooded/stranded Texas residents and their pets.

**Shared from the 2017-09-16 Houston Chronicle eEdition. (\$19 Billion)**--Amount the insurance trade association expects Harvey will cost in insured losses.**(\$12 Billion)**-- Amount in insured losses during Hurricane Ike. Previously, Ike was the costliest storm to hit Texas. (\$238 Million)-- Amount in advance payments from the National Flood Insurance Program to 85,000 flood-insured policyholders in Texas. The council expects the flooding of some 250,000 private passenger and commercial vehicles will cost \$4.75 Billion in insured losses. Insured windstorm and other storm-related property losses are expected to top \$3 Billion. This doesn't include residential property losses due to flooding or any uninsured losses.

By the end of Week 3 after Harvey, State Farm customers throughout Texas had filed 35,200 auto claims and 41,400 property claims related to Harvey. The Texas Windstorm Insurance Association, the insurer of last resort for wind and hail coverage along the coast, reported 59,368 claims as of Friday. The Texas FAIR Plan Association, which provides residential property insurance in underserved areas, reported 13,874 claims as of Friday. Farmers Insurance reported more than 40,000 claims in Texas, 15,000 for city of Houston and its surrounding areas. The company ultimately expects the hurricane and related storms to generate about 60,000 claims at an estimated gross cost of \$500 Million. After reinsurance and taxes, Farmers estimates that its net incurred loss will be \$140 Million. These claims numbers do not include flooded houses.

The National Flood Insurance Program, managed by the Federal Emergency Management Agency, insures 98 percent of U.S. flood insurance policies. That program is expected to pay \$11 Billion to homeowners who carried flood insurance. As of September 15, 85,000 flood-insured policyholders in Texas received \$238 million in advance payments from the National Flood Insurance Program. "If you're looking at \$11 Billion in homes that had flood insurance ... you're looking at a much higher loss amount from those uninsured," Hanna said. "It's going to be well over \$50 Billion in uninsured losses."

**A detailed FINAL report by Jeff Lindner, Meteorologist at HCFCD, is included on pages 28 to 65 and includes Flooding and Rainfall presentations.**



## MEMORANDUM



9900 Northwest Freeway  
Houston, TX 77092  
713-684-4000

**DATE:** June 4, 2018

**TO:** HCFCF Flood Watch/Partners

**FROM:** Jeff Lindner  
Director of Hydrologic Operations/Meteorologist

Steve Fitzgerald  
Chief Engineer

**RE:** Immediate Report – Final  
Hurricane Harvey - Storm and Flood Information

---

This is the third and final report summarizing the catastrophic flooding produced by the landfall and slow movement of Hurricane Harvey.

### **GENERAL FLOODING STATEMENT**

The tropical wave that would eventually develop into Hurricane Harvey moved off the west coast of Africa on August 11<sup>th</sup> and tracked westward across the tropical Atlantic becoming a tropical storm on August 17<sup>th</sup> and then moved into the Caribbean Sea where Harvey became disorganized and was downgraded to a tropical wave. The tropical wave entered the Gulf of Mexico on the afternoon of the 22<sup>nd</sup> and was upgraded again to tropical depression Harvey on the morning of the 23<sup>rd</sup>. Over the next 48 hours Harvey would undergo a period of rapid intensification from a tropical depression to a category 4 hurricane and make landfall along the Texas coast near Port Aransas around 10:00 p.m. on August 25<sup>th</sup>. The upper air steering patterns that moved Harvey toward the Texas coast weakened and Harvey's forward motion slowed to near 5 mph after landfall and then to a meander just north of Victoria, TX on the 26<sup>th</sup>. Rain bands on the eastern side of the circulation of Harvey moved into southeast Texas and Harris County on the morning of the 25<sup>th</sup> and continue through much of the night and into the 26<sup>th</sup>. A strong rainband developed over Fort Bend and Brazoria Counties during the evening hours of the 26<sup>th</sup> and spread into Harris County and slowed while training from south to north. Flash flooding developed rapidly between 8:00 p.m. and 11:00 p.m. as tremendous rainfall rates occurred across much of Harris County. Additional rain bands continued to develop into the morning hours of the 27<sup>th</sup> producing additional excessive rainfall amounts.

As the center of Harvey slowly moved east-southeast and back offshore, heavy rainfall continued to spread across Harris County through much of the 29<sup>th</sup> and the 30<sup>th</sup> exacerbating the ongoing widespread and devastating flooding. Harvey maintained tropical storm intensity the entire time while inland over the Texas coastal bend and southeast Texas. After moving offshore, Harvey made another landfall just west of Cameron, Louisiana on the morning of the 30<sup>th</sup>.

All 4.7 million people in Harris County were impacted directly or indirectly during the flood and after the flood waters receded. 60,049 residents were rescued by government resources across all portions of Harris County, most of them from their homes with 32,000-34,000 staying in 65

temporary shelters. Tens of thousands of additional residents were rescued by local civilian resources and help that arrived from around Texas and surrounding states. On Sunday morning, August 27<sup>th</sup>, parts of all of the 22 major freeways in the Houston metropolitan area were flooded and impassable resulting in nearly impossible travel conditions and creating significant challenges to rescue operations across not only Harris County but the entire region.

It is estimated that over 300,000 vehicles were flooded across Harris County many of which were at homes, parking garages, and dealership lots.

The Harris County Medical Examiner's Office confirmed 36 flood related deaths across Harris County. Unlike with recent flooding across Harris County, the majority of the fatalities associated with Harvey were not from drowning in vehicles, but instead from people outside in the fast moving or high water levels. Additionally, Harvey is one of the only flood events where a few people drowned in their home or work place. Statewide Harvey resulted in 68 directly fatalities the largest number from a landfalling hurricane in Texas since 1919.

FEMA assistance to help individuals and families recover so far:

- 47,000+ Flood Insurance Claims (\$2.9B)
- 15,800+ Small Business Loans (\$1.2B)
- 177,600 Individual Assistance approvals (\$4.8B)

Damage estimates indicate hurricane Harvey's landfall in Texas and flooding across the Houston area is the second costliest hurricane in American history with 125 billion dollars in damage. Only Hurricane Katrina (2005) with 160 billion dollars in damage exceeds Harvey. The table below lists the top 5 costliest tropical cyclone impacts in US history adjusted for inflation.

Storm	Damage	Year	Category
Katrina	\$ 160,000,000,000	2005	3
Harvey	\$ 125,000,000,000	2017	4
Sandy	\$ 70,200,000,000	2012	1
Irma	\$ 50,000,000,000	2017	4
Andrew	\$ 47,790,000,000	1992	5

On April 12, 2018, the name Harvey was officially retired from the National Hurricane Center list of tropical cyclone names and will never be used again. Names are reused every six years unless the storm is particularly deadly and devastating in which that name is then retired. The name Harvey will be replaced with Harold and will first appear in 2023.

### **RAINFALL**

Peak total rainfall for the various time periods are listed below for HCFCD gages across Harris County.

Time	1-hr	2-hr	3-hr	6-hr	12-hr	24-hr	2-day	4-day
Peak Rainfall (inches)	6.8	11.9	14.8	18.9	20.9	25.6	35.2	47.4

**Duration** – Rain began Friday morning, August 25<sup>th</sup> across the county with the first heavy band entering the county Saturday evening, August 26<sup>th</sup>. Heavy rain bands continued to sweep across the entire county through Tuesday, August 29<sup>th</sup>. The majority of the rainfall occurred during a 4 day period and breaks in rainfall between bands were short and infrequent.

**Total Amounts** – Total rainfall amounts ranged from 26 to 47 inches across the county for 4 days. The 2 day amount ranged from 20 to 35 inches and the 1 day from 13 to 25 inches. The lowest totals occurred over the northwest and northeast part of the county with the highest totals focused across the southeast part of the county along I-45 from near the City of South Houston and Pasadena southward to Friendswood and Webster and eastward along I-10 to Baytown.

A maximum 2 day rainfall total of 34.5 inches was recorded at Clear Creek and I-45 and 35.2 inches at Berry Bayou and Forest Oaks Blvd.

A maximum 4 day rainfall total of 47.4 inches was recorded at Clear Creek and I-45

**Exceedance Probability** – Rainfall was generally less than a 2% (50-yr) event for the time 15-min to 6-hr time periods for most areas except southeast Harris County and Brays Bayou where 1% (100-yr) to 0.2% (500-yr) and greater rainfall occurred. Rainfall for the 12-hr to 4 day time periods ranged from 1% (100-yr) to 0.2% (500-yr) and greater for all watersheds.

The maximum and weighted ranges shown below are county-wide and recurrence intervals greater than 500-yr are approximate.

The 47.4 inches of rainfall at I-45 and Clear Creek over a 4 day period is 95% of the Probable Maximum Precipitation (PMP).

<b>Duration</b>	<b>Rainfall Amount</b>	<b>Return Interval – years (exceedance probability)</b>
<b>1-Hour</b>		
Maximum	6.8"	1,500 (0.0667%)
Weighted Range	4-5"	50-500 (2.0% - 0.2%)
<b>24-Hour</b>		
Maximum	25.6"	5,000 (0.02%)
Weighted Range	16-20"	200-1,000 (0.5%-0.1%)
<b>2-Day</b>		
Maximum	35.2"	12,000 (0.08%)
Weighted Range	23-30"	1,500-5,000 (0.067%-0.02%)
<b>4-Day</b>		
Maximum	47.4"	50,000 (0.002%)
Weighted Range	30-40"	3,000-20,000 (0.033%- 0.005%)

Two other rainfall factors that influence flood levels are the intensity (inches per hour) variation over time and the distribution in the watershed (area distribution). For Hurricane Harvey, the intensity was moderate to high most of the time. Due to the length of the rainfall event and the



numerous bands that developed, the areal distribution in most watersheds did not vary significantly.

The following table compares the extraordinary rainfall associated with Harvey against Tropical Storm Allison in June 2001, the Tax Day Flood of April 2016, and the October 1994 Flood for various time periods. It is interesting that Tropical Storm Allison exceeds Harvey's rainfall in the 6, 12 and 24-hr periods. In the 2 day period Harvey produced 6.0 inches more than Allison and 8.9 inches more over 4 days.

Duration	Max Rainfall (inches)			
	Harvey	Allison June 2001	Tax Day April 2016	October 1994
1-hr	6.8	5.7	4.7	3.7
2-hr	11.9	9.9	7.3	4.7
3-hr	14.8	13.5	8.3	5.3
6-hr	18.9	21.2	13.9	7.2
12-hr	20.9	28.3	16.7	12.0
1 day	25.6	28.4	17.4	20.9
2 days	35.2	28.5	17.5	23.1
4 days	47.4	38.5	N/A	28.9

A total of 1 trillion gallons of water fell across Harris County over the 4 day period which would fill NGR Stadium 1472 times and cover Harris County's 1,777 sq. miles with an average of 33.7 inches of water. This volume of water would also run Niagara Falls for 15 days.

#### **RAINFALL HISTORICAL CONTEXT**

There are three ways to examine a rainfall event to determine its historic nature and comparison to other events. This includes duration, amount, and spatial coverage of rainfall. Texas State Climatologist Dr. John Nielson-Gammon examined the largest rainfall events ever recorded in United States history and compared against Hurricane Harvey for durations of 48, 72, and 120 hours and in spatial coverage of 1,000, 2,000, 5,000, 10,000, 20,000, and 50,000 square miles. Harvey exceeded the previous records in all of the 18 different combinations except one. The most astounding statistic is that for the 120 hour duration over 10,000 square miles, Harvey exceeded the previous record from June 1899 by 13.33 inches or 62%. The rainfall amounts and spatial coverage of those amounts have never been experienced across the United States since reliable records have been kept.

Additionally, the average 33.7 inches of rainfall from Harvey across Harris County exceeds the worst storm event ever recorded for a similar square mile area as Harris County in the state of Louisiana in August of 1940 by 3.9 inches.

The following table shows the 120 hour rainfall average for Harvey compared against the previous record for various coverage areas:

Area (Sq Mi)	Event	Average Rainfall (in)	Over Previous Record
1000	Harvey	45.71	40%
	Louisiana 1940	32.64	
2000	Harvey	43.69	47%
	Louisiana 1940	29.80	
5000	Harvey	39.72	55%
	TX June 1899	25.60	
10000	Harvey	34.72	62%
	TX June 1899	21.39	
20000	Harvey	28.22	51%
	Beulah 1967	18.70	
50000	Harvey	19.05	19%
	Beulah 1967	16.00	

For Harris County, the 33.7 inches averaged over 1,777 square miles was 68% of the annual rainfall of 49.77 inches at Bush IAH in a 4 day period.

Over a 50,000 square mile area, Harvey dropped upwards of 16.6 trillion gallons of water which could supply the entire US water needs for 280 days and fill Lake Conroe 116 times.

### **CHANNEL FLOODING**

Disastrous flooding occurred on many of the watersheds in Harris County except Sims Bayou, portions of White Oak Bayou, and Horsepen Creek. Historical records held by previous massive floods in October 1994, Tropical Storm Allison, and April 2016 (Tax Day) were exceeded by Harvey at many locations.

#### **Clear Creek**

Record flooding occurred along the entire channel and the major tributaries of Turkey Creek, Chigger Creek, Cowart Creek, and Mary's Creek and upper Mud Gully (A120). Hurricane Harvey exceeded the previous water level records establish by Tropical Storm Claudette in 1979 by as much as 2.0-3.0 feet. Water levels in Clear Lake averaged 1.0-2.0 feet lower than Hurricane Ike's storm surge in 2008. Harvey water levels along Turkey Creek (A119) and upper Mud Gully (A120) exceeded those levels recorded during both Tropical Storm Claudette and Tropical Storm Allison. Water levels along all of Clear Creek, Turkey Creek, and Mary's Creek equaled or exceeded the .2% (500-yr) annual exceedance probability. Flooding of structures along Clear Creek and its tributaries in both Harris County and portions of Brazoria and Galveston Counties was the worst ever recorded.

#### **Armand Bayou**

Flooding along upper Armand Bayou surpassed previous records from Tropical Storm Claudette and Tropical Storm Allison with water surface elevations at or slightly above the .2% (500-yr) level for the middle and upper portions of the watershed or upstream of Genoa Red-Bluff. Water levels in the lower portion of Armand Bayou were nearly equal to the storm surge produced by Hurricane Ike in 2008. Horsepen Bayou (B104) a tributary to Armand Bayou established new record levels along the entire channel surpassing both Tropical Storm Allison and Hurricane Ike's storm surge. Water levels along Big Island Slough (B106) for Harvey did not break previous records established during Tropical Storm Claudette, but were similar to those levels

experienced during Tropical Storm Allison. Water levels along Willow Spring Bayou (B112) exceeded all previous records held by Tropical Storm Claudette and surpassed the .2% (500-yr) annual exceedance probability at each bridge crossing.

#### **Sims Bayou**

Sims Bayou was one of the few channels in the entire county that did not suffer widespread and extensive overbank channel flooding largely due to the completion of the federal flood risk reduction project and three HCFCD regional detention basins. Water levels for Harvey were generally below the historical records of Tropical Storm Allison and averaged between a 2.0% (50-yr) and 1.0% (100-yr) level downstream of Martin Luther King Blvd and generally below a 10% (10-yr) annual exceedance probability from Airport Road upstream to the headwaters. Significant flooding occurred along Berry Bayou, a tributary, to Sims Bayou which runs northward along the east side of SH 3. The period of record along Berry Bayou is short, only extending back to the early 2000's, and Harvey exceeded all previous events including Tropical Storm Erin (2007), Hurricane Ike (2008) and flooding in June 2006, but it is not known if Harvey exceeded levels during Tropical Storm Allison (2001) since no data from Allison is available.

#### **Brays Bayou**

Water levels along Brays Bayou upstream of Calhoun were the highest ever recorded surpassing previous historic floods in September 1983, Tropical Storm Allison and Memorial Day 2015. Downstream of Calhoun to the Houston Ship Channel confluence, Tropical Storm Allison water levels were higher. Water levels along Brays Bayou in the Texas Medical Center exceeded Tropical Storm Allison water levels by 0.5 to 1 foot. Upstream of the 610 Loop including Meyerland, water levels exceeded the September 1983, Memorial Day 2015, and Tax Day 2016 by an average of 1.0-2.0 feet. Harvey was one of the most significant flooding events ever recorded along Brays Bayou with water levels generally averaging between the 2% (50-yr) and 1% (100-yr) annual exceedance probability in the middle reach of the watershed. The lower and upper reaches were below the 2% (50-yr) annual exceedance probability primarily due to the completion of the Brays federal project in the lower portion of the watershed and extensive regional detention and slightly lower rainfall amounts in the upper areas.

Flooding along Willow Waterhole (D112) also established new records for Harvey and exceeded the previous record event on Memorial Day 2015 by an average of 1.0-3.0 ft. Water surface elevations along Willow Waterhole were generally at or above the .2% (500-yr) annual exceedance probability.

Additionally, significant backwater flooding occurred along several lateral channels and tributaries that drain to Brays Bayou as a result of high flows in Brays Bayou.

#### **Keegans Bayou**

Water levels along much of Keegans Bayou were similar to the Memorial Day 2015 flood. Generally, Harvey did not set new records along Keegans Bayou as most records continue to stand from the Memorial Day 2015 flood. Water surface elevations averaged between the 2% (50-yr) and 1% (100-yr) along much of the channel.

#### **White Oak Bayou**

Record flooding occurred along the lower portion of White Oak Bayou from the confluence with Buffalo Bayou in Downtown Houston upstream to Shepherd Dr. Water levels in Downtown Houston upstream to near I-45/I-10 exceeded the previous records during Tropical Storm Allison by 2.0-4.0 ft. Upstream of Shepherd Dr. water levels averaged below Tropical Storm Allison levels, and in Jersey Village well below the 2016 Tax Day, Tropical Storm Allison, and Tropical Storm Frances levels. Water surface elevations from Downtown Houston to Shepherd Dr. averaged between the 1% (100-yr) and .2% (500-yr) annual exceedance probabilities and



generally between the 10% (10-yr) and 2% (50-yr) upstream of Ella Blvd and less than the 10% (10-yr) upstream of North Houston Rosslyn including the Jersey Village area.

Water levels on the major tributaries of White Oak Bayou including Little White Oak Bayou, Brickhouse Gully, Cole Creek, and Vogel Creek all averaged below the historic records held by Tropical Storm Allison. Although records from Allison are few, where marks were obtained in 2001, suggest Allison averaged 1.0-2.0 feet higher than Harvey. Water surface elevations averaged between the 1% (100-yr) and .2% (500-yr) from Downtown Houston to the 610 North Loop on Little White Oak Bayou and the entire reach of Brickhouse Gully.

### **San Jacinto River**

Catastrophic record flooding occurred along the entire San Jacinto River system including the West Fork, East Fork, main stem below Lake Houston, and major tributaries along the river including Jackson Bayou. Massive flooding occurred throughout Humble, Kingwood, Huffman, Crosby, Highlands, and portions of Sheldon. Extreme flows on the lower portion of the San Jacinto River around Banana Bend completely lifted houses off their elevated pilings and resulted in severe damage to roadway access into that subdivision. The previous record flood levels of October 1994 were exceeded at all locations along each section of the river. Along the West Fork of the San Jacinto River water levels surpassed October 1994 by 3.0-4.0 ft, and as much as 5.0 ft along the East Fork of the San Jacinto River. Main stem river flooding below Lake Houston exceeded the previous record in October 1994 by 1.0-3.0 ft and at the I-10 crossing water levels exceeded Hurricane Ike's storm surge by 4.0 ft. Water levels along the West Fork of the San Jacinto River averaged above the .2% (500-yr), along the East Fork of the San Jacinto River were 5.0 ft above the .2% (500-yr) level and along the main stem of the river below Lake Houston averaged between the 1% (100-yr) and .2% (500-yr) annual exceedance probabilities. Several locations along the river system experienced water levels into the second floor of homes or the first floor of elevated structures requiring extensive water rescue efforts. Additionally, large amounts of debris and heavy sedimentation upwards of 4.0-8.0 ft in some locations have been noted especially along the West Fork of the San Jacinto River.

