

# Geography Extended Essay

**How effective were the local flood management measures around the Addicks Reservoir, during the ‘Tax Day’ floods of April 2016?**

**(Word Count 3,975)**



[https://spacecityweather.com/wp-content/uploads/2016/07/14123003699\\_cc4a2ad810\\_k.jpg](https://spacecityweather.com/wp-content/uploads/2016/07/14123003699_cc4a2ad810_k.jpg)

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**Definitions**

- cfs                   Cubic feet per second
- HCFC               Harris County Flood Control District
- HCOHSEM          Harris County Office of Homeland Security and Emergency Management
- REP                 Rainfall Exceedance Probability
- U.S.                 United States of America
- USACE              U.S. Army Corps of Engineers

## 1.0 INTRODUCTION

Houston is the most populated city in Texas and the fourth most populous city in the United States (U.S.), with approximately 2.3 million people living in the metropolitan area<sup>1, 2</sup>. The city covers an area of approximately 599 square miles making it the ninth largest city by area in the U.S.<sup>3</sup>. Houston receives an average annual rainfall of over 47 inches per year<sup>4</sup> and suffers from significant flood events, the most recent of which occurred on 17<sup>th</sup> April 2016, and became known as the 'Tax Day Flood' (*note Hurricane Harvey was ongoing at the time of writing and significantly exceed this event*). Houston has in place major 'anti-flood' networks comprising of watersheds, bayous, creeks and reservoirs. This report analyzes the effectiveness of the flood management systems local to the Addicks reservoir during the Tax Day Flood, and focuses on the following question:

- How effective were the local flood management measures around the Addicks reservoir, during the 'Tax Day' floods of April 2016?

To answer this question, the following were investigated:

- The flood protection infrastructure in place around Addicks Reservoir.
- The weather during the event.
- The impact of the event on residents living by Addicks Reservoir.
- The perceived effectiveness of the Addicks reservoir and the emergency management systems by locals

I chose to research this subject for three reasons:

1. Changes in weather patterns, more frequent and larger flooding events and the continuous building work in Houston make this a 'hot topic' of interest in Houston. *Note Houston is currently undergoing the most extreme and catastrophic flood event in its history due to Hurricane Harvey.*
2. The 'Tax Day flood' event affected me, my friends and family. Local roads were closed and most schools were closed for a week. There were seven fatalities in Harris County directly related to the flooding.
3. I have an interest in hydrology and wish to study this subject further as part of an Environmental Science course at University.