### **Lake Houston**

A record pool elevation of 53.1 ft was recorded at the Lake Houston Spillway surpassing the previous record of 52.3 ft in October 1994. An estimated discharge of 425,000 cfs or 5.0 times the average flow of Niagara Falls occurred at the peak flow over the Lake Houston spillway. This amount of flow would fill NRG Stadium in 3.5 minutes.

### **Hunting Bayou**

Water levels along Hunting Bayou were near or slightly above those of Tropical Storm Allison and generally averaged between the 1% (100-yr) and .2% (500-yr) annual exceedance probability downstream of Wallisville Rd. and 2% (50-yr) to 1% (100-yr) upstream of Wallisville Rd. to US 59. Flooding along Hunting Bayou was similar to Tropical Storm Allison and did reach near the rooftop of homes just north of I-10. Record flood levels were established in the upper portion of the watershed from near Lockwood Dr. west to just downstream of the headwaters.

### **Vince Bayou**

Water levels along both Vince and Little Vince Bayous in Pasadena established new record levels surpassing those of Tropical Storm Allison. Levels along Vince Bayou exceeded Tropical Storm Allison by 2.0-4.0 ft and Tropical Storm Claudette by 5.0-7.0 ft and averaged 1.0-3.0 ft above the .2% (500-yr) annual exceedance probability except from SH 225 to the Ship Channel where water levels were in the 1% (100-yr) and .2% (500-yr) range. Along Little Vince Bayou water levels exceeded Tropical Storm Allison at all locations, but did not exceed Tropical Storm Claudette at the headwaters of the watershed. Water surface elevations along the entire reach of Little Vince Bayou exceeded the .2% (500-yr) annual exceedance probability including

several locations where the values were exceeded by 2.0-4.0 ft. Flooding across much of Pasadena was significantly more widespread and deep compared to Tropical Storm Allison.

### **Spring Creek**

Flooding along Spring Creek was slightly higher than the devastating flooding of May 2016, and many of the same structures that flooded just one year ago were flooded again. Harvey water levels did not exceed the October 1994 flood levels at most locations, and based on this Harvey is not a record flood along Spring Creek, but the second surpassing that of May 2016. Significant backwater from the West Fork of the San Jacinto River into lower Spring Creek surpassed the October 1994 flood elevation by 5.0 ft at the end of Lee Rd north of Bush IAH. Water surface elevations along Spring Creek generally averaged between the 1% (100-yr) and .2% (500-yr) elevations. As noted during the May 2016 flooding, water reached near the rooftops of some homes south of The Woodlands and west of I-45 and velocities led to extensive damage to fences and brick privacy walls as well as some outside facing walls of homes.

One of many persistent rumors during and after Hurricane Harvey is that flooding along Spring Creek resulted from water releases from Lake Conroe. Flooding along Spring Creek was a direct result of the 20.0-28.0 inches of rainfall cross the watershed and not a result of releases from Lake Conroe. Releases from Lake Conroe do not affect water surface elevations along Spring Creek.

### **Cypress Creek**

Record flooding occurred along Cypress Creek and many of its tributaries from the confluence with Spring Creek upstream to near US 290. Water levels west of US 290 to the headwaters in eastern Waller County were generally equal to or slightly below levels recorded last year during the April 2016 Tax Day flood. Flooding along the middle and lower portions of Cypress Creek east of US 290 was the highest ever recorded and exceeded the Tax Day flooding by 2.0-5.0 feet. Water levels were generally between the 1% (100-yr) and .2% (500-yr) annual exceedance probabilities from the confluence with Spring Creek upstream to Aldine Westfield. Upstream of Aldine Westfield to Barker Cypress water levels exceeded the .2% (500-yr) annual exceedance probability with location upstream of US 290 to the headwaters averaging between a 1% (100-yr) and .2% (500-yr) annual exceedance probability. 24 of the 20 high water marks collected along Cypress Creek were new records. Additionally, record flooding also occurred along several of the tributaries including (K111, K133, and K142). Water levels on K111 exceeded the previous record during the Tax Day flooding of 2016 by 4.0 ft.

### **Little Cypress Creek**

Significant flooding occurred along much of Little Cypress Creek, but high water marks compared against the historical record indicate that Harvey did not exceed water levels during the Tax Day flooding of 2016 which remains the record for all of Little Cypress Creek except for the Kluge bridge crossing which exceeded Tax Day 2016 by 0.60 of a ft. The flooding at Kluge Rd was likely a combination of flow down Little Cypress Creek and backwater flooding from Cypress Creek. Water levels averaged near or above the .2% (500-yr) annual exceedance probability along the entire channel.

### **Willow Creek**

Record flooding occurred along Willow Creek from SH 249 downstream to the confluence with Spring Creek, surpassing previous record floods in October 1994 and Tax Day 2016. Harvey water levels exceeded the previous record flood levels by 2.0-3.0 ft from October 1994. Water levels upstream of SH 249 to the headwaters were below those of the flooding in October 1994, October 1998, Tropical Storm Allison, and the 2016 Tax Day flooding. Water levels east of SH

249 averaged generally between the 1% (100-yr) and .2% (500-yr) annual exceedance probability and west of SH 249 generally below the 2% (50-yr) annual exceedance probability.

#### **Carpenters Bayou**

Record flooding generally occurred along the entire channel, except from I-10 downstream to the mouth where the previous historic record during Tropical Storm Allison holds. Out of eight bridge crossings five exceeded the previous records of Tropical Storm Allison and the water level at the Sheldon bridge crossing exceeded the storm surge elevation recorded during Hurricane Ike. Water levels along the bayou averaged between the 2%% (50-yr) and 1% (100-yr) annual exceedance probability from the mouth to Woodforest Dr. and 1% (100-yr) and .2% (500-yr) upstream of Woodforest Dr.

#### **Goose Creek**

Record flooding occurred along Goose Creek upstream of HWY 146 to the headwaters surpassing the previous record of Hurricane Alicia (1983) and the October 1994 flooding by 2.0-4.0 ft. South of HWY 146, water levels exceeded all previous rainfall events, but did not exceed the storm surge levels produced by both Hurricane Ike (2008) and Hurricane Alicia (1983). Harvey's rainfall run-off averaged nearly 50% of Hurricane Ike's storm surge values. Water surface elevations generally averaged between 1% (100-yr) and .2% (500-yr) annual exceedance probability north of HWY 146 and generally at or below the 10% (10-yr) south of HWY 146.

#### **Greens Bayou**

Record flooding occurred along Greens Bayou from E Mount Houston Pkwy downstream (south) to the Houston Ship Channel exceeding Tropical Storm Allison by an average of 1.0-2.0 ft. Upstream (west) of E Mount Houston Pkwy water level were below Tropical Storm Allison and near the October 2002 flood. Harvey water levels were above the .2% (500-yr) annual exceedance probability downstream of E Mount Houston Pkwy, generally between the 10% (10-yr) and 2% (50-yr) upstream of I-45, and 2% (50-yr) to 1% (100-yr) in between. Water levels rose to rooftops south of Ley Rd downstream to I-10.

#### **Halls Bayou**

Water levels were similar to Tropical Storm Allison along much of the channel, but at most locations, Allison exceeds Harvey and remains the flood of record. One exception is in the reach from Airline Dr. upstream to just west of I-45 where Harvey did surpass the previous record water levels of Tropical Storm Allison by an average of 0.5 of a foot. While high water marks are not available for Mesa Dr. for Tropical Storm Allison, the next upstream bridge at Tidwell did exceed the Tropical Storm Allison mark and it is possible that Mesa also exceeded Tropical Storm Allison especially given the record flooding on the lower portion of Greens Bayou. Water levels were above the .2% (500-yr) annual exceedance probability downstream of Wayside, generally between the 10% (10-yr) and 2% (50-yr) upstream of Wayside to the Hardy Toll Rd, and 1% (100-yr) and .2% (500-yr) upstream of the Hardy Toll Rd.

#### **Garners Bayou**

Record flooding occurred along the entire channel from Bush IAH downstream to the confluence with Greens Bayou. Harvey water levels exceeded previous records held by Tropical Storm Allison and flooding in October 2002. Tropical Storm Allison records were generally exceeded by 2.0-3.0 ft along the entire channel. Water levels averaged between the 1% (100-yr) and .2% (500-yr) annual exceedance probabilities along the entire channel.



### **Cedar Bayou**

Record flooding occurred along the entire channel and surpassed the previous record from October 1994 by 3.0-4.0 ft. Additionally, Harvey exceeded Hurricane Ike's storm surge at the HWY 146 bridge by an astounding 5.0 ft. All eight bridge crossing over Cedar Bayou exceeded the .2% (500-yr) annual exceedance probabilities including over 6.0 ft at the I-10 crossing. Flow from the bayou overtopped both east and west bound mainlanes of I-10 and water reached to rooftop levels and higher in some locations between US 90 and HWY 146. The Chevron Phillips refinery just north of I-10 was completely flooded.

### **Mason Creek**

Harvey's rainfall produced the highest known water levels along the entire channel of Mason Creek exceeding the previous record levels from the 2016 Tax Day flood by 1.0-2.0 ft. Water levels averaged between the 1% (100-yr) and .2% (500-yr) annual exceedance probabilities along the entire channel.

### **Upper Buffalo Bayou/Cane Island Branch**

Record flooding occurred along upper Buffalo Bayou and Cane Island Branch from southeast Waller County through the City of Katy to Barker Reservoir. Water levels generally exceeded the previous record from the 2016 Tax Day flood by 1.0-2.0 ft especially in the City of Katy which resulted in widespread devastating flooding. The majority of the flooding from Harvey along Cane Island Branch and its tributaries occurred from the channel exceeding their banks. Extreme amounts of overland flow flooding occurred in the 2016 Tax Day flooding in rural portions of extreme western Harris and southeast Waller Counties that was not as high, nor as widespread with Harvey. This is likely due to lower short duration rainfall intensities compared to Tax Day 2016 when the core of maximum rainfall occurred just northwest of this area. Along upper Buffalo Bayou through portions of Cinco Ranch east of SH 99, a record pool elevation in Barker Reservoir resulted in water levels overtopping the banks of the bayou near Fry Rd and east of SH 99 from a combination of both a high pool level in Barker Reservoir and upstream inflows draining from southeastern Waller County, northeast Fort Bend County, and western Harris County.

### **Langham Creek**

Record flooding occurred along much of the creek from Addicks Reservoir to the upstream headwaters near Fry Rd. Water levels were generally 1.0-2.0 ft higher than the previous record flooding on Tax Day 2016 and averaged between a 1% (100-yr) and .2% (500-yr) annual exceedance probability. A record pool elevation in Addicks Reservoir resulted in backwater flooding along the lower portions of Langham Creek at Addicks Satsuma Rd upstream to HWY 6. Flows from the natural overflow from Cypress Creek impacted the Langham Creek watershed.

Langham Creek also experienced significant flooding on the downstream (south) side of Addicks Dam to the confluence with Buffalo Bayou. Harvey exceeded the previous record at Memorial Dr. established in April 2009 by over 6.0 ft as a result of backwater flooding from Buffalo Bayou and Corps of Engineers releases from Addicks Reservoir.

### **South Mayde Creek**

Record flooding occurred at all 13 bridge crossings over South Mayde Creek surpassing the previous records established during the 2016 Tax Day flood, October 1998, and October 1994. On average water levels were 2.0-3.0 ft higher than the 2016 Tax Day flooding and were generally between the 1% (100-yr) and .2% (500-yr) annual exceedance probabilities. Large volumes of Cypress Creek overflow affected the upper portions of South Mayde Creek and the lower portion of the creek was heavily affected by the record pool elevation in Addicks

Reservoir. Record levels at Barker Cypress Rd. and Groeschke Rd. matched closely to the Addicks peak pool elevation.

#### **Bear Creek**

Harvey flooding along Bear Creek was generally worse than the 2016 Tax Day flooding downstream of FM 529 and along the very upper end of the channel. Water levels at Clay Rd. and FM 529 bridges did not exceed the 2016 Tax Day flooding. Water level elevations were generally between the 1% (100-yr) and .2% (500-yr) annual exceedance probabilities upstream of FM 529 and greater than the .2% (500-yr) downstream. Cypress Creek overflow impacted Bear Creek, especially the upper portion of the watershed where the overflow was the highest recorded on record.

#### **Horsepen Creek**

The only bridge that recorded a record water level for Harvey was W Little York and this was likely a direct result of the record pool elevation of Addicks Reservoir. On average the 2016 Tax Day flood was 2.0-3.0 ft higher than the levels recorded during Harvey at the bridges upstream of Huffmeister and were generally between the 10% (10-yr) and 2% (50-yr) annual exceedance probabilities. This channel is susceptible to intense short duration rainfall rates which in the past have caused significant house flooding, but in this particular area, Harvey's short duration intense rainfall rates were low enough to prevent significant flooding along much of the channel.

#### **Buffalo Bayou**

Record flooding occurred at every bridge crossing along Buffalo Bayou as Harvey water levels exceeded previous floods of record from Tax Day 2016, March 1992, and Tropical Storm Allison (2001). In Downtown Houston, water levels exceeded the previous record from Tropical Storm Allison by 5.0-7.0 ft. From Downtown Houston westward to the 610 West Loop water levels exceeded Tropical Storm Allison by 2.0-4.0 ft and the March 1992 flooding by 4.0-6.0 ft. West of the 610 West Loop water levels exceeded the previous record from Tax Day 2016 by 5.0-8.0 ft. Water levels were generally above the .2% (500-yr) annual exceedance probabilities from HWY 6 downstream to Farther Point and between the 1% (100-yr) and .2% (500-yr) downstream of Farther Point to east of Downtown Houston.

Water levels recorded at the Houston Ship Channel Turning Basin were 5.0 ft above the 2016 Tax Day flooding, and only 3.0 ft lower than levels recorded during Hurricane Ike.

Water level elevations and duration were influenced by Corps of Engineers emergency releases during the extreme rainfall event as well as the subsequent releases to empty the Addicks and Barker Reservoirs (see Addicks and Barker Reservoirs below).

#### **Houston Ship Channel**

Incredible amounts of rainfall run-off were discharged into the Houston Ship Channel from many of the bayous and creeks draining Harris County. The NOAA tide gage at Manchester (610 E Loop) recorded a peak water surface elevation of 12.06 ft on August 29<sup>th</sup>. Hurricane Ike's storm surge flooding at the same tide gage was 12.34 ft indicating Harvey's rainfall run-off was only .28 of a foot lower than Ike's storm surge.

#### **Lake Conroe**

A new record pool elevation of 206.20 ft was recorded for Lake Conroe surpassing the previous record pool of 205.60 ft in October 1994. A peak release rate of 79,140 cfs was passed through the Lake Conroe flood gates into the West Fork of the San Jacinto River in accordance with emergency procedures for an extreme event to protect the integrity of the dam structure. A peak inflow of 130,000 cfs was recorded into Lake Conroe. While Lake Conroe released 79,140 cfs, three other uncontrolled watersheds: Spring Creek, Cypress Creek, and Lake Creek contributed

a total of 165,200 cfs into the West Fork of the San Jacinto River. It is estimated that 240,900 cfs flowed through the West Fork of the San Jacinto River at Humble (US 59) of which 32% was water from Lake Conroe. Of the total estimated inflow of 491,800 cfs into Lake Houston 16% was from Lake Conroe. The table below shows the peak discharge rates into Lake Houston from the major watersheds that drain into the lake.

<b>Watershed</b>	<b>Peak Discharge (cfs)</b>
East Fork of San Jacinto River	120,000
Peach Creek	77,000
Caney Creek	21,100
Cypress Creek	31,500
Spring Creek	78,400
West Fork of San Jacinto River (Porter)	131,000
Luce Bayou	32,800
<b>Total</b>	<b>491,800</b>

### **USGS GAGE RECORDS**

The United State Geological Survey (USGS) operates 50 gage locations across Harris County. 32 of the 50 sites or 62% recorded record flow (discharge) during Harvey. The table below lists the peak Harvey discharge and stage and the previous record.

<b>Location</b>	<b>Hurricane Harvey</b>		<b>Previous Record</b>		
	<b>Discharge</b>	<b>Stage</b>	<b>Discharge</b>	<b>Stage</b>	<b>Previous Record Date</b>
Goose Creek at Baker Rd.	16,300	24.0	4,700	20.1	April-09
Spring Creek at SH 249	48,900	166.4	45,400	165.5	May-16
Willow Creek at Kuykendahl Rd.	11,200	133.9	7,200	131.2	September-08
Cypress Creek at Katy-Hockley Rd.	12,800	162.9	9,950	162.3	April-16
Cypress Creek at House-Hahl Rd.	22,600	149.3	20,800	148.2	April-16
Cypress Creek at Stuebner-Airline Rd.	23,100	113.8	14,300	110.5	April-16
Cypress Creek At I-45	31,500	97.1	26,000	94.8	May-29
Luce Bayou above Lake Houston	32,800	37.9	25,900	35.1	October-94
Buffalo Bayou at Greenbusch Rd.	17,900	118.3	5,660	111.9	April-16
South Mayde Creek at Heathergold Dr.	12,200	112.7	9,780	112.4	April-16
Langham Creek at Park Row Dr.	7,320	82.7	3,890	74.2	April-16
Buffalo Bayou at Dairy Ashford Rd.	13,800	77.3	11,200	78.1	August-45
Buffalo Bayou at W Belt Dr.	14,600	71.2	7,290	65.3	March-92
Buffalo Bayou at Piney Point Dr.	15,000	62.8	7,990	57.3	April-09
Buffalo Bayou at Shepherd Dr.	36,400	41.9	19,000	41.0	May-29
White Oak Bayou at Alabonson Rd.	15,500	77.8	13,400	78.0	June-01
White Oak Bayou at Heights Blvd.	50,600	44.3	28,100	43.9	June-01
Little White Oak Bayou at Trimble St.	9,630	44.1	8,760	44.0	May-15
Brays Bayou at Belle Park Dr.	6,300	70.5	5,090	69.6	September-83
Brays Bayou at Main St.	35,100	45.7	33,000	45.0	June-01
Sims Bayou at Hiram Clarke St.	13,500	46.8	9,030	53.0	June-01
Sims Bayou at Telephone Rd.	39,600	26.6	25,800	23.4	June-01
Berry Bayou at Nevada St.	3,630	31.3	3,580	25.9	April-09



Vince Bayou at W. Ellaine St.	8,430	22.3	6,870	20.3	June-01
Hunting Bayou at Hoffman St.	1,730	44.3	1,080	42.3	September-08
Hunting Bayou at IH 610	6,680	37.1	4,390	35.4	September-08
Greens Bayou at Cutten Rd.	5,840	111.8	5,670	112.0	June-01
Garners Bayou at Beltway 8	24,900	57.9	12,400	58.1	June-01
Greens Bayou at Ley Rd.	128,000	44.9	69,700	40.5	June-01
Clear Creek at Mykawa St.	4,490	47.4	2,000	43.6	October-06
Clear Creek at FM 528	44,100	24.3	16,900	20.3	June-01
E San Jacinto River at FM 1485	120,000	81.2	74,100	76.0	October-94
W San Jacinto River at SH 99	131,000	94.9	130,000	84.4	October-94
Cedar Bayou at US 90	10,600	59.1	7,800	58.8	October-94

**Note:** gages outside of Harris County were included along the West Fork of the San Jacinto River and upper Buffalo Bayou.

### **HOUSE FLOODING ESTIMATES**

Harvey produced the largest and most devastating house flooding event ever recorded in Harris County. Structure flooding occurred from both overflowing creeks and bayous as well as internal drainage system being overwhelmed by the intense short duration rainfall rates.