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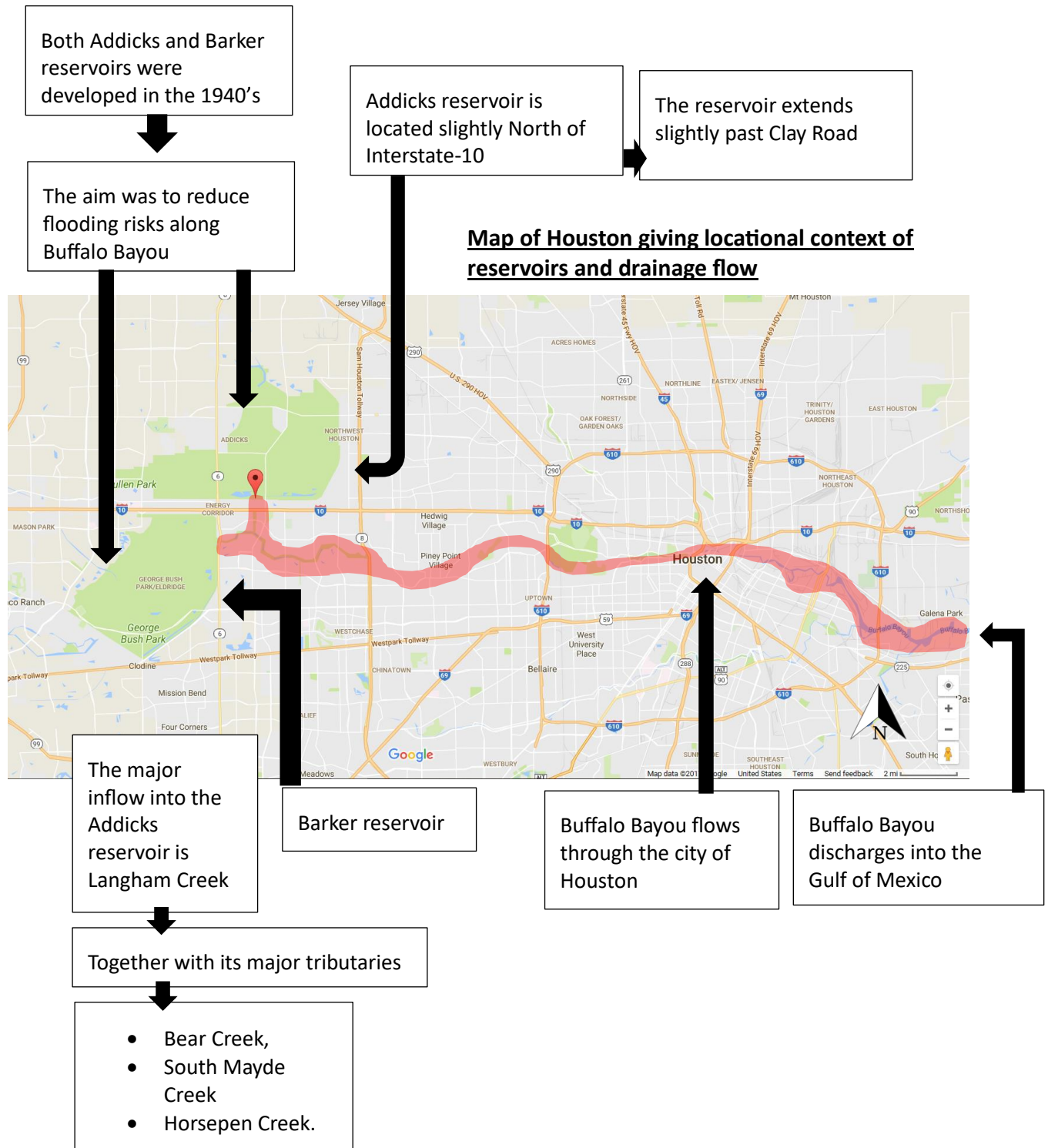
<sup>1</sup> American Fact Finder U.S. Census Bureau

<sup>2</sup> "Population Finder". American Fact Finder. U.S. Census Bureau. 2009. Archived from *the original* on November 18, 2015

<sup>3</sup> [https://en.wikipedia.org/wiki/List\\_of\\_United\\_States\\_cities\\_by\\_area](https://en.wikipedia.org/wiki/List_of_United_States_cities_by_area)

<sup>4</sup> <https://www.currentresults.com/Weather/Texas/average-yearly-precipitation.php>

## 2.0 LOCATIONAL CONTEXT

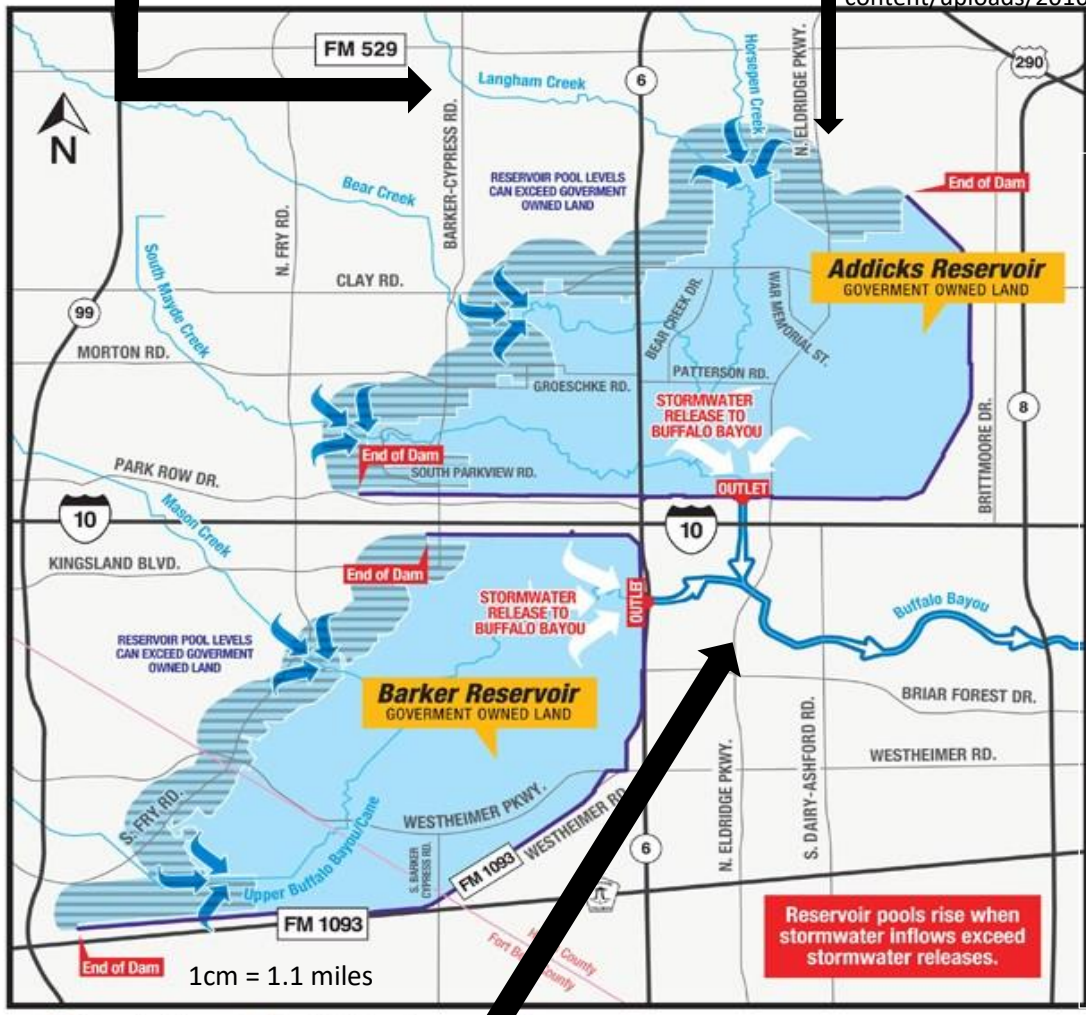


Rainfall within 138 square miles of the Addicks Reservoir watershed  
 ↓  
 Drains into watershed's Primary waterway, Langham Creek

Significant amount of storm water overflow from the Cypress Creek  
 ↓  
 Flows into Addicks reservoir during heavy rainfall events

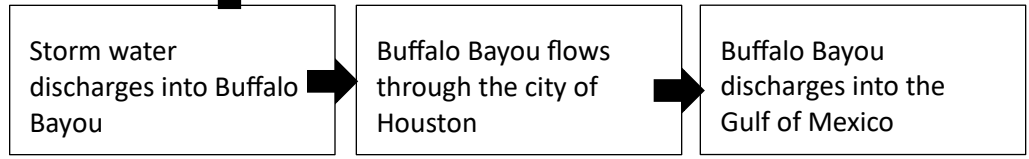


**Locational context of reservoirs in relation to road access**



<http://bigjollypolitics.com/wp-content/uploads/2016/05/watershedsweb.jpg>

[https://www.hcfd.org/media/2297/addicksbarkerreservoirs\\_releaservsd4-1.jpg](https://www.hcfd.org/media/2297/addicksbarkerreservoirs_releaservsd4-1.jpg)



### 3.0 RESEARCH

Research for this essay was conducted via multiple sources to attain a wide range of information/data and reduce the risk of bias. The sources of this information are as follows and these are cited throughout the essay.

**Primary Data:**

1. Survey of residents
2. Personal interviews
3. Site visit to Addicks Reservoir and dam

**Secondary Data:**

1. Research of relevant websites
2. Final report of Harris County Flood Control District (HCFCD) related to the Tax Day flood.
3. Media reports from the Tax Day flood

### 3.1 PRIMARY DATA

A survey was undertaken of residents to gain their insight in to the questions raised in this report. The survey was undertaken at ‘Congressman Bill Archer Dog Park’, located close to the Addicks Reservoir. A blank copy of the survey is in Appendix 1, with data analysis shown in Appendix 2.

Interviews were undertaken, either in person or via email with the following key people:

1. Mr. Richard Long                      Natural Resource Management Specialist working for U.S. Army Corps of Engineers
2. Mr. Charles Ciliske                  U.S. Army Corps of Engineers
3. Mr. Jeff Lindner                      Chief Meteorologist working for HCFCD
4. Ms. Hailie Frazee                    Communications Planer for HCOHSEM

Email correspondence is included in Appendix 3 of this report.

A site visit was undertaken of the Addicks Reservoir and dam on 30/05/17. Special thanks go to Mr. Richard Long for hosting my visit and answering questions.