Based on house flooding assessments, the estimated total number of homes flooded within Harris County is 154,170. Estimated numbers are based on damage and flood assessment reports from most of the cities within Harris County, Harris County Permit Office, Harris County Appraisal District, FEMA flood insurance paid claims, and FEMA Individual Assistance payments for repairs. Duplicates and homes with invalid addresses were removed. Thanks are extended to the cities, Harris County, City of Houston, and FEMA for their hard work locating, assessing damages, and compiling the lists of the tens of thousands of flooded houses. The sheer magnitude of the damage and number of homes, as well as the impact on the residents in this all-time record breaking flood made the job difficult for the flood damage assessment teams.

Using the 2016 building footprint data for Harris County indicates that the 154,170 homes flooded during Harvey was 9%-12% of the total number of buildings in the county.

Of the 154,170 homes flooded, 48,850 were within the 1% (100-yr) floodplain, 34,970 within the .2% (500-yr) floodplain, and 70,370 were outside of the 1% (100-yr) and .2% (500-yr) floodplains. Of the 154,170 homes flooded, 105,340 or 68% were outside the 1% (100-yr) floodplain. The large number of homes flooded outside the 1% (100-yr) floodplain were a result of the extremely high water levels along many creeks and bayous which exceeded the 1% and in some instances the .2% floodplains as well as intense short duration rainfall rates which resulted in significant flooding from overwhelmed internal drainage systems.

Of the 154,170 homes flooded, 55,570 or 36% had flood insurance policies in effect just prior to the onset of Harvey on August 24, 2017. 64% of the homes flooded did not have a flood insurance policy in effect.

Of the 239,430 total flood insurance policies across Harris County the 55,570 flooded homes with flood insurance were about 23% of the total number of Harris County policies.

In addition to the house flooding, thousands of apartment units, condos, and townhouses were flooded with estimates ranging from 5,000 to 15,000 units flooded across Harris County.

Thousands of commercial structures and businesses were flooded with varying degrees of damage and inundation.

The table below indicates the number of flooded homes broken down by various watersheds and tributaries across Harris County. The San Jacinto River was broken down into the West Fork, East Fork, and the main stem below Lake Houston. Turkey Creek (A119) and Mud Gully (A120) were broken out of the Clear Creek numbers. The Galveston Bay watershed represents those small tributaries and lateral channels that drain directly to Galveston Bay along its immediate western shore in the southeastern portion of Harris County.

<b>Watershed</b>	<b>House Flooding</b>	<b>Watershed</b>	<b>House Flooding</b>
Brays Bayou	23,810	Willow Waterhole	2,940
Buffalo Bayou	17,090	Vince Bayou	2,720
Greens Bayou	12,900	Ship Channel	2,370
Halls Bayou	11,830	Cedar Bayou	2,200
Cypress Creek	8,750	Barker Reservoir	1,910
Berry Bayou	8,510	Spring Gully & Goose Creek	1,890
White Oak Bayou	7,830	San Jacinto River (East Fork)	1,280
Hunting Bayou	7,420	San Jacinto River (Main Stem)	850
Turkey Creek & Mud Gully	6,500	Little Cypress Creek	700
Sims Bayou	6,370	Spring Creek	510
Addicks Reservoir	6,010	Galveston Bay	490
Clear Creek	5,480	Willow Creek	310
San Jacinto River (West Fork)	4,620	Carpenters Bayou	230
Little White Oak Bayou	4,540	Luce Bayou	190
Armand Bayou	3,790	Jackson Bayou	130

**Total 154,170**

Jurisdiction	House Flooding	Jurisdiction	House Flooding
Houston	96,410	Webster	290
Unincorporated Harris County	34,600	West University Place	240
Pasadena	4,610	Seabrook	210
South Houston	4,310	Hunters Creek Village	190
Baytown	3,510	Shoreacres	190
Bellaire	3,170	Piney Point Village	170
Friendswood	1,750	Pearland	140
La Porte	890	Taylor Lake Village	90
Deer Park	820	League City	70
Katy	630	Bunker Hill Village	20
Humble	590	Other Cities	930
Nassau Bay	340		

**Total 154,170**

**Note:** About 15,000 additional homes flooded in the portions of the watersheds that extend outside of Harris County into Galveston, Brazoria, Fort Bend, Waller, Montgomery, Liberty, and Chambers Counties. The largest concentration of flooded homes was along Clear Creek in northern Galveston and northern Brazoria Counties and in Fort Bend County in the flood pool of Barker Reservoir. The adjacent county numbers are not listed in the counts by watershed or jurisdiction above.

Flood Event	Total House Flooding Estimates	FEMA Flood Insurance Claims
August 2017 (Harvey)	154,170	Included & Individual Assistance
June 2001 (TS Allison)	73,000	Count from FEMA
April 17-18, 2016	9,840	Included
May 25, 2015	6,335	Included
June 19, 2006	3,370	Not included
October 1994	3,248	Not included
April 28, 2009	2,305	Not included

Harvey flooding was unusually deep in some areas, due in part to the intense short duration rainfall rates and the record flood levels along many creeks and bayous. Water levels rose to the second story of some structures near Hobby Airport, lower Cedar, Hunting, Buffalo, and Greens Bayous, and along many portions of the San Jacinto River system. This event was one





of the only times where HCFCD and emergency management officials urged residents to climb on to their roofs to escape the increasing depths of the flood waters.

### **ADDICKS AND BARKER RESERVOIRS**

The Corps of Engineers owns, operates, and maintains the Addicks and Barker stormwater detention reservoirs constructed in the 1940's to reduce flows downstream on Buffalo Bayou.

Addicks Reservoir peaked at a record elevation of 109.10 ft at 7:00 a.m. on August 30<sup>th</sup> surpassing the previous record of 102.65 ft last year during the "Tax Day" Flood of 2016 by 6.45 ft. At maximum pool the reservoir was impounding 217,726 acre feet of water. The pool reached an elevation of 108.0 ft on August 29<sup>th</sup> at 7:15 a.m. which resulted in uncontrolled flow over the natural ground at the end of the north spillway for the first time ever. This flow out of the reservoir impacted several subdivisions and businesses on either side of Tanner Rd from Eldridge Pkwy to Brittmore Park Dr. The pool elevation fell to 107.99 ft on September 1<sup>st</sup> at 8:30 p.m. ending the flow around the north end spillway. The pool elevation did not exceed the elevation of the south spillway.

A peak maximum inflow of 72,200 cfs was flowing into Addicks Reservoir on the morning of August 28<sup>th</sup> from Bear, Langham, and South Mayde Creeks (flows not available from Horsepen Creek). This included a peak flow on Bear Creek of 41,000 cfs. Harvey exceeded the previous maximum inflows recorded during last year's Tax Day flood by 31,300 cfs. In fact the flow down Bear Creek alone exceeded the entire combined peak inflow of the 2016 Tax Day flood.

Barker Reservoir reached a peak pool elevation of 101.56 ft on August 30<sup>th</sup> at 6:00 a.m. impounding 171,000 acre feet of water. Barker Reservoir exceeded its previous record pool of 95.22 ft during the 2016 Tax Day flood by 6.34 ft. The pool of Barker Reservoir did not exceed the elevations of the north or south spillways.

Addicks and Barker Reservoirs combined impounded a total of 388,726 acre-feet of water at peak pool elevations or 126 billion gallons of water which is about 2.4 times bigger than the normal storage of Lake Houston and would fill NRG Stadium 187 times.

Widespread flooding of homes and streets occurred within the pools upstream of Addicks and Barker Reservoirs as well as flooding of major roadways within the reservoirs. Additionally, house flooding occurred near the northern spillway of Addicks as flow left the reservoir pool and flowed east along Tanner Rd. This was the first time that homes had ever flooded from the pools of either reservoir.

Downstream on Buffalo Bayou, the Harvey flood event produced a peak flow at the USGS Piney Point gage of about 12,200 cfs at 1:15 am on the 28<sup>th</sup>. Because of the severity of the actual and forecasted rainfall in the upstream watersheds, overflow from Cypress Creek, and forecasted reservoir water levels, the Corps made the decision to release a combined 16,000 cfs based on their Water Control Plan criteria. This is the highest release rate since the outlets were fully gated in 1963.

Thankfully, there were only a few minor rainstorms in the watersheds after Harvey allowing the reservoir water levels to drop below critical elevations and the releases were slowly reduced in a relatively short timeframe. House flooding ceased upstream of the reservoirs about September 7 and downstream about September 12<sup>th</sup>. State Highway 6 in Addicks Reservoir was fully opened on September 25<sup>th</sup>. The Harvey rainfall drained from the reservoirs by mid-October 2017.

## **CYPRESS CREEK OVERFLOW**

Data collected from the upper Cypress Creek overflow zone indicates that Harvey exceeded the 2016 Tax Day flood levels by 4-6 inches suggesting that Harvey was a record overflow event. High water marks along and south of Cypress Creek and west of Barker Cypress indicated water levels were 1.0-2.0 ft higher than the April 2016 Tax Day flooding and this was also verified from structure flooding along the west side of Barker Cypress from the overflow that did not occur in 2016. Large amounts of Cypress Creek overflow progressed down South Mayde, Bear, Langham, and Horsepen Creeks into Addicks Reservoir. An estimated 45,000 to 65,000 acre feet of water flowed out of the Cypress Creek watershed into the Addicks Reservoir watershed and eventually the Addicks Reservoir pool.

Per observations and gage readings along Cypress Creek at Huffmeister Rd. and Eldridge Pkwy extremely high water levels in Cypress Creek flowed southward across the Cypress Creek watershed divide and into the upper portions of White Oak Bayou along and west of Eldridge Pkwy. Water levels in the Cypress Creek watershed exceeded the natural height of the ground along Cypress N Houston Rd. allowing Cypress Creek flow to move southward into the Barwood subdivision from the north and enter HCFCD lateral channels E133-00-00 and E132-00-00 and eventually White Oak Bayou. This overflowing of water from Cypress Creek into White Oak Bayou lasted approximately 24 hours and is the most significant overflow event ever recorded in this area given the record water levels along Cypress Creek.

## **HIGH WATER MARKS**

Hurricane Harvey resulted in the largest high water marking effort ever attempted by HCFCD, with a total of 588 marks collected. The previous record was post Hurricane Ike (2008) when 496 marks were collected of which 131 were storm surge marks. The table below indicates a breakdown of the high water mark effort across Harris County post Harvey.

HCFCD Channels	451
Detention Basins	71
Cypress Creek Overflow	20
Addicks Spillway	13
Addicks Pool	10
Barker Pool	6
Inverness Forest Levee	5
Northgate Levee	12
<b>Total</b>	<b>588</b>

Of the 451 channel high water marks collected 228 or 51% were new record levels.

## **HARRIS COUNTY FLOOD CONTROL DISTRICT ACTIONS**

- The HCFCD Flood Operations and Hurricane Response teams were activated on Wednesday August 23<sup>rd</sup> and returned to normal operations on Friday, September 15<sup>th</sup>.
- Clear Creek Second Outlet Gates were opened on the afternoon of August 24 and were closed on September 13.
- HCFCD phone bank operators answered an estimated 12,000 calls over a 3 day period.
- HCFCD has conducted over 300 media interviews related to Harvey.
- HCFCD performed a helicopter survey on Wednesday August 30<sup>th</sup>, a second survey on the 31<sup>st</sup>, and a 3<sup>rd</sup> survey on September 8<sup>th</sup>.
- Approximately 60 HCFCD staff worked throughout the duration of Harvey and the following recovery.

## **HARRIS COUNTY FLOOD CONTROL DISTRICT FACILITIES**

All channels and detention basins were in good condition prior to the start of the rainfall and flooding. The second HCFCD mowing cycle of 2017 was 70% complete. Vegetation growth along the channels did not impede storm water flows. Bridge and culvert crossings were checked county-wide and debris was removed where found prior to the onset of Harvey's rainfall.

The extended record excessive rainfall coupled with the extreme record flows and long duration of those flows resulted in damage to HCFCD infrastructure, gage monitoring equipment, and portions of the Inverness Forest Levee.

Back flow of water through the Inverness Forest pump station at the height of water levels along Cypress Creek resulted in erosion near a portion of the levee toe and the concrete structure housing the pumps. A mandatory evacuation order was issued for that part of the subdivision that would be affected if the levee breached or overtopped on August 27<sup>th</sup> at 10:10 p.m. and that order was lifted on August 31<sup>st</sup> at 7:15 p.m. HCFCD contractors completed repairs to the levee in 3 days at a cost of \$50,000.

The Harris County Flood Warning System suffered damage to several sites mainly due to the rise of water to heights that flooded the gage structure and the electronics housed. A total of 7 HCFCD gages were completely destroyed with an additional 5 suffering partial damage mainly to the water level measuring devices. HCFCD crews with the help of out of state contractors began repairs on September 3<sup>rd</sup>, and all damaged sites were restored to full service by September 14<sup>th</sup>. A total of 375,000 rainfall and stage data points arrived into the flood warning system from the remote field gages. The flood warning system website experienced over 4.6 million page views during Harvey.

- One inch of rainfall in 15 minutes alarms were triggered 336 times during the duration of Harvey
- Three feet below bankfull alarms were triggered 170 times during Harvey (some locations multiple times)

A total of 1,200 locations were identified to have damage including erosion, slope failures, sink holes, silt deposits, concrete failures, and drainage pipe separations. A total of 106,000 cubic yards of debris has been removed from HCFCD channels with the majority of the debris removal being along Spring Creek, Cypress Creek, Willow Creek, Langham Creek, and Buffalo Bayou. An additional 30,000 cubic yards of debris is currently in the process of being removed along Buffalo Bayou and Cypress Creek. To date, debris removal efforts have cost \$3.3 million dollars.

## **PROJECTS AND PROGRAMS THAT HELPED REDUCE HOUSE FLOODING**

Hurricane Harvey's relentless and widespread heavy rainfall filled every channel and detention basin in every watershed in Harris County at some point during the four day historic event. Despite the HCFCD channels and detention basins being overwhelmed, they did perform as designed moving and/or storing the rainfall runoff. Capital and maintenance projects as well as flood risk reduction programs helped reduce the number of homes flooded. Some of the major capital project efforts that could be quantified are discussed below. Although difficult to accurately quantify, total avoided damages across Harris County during Hurricane Harvey certainly exceed the estimates below. Also, many thousands of homes flooded from rainfall runoff flowing to the primary channels and major tributaries.



**Sims Bayou:**

The recently completed HCFCD and Corps of Engineers' Sims Bayou Federal Project and supplemental detention basins constructed by HCFCD reduced the number of homes flooded by about 6,500 along Sims Bayou. While some homes did flood along Sims Bayou, many more flooded from stormwater flowing to the bayou. The federal project consists of 19.3 miles of channel conveyance improvements from the Houston Ship Channel to Croquet Street just west of S. Post Oak. The HCFCD constructed three regional detention basins upstream of Scott Street to reduce flood levels even further. Bottom line – the larger channel carried a lot more stormwater downstream away from subdivisions along the bayou and the large detention basins stored stormwater that would otherwise flow through subdivisions along the bayou.

**Brays Bayou:**

Project Brays (a partnership project with the Corps of Engineers) construction completed to date prevented the flooding of about 10,000 homes and businesses along Brays Bayou that would have otherwise flooded without the project work. The 16.4 miles of channel conveyance improvements and multiple bridge replacements/modifications helped lower flood levels and excavation in the Eldridge, Old Westheimer, Arthur Storey Park, and Willow Waterhole regional detention basins temporarily held back several billion gallons of stormwater that otherwise would have flowed downstream. The Brays Bayou federal project is getting close to being completed with only 2.8 miles of channel conveyance improvements and 12 bridge replacements left.

**White Oak Bayou:**

The HCFCD Regional Project and Federal Project (a partnership project with the Corps of Engineers) construction completed to date prevented the flooding of about 5,500 homes and businesses that would have otherwise flooded without the project. For example, the 9.5 miles of channel conveyance improvements (including Championship Park at the mouth) and multiple bridge replacements/modifications helped lower flood levels and excavation of ten regional and federal detention basins temporarily held back stormwater that otherwise would have flowed downstream.

**Greens Bayou:**

The HCFCD Regional Project and Federal Project (a partnership project with the Corps of Engineers) construction completed to date reduced water levels along Greens Bayou. Partial excavation of six regional and one federal detention basin held back a large volume of stormwater that otherwise would have flowed downstream.

**Other HCFCD Projects:**

Many channel conveyance improvement projects and stormwater detention basins constructed by the HCFCD and other entities in other watersheds also helped reduce flood levels.

**Home Buyout Program:**

Past voluntary home buyouts throughout the county of homes deep in the floodplain were effective for this storm event. Through a partnership with FEMA, more than 2,000 homes were acquired, the residents moved to higher ground, and the homes demolished. The sites are kept undeveloped and are useful as open space and natural floodplain functions. In addition, the HCFCD has acquired about 1,000 additional homes. In the watersheds listed below, approximately 2,300 homes would have flooded had the HCFCD and FEMA not purchased and removed them.

<b>Watershed</b>	<b># of Homes</b>
Greens Bayou	723
San Jacinto River	283
Cypress Creek	279
Halls Bayou	257
White Oak Bayou	221
Armand Bayou	64
Clear Creek	52
Brays Bayou	34
Other Watersheds	387

***Total***                      ***2,300***

**Stormwater and Floodplain Regulation Programs:**

Since the early 1980s, Harris County and the cities in Harris County have been incrementally improving stormwater, floodplain, development, and infrastructure regulations to reduce flood risks in new developments while not increasing flood risks upstream or downstream. As a result, a substantial number of the hundreds of thousands of homes built in Harris County since the 1980s were spared from flooding during Hurricane Harvey. In fact of the 75,000 homes built in subdivisions in unincorporated Harris County since 2009, and utilizing infrastructure requirements for drainage and extreme event flow analysis only 467 or 0.6% flooded during Harvey. Of those 467 homes flooded, zero homes were substantially damaged.