### 3.2 SECONDARY DATA

Key websites used for research were:

- Harris County Flood Control District (HCFCD):                      <https://www.hcfcd.org/>
- Harris County Office of Emergency Management (HCOEM):                      <http://www.readyharris.org/>

## 4.0 BACKGROUND

### 4.1 EMERGENCY MANAGEMENT

In times of emergency, such as the Tax Day floods, the Office of Homeland Security and Emergency Management (HCOHSEM) will start to push out information if Houston is under a weather watch/warning. The messages include weather information, tips on how to prepare (should the storm become severe), and directions on where to find more information. Once the Emergency Operations Center and Joint Information Center are activated, HCOHSEM will be able to gather all information from partnering agencies, and that is the information that is broadcast to the public via social media, TV, radio interviews and emails. In addition, the HCOHSEM oversee emergency planning, preparation, response, and recovery.

*Hallie Frazee is a communications planner at HCOHSEM, who's role is to aid in the response phase of the incident at a strategic level. Please see Appendix 3 for my interview with Ms. Frazee.*

Addicks reservoir is located in Harris County, Houston. The operation and management of the reservoir is the responsibility of the U.S. Army Corps of Engineers who are responsible for maintaining and managing the reservoir infrastructure, and who work in conjunction with the Harris County Flood Control District (HCFCD).

The HCFCD's role is to serve as the local partner for major projects with the U.S. Army Corps of Engineers, and support the Corps of Engineers in making decisions regarding operations of the reservoir and dam during flood events. During the Tax Day flood event, HCFCD played a major role in acting to monitor and supply information to keep the public up to date. A key source of data used in this report has been provided directly by HCFCD, and specifically adapted from a report 'Immediate Report – Final' issued by HCFCD's Mr. Jeff Lindner on June 27, 2016, who is the Meteorologist/Flood Watch Manager for HCFCD.

### 4.2 ADDICKS RESERVOIR

Harris County has a history of flooding; suffering through 16 major floods from 1836-1936<sup>5</sup>. More recently in June 2001, Tropical Storm Alison caused massive flooding impacting over 73,000 homes<sup>6</sup>. This regular flooding has prompted the continued development of the flood control measures around Houston, which includes the Addicks reservoir. The Addicks reservoir is one of two flood management reservoirs (the other is Barker Reservoir), and was originally located in the country, way out in Harris county. The continued expansion of Houston has led to homes being built around the reservoir and on its upstream watershed.

Rural and agricultural uses have historically dominated the upstream regions of the watershed, but residential and commercial developments are rapidly growing. There are 159 miles of open waterways in the Addicks Reservoir watershed, including Langham Creek and its major tributaries. Based on the 2010 U.S. Census, the estimated population of the Harris County portion of the Addicks Reservoir watershed is 295,694<sup>7</sup>.

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<sup>5</sup> <https://www.hcfcd.org/flooding-floodplains/harris-countys-flooding-history/>

<sup>6</sup> Memorandum report (June 27, 2016) Jeff Lindner and Steve Fitzgerald. Immediate Report - Final

<sup>7</sup> <https://www.hcfcd.org/projects-studies/addicks-reservoir/>

As well as the reservoir, Addicks consists of a dam which was completed in 1948 by the U.S. Army Corps of Engineers. The Corps owns, maintains, and operates the facility including the issuing of permits for use in the reservoir basin.<sup>8</sup>

Normally, the Addicks reservoir is empty with open dam gates. Weather systems are continuously monitored and if a storm is predicted to hit Houston, the gates would be closed pre-storm allowing the reservoir to fill. Once the management team has had confirmation that the storm has passed, they will gradually re-open the flood gates allowing water to escape in a controlled manner into the Buffalo Bayou at a controlled rate such that the flow at the Piney Point gauge does not exceed 2,000 cfs. Following constant monitoring, the USACE and HCFCF have decided to begin the process of retiring the existing dam, and replacing it with a newer one.

Richard Long explained that “the purpose of this construction is to ensure the integrity of the dams in years to come. This work is necessary to ensure that seepage does not occur and around the old water structures, a weakness discovered during a recent review of the dams capabilities. This 75 million project began in early 2016 and is scheduled to be completed in early 2020.” Please see appendix 3 for a copy of my email correspondence.