# Rainfall Intensity Report

12AM 8-25-17 thru 10PM 8-29-17

Clear Creek, A100											4-Day %PMP
Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day Site
100	0.6	1.5	2.5	4.0	6.6	9.1	12.8	14.8	18.3	24.8	33.6 A100 Clear Lake 2nd Outlet @ SH 146
110	0.7	2.0	3.2	5.9	10.8	14.6	18.9	20.9	25.6	34.5	47.4 A100 Clear Creek @ I-45
115	0.7	1.6	2.8	4.8	6.4	8.9	10.5	12.5	15.2	25.2	35.4 Cowart Creek @ Baker Road
120	0.6	1.6	3.0	5.7	10.5	13.5	16.2	19.2	22.6	33.5	42.8 A100 Clear Creek @ FM 528
125	0.6	1.6	2.6	4.1	5.6	8.2	9.9	12.4	15.7	25.3	37.2 Chigger Creek @ Windsong Lane
130	0.7	2.0	3.3	6.4	11.9	14.8	17.3	19.4	23.2	33.5	44.0 A100 Clear Creek @ Bay Area Boulevard
140	0.7	1.7	3.2	5.2	9.7	12.2	14.8	17.6	20.5	31.8	40.9 A119 Turkey Creek @ FM 1959
150	0.6	1.6	2.8	5.1	6.5	8.7	10.8	14.2	16.6	28.0	37.0 A100 Clear Creek @ Country Club Drive
160	0.7	1.9	3.6	6.8	9.7	13.2	15.7	18.6	22.2	31.8	39.1 A120 Beamer Ditch @ Hughes Road
170	0.7	1.8	3.0	5.2	8.0	10.4	14.9	16.4	21.5	28.9	36.3 A100 Clear Creek @ Nassau Bay
180	0.6	1.7	2.8	4.2	5.8	6.5	8.4	13.2	15.8	25.5	33.8 A100 Clear Creek @ Mykawa Road
190	0.6	1.5	2.6	3.0	4.3	5.6	6.6	10.6	13.2	23.8	28.9 A100 Clear Creek @ SH 288
200	0.6	1.4	2.4	4.3	6.2	8.1	12.1	14.2	19.1	30.0	39.7 A104 Taylor Lake @ Nasa Road 1

Armand Bayou, B100											4-Day %PMP
Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day Site
210	0.8	1.5	2.9	5.1	7.5	8.9	13.5	15.7	21.2	30.8	40.6 B100 Armand Bayou @ Pasadena Lake (Nasa Road 1)
220	0.8	1.6	2.7	4.9	7.4	9.7	13.3	15.2	21.3	30.8	41.6 B100 Armand Bayou @ Genoa-Red Bluff Road
230	0.7	1.4	2.3	3.4	5.0	5.8	9.2	11.6	18.2	28.0	38.0 B106 Big Island Slough @ Fairmont Parkway
240	0.5	1.4	2.7	4.6	8.4	11.4	14.3	16.7	20.1	31.8	42.6 B100 Armand Bayou @ Beltway 8
250	0.6	1.6	2.9	4.6	8.0	10.8	14.6	16.5	22.5	33.9	44.7 B104 Horsepen Creek @ Bay Area Boulevard
270	0.7	1.8	2.8	5.2	7.4	9.2	12.6	14.6	21.6	32.1	42.9 B112 Willow Spring Bayou @ Fairmont Parkway

Sims Bayou, C100											4-Day %PMP
Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day Site
310	0.6	1.8	3.4	6.0	10.5	14.2	17.0	20.1	23.2	34.6	43.9 C106 Berry Bayou @ Nevada Avenue
320	0.9	2.0	3.6	6.1	9.6	12.8	15.6	19.4	23.0	35.2	44.4 C106 Berry Bayou @ Forest Oaks Boulevard
340	0.7	1.9	3.0	5.1	7.1	9.1	11.3	16.3	19.2	29.4	37.2 C100 Sims Bayou @ Telephone Road
360	0.7	1.8	3.4	4.5	5.1	5.5	6.6	12.3	14.5	24.2	32.6 C100 Sims Bayou @ Martin Luther King Road
370	0.5	1.3	2.2	2.9	4.7	6.3	7.3	11.4	13.8	23.0	30.0 C100 Sims Bayou @ SH 288
380	0.5	1.5	2.6	3.6	4.3	4.9	5.8	10.6	13.4	21.9	29.2 C100 Sims Bayou @ Hiram-Clarke Road

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# Rainfall Intensity Report

12AM 8-25-17 thru 10PM 8-29-17

## Brays Bayou, D100

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
1020	0.6	1.4	2.4	3.2	5.2	6.5	7.8	12.8	15.9	25.0	32.4	NRG Park	67%
400	0.8	1.4	1.9	3.2	5.5	7.3	8.4	12.9	16.0	25.9	33.4	D109 Harris Gully @ South McGregor Way	70%
410	0.7	1.9	2.4	4.0	5.8	7.5	9.5	14.3	17.2	28.8	35.2	D100 Brays Bayou @ Lawndale Street	73%
420	0.4	1.2	1.8	3.2	5.1	6.4	7.4	11.5	14.2	22.8	29.1	D100 Brays Bayou @ South Main Street	61%
430	0.5	1.2	2.0	3.1	4.9	5.7	6.8	11.2	13.8	23.4	30.0	D100 Brays Bayou @ Stella Link Road	62%
435	0.6	1.8	2.9	4.4	4.9	5.4	7.0	13.0	16.6	24.8	32.1	D112 Willow Water Hole @ Willowbend Boulevard	67%
440	0.7	1.8	3.2	4.6	5.2	5.3	7.6	13.6	17.8	27.0	34.1	D100 Brays Bayou @ Rice Avenue	71%
445	0.6	1.7	2.6	3.8	4.4	4.5	7.3	12.4	17.2	25.8	33.5	D112 Willow Water Hole @ Landsdowne Drive	70%
460	0.6	1.4	2.4	3.4	4.5	5.7	10.0	14.0	18.1	27.7	34.9	D100 Brays Bayou @ Gessner Road	73%
465	0.4	1.2	2.0	3.5	4.9	6.0	10.1	14.0	17.6	27.6	34.7	D100 Brays Bayou @ Beltway 8	72%
470	0.6	1.4	2.3	3.1	5.5	6.7	10.2	14.0	17.7	26.6	33.8	D100 Brays Bayou @ Belle Park Drive	70%
475	0.4	1.2	1.9	2.7	4.2	5.3	8.2	11.6	14.9	24.3	30.8	D100 Brays Bayou @ Bellaire Boulevard	64%
480	0.4	1.3	2.3	3.3	6.0	7.3	11.0	14.4	18.1	27.0	35.4	D118 Keegans Bayou @ Roark Road	74%
485	0.6	1.2	1.6	2.4	3.5	4.1	5.8	9.8	16.0	23.3	31.2	D100 Brays Bayou @ SH 6	65%
490	0.6	1.4	2.2	2.8	4.7	5.5	8.6	12.2	15.5	24.7	32.1	D118 Keegans Bayou @ Keegan Road	67%
495	0.4	1.0	1.5	2.2	3.2	3.8	5.0	8.8	14.1	22.2	30.6	D118 Keegans Bayou @ Rocky Valley	64%

## White Oak Bayou, E100

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
510	0.4	1.1	1.9	3.3	5.1	6.0	7.6	12.7	16.8	25.4	31.6	Harris County Flood Control @ Brookhollow	66%
530	0.4	1.1	2.1	3.2	4.8	5.4	6.4	10.2	14.7	23.3	28.8	E100 White Oak Bayou @ Ella Boulevard	60%
535	0.4	1.0	1.9	3.4	5.2	6.0	8.0	12.8	17.7	26.3	32.8	E100 White Oak Bayou @ Pinemont Drive	68%
545	0.3	0.9	1.6	2.4	3.5	3.9	6.1	11.2	16.3	23.8	29.1	E100 White Oak Bayou @ Fairbanks North Houston Road	61%
550	0.3	0.9	1.6	2.6	3.8	4.3	7.0	11.0	16.0	24.0	29.7	E100 White Oak Bayou @ Lakeview Drive	62%
555	0.4	0.9	1.5	2.7	3.8	4.4	6.6	10.0	15.2	21.7	27.4	E100 White Oak Bayou @ Jones Road	57%
560	0.6	1.5	2.5	4.0	4.8	5.2	6.5	12.4	16.8	27.0	33.6	E101 Little White Oak Bayou @ Trimble Street	70%
570	0.6	1.4	2.1	3.6	4.7	6.3	7.6	14.2	18.0	28.5	35.0	E101 Little White Oak Bayou @ Tidwell Road	73%
575	0.5	1.0	2.0	3.6	4.9	5.8	8.0	12.8	18.0	25.7	31.6	E100 White Oak Bayou @ Tidwell Road	66%
580	0.4	1.0	1.8	3.1	4.6	5.4	7.6	11.7	16.6	24.9	30.8	E115 Brickhouse Gully @ Costa Rica Road	64%
585	0.4	1.1	2.0	3.6	4.8	5.5	7.9	12.4	18.4	27.2	34.0	E121 Vogel Creek @ Victory Drive	71%
590	0.4	0.9	1.5	2.5	3.8	4.7	7.1	11.3	16.6	25.6	31.7	E117 Cole Creek @ Deihl Road	66%
595	0.4	1.2	2.0	3.4	4.6	5.5	7.6	12.2	18.2	26.7	33.1	E121 Vogel Creek @ Gulf Bank Road	69%

## Little Cedar Bayou, F216

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
610	0.6	1.3	2.2	3.8	7.0	9.7	13.1	15.0	19.3	29.8	40.6	A104 Taylor's Bayou @ Shoreacres Boulevard	82%
620	0.6	1.4	2.3	4.2	5.8	8.6	12.0	14.3	19.6	30.6	41.4	F216 Little Cedar Bayou @ 8th Street	83%
640	0.5	1.4	2.1	3.5	5.4	7.6	10.6	12.9	19.8	30.9	40.8	F101 Lateral @ Sens Road	82%



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## San Jacinto River, G103

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
720	0.5	1.2	1.9	2.8	4.1	5.0	6.4	10.5	16.8	22.1	31.4	G103 San Jacinto River @ US 90	63%
750	0.4	1.0	1.3	2.1	2.6	3.3	5.8	8.8	14.3	20.4	30.0	G103 Lake Houston Dam Spillway	60%
760	0.4	0.9	1.4	2.4	4.0	4.4	6.0	11.2	17.8	24.3	32.7	G103 San Jacinto River @ US 59	68%
790	0.5	0.8	1.4	1.7	2.2	3.0	5.0	8.0	15.5	20.4	27.2	G103 East Fork San Jacinto @ FM 1485	57%

## Hunting Bayou, H100

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
820	0.7	1.7	3.2	4.3	7.8	9.9	12.1	14.5	19.2	29.8	39.1	H100 Hunting Bayou @ I-10	81%
830	0.6	1.5	2.6	4.4	7.1	9.1	11.8	15.5	19.6	29.2	37.2	H100 Hunting Bayou @ Loop 610 East	77%
840	0.6	1.2	2.0	3.7	5.3	7.2	9.4	14.2	18.8	28.7	36.2	H100 Hunting Bayou @ Lockwood Drive	75%

## Vince Bayou, I100

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
920	0.6	1.7	3.0	4.9	8.8	12.3	15.2	18.0	21.2	32.8	42.0	I100 Vince Bayou @ West Ellaine Down Stream	84%
940	0.6	1.4	2.6	4.2	8.0	11.4	14.1	16.8	20.2	31.6	42.1	I101 Little Vince Bayou @ Jackson Avenue	84%

## Spring Creek, J100

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
1040	0.4	1.0	1.5	2.3	3.4	3.8	6.0	10.7	16.4	22.5	26.8	J100 Spring Creek @ FM 2978	56%
1050	0.4	0.8	1.4	2.6	3.5	4.4	6.4	10.8	17.3	24.3	29.4	J100 Spring Creek @ I-45	62%
1060	0.5	1.2	2.0	3.4	4.0	4.3	5.1	8.5	14.3	22.4	26.9	J100 Spring Creek @ Kuykendahl Road	56%
1070	0.4	0.9	1.5	2.7	3.8	4.5	6.7	10.2	15.6	21.6	25.6	J100 Spring Creek @ SH 249	53%
1074	0.5	1.2	2.1	3.0	3.9	4.8	7.4	12.8	17.0	25.5	28.0	Walnut Creek @ Joseph Road	59%
1076	0.4	1.0	1.8	2.7	3.6	4.8	8.4	13.4	18.4	26.5	28.4	Birch Creek @ Riley Road	59%
1084	0.4	1.0	1.5	2.5	3.9	4.3	6.9	11.5	16.4	24.4	26.6	Threemile Creek @ Joseph Road	56%
1086	0.6	1.2	1.8	2.6	3.4	3.9	6.7	11.1	17.2	26.2	27.8	Threemile Creek @ FM 362	58%
1090	0.4	0.9	1.6	2.9	4.4	4.8	7.6	11.5	16.3	24.9	27.8	J100 Spring Creek @ Hegar Road	58%

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## Cypress Creek, K100

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
1110	0.4	1.2	1.8	2.5	4.1	5.5	7.0	12.2	19.4	28.0	34.9	K100 Cypress Creek @ Cypresswood Drive	73%
1115	0.4	0.8	1.3	2.4	3.4	4.5	6.4	10.6	17.3	24.4	31.1	K600 Cypress Creek @ Inverness Forest	65%
1120	0.4	0.9	1.3	2.3	3.5	4.5	6.4	10.3	17.0	25.0	30.9	K100 Cypress Creek @ I-45	65%
1130	0.5	1.0	1.4	2.2	3.4	4.1	5.6	10.0	16.1	23.8	29.4	K100 Cypress Creek @ Kuykendahl Road	62%
1140	0.3	0.8	1.3	2.0	3.2	3.9	5.9	10.8	16.4	23.9	30.1	K100 Cypress Creek @ Stuebner-Airline Road	63%
1150	0.4	1.0	1.3	2.1	3.2	4.0	6.0	10.1	16.3	23.4	28.9	K100 Cypress Creek @ SH 249	61%
1165	0.4	0.9	1.6	2.9	3.9	4.3	6.2	9.2	13.3	19.3	24.6	K100 Cypress Creek @ Eldridge Parkway N.	51%
1170	0.4	0.9	1.6	2.9	3.9	4.6	7.0	10.4	15.3	22.6	28.6	K100 Cypress Creek @ Huffmeister Road	60%
1180	0.4	1.2	1.8	2.6	3.8	5.1	7.2	10.2	18.2	27.8	31.9	K100 Cypress Creek @ Katy-Hockley Road	67%
1185	0.6	1.6	2.3	2.9	4.2	5.8	8.4	11.3	19.9	28.3	33.0	K100 Cypress Creek @ Sharp Road	69%
1186	0.4	1.0	1.6	2.1	3.0	4.4	7.3	10.5	17.0	23.2	26.6	Live Oak Creek @ Penick Road	56%
1190	0.5	1.4	2.6	3.5	4.2	4.5	6.4	9.7	17.1	25.8	29.0	K166 Little Mound Creek @ Mathis Road	61%
1195	0.8	1.7	3.0	4.1	4.8	5.2	6.5	10.8	16.8	23.6	25.8	Mound Creek @ FM 362	54%
1210	0.4	1.0	1.8	3.1	4.0	4.6	6.6	9.8	15.6	22.6	28.6	L100 Little Cypress Creek @ Kluge Road	60%
1220	0.5	1.2	1.9	2.5	3.4	4.4	7.2	11.0	15.8	24.2	29.2	L100 Little Cypress Creek @ Cypress Rosehill Road	61%
1230	0.4	1.0	1.8	3.3	4.9	5.2	8.0	11.7	16.4	26.0	29.8	L100 Little Cypress Creek @ Becker Road	62%

## Willow Creek, M100

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
1320	0.5	1.0	1.4	2.0	2.9	3.6	5.6	8.9	15.3	22.0	27.2	M100 Willow Creek @ Kuykendahl Road	57%
1340	0.4	0.9	1.5	2.6	3.7	4.4	6.6	10.0	15.2	21.6	26.6	M100 Willow Creek @ SH 249	56%

## Carpenters Bayou, N100

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
1420	0.6	1.4	2.5	3.8	4.8	5.8	8.5	10.8	18.4	28.2	38.9	N100 Carpenters Bayou @ I-10	81%
1440	0.5	1.2	2.2	3.6	5.5	6.2	7.5	10.4	18.6	27.4	36.8	N100 Carpenters Bayou @ Wallisville Road	77%
1460	0.5	1.3	2.2	3.9	5.9	6.5	7.9	11.6	18.3	25.5	35.2	N100 Carpenters Bayou @ US 90	73%

## Goose Creek, O100

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
1520	0.6	1.5	2.5	4.1	7.2	9.3	12.6	15.0	20.3	29.6	37.8	O100 Goose Creek @ SH 146	76%
1540	0.6	1.6	2.3	4.1	7.6	10.5	14.2	16.0	24.0	33.0	42.9	O100 Goose Creek @ Baker Road	86%

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## Greens Bayou, P100

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
1600	0.5	1.2	1.6	2.6	3.2	4.5	6.1	8.6	15.2	22.8	31.4	P100 Greens Bayou @ Mount Houston Parkway	55%
1610	0.6	1.2	2.1	3.2	6.3	9.3	11.8	14.8	20.3	30.8	40.6	P100 Greens Bayou @ Normandy Street	84%
1620	0.4	1.0	1.8	2.9	4.9	7.1	10.2	13.8	20.8	29.4	38.3	P100 Greens Bayou @ Ley Road	80%
1630	0.3	0.7	1.3	2.3	4.3	5.0	6.5	9.6	16.4	23.1	32.0	P130 Garners Bayou @ Beltway 8	67%
1640	0.4	1.2	2.0	3.2	4.6	5.9	8.3	13.4	20.0	28.2	37.2	P100 Greens Bayou @ US 59	77%
1645	0.4	1.2	1.7	2.9	4.1	5.4	7.2	11.7	17.7	25.3	34.2	P100 Greens Bayou @ Beltway 8	71%
1650	0.4	1.0	1.4	1.8	3.1	4.6	6.4	10.2	18.0	25.7	35.4	P130 Garners Bayou @ Rankin Road	74%
1660	0.4	0.9	1.4	2.4	3.8	4.7	6.1	10.7	16.5	24.4	31.1	P100 Greens Bayou @ Knobcrest Drive	55%
1665	0.4	1.0	1.3	2.2	3.5	4.2	6.4	10.9	16.5	24.3	30.1	P100 Greens Bayou @ Bammel N Houston Road	53%
1670	0.4	0.9	1.4	2.6	3.4	3.7	6.2	11.0	16.5	23.8	29.6	P100 Greens Bayou @ Cutten Road	61%
1695	0.4	0.9	1.4	2.4	4.0	5.9	7.6	12.6	18.3	26.7	35.2	P138 @ Aldine Westfield Road	73%

## Halls Bayou, P118

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
1675	0.4	1.2	2.3	3.9	6.1	7.9	10.7	14.8	20.6	29.5	38.2	P118 Halls Bayou @ Tidwell Road	79%
1680	0.4	0.9	1.5	2.6	4.1	6.2	8.2	13.0	17.7	26.8	34.4	P118 Halls Bayou @ Jensen Drive	72%
1690	0.3	0.8	1.3	2.5	4.0	5.7	7.3	12.6	17.8	26.8	34.3	P118 Halls Bayou @ Airline Drive	71%

## Cedar Bayou, Q100

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
1720	0.6	1.4	2.3	3.6	5.7	8.0	12.5	14.5	21.8	27.5	35.8	Q100 Cedar Bayou @ SH 146	72%
1725	0.6	1.4	2.8	5.3	8.4	10.0	16.4	18.6	28.6	33.4	41.7	Smith Gully @ SH 146	84%
1740	0.5	1.4	2.5	3.6	5.5	7.2	11.6	14.1	23.2	28.3	37.0	Q100 Cedar Bayou @ US 90	74%

## Jackson Bayou, R100

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
1840	0.5	1.2	2.1	3.5	5.0	6.1	7.6	12.1	21.8	27.5	37.5	R102 Gum Gully @ Diamond Head Boulevard	75%

## Luce Bayou, S100

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
1940	0.4	1.0	1.4	2.1	3.3	4.0	5.5	9.5	17.5	22.9	31.8	S100 Luce Bayou @ FM 2100	56%



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## Barker Reservoir, T100

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
2010	0.4	1.0	1.6	2.4	4.0	4.9	7.3	11.7	18.1	27.7	36.3	Barker Dam	76%
2020	0.6	1.2	1.8	3.1	5.1	6.2	8.0	10.0	16.8	24.6	32.1	T101 Mason Creek @ Prince Creek Drive	67%
2025	0.4	1.0	2.0	3.4	6.0	7.5	9.4	11.0	17.6	24.4	32.4	T100 Buffalo Bayou @ Peek Road	68%
2030	0.4	1.2	2.0	3.4	5.4	6.9	9.3	11.2	18.0	26.6	33.2	T100 Buffalo Bayou @ Greenbusch Road	70%
2040	0.4	1.0	1.8	3.0	4.9	6.5	9.0	11.2	16.8	22.9	29.0	T100 Buffalo Bayou @ US 90	61%
2050	0.5	1.0	1.8	3.1	5.2	6.8	9.8	13.0	20.2	27.0	32.8	Cane Island Branch @ Clay Road	69%
2060												Willow Fork Creek @ Pederson Road	
2090	0.4	0.9	1.5	2.0	3.2	4.6	8.4	11.9	16.7	23.0	27.0	Brookshire Katy Drainage District @ Morrison Road	56%