**Photographs from site visit accompanied by Mr. Richard Long**



**Photograph 1:** The new flood dam gate being built



**Photograph 2:** The old flood dam gate which is soon due to be retired.

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<sup>8</sup> <https://www.hcfcf.org/projects-studies/addicks-reservoir/is>



**Photographs from site visit accompanied by Mr. Richard Long continued**



**Photograph 3:** The Flood Gates



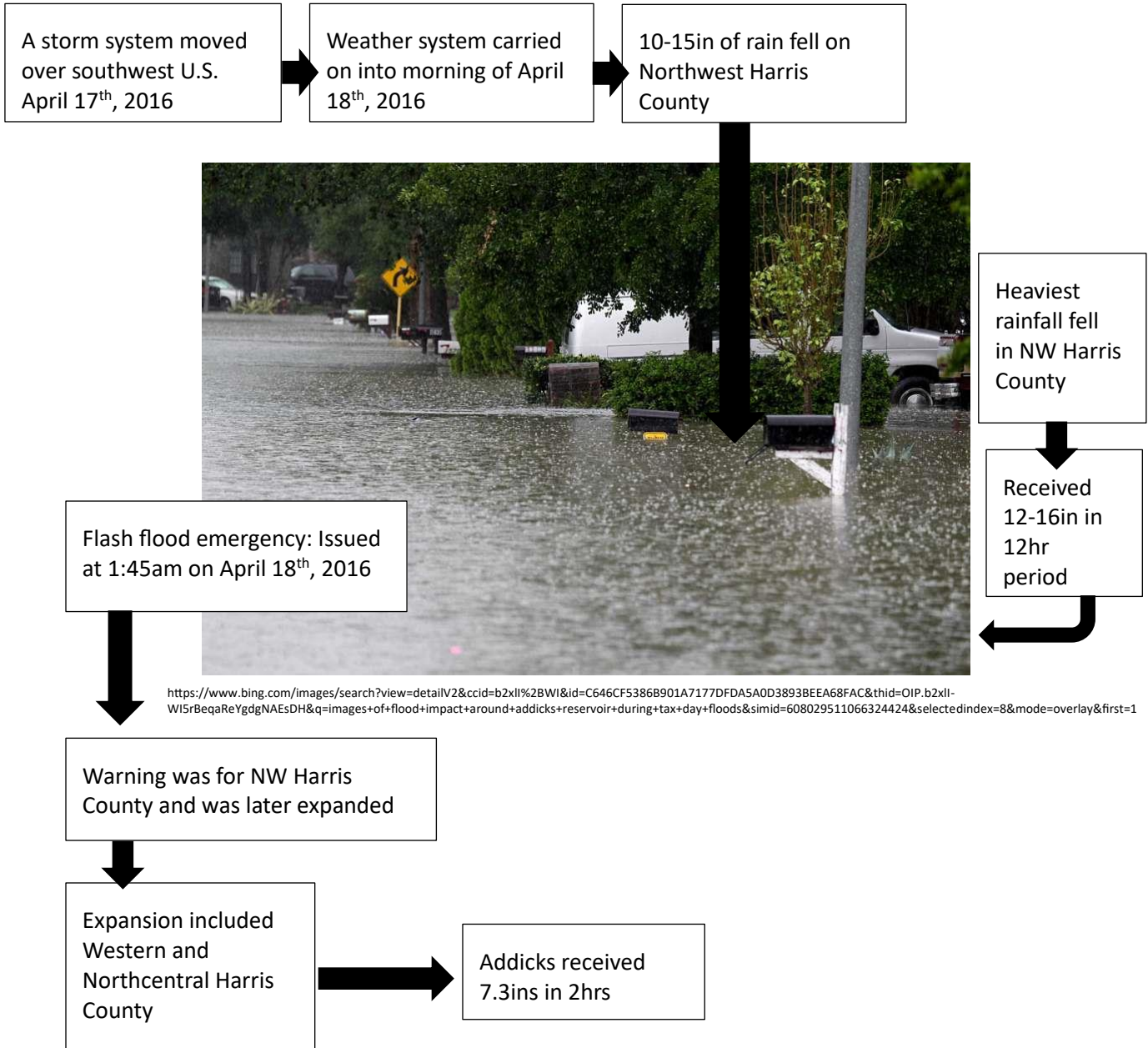
**Photograph 4:** A plaque commemorating the USACE