## Addicks Reservoir, U100

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
2110	0.5	1.2	2.0	2.6	5.1	5.8	8.1	11.7	18.2	26.4	33.2	Addicks Dam	70%
2120	0.5	1.0	1.7	2.9	4.1	5.1	7.6	11.2	16.9	25.8	32.3	U100 Langham Creek @ West Little York Road	68%
2130	0.4	1.1	1.9	2.7	4.3	5.2	8.3	11.6	16.0	24.1	29.6	U106 Horsepen @ Trailside Drive	62%
2140	0.5	1.1	1.7	3.0	4.5	5.6	7.0	10.0	17.2	26.4	32.5	U100 Langham Creek @ Longenbaugh Road	68%
2150	0.4	1.2	1.6	2.3	3.6	4.8	6.5	9.4	16.5	24.8	31.8	U101 South Mayde @ Greenhouse Road	67%
2160	0.4	1.1	1.7	2.4	4.0	5.1	6.5	9.4	16.6	25.1	32.3	U102 Bear Creek @ Clay Road	68%
2170	0.6	1.4	2.1	3.0	4.1	5.4	7.7	10.3	17.5	26.7	33.1	U101 South Mayde @ Morton Road	69%
2180	0.6	1.5	2.1	3.0	4.4	5.4	7.7	10.6	17.7	27.0	32.9	U102 Bear Creek @ FM 529	69%
2190	0.6	1.4	2.2	3.0	4.4	5.8	8.1	11.0	18.0	26.7	32.8	U101 South Mayde Creek @ Peek Road	69%

## Buffalo Bayou, W100

Sensor ID	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	Site	4-Day %PMP
1000	0.6	1.5	2.3	3.4	4.8	5.9	7.4	13.2	17.5	27.2	34.4	Houston Transtar	71%
2210	0.6	1.2	2.0	3.6	5.8	8.0	10.4	15.0	19.2	28.7	34.4	W100 Buffalo Bayou @ Turning Basin	71%
2240	0.5	1.2	2.2	3.5	5.1	6.6	7.8	13.5	16.5	26.2	32.9	W100 Buffalo Bayou @ Shepherd Drive	68%
2250	0.5	1.1	2.1	2.8	3.6	4.4	7.2	12.3	17.1	25.5	31.4	W140 Spring Branch @ Bingle Road	65%
2255	0.4	1.1	2.0	2.8	3.5	4.1	6.8	11.7	16.5	24.8	30.4	W140-01 Briar Branch @ Campbell Road	63%
2260	0.5	1.2	2.2	3.0	3.6	4.0	7.0	11.6	16.2	24.3	29.7	W100 Buffalo Bayou @ San Felipe Drive	62%
2270	0.5	1.2	2.3	3.9	4.8	5.7	10.4	14.2	18.6	29.4	36.9	W100 Buffalo Bayou @ West Beltway 8	77%
2280	0.4	1.2	2.2	3.5	4.6	5.5	9.6	13.1	17.5	27.2	34.2	W156 Rummel Creek @ Brittmoore Road	71%
2290	0.5	1.3	2.1	3.0	5.1	6.2	9.3	13.1	19.0	27.8	35.4	W100 Buffalo Bayou @ Dairy Ashford Road	74%

# Rainfall Intensity Report

12AM 8-25-17 thru 10PM 8-29-17

Region 1--Addicks, Barker, Cypress, Spring, and Willow												
Period	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	
2-year	0.7	1.1	1.4	1.9	2.2	2.5	2.9	3.4	4.1	4.7	5.4	
5-year	0.9	1.4	1.8	2.5	3.0	3.3	4.0	4.8	5.8	6.6	7.6	
10-year	1.0	1.5	2.1	2.8	3.5	3.9	4.9	5.9	7.1	8.1	9.2	
25-year	1.1	1.8	2.4	3.4	4.2	4.8	6.1	7.4	9.0	10.1	11.3	
50-year	1.2	2.0	2.7	3.8	4.9	5.6	7.2	8.7	10.6	11.8	13.1	
100-year	1.3	2.2	3.0	4.2	5.5	6.5	8.5	10.2	12.4	13.6	14.9	
500-year	1.5	2.7	3.9	5.5	7.5	9.0	12.2	14.7	17.7	18.7	19.8	
1000-year	1.7	3.0	4.3	6.1	8.3	9.9	13.4	16.2	19.8	21.1	22.5	
2000-year	1.8	3.3	4.8	6.7	9.3	11.1	15.1	18.3	22.4	23.8	25.2	
5000+-year	2.0	3.7	5.4	7.7	10.7	12.9	17.6	21.4	26.2	27.7	29.3	
PMP				13.8	20.2	23.6	30.2	38.2	45.9	47.8	47.8	
*2-Day and 4-Day same based on PMP Development Methods												

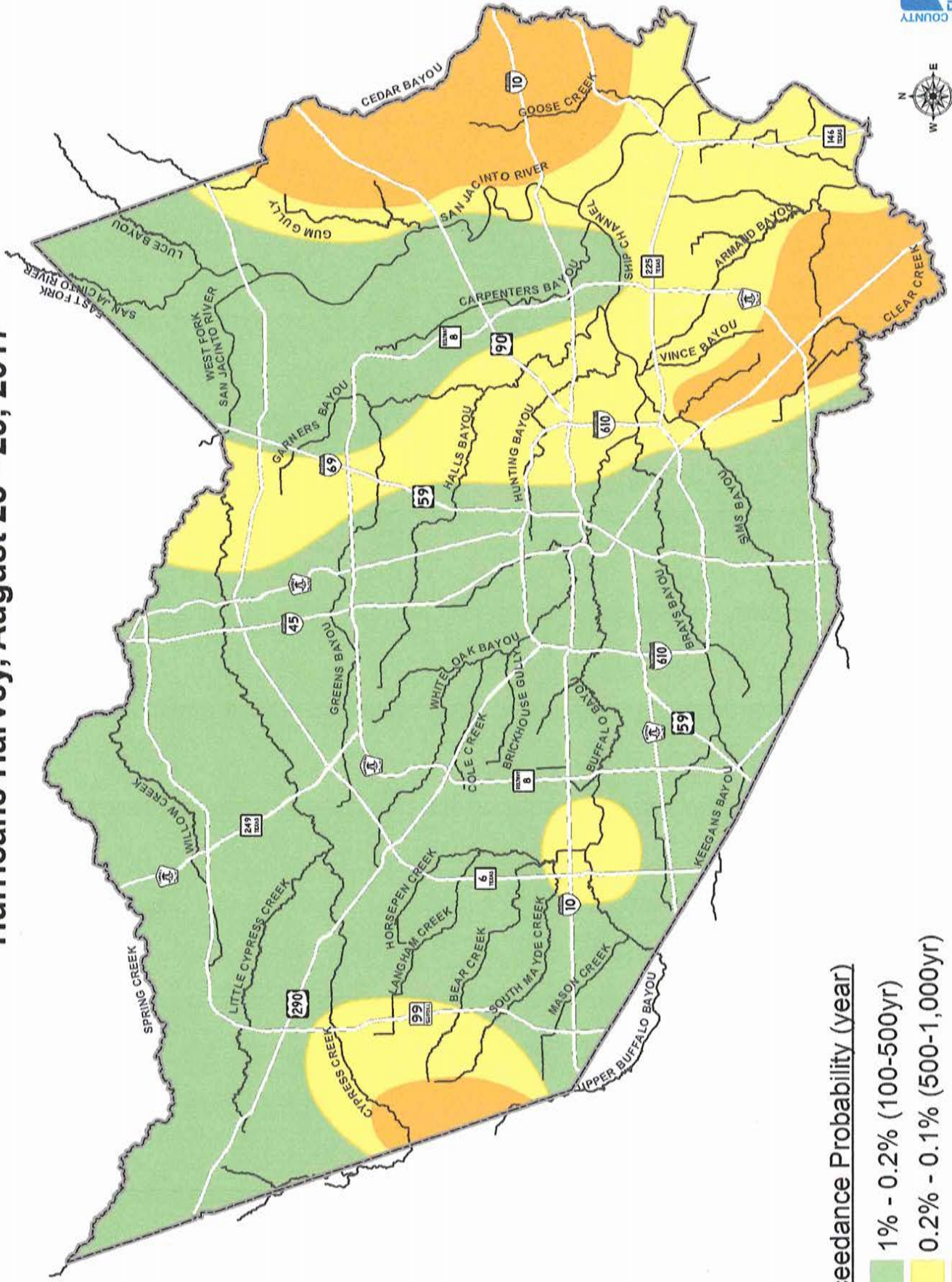
Region 2--Brays, Buffalo, Greens, Hunting, Luce, West Fork San Jacinto, and White Oak												
Period	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	
2-year	0.7	1.1	1.4	2.0	2.3	2.6	3.1	3.7	4.4	5.0	5.8	
5-year	0.8	1.4	1.8	2.5	3.1	3.5	4.3	5.1	6.2	7.1	8.1	
10-year	0.9	1.5	2.1	2.9	3.6	4.1	5.1	6.2	7.6	8.6	9.8	
25-year	1.0	1.8	2.4	3.4	4.3	5.0	6.4	7.8	9.6	10.8	12.1	
50-year	1.1	2.0	2.7	3.8	5.0	5.8	7.6	9.2	11.3	12.5	14.0	
100-year	1.2	2.2	3.0	4.3	5.7	6.7	8.9	10.8	13.2	14.5	15.9	
500-year	1.4	2.7	3.9	5.5	7.6	9.2	12.8	15.5	18.9	20.0	21.1	
1000-year	1.5	3.0	4.3	6.1	8.4	10.1	14.0	17.1	21.1	22.5	24.0	
2000-year	1.7	3.3	4.8	6.7	9.4	11.3	15.8	19.3	23.9	25.4	26.9	
5000+-year	1.9	3.7	5.4	7.7	10.8	13.1	18.4	22.5	27.9	29.6	31.2	
PMP				14.2	20.6	24.1	30.3	38.2	45.9	47.9	48.1	

Region 3--Armand, Carpenters, Cedar, Clear, Galveston Bay, Goose, Jackson, Lower San Jacinto River,												
Period	5-min	15-min	30-min	1-hour	2-hour	3-hour	6-hour	12-hour	1-day	2-day	4-day	
2-year	0.7	1.1	1.5	2.0	2.4	2.7	3.2	3.8	4.5	5.3	6.2	
5-year	0.8	1.4	1.9	2.5	3.1	3.5	4.4	5.3	6.4	7.5	8.7	
10-year	0.9	1.5	2.1	2.9	3.7	4.2	5.3	6.4	7.8	9.0	10.5	
25-year	1.0	1.7	2.4	3.4	4.4	5.1	6.6	8.0	9.8	11.2	12.9	
50-year	1.1	1.9	2.7	3.8	5.0	5.9	7.7	9.5	11.6	13.1	14.8	
100-year	1.2	2.1	3.0	4.3	5.7	6.8	9.1	11.1	13.5	15.1	16.9	
500-year	1.4	2.5	3.7	5.5	7.7	9.4	13.1	15.9	19.3	20.7	22.3	
1000-year	1.5	2.8	4.1	6.1	8.5	10.4	14.4	17.5	21.6	23.3	25.3	
2000-year	1.7	3.0	4.5	6.8	9.5	11.6	16.2	19.7	24.4	26.2	28.4	
5000+-year	1.9	3.4	5.1	7.7	10.9	13.4	18.9	23.0	28.6	30.5	32.9	
PMP				14.8	21.5	25.1	30.3	38.2	46.4	48.7	49.8	

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# One Day Peak Rainfall Frequency Hurricane Harvey, August 25 - 29, 2017



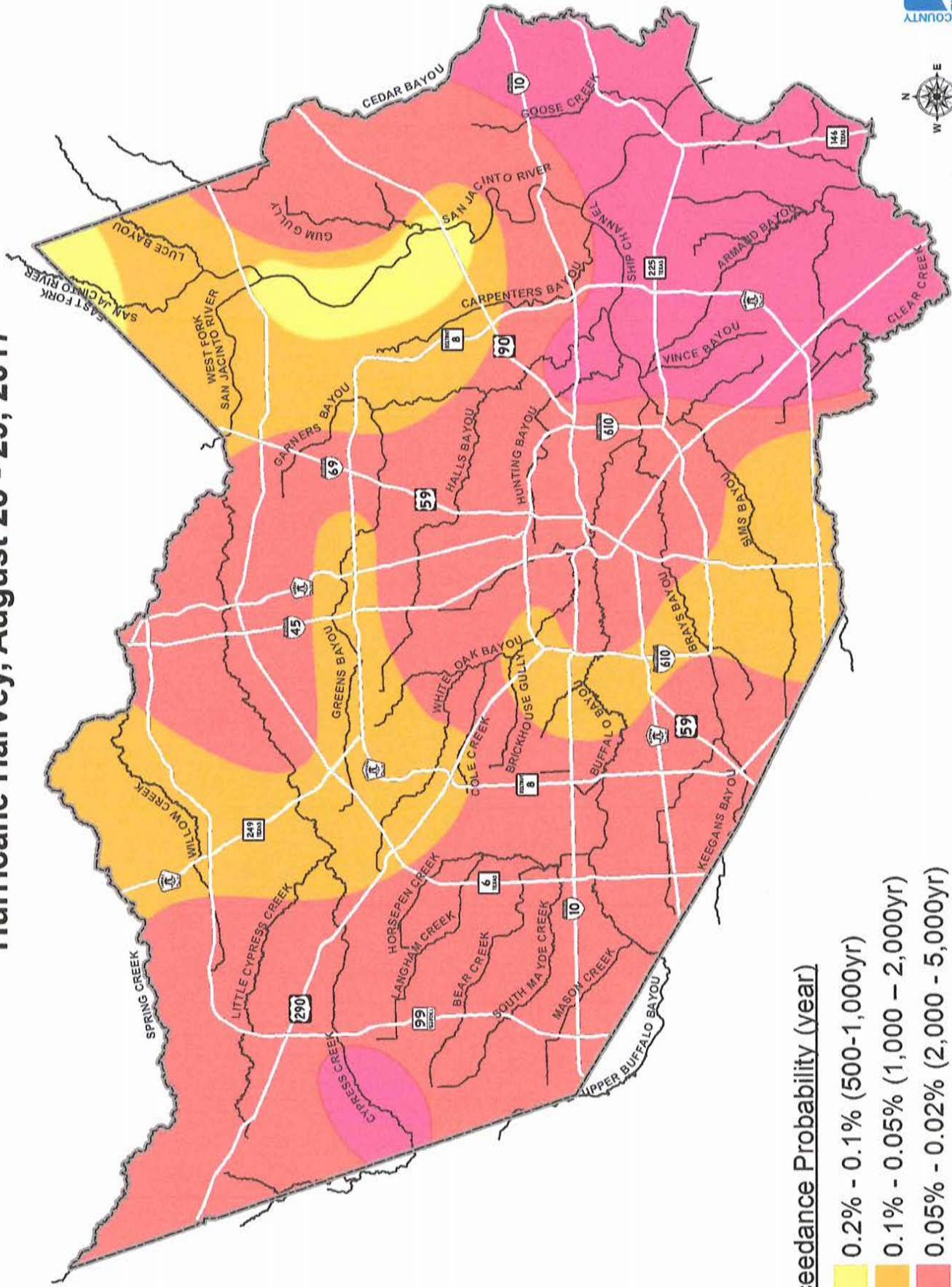
Exceedance Probability (year)

- 1% - 0.2% (100-500yr)
- 0.2% - 0.1% (500-1,000yr)
- 0.1% - 0.05% (1,000 - 2,000yr)

Based on HCFCO Rainfall Gages



# Two Day Peak Rainfall Frequency Hurricane Harvey, August 25 - 29, 2017



## Exceedance Probability (year)

- 0.2% - 0.1% (500-1,000yr)
- 0.1% - 0.05% (1,000 - 2,000yr)
- 0.05% - 0.02% (2,000 - 5,000yr)
- 0.02%+ (5,000yr+)

Based on HCFC Rainfall Gages



This map displays the projected flood inundation probability across Harris County, Texas, categorized by the return period of the flood event. The county's major waterways, including the San Jacinto River, Houston Ship Channel, and numerous bayous and creeks, are clearly delineated. Major highways such as I-67, I-10, I-29, and various state routes are also shown. The map uses a color-coded system to represent different levels of inundation risk.

Flood Inundation Probability	Return Period (Year)
0.05%	2,000 - 5,000 years
0.02% - 0.005%	5,000 years - 20,000 years

- 0.05% - 0.02% (2,000 - 5,000yr)
- 0.02% - 0.005% (5,000yr - 20,000yr)
- .005%+ (20,000yr+)



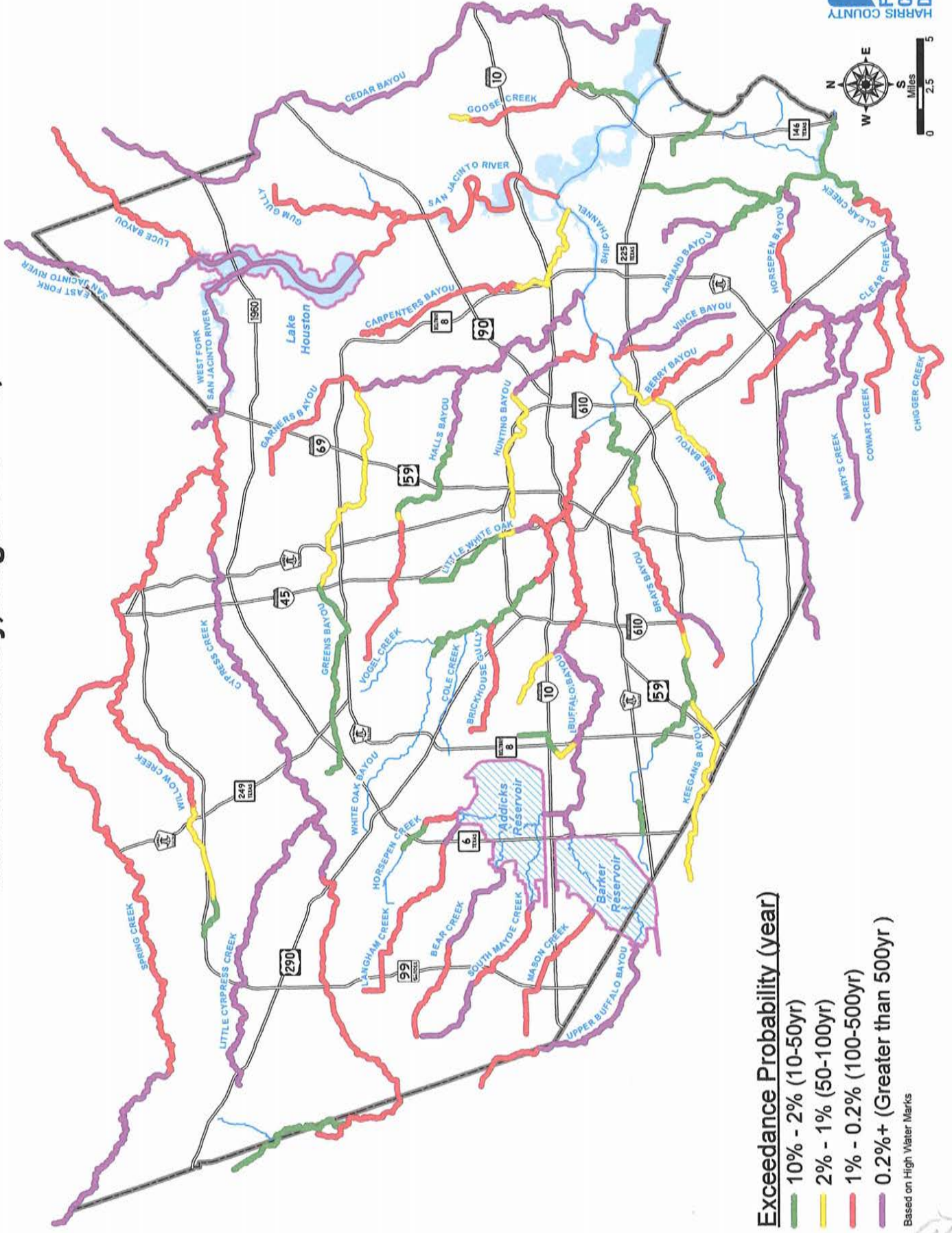
HARRIS COUNTY  
FLOOD CONTROL DISTRICT  
10/16/2017



A vertical scale bar labeled "Miles" with markings at 0, 2.5, and 5.