**Photograph 5:** The access road located on top of the reservoir wall.

### 4.3 THE TAX DAY FLOOD

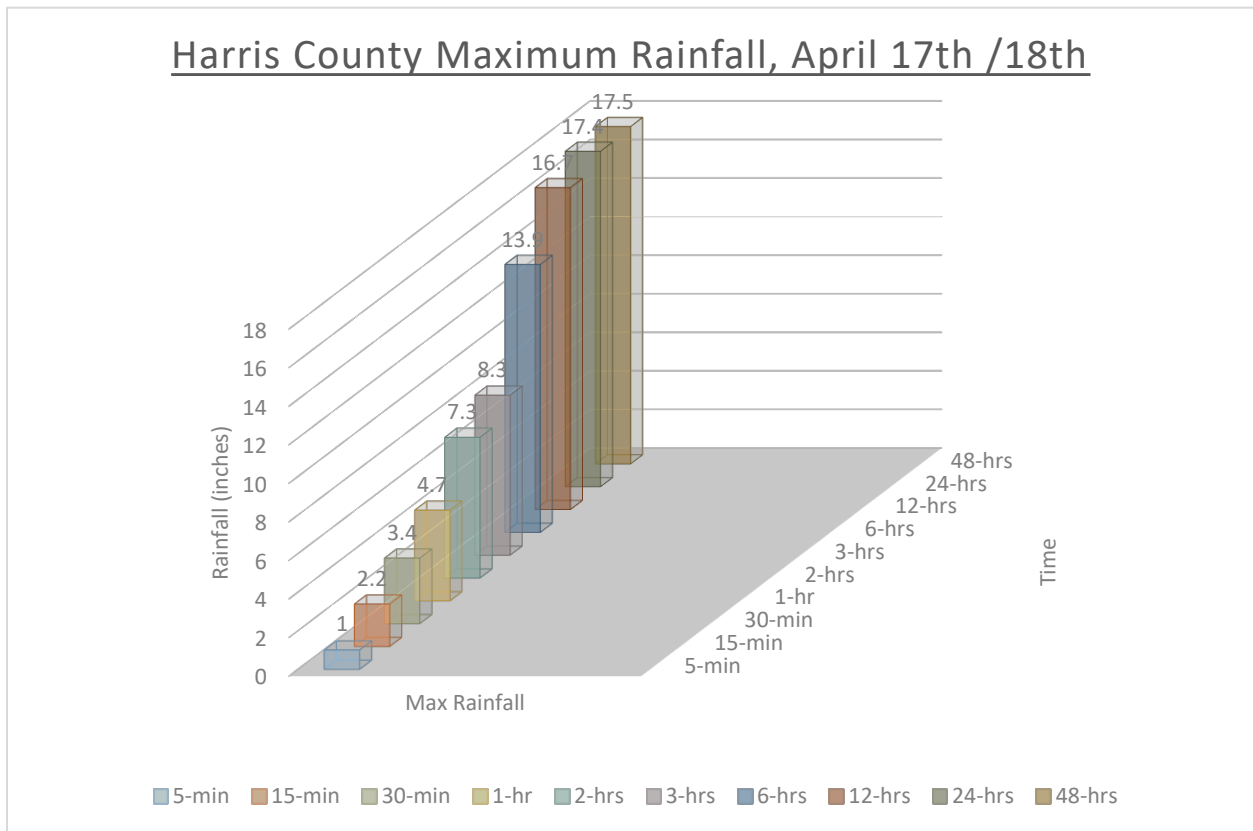
**Image showing flood impact around the Addicks Reservoir with annotations describing the event.**



**Table 1<sup>9</sup>**  
**Table Indicates Harris County Maximum Rainfall, April 17<sup>th</sup> / 18<sup>th</sup>**

Duration	Max Rainfall (inches)	Duration	Max rainfall (inches)
5 minutes	1.0	3 hours	8.3
15 minutes	2.2	6 hours	13.9
30 minutes	3.4	12 hours	16.7
1 hour	4.7	24 hours	17.4
2 hours	7.3	48 hours	17.5

Notes: 1- Data extracted from the Memorandum Report issued June 27, 2016 by Mr. J. Lindner.



<sup>9</sup> Memorandum report (June 27, 2016) Jeff Lindner and Steve Fitzgerald. Immediate Report - Final

In total an average of 7.75 inches of rain fell across Harris county, which equates to approximately 240 billion gallons of water. *Note the current estimated (ongoing) rainfall in Harris County resulting from hurricane Harvey is over 25 inches, and over 1000 billion gallons.*

HCFCFCD calculates a Rainfall Exceedance Probability (REP) which is a function of the rainfall intensity and duration (over a 12-hour period). It can be viewed as defining the event in terms of a probability of the event occurring (e.g. 1 in 100-year event). The rainfall across the Addicks Watershed, combined with the Cypress Creek Overflow, resulted in massive inflows into the reservoir via Langham Creek. The REP calculated for Langham Creek (West Little York) was calculated as 0.11%, (or 1 in 900 years). The REP for the flow leading out of Addicks reservoir via Buffalo Bayou was calculated as 4%-10%, (or 1 in 25 years and 1 in 10 years) along its length<sup>10</sup>.