# Peak Channel Water Surface Elevation Frequencies Hurricane Harvey, August 25 - 29, 2017

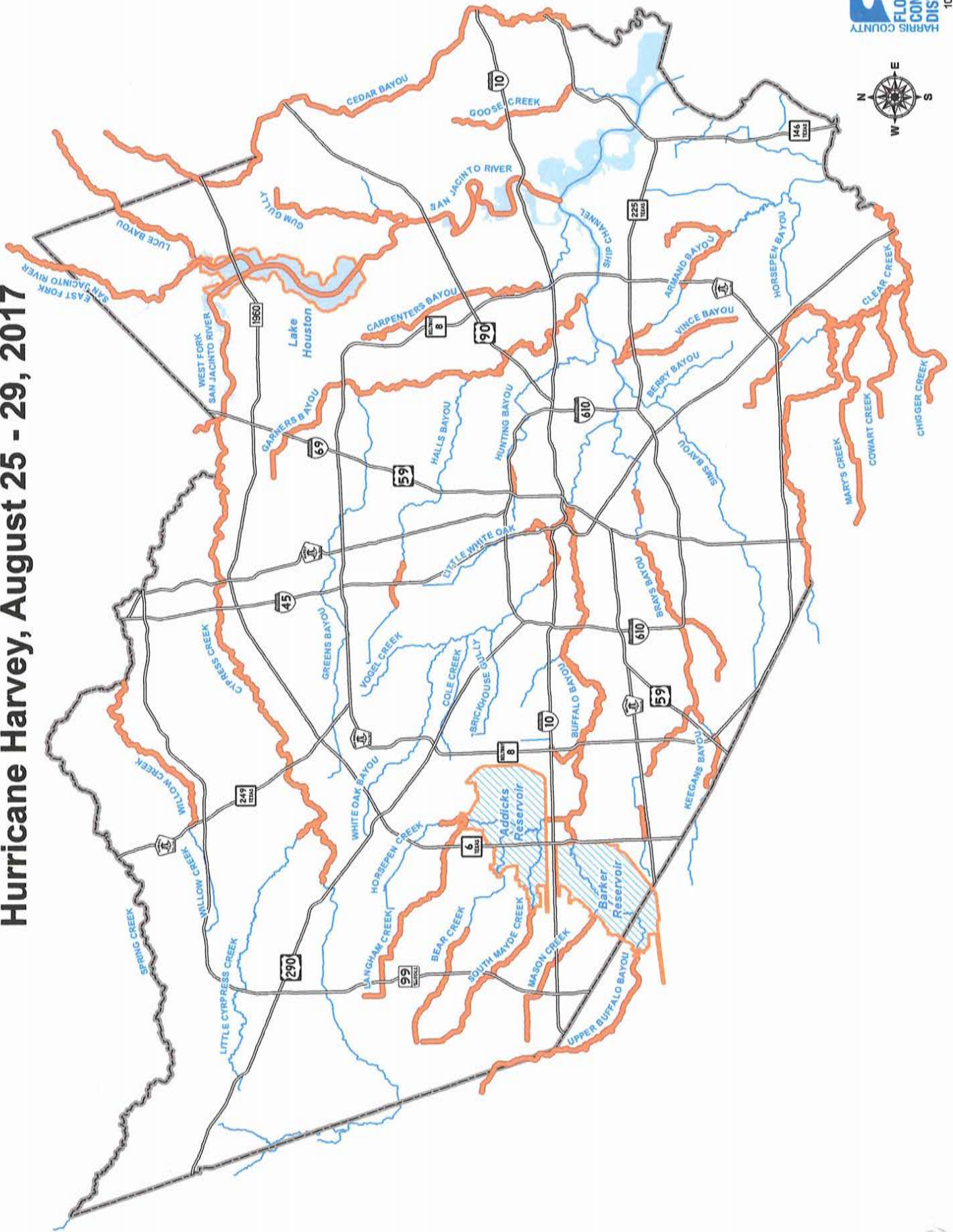


**Exceedance Probability (year)**

- 10% - 2% (10-50yr)
- 2% - 1% (50-100yr)
- 1% - 0.2% (100-500yr)
- 0.2%+ (Greater than 500yr)

Based on High Water Marks

# Record Flood Levels Hurricane Harvey, August 25 - 29, 2017





# Hurricane Harvey

Jeff Lindner

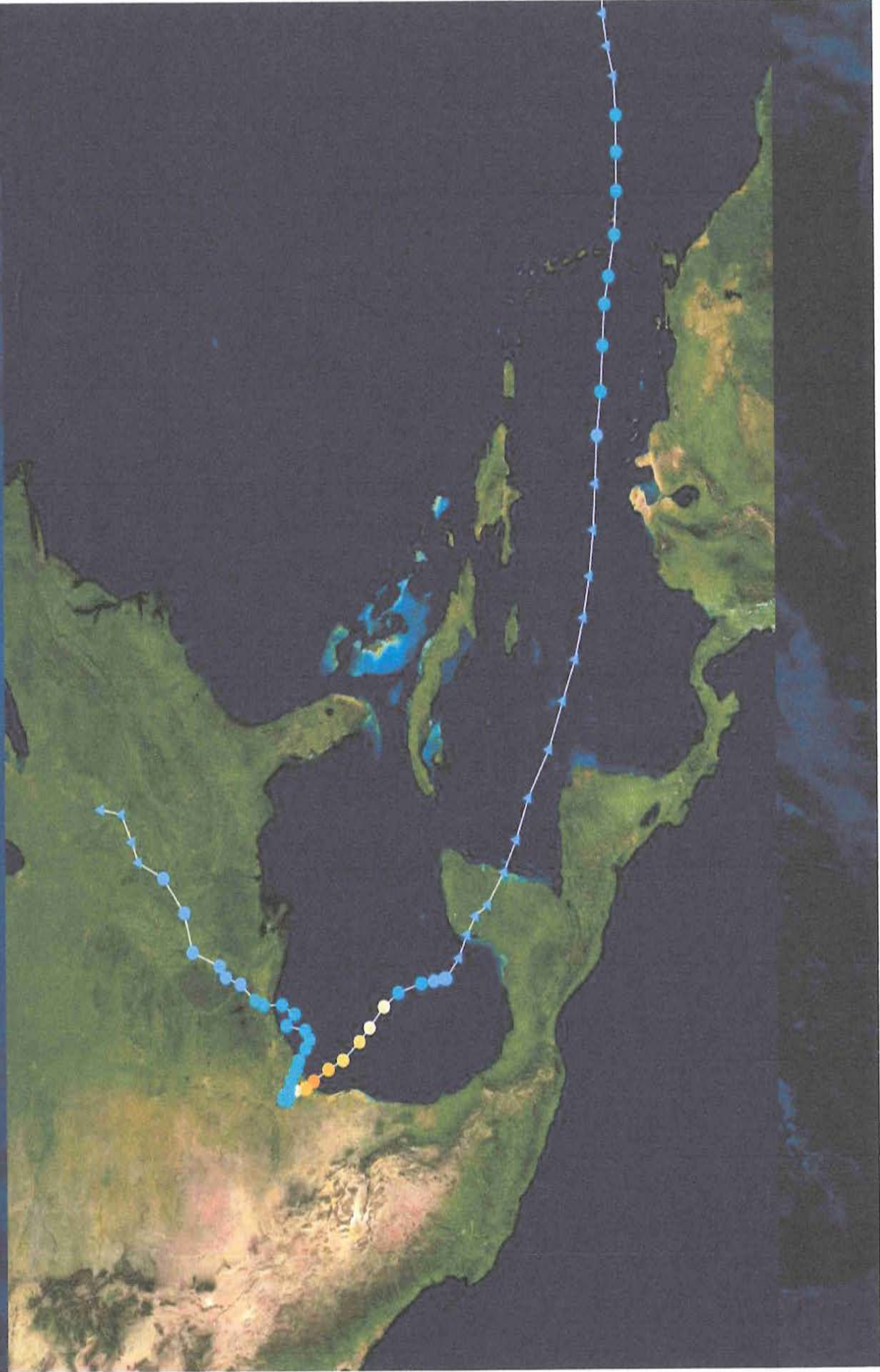
Meteorologist

Harris County Flood Control District





# Hurricane Harvey Track





I do not need to tell you how dire a situation we have  
“every available rescue asset is deployed”



**“If you have a boat,  
we need your help”**  
Harris County Judge Ed Emmett



**56,000 911 calls in 15 hrs**

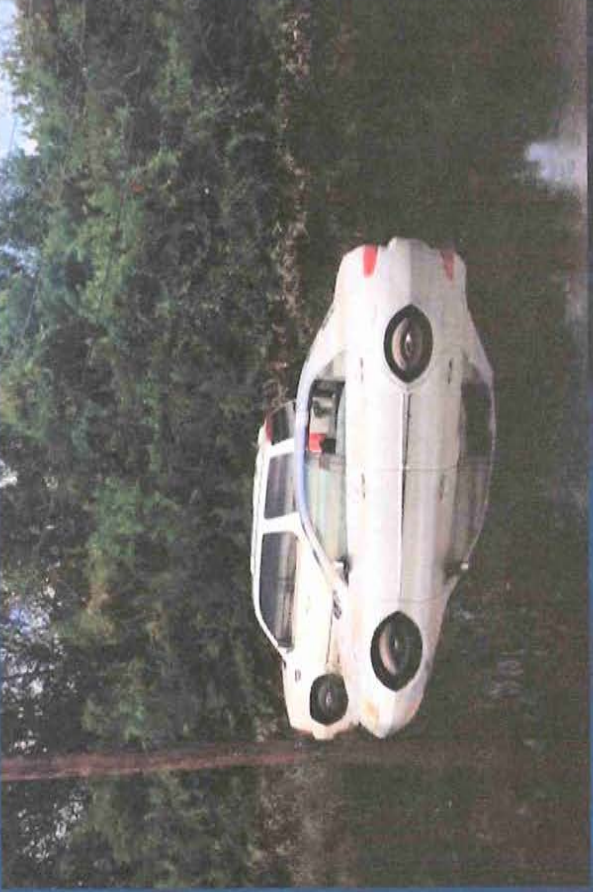


# Harris County Rainfall Statistics

- 1 Trillion gallons of water over 4-days (1,777 sq mi)
  - Would run Niagara Falls for 15 days
  - Fill the Astrodome 3200 times
- 33.7 inches average Harris County rainfall over 4 days
  - 68% of Harris County yearly rainfall in 4 days
  - 69% of PMP
- Max 4 day total: 47.40 in at Clear Creek at I-45
  - 95% of PMP



# Damage



- Est. 80-140K structures flooded
- 300,000 vehicles flooded (HC)
- Est. damages (100-125 B)
- 60,140+ persons rescued



# Cypress Creek Overflow



**65,000 acre-feet or 21.1 billion gallons of water  
passed from Cypress to Addicks**

SOURCE: Jeff Lindner

65

26/50

## **TECHNICAL MANAGEMENT COMMITTEE REPORT**

### **2017 Annual Report**

Held two meetings with the new regional leadership of the U.S. Army Corps of Engineers. Through these meetings, established a revitalized relationship with them and a basis for developing shared perspectives and pursuing shared goals. We wholly support U.S.A.C.E. overview of flood prevention and control measures for our watershed (including regional detention reservoirs, of which they currently have ownership).

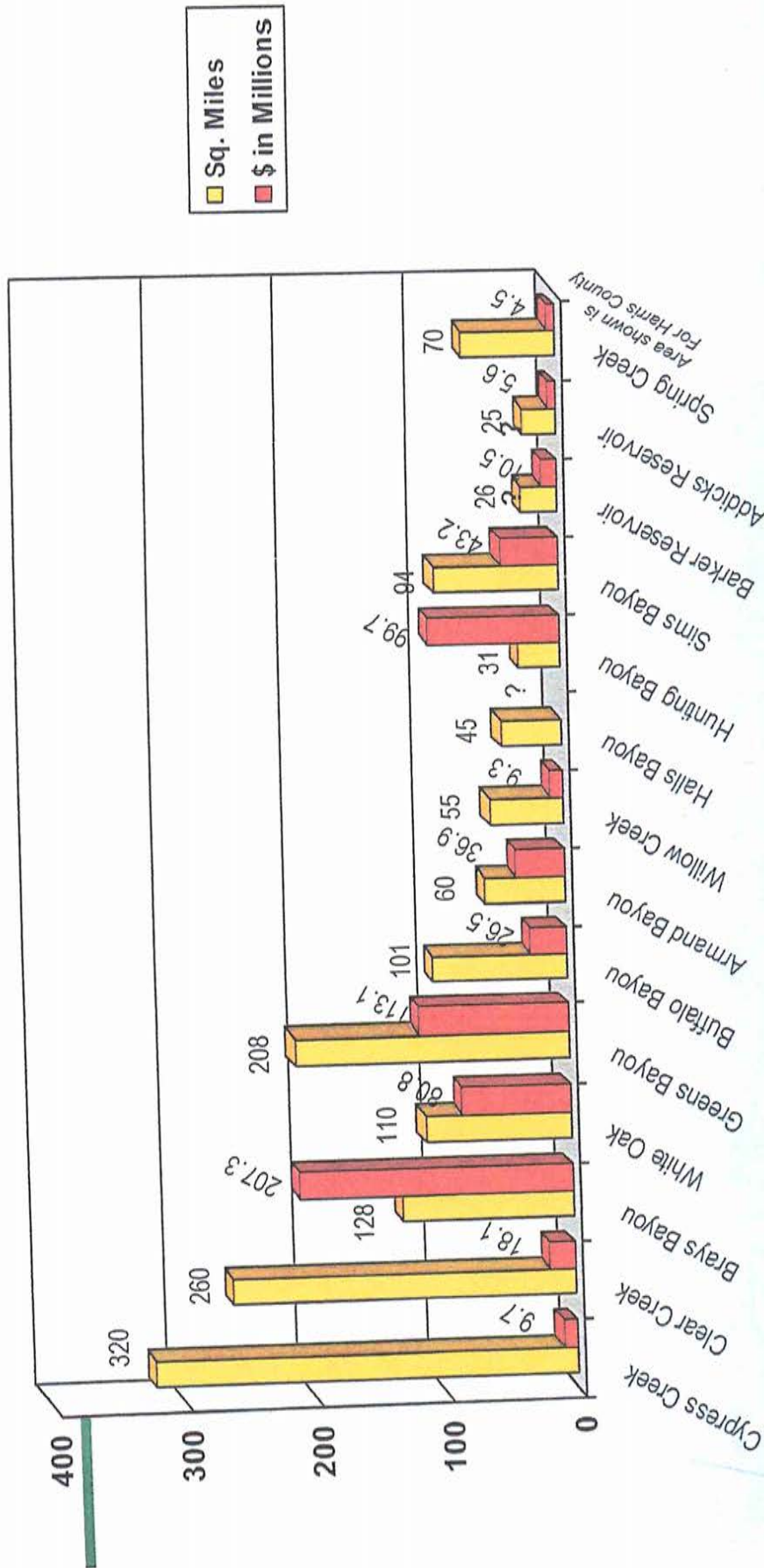
Held a meeting with Harris County Flood Control District's new Manager of Planning, Alief xxxxx and their communications lead, Deana Green. Significant progress was made in reestablishing the strong association between HCFCD and the Cypress Creek Flood Control Coalition (weakened in recent years through retirements in their technical leadership and other factors). For the first time, after years of attempts, HCFCD has acknowledged our technical argument that County regulations allow excessive discharges from developer's detention ponds (a position based on extensive investigation by industry-leading experts Dr. Bedient (at Rice University) and engineering consultant Mr. Dunbar).

In a technical study separate from the one described above, Mr. Dunbar and Dr. Bedient were commissioned by CCFCC to perform an analysis of the recent flood events that impacted numerous neighborhoods along both Cypress Creek and Little Cypress Creek. The primary concern was whether the flooding that was experienced along these two creeks from these recent storm events (i.e. the April 2016 Tax Day, the May 2016 Memorial Day and the August 2017 Harvey storms) was consistent with the flooding that would have been predicted by the current FEMA floodplain mapping and corresponding modeling of these two creeks, and if not, why not. The results of this analysis showed that the floodplain mapping and models for these two creeks are no longer adequately reflecting what actually happens during major storm events; and therefore, the floodplain mapping and its models need to be updated to reflect current conditions within the Cypress Creek Watershed.

Along those lines, there are several major tributaries to Cypress Creek from the Waller County line all the way to I-45 which contribute large volumes to the Creek during major storms. The volumes associated with the tributaries are currently not accounted for in modeling. A water level gage on the lower end of any of the major tributaries to Cypress Creek would be helpful. It would provide a continuous reading of water levels during storm events to assist in any understanding of flood potential downstream as well as providing information for post flood analysis.



# AREA TO CAPITAL COMPARISON



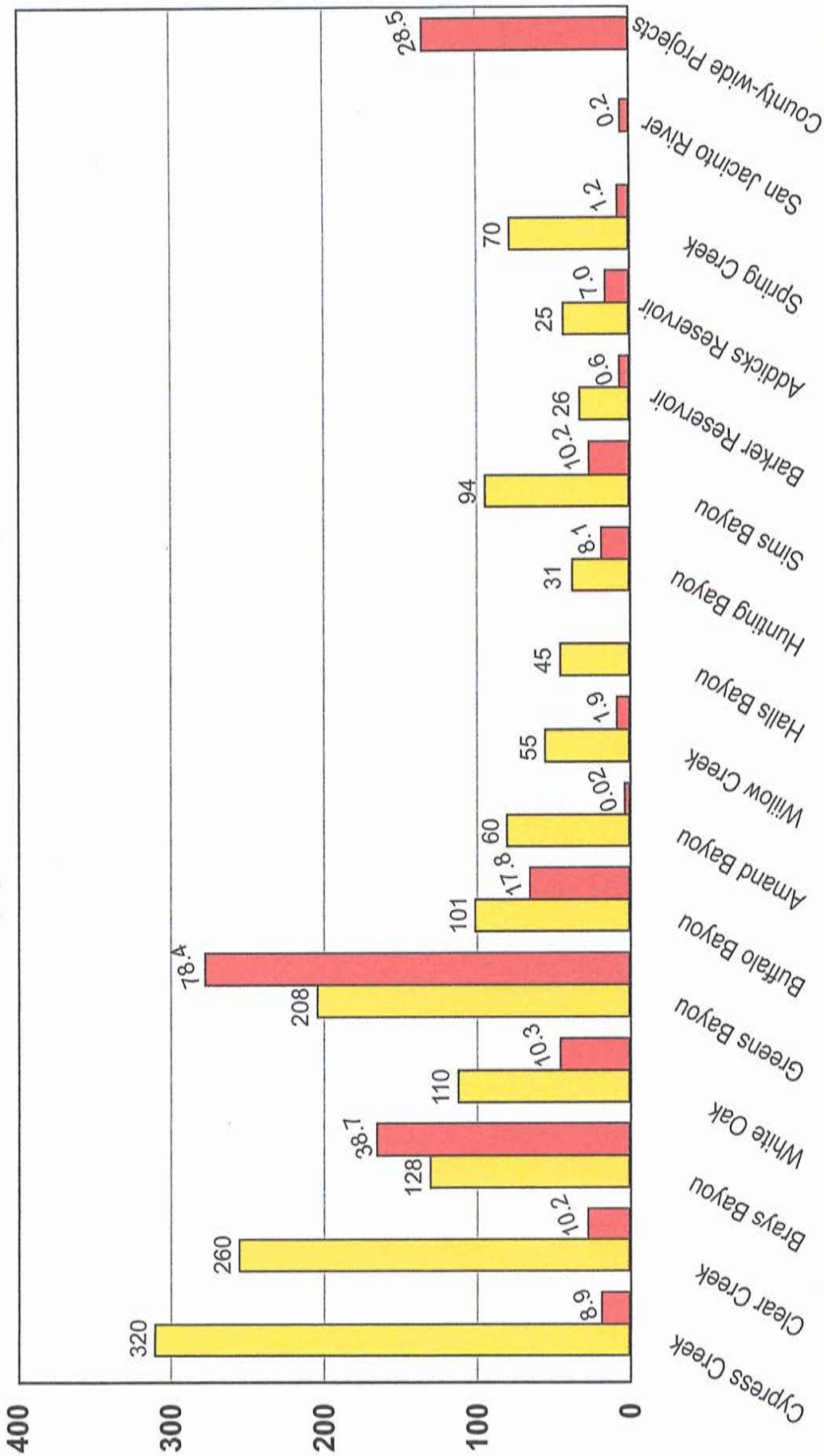
## Watershed (5 year period)

The total 5-year Capital Improvement Plan of \$795.5m includes \$113.0M for home-buyout, \$9.1M (San Jacinto River) and \$18.5M for 7small buyouts which are not shown in graph.