**Table 2**

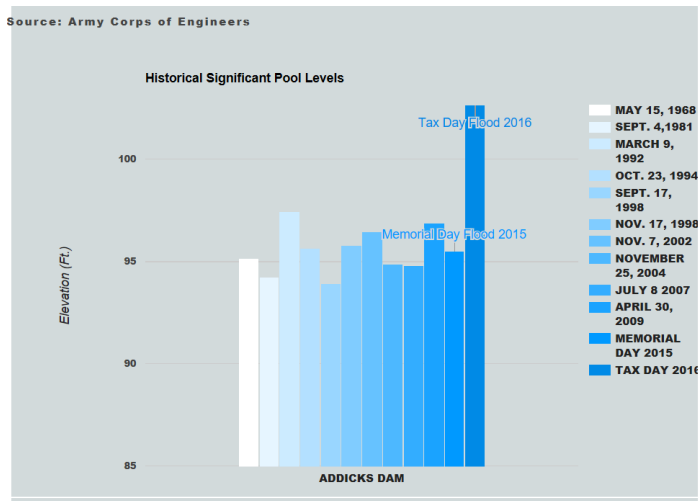
Table 2 compares the maximum rainfall (inches) over a 12-hour period for Langham Creek and its tributaries Bear Creek and South Mayde Creek, together with Cypress Creek, during the Tax Day flood to previous storms of record

Location	April 2016	April 2009	October 1998	October 1994
Langham Creek at W Little York	16.6	7.5	3.2	3.4
Cypress Creek at Katy Hockley	15.1	7.0	7.9	3.0
Bear Creek at FM529	14.4	10.4	4.3	N/A
South Mayde Creek at Greenhouse	12.4	7.6	3.1	2.5

Note:

- 1) Data extracted from the Memorandum Report issued June 27, 2016 by Mr. J. Lindner.
- 2) Data from Horsepen Creek is unavailable.

**Graph flood elevation levels within Addicks over significant flooding dates**



<http://www.houstonchronicle.com/news/houston-texas/houston/article/Houston-dams-are-old-beat-up-and-a-vital-line>

<sup>10</sup> Memorandum report (June 27, 2016) Jeff Lindner and Steve Fitzgerald. Immediate Report - Final

Peak inflows into the Addicks Reservoir were estimated at 49,150 cfs, occurring early morning on April 18<sup>th</sup>, 2016. Three of the creeks set new records for inflow into the reservoir.

**Table 3**

**Table 3 indicates peak inflows (cfs) into Addicks compared to the 2009 event of record.**

Location	April 2016	April 2009	Record Flow Year
Langham Creek at W Little York	19,100	12,800	19,100 (2016)
Bear Creek at Clay Rd.	25,500	24,110	25,500 (2016)
South Mayde Creek (at Groeschke)	4,550	4,000 approx.	4,550 (2016)

Note:

- 1) Data extracted from the Memorandum Report issued June 27, 2016 by Mr. J. Lindner.
- 2) Data from Horsepen Creek is unavailable.

**Table 4**

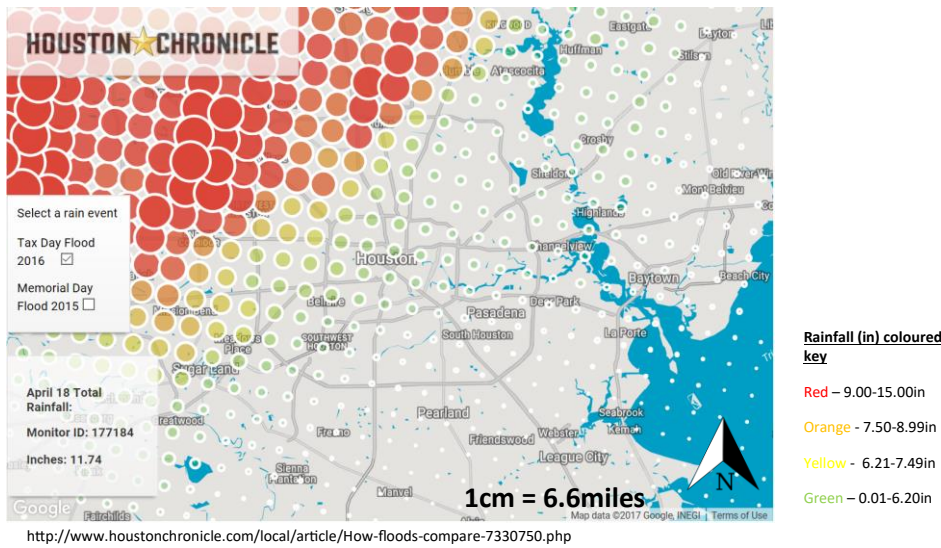
**Table 4 indicates the new record flood levels for selected locations based on historical high water marks**