Data for the Capital Improvement Plan submitted by Harris County Flood Control District for a five-year period beginning 03/01/03 and accepted by Harris County Commissioners Court on 02/04/03 meeting.

# AREA TO CAPITAL COMPARISON

(5-year Period - 2017-2021)



Area shown is  
for Harris County



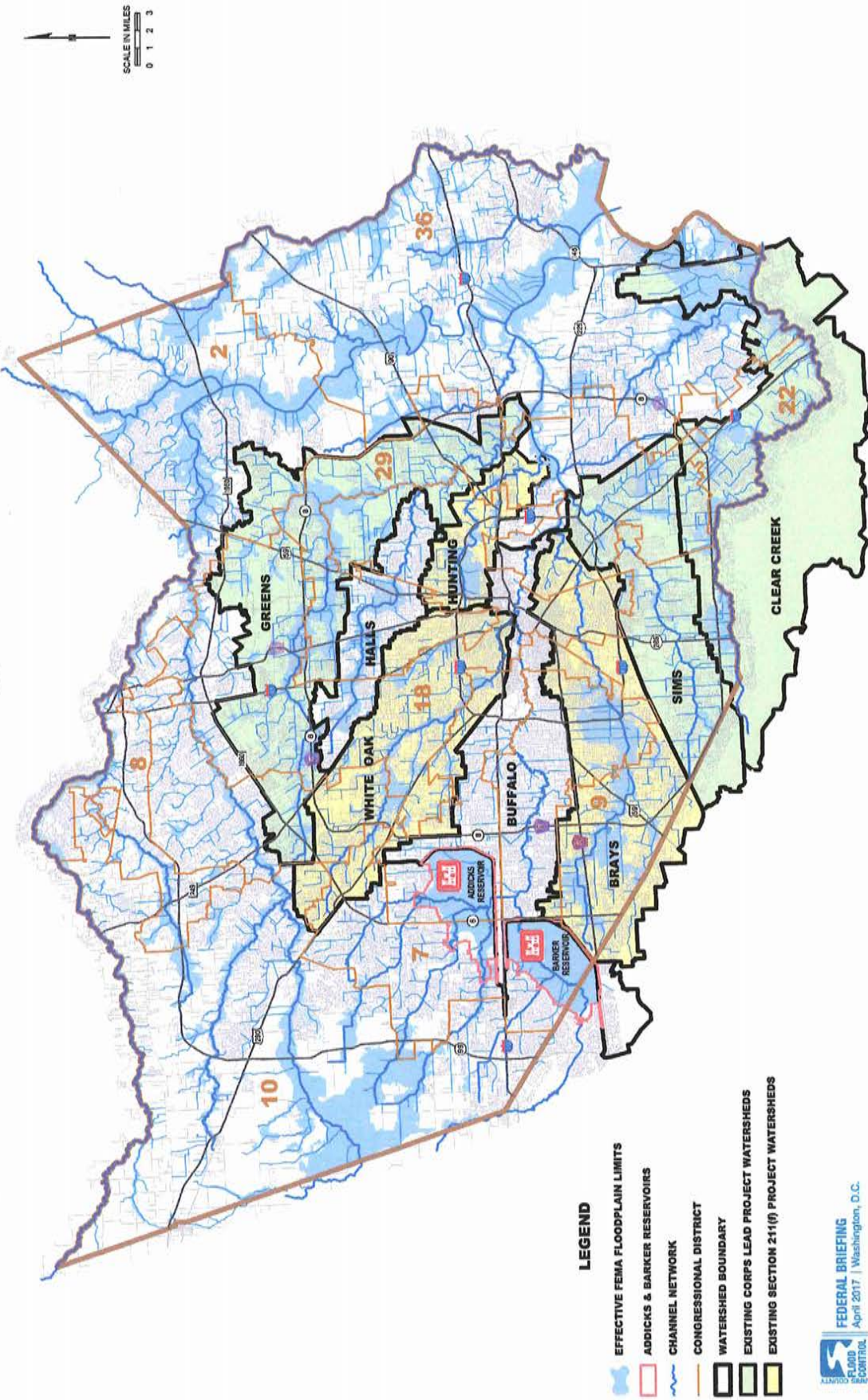
## Watershed (5 year period)

Data for the June 2017 Capital Improvement Plan submitted by Harris County Flood Control District for a five-year period, fiscal year 2017 - fiscal year 2021.  
(Appendix A "Currently Funded Projects")

The total 5-year Capital Improvement Plan of \$222.5M includes \$2.9M in 2017-2018 for home-buyout.



# Active Federal Flood Damage Reduction Projects



32/124



## Federal Flood Control Projects in Harris County, Texas Milestone Date Summary

PROJECT	STUDY AUTHORIZATION	PROJECT AUTHORIZATION	LCA, PCA, or PPA	PHYSICAL CONSTRUCTION START	PHYSICAL CONSTRUCTION COMPLETE
<b>--- Completed ---</b>					
Addicks and Barker Reservoirs, Buffalo Bayou	1936	1940	1940	1940	1948
Brays Bayou	1948	1954	1955	1957	1968
White Oak Bayou	1948	1954,1965	1955,1967	1964	1976
Vince Bayou	1958	1962	1964	1973	1980
Little Vince Bayou	1958	1962	1964	1986	1988
Cypress Creek	1946	1988	2001	1999	2001
<b>--- Under Construction ---</b>					
Sims Bayou	1948	1986,1990,1992	1990	1994	2015
Clear Creek	1962	1968	1986	1988	--
Brays Bayou*	1948	1990	2000, 2010	1994	--
Hunting Bayou*	1948	1990	2014	2008	--
White Oak Bayou*	1948	1986	2014	1998	--
Greens Bayou	1948	1990	2015	2015	--
<b>--- Authorized ---</b>					
Halls Bayou	1948	1990	--	--	--
Buffalo Bayou - Main Stem	1948	--	--	--	--
Carpenters Bayou	1948	1990	--	--	--
Little White Oak Bayou	1948	1990	--	--	--

\* Section 211(f) Projects

30/124 (40)



# Buffalo Bayou & Tributaries, TX (Phase 2)

U.S. ARMY CORPS OF ENGINEERS

BUILDING STRONG<sup>®</sup>

FACT SHEET as of May 23, 2017

**AUTHORIZATION:** Section 216 of FCA 1970, Review of Completed Projects

**TYPE OF PROJECT:** Flood Risk Management

**PROJECT PHASE:** Feasibility



Addicks Uncontrolled Auxiliary Spillway



Barker Uncontrolled Auxiliary Spillway

**CONGRESSIONAL INTEREST:** Senators Cornyn and Cruz (TX), and Representatives Poe (TX-2), Culberson (TX-7), A. Green (TX-9), McCaul (TX-10), Weber (TX-14), Jackson-Lee (TX-18), Olson (TX-22), and G. Green (TX-29).

**NON-FEDERAL SPONSOR:** Harris County Flood Control District

**BACKGROUND:** The Addicks and Barker Dams and Reservoirs are part of the Buffalo Bayou and Tributaries flood risk management system located within the west side of the City of Houston, Texas. This system provides flood risk management benefits for the City of Houston, the fourth largest city in the United States. Over 4 million people live and work in and transit through the Buffalo Bayou watershed. Industrial, commercial, and residential development is located throughout the Buffalo Bayou corridor. In addition to commercial and residential structures, this development includes hospitals, highways, roads and utilities, oil industry infrastructure and water and sewerage treatment facilities.

The Addicks and Barker reservoirs serve as detention basins designed to collect excessive amounts of rainfall during storm events. Following a storm event, the dams release the collected rainfall down Buffalo Bayou at a controlled rate that prevents flooding in downtown Houston and the urban areas west of downtown. A dam safety modification study was completed in June 2013 that identified a risk management plan to address the seepage and piping issues associated with the outlet work structures at both dams. The design of the dam safety modifications which include construction of new outlet works at both dams and the grouting and abandonment of the existing outlet works was completed in May 2015 with award of the construction contract in August 2015. A follow on Phase 2 Section 216 study is required to address the non-failure breach associated with flows around the ends of the dams at the auxiliary spillways which would result in significant flooding both upstream and downstream of the dams. The purpose of the study will be to investigate the non-breach risk, risk exposure (both downstream and upstream) and potential operational concerns associated with flows over and around the uncontrolled auxiliary spillways at the ends of the dams. The Population at



Risk (PAR) for the non-failure breach resulting in flood flows around the ends of the dams is estimated to be 1.04 million people with the potential loss of life estimated at 267 people. Property damage, as a result of the non-failure breach of Addicks and Barker dams, is estimated to be \$31.4 billion and \$14.5 billion, respectively.

**STATUS:** The project was funded in the FY16 or FY17 budget. A Non-Federal Sponsor letter of intent was received from Harris County Flood Control District dated February 27, 2017 to request funds in FY18 budget.

**ISSUES:** Phase I of the Buffalo Bayou Dam Safety construction project is currently underway and will address the seepage and piping issues associated with the outlet work structures at the Addicks and Barker Dams. A follow on Phase 2 Section 216 study is required to address the non-failure breach associated with flows around the ends of the dams at the auxiliary spillways which would result in significant flooding both upstream and downstream of the dams.

**FINANCIAL SUMMARY (\$):**

	<b><u>FEASIBILITY</u></b>
Federal Cost Estimate	\$1,500,000
Non-Federal Cost Estimate	\$1,500,000
Total Project Cost	\$3,000,000
Allocation thru FY 2014	\$0
Allocation for FY 2015	\$0
Allocation for FY 2016	\$0
Allocation for FY 2017	\$0
President Budget FY 2018	\$0
Amount That Could Be Used In FY 2018	\$300,000
Balance to Complete	\$1,200,000

**SCHEDULE:**

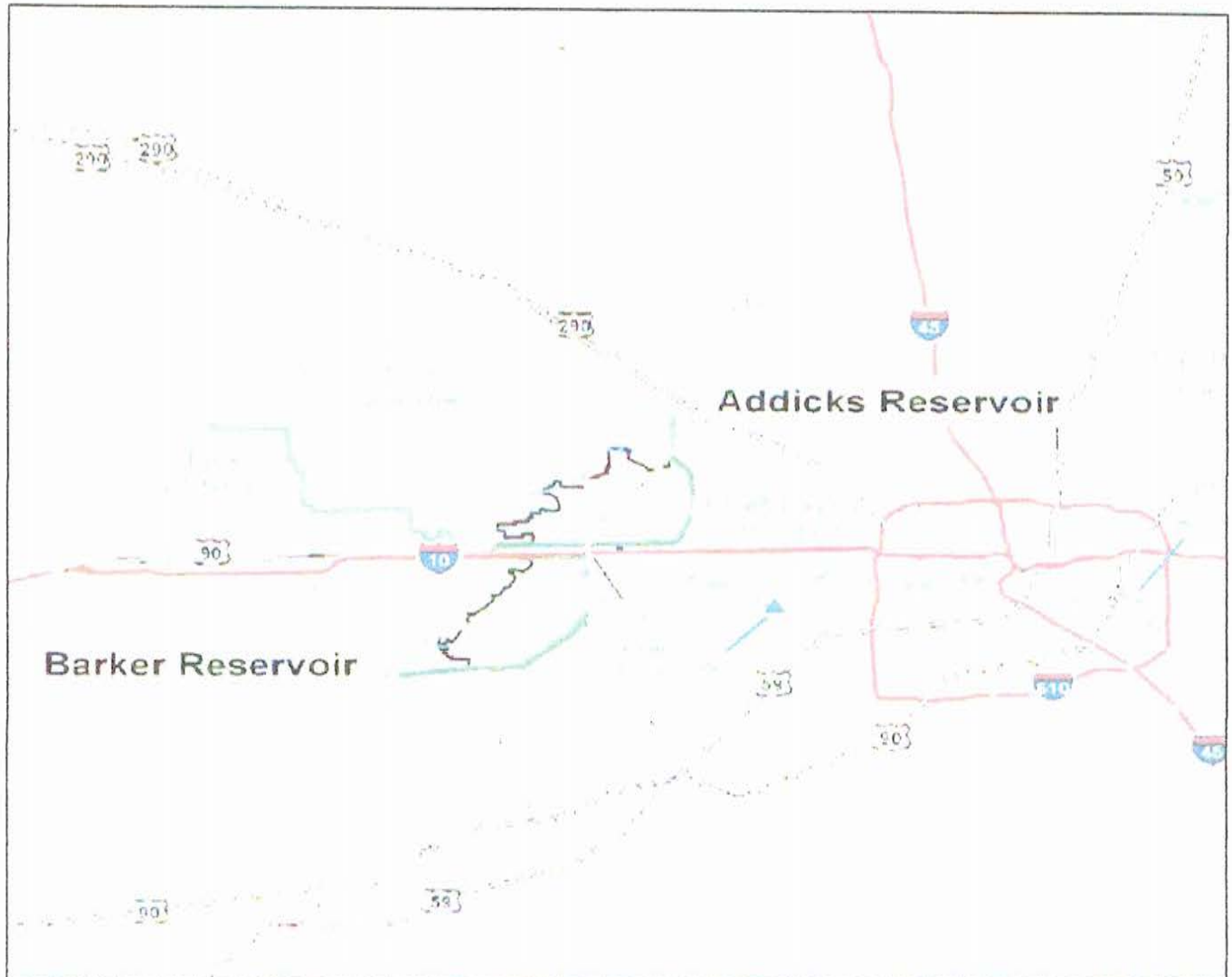
FY 2017 Scheduled Work: This study is not in the FY 17 budget.

FY 2018 Budget: This study is not in the FY18 budget. If funds are received, they could be used to sign a Federal Cost Share Agreement (FCSA), develop the PMP and initiate the feasibility study. (\$300,000).

**COMPLETION:** With optimum funding, the project completion date is September 2021.

For more information regarding the Buffalo Bayou and Tributaries, TX Phase 2 Feasibility study, contact Dr. Edmond J. Russo, Jr., P.E. Deputy District Engineer for Project Management at 409-766-3018 or [Edmond.J.Russo@usace.army.mil](mailto:Edmond.J.Russo@usace.army.mil).







# Houston Regional Watershed Assessment, TX

U.S. ARMY CORPS OF ENGINEERS  
FACT SHEET as of May 23, 2017

BUILDING STRONG®

**AUTHORIZATION:** The study is authorized by Water Resources Development Act (WRDA) OF 1986 (33.U.S.C. 2267a), Section 729, as amended 9WRDA 2000, WRDA 2007)



**TYPE OF PROJECT:** Flood Risk Management

**PROJECT PHASE:** New Start Feasibility

**CONGRESSIONAL INTEREST:** Senators Cornyn and Cruz (TX), and Representatives Poe (TX-2), Culberson (TX-7), A. Green (TX-9), McCaul (TX-10), Weber (TX-14), Jackson-Lee (TX-18), Olson (TX-22), and G. Green (TX-29).

**NON-FEDERAL SPONSOR:** The potential non-Federal sponsor is Harris County Flood Control District.

**BACKGROUND:** The study area includes 22 primary watersheds within Harris County, 1,756 square miles encompassing Houston Metropolitan region, each having unique flooding problems. These include Spring Creek, Little Cypress Creek, Willow Creek, Cypress Creek, Addicks, Barker, Buffalo Bayou, Clear Creek, Sims Bayou, Brays Bayou, White Oak, Greens Bayou, Hunting Bayou, Vince Bayou, Armand Bayou, Carpenters Bayou, San Jacinto River, Jackson Bayou, Luce Bayou, Cedar Bayou, Spring Gully and Goose Creek, and San Jacinto and Galveston Bay Estuaries. Flooding problems in the watershed are frequent, widespread, and severe. Recent historical flooding in the region was documented in 1979, 1980, 1983, 1989, 1993, 1994, 1997, 2001, 2006, 2007, 2008, 2015 and most recently April 2016 with the loss of 8 lives, widespread damages to 5400 homes and about \$3 billion worth of damages to businesses. The principle purpose of the study is to develop a watershed management plan that would provide a system wide approach to water resources management. There is a significant opportunity to integrate and improve the operations of existing flood risk management systems and activities in Houston, TX, the 4th largest metropolitan region in the nation, while seeking opportunities to restore degraded ecosystems.

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**STATUS:** The project was not in the President's FY16 Budget.

**ISSUES:** Recent historical flooding in the region was documented in 1979, 1980, 1983, 1989, 1993, 1994, 1997, 2001, 2006, 2007, 2008, 2015 and most recently April 2016 with the loss of 8 lives, widespread damages to 5400 homes and about \$3 billion worth of damages to businesses.

**FINANCIAL SUMMARY (\$):**

Federal Cost Estimate	\$1,500,000
Non-Federal Cost Estimate	\$1,500,000
Total Project Cost	\$3,000,000

**FEASIBILITY**

Allocation thru FY 2014	\$0
Allocation for FY 2015	\$0
Allocation for FY 2016	\$0
Allocation for FY 2017	\$0
President Budget FY 2018	\$0
Amount That Could Be Used In FY 2018	\$500,000
Balance to Complete	\$1,000,000

**SCHEDULE:**

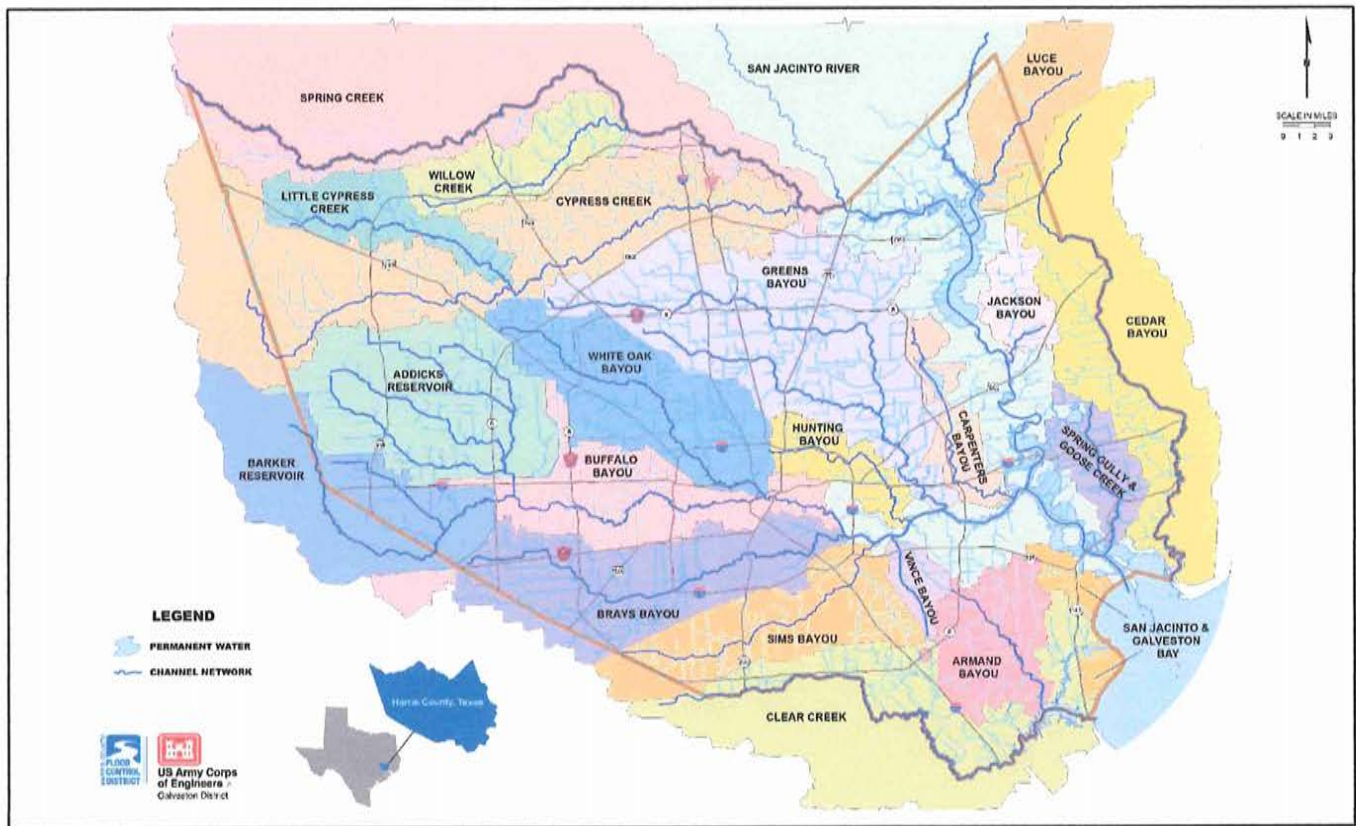
**FY 2017 Scheduled Work:** The study was not funded in the FY2017 President's budget.

**FY 2018 Budget:** The study was not funded in the FY2018 President's budget. If funds are received they would executed a Federal Cost Share Agreement (FCSA), develop a PMP and initiate the feasibility study.

**COMPLETION:** With optimum funding, the study completion date is September 2021.

**For more information** regarding the Houston Regional Watershed Assessment, TX study, contact Dr. Edmond J. Russo, Jr, P.E. Deputy District Engineer for Project Management at 409-766-3018 or [Edmond.J.Russo@usace.army.mil](mailto:Edmond.J.Russo@usace.army.mil).





2017 LEGISLATION/LITIGATION

NEGATIVE DECISION OF TEXAS SUPREME COURT IN KERR VS. HCFCD

FEDERAL LAWSUIT FILED BY THE TIRZ 17(MEMORIAL)NEIGHBORHOOD VS. CITY OF HOUSTON

GOVERNOR ABBOTT VETOES HB 2334 WHICH GAVE HCFCD POWER TO FIND DEVELOPERS FOR NON-COMPLIANCE WITH REGULATIONS

DR. TOM OLIVERSON REQUESTS MEETING WITH CCFCC FOR ASSISTANCE IN DEVELOPING FLOODING ACTION LIST FOR UPCOMING LEGISLATIVE SESSION

## **Cypress Creek Greenway Project – CCFCC Annual Report for 2017**

During 2017 our coordination and advocacy efforts continued for the development of the Cypress Creek Greenway (CCG). The Cypress Creek Greenway Project (CCGP) is a committee within the CCFCC. The Cypress Creek Greenway is a linear greenway along Cypress and Little Cypress Creeks and will extend from west of US 290 to the east where the CCG will join the Spring Creek Greenway, a distance of over 40 miles. The greenway will connect existing and future anchor parks along Cypress Creek with a multi-use, all weather trail.

In addition to our efforts many partners are doing things to make the vision for the Greenway a reality. Since 2004 when the CCGP began 24 parks which will be connected to the CCG have been opened. These were built by MUDs, Harris County Precincts 3 and 4, and developers. While we have not been the catalyst for all of these parks, the large number of parks being developed clearly demonstrates the interest that there is in creating amenities within the Cypress Creek a corridor. In addition to these parks over 15 trail projects have been completed outside of the parks and numerous acreage acquisitions have occurred. Below are 2017 highlights from the efforts of the CCGP and its many partners.

- **Harvey Flooding along Cypress Creek** – Unprecedented and devastating flooding occurred along Cypress Creek as a result of about 30" of rain falling across the Cypress Creek watershed in the 8/25-29/17 time period. Essentially all of the areas included within the Cypress Creek Greenway were inundated with several feet of water. However, the CCG functioned as it should by being a place for flood waters to flow and accumulate. Tracts which had been acquired as part of the CCG but had originally been promoted for development flooded. Had these tracts been developed any structures which would have been constructed would have flooded. Precinct 4 park buildings at the Kickerillo-Mischer Preserve, Collins Park, and Mercer Botanical Gardens suffered significant flood damage but most park amenities were opened to the public soon after the flood waters receded.
- **Kickerillo-Mischer Preserve** – On 4/1/17 a grand opening was held for the Kickerillo-Mischer Preserve on the north side of Cypress Creek just east of SH 249. Precinct 4 Parks Department developed and maintains the 82 acre property which includes a 40 acre lake, 1.7 mile paved hiking and biking loop trail around the lake, restrooms, parking, fishing piers, and picnic tables.

CCFCC and the CCGP began efforts to create the Preserve in 2004. Through efforts along with several partners including the HP Park Alliance (a local grass roots community group), HP, Harris County, HCFCD, and Harris County Precinct 4 a donation of the acreage was obtained from V & W Partners (Kickerillo Properties and Mischer Investments) in 2009.

When funding became available Harris County Precinct 4 began development of the Preserve. The Prestonwood Utility District leased an empty fire station to Precinct 4 for use as the KMP Preserve headquarters and participated in the construction of a bridge connecting the headquarter to the Preserve, both of which helped to accelerate the development and opening of the Preserve.

Precinct 4 has assigned a park director and education director to the KMP and these along with the Precinct 4 Trails as Parks (TAP) Program are providing significant public outreach and



educational programming at the KMP. The KMP is an extremely popular and much appreciated amenity for area residents.

- **Cypress Creek/SH 249 Area Trail Master Plan** – The completed trail master plan continues to serve as a planning tool for the approximately 14 square mile area surrounding “a nucleus” consisting of the Lone Star/HP campus and The Vintage area near Cypress Creek and SH 249. Discussions with several partners and potential partners regarding trail connectivity projects were underway prior to the Harvey flooding. With partners being flooded the trail connectivity obviously became a lower priority item to consider. However, in 2018 discussions will resume with the goal of encouraging additional trail connections to the newly opened Kickerillo-Mischer Preserve, upstream and downstream along Cypress Creek, and into the surrounding residential areas. A copy of the plan can be viewed at <http://www.ccfcc.org/CCREEKTMP/index.html>.
- **Trash Bash at Collins Park** – Bayou Preservation Association’s Trash Bash event was held at Collins Park on Cypress Creek on Saturday, 3/25/17. Approximately 450 volunteers participated in the event during which about 50 cubic yards of trash was picked up along Cypress Creek and its tributaries. There was an increased and successful focus on education at the event this year. The number of volunteers was down significantly this year from 2016, due at least in part to some very early morning rain, and an ominous but inaccurate forecast for additional rain.
- **Educational Hike along Cypress Creek** – On 1/28/17 Steve Hupp (Bayou Preservation Association) and I led a small group on an educational hike along Cypress Creek across and upstream from the 100 Acre Wood. It was part of REI’s All Out 2017 Program, an effort to get more folks to participate in outdoor activities. The feedback from the participants was very positive and the event could be a model for other education/outreach events.
- **Cypress Creek Paddling Trail** – Although approval was received from TPWD to establish the Bayou Preservation Association-sponsored Paddling Trail on Cypress Creek from Telge Road to SH 59 progress has been slow on moving forward with the project. It has been decided to shorten the trail and the final trail will extend from SH 249 to US 59. The upper portion of Cypress Creek has been deemed to be too shallow and with the potential for too many blockages for less experienced paddlers. Reconnaissance paddle trips have been made to assess the post-Harvey effects on the creek and paddle trail. Also, there has been damage to the previously constructed launch sites as a result of Harvey.
- **Precinct 4 Greenway Activity** – the Precinct 4 Parks Department has been working on Cypress Creek Greenway trail access and planning along multiple stretches of Cypress Creek. Acreage acquisition of key tracts for trail access is planned and underway in coordination with the HCFCD and the Harris County ROW Department.

Jim Robertson, Chairman  
Cypress Creek Greenway Project

03/06/18

# Cypress Creek Flood Control Coalition Balance Sheet Standard

As of December 31, 2017

	<u>Dec 31, '17</u>
<b>ASSETS</b>	
Current Assets	
Checking/Savings	
1.1110 — Checking - Amegy Bank 36...	58,003.03
1.1130 — Investments - Amegy	<u>16,097.33</u>
Total Checking/Savings	<u>74,100.36</u>
Total Current Assets	74,100.36
Fixed Assets	
1.1300 — Computer & Office Equipment	<u>2,334.30</u>
Total Fixed Assets	<u>2,334.30</u>
<b>TOTAL ASSETS</b>	<u><b>76,434.66</b></u>
<b>LIABILITIES &amp; EQUITY</b>	
Liabilities	
Current Liabilities	
Accounts Payable	
1.2110 — Trade Accounts Payable	<u>177.42</u>
Total Accounts Payable	<u>177.42</u>
Total Current Liabilities	<u>177.42</u>
Total Liabilities	177.42
Equity	
3000 — Opening Bal Equity	24,870.64
3900 — Retained Earnings	44,909.50
Net Income	<u>6,477.10</u>
Total Equity	<u>76,257.24</u>
<b>TOTAL LIABILITIES &amp; EQUITY</b>	<u><b>76,434.66</b></u>

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03/06/18

# Cypress Creek Flood Control Coalition Profit and Loss Standard

January through December 2017

	<u>Jan - Dec '...</u>
<b>Ordinary Income/Expense</b>	
<b>Income</b>	
1 - 2 — Resident Voluntary Contribu...	22,808.49
1 - 4 — Interest Earnings	7.21
<b>Total Income</b>	<u>22,815.70</u>
<b>Expense</b>	
10 — Office Supplies, Print, Postage	2,067.89
13 — Contributions & Membership ...	1,460.00
23 — Cypress Creek Greenway Proj...	2,750.10
7 — Administration Expense	2,677.17
11 — Computer ops and maintenanc...	3,806.57
12 — D&O L Liability Insurance	914.00
17 — Seminar / Conference Expense	969.24
9 — Earthlink, SBC,DSL,Symantec	1,693.63
<b>Total Expense</b>	<u>16,338.60</u>
<b>Net Ordinary Income</b>	<u>6,477.10</u>
<b>Net Income</b>	<u><u>6,477.10</u></u>



CCFCC  
2018 Budget

Funds/Expense			2017 Budget	Actual 2017	Proposed	Current	Total 2018
					2018 Budget	05/16/18	
<b>Funds</b>							
	<b>Bank Balance Checking</b>			\$61,135.33		\$40,662.86	
	<b>Bank Balance Savings</b>			\$16,097.33		\$16,097.87	
	<b>Total Funds Available</b>			\$77,232.66		\$56,760.73	
1-1	MUD/HOA Contributions						
1-2	Resident Vountary Contribution		\$21,000.00	\$21,746.23	\$22,000.00	\$1,022.32	\$7,950.91
1-3	Grant Applications						
	3a.- Houston Endowment						
	3b. - Other Sources (See Treasurer's Report)						
<b>Total</b>	<b>1-3 Grant Applications</b>						
	Misc						
1-4	Interest Earnings (Includes cking & savings)		\$6.00	\$7.20	\$7.00	\$0.62	\$3.10
<b>Total</b>	<b>Income</b>		<b>\$21,500.00</b>	<b>\$21,753.43</b>	<b>\$22,007.00</b>	<b>\$1,022.94</b>	<b>\$7,954.01</b>
<b>Expense</b>							
1	Membership Bus. & Community Outreach			\$24.89			
2	Annual Meeting						
3	Preservation Committee						
4	IT Mgt-Evaluation Comm.						
5	AWBD Committee						
6	Legal & Accounting Fees & Banking fees						
7	Administration Expense	RD Smith	\$1,000.00	\$2,201.94	\$2,200.00		\$247.18
8	Fed Income Tax Preparation					\$20.85	
9	ATT, SBC,DSL,Symantec		\$1,500.00	\$1,747.61	\$2,000.00	\$128.91	\$643.80
10	Office Supplies,Print Postage		\$1,500.00	\$2,701.25	\$3,000.00	\$90.60	\$486.40
11	Computer ops & maint.			\$4,105.01	\$2,000.00	\$3,297.18	\$4,520.83
12	D&O Liability Insurance		\$1,000.00	\$914.00	\$1,000.00		\$914.00
13	Contributions & membership Dues		\$1,500.00	\$1,460.00	\$1,500.00		\$0.00
14	Houston-Galveston Area Council						
15	Publications						
16	Environmental Affairs Committee						
17	Seminar/Conference Expense		\$100.00	\$423.80	\$400.00		\$0.00
<b>Total 1-&gt;17</b>			<b>\$6,600.00</b>	<b>\$13,578.50</b>	<b>\$12,100.00</b>	<b>\$3,537.54</b>	<b>\$7,273.19</b>
18	Engr / Tech Consultation						
	18-1 PY Work to be Paid in '2018						
	Rice Univ. NAI Project						
	LG Dunbar-Engineering Consulting		\$12,000.00		\$12,000.00		\$0.00
<b>Total 18-1 PY Work to be Paid in '18</b>			<b>\$12,000.00</b>		<b>\$12,000.00</b>		<b>\$0.00</b>
	18-ii CY 2018 Work						
	Rice Univ-stream gage study		\$20,000.00		\$20,000.00		\$20,000.00
	Future Conditions-begin 4/1/10 (L Dunbar)						
	Houston Endowment for Future Conditions)(Encumbered Grant)						
	Aerial Photo's						
<b>Total 18-ii-CY 2018 Work</b>							
<b>Total 18</b>	<b>Engr / Tech Consultation</b>		<b>\$32,000.00</b>		<b>\$32,000.00</b>		<b>\$20,000.00</b>
19	Reserve for Future Requirements						
20	Grant Proposal Expense						
21	Operator Fee - Customer Billing						
22	Bookkeeping						
23	Cypress Creek Greenway Project-J Robertson		\$3,000.00		\$3,000.00	\$1,141.37	\$1,141.37
	23a Meyer Park / REI (Encumbered Grant)						
	23b Memorial Lady Bug (Encumbered Grant)						
	23d Cypress Creek Greenway Project-other						
<b>Total 23</b>	<b>Cypress Creek Greenway project</b>		<b>\$3,000.00</b>	<b>\$2,750.10</b>	<b>\$3,000.00</b>	<b>\$1,141.37</b>	<b>\$1,141.37</b>
24	Detention Pond Committee						
25	Contingencies						
26	Misc. office Equipment						
<b>Total expense</b>			<b>\$41,600.00</b>	<b>\$16,328.60</b>	<b>\$47,100.00</b>	<b>\$4,678.91</b>	<b>\$28,414.56</b>
<b>Total Income</b>			<b>\$21,500.00</b>	<b>\$21,753.43</b>	<b>\$22,007.00</b>	<b>\$1,022.94</b>	<b>\$7,954.01</b>

# Cypress Creek Flood Control Coalition

6/15/18

## Board of Directors

D.M. (Dave) Baldwin Term ends 3-20  
15823 Pebble Bend Dr., Houston, Tx 77068

G.P.(Pat) Kelly Term ends 3-20  
13123 Bristolberry Dr., Cypress, Tx 77429

John Porea, Treasurer Term ends: 3-21  
19430 Remington Manor St., Spring, TX 77379

James H. Robertson Term ends: 3-20  
Chair: Cypress Creek Greenway  
12422 Normont Drive, Houston, TX, 77070

John J. (Jack Sakolosky, Secretary Term ends: 3-21  
12027 Laneview, Houston, TX 77070

John E. Sherman Term ends: 3-19  
14321 Cashel Forest Dr., Houston, TX 77069  
Chairman: Nominations Committee

Richard D. Smith, Pres. Term ends: 3-19  
Chair: Communications Program  
12526 Texas Army Trail, Cypress, TX 77429

Peter R. Smullen, VP Term ends: 3-19  
Chair: Technical Management Committee  
12518 Texas Army Trail, Cypress, TX 77429

Carl Zeitler Term ends: 3-21  
11835 Brush Canyon Dr. Tomball, TX 77377

## Member Organization

Old Oaks Community Improvement Assoc. (H)281-440-4345  
[superone@comcast.net](mailto:superone@comcast.net) (C)713-851-1358

Lakewood Glen POA 281-923-4303  
[Roiproperties52@sbcglobal.net](mailto:Roiproperties52@sbcglobal.net)

Harris County MUD 383 (C) 713 402 8538  
[jptx1001@gmail.com](mailto:jptx1001@gmail.com)

Enclave at Lakewood POA (H) 281 370 8243  
[jhrver@aol.com](mailto:jhrver@aol.com) (C) 713 419 8584

Lake Forest Utility District (H) 281 370 7808  
[J.Sakolosky@sbcglobal.net](mailto:J.Sakolosky@sbcglobal.net) (C) 713 703 5285

HOA Advisor.-Champions Terrace, (C) 713 594 6397  
MUD 48 Director  
[jesherman9455@att.net](mailto:jesherman9455@att.net)

Timberlake Imp. District (H) 281 469 5161  
[floodalliance@ccfcc.org](mailto:floodalliance@ccfcc.org)

Ravensway/Sarecen Park HOA (H) 281 894 4248  
P-R-S@att.net (C) 281-900-2369

Malcomson Road Utility District (H) 281 655 7941  
[Carl.Zeitler@ieee.org](mailto:Carl.Zeitler@ieee.org) (C) 512 658 1544

## OTHER CHAIR PERSONS

Paul Alli  
3747 Prelude Springs Lane, Spring, TX 77386

Computer Systems (C) 281 352 7129

.Temporarily vacant

Chair: Environmental Affairs

Patsy Gillham  
13110 Chaville, Cypress, TX 77429

Chair: Preservation Committee (H) 281 469 1966  
Tower Oaks Plaza, Resident  
[PatsyGillham@yahoo.com](mailto:PatsyGillham@yahoo.com)

Joe Velasco  
15223 Rainhollow Drive, Houston, TX 77070

Chair: IT Mgmt. (Information Technology) (H) 281 374 0465  
[jzvelas@gmail.com](mailto:jzvelas@gmail.com) (C) 832 493 0395

**Bookkeeper:** John Porea, Treasurer

**Audit/Tax Returns:** Lynda Maney 832 277 7827  
15550 Kingfield, Apt. 1415, Houston, TX 77084

**CCFCC Registered agent:**

Michael T. Turner, Attorney 713 622 6440

**Bank:** Amegy Bank

Rep: Shazia Flores, Asst. VP 713 232 6017  
[shazia.flores@amegybank.com](mailto:shazia.flores@amegybank.com)

**Insurance:** HARCO Insurance Services  
10777 Northwest Freeway, Suite #700  
Houston, TX 77092-7313  
Agent: Ruthie Mead 713 681 2500

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