Watershed	Bridge	April 2016 Elevation (ft)	Flood Frequency	Previous Record (ft)	Previous Record Data
Langham Creek	W. Little York	112.84	0.2% (500-yr)	110.70	April 2009
Bear Creek	Clay	114.86	0.2% (500-yr)	114.40	April 2009
Horsepen Creek	Trailside	118.90	1% (100-yr)	112.80	October 2009

Note:

- 1) Data extracted from the Memorandum Report issued June 27, 2016 by Mr. J. Lindner.
- 2) The above flood levels based on historical high-water marks compared to best available data from April 2016 flood. All elevations are in feet.<sup>11</sup>

**Rainfall intensity over Houston during Tax Day Flood event**



<sup>11</sup> Memorandum report (June 27, 2016) Jeff Lindner and Steve Fitzgerald. Immediate Report - Final

#### 4.4 FLOOD MANAGEMENT

Under ‘normal’ flood control circumstances, the controlled discharge from the Addicks Reservoir into Buffalo Bayou is maintained at a maximum discharge rate of 2,000 cfs at the Piney Point gauge. The Tax Day flood resulted in a maximum discharge of 7,190 cfs at the gauge<sup>12</sup>.

Following the storm, the upstream watersheds were directing so much water to the Addicks and Barker reservoirs that the Corps of Engineers decided that to protect the integrity of the dam, downtown Houston, and downstream property owners, they would release a combined amount of 4,000 cfs from the two reservoirs into Buffalo Bayou to quickly restore the ‘flood holding capacity of both dams. Once the flood levels had dropped sufficiently, the total discharge was reduced to 3,000 cfs. The Addicks reservoir had its peak pool elevation at 102.65ft at 6:30am on April 23, 2016, with a total area of 122,900 acre-ft. of water. The previous pool elevation record was 97.46<sup>13</sup> ft. At peak pool elevation, the storm water storage occupied 93% of the government owned land and 60% of the total reservoir capacity.<sup>14</sup> Addicks surpassed the 100-yr pool level of 101.16ft by 1.49ft. *Note the Addicks dam pool elevation reached 108-ft (topped out) and started to release water via the spillway (overflow) during Hurricane Harvey. The release rate from the dam exceeded 8,000 cfs from the dam gates and spillway overflow.*

#### 4.5 FLOOD IMPACT

The flooding resulted in seven vehicle fatalities in Harris county, with two other fatalities reported in neighboring counties. Approximately 40,000 cars and trucks were flooded, and several school districts in north and west Harris county were closed all week<sup>15</sup>.

The record high water levels in Addicks did result in some flooding of streets in the subdivisions near the reservoir. Highway 6, North Eldridge Parkway, and Clay road experienced severe street flooding.<sup>16</sup> Highway 6 went under water on April 18<sup>th</sup> around 11:45am and was impassible for 4 weeks.

Based on subsequent damage assessment reports and FEMA insurance claims, it was estimated that 9,840 homes were flooded in Harris county. Additionally, there were 2,700 apartments and 50 commercial properties flooded. This number is a best estimate based on available data and does not include those that did not have insurance<sup>17</sup>.

Although these streets did experience water flowage, the Corps of Engineers estimated that \$5.1 billion of flood damages were prevented along Buffalo Bayou because of the reservoirs, and quick thinking of water release through the dam by the Corps of Engineers.<sup>18</sup> In the last 2 years, HCFCD estimates that the Addicks and Barker reservoirs have prevented a combined total of \$7.7 billion of damages along the Buffalo Bayou corridor and within the city of Houston.<sup>19</sup>

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<sup>12</sup> Memorandum report (June 27, 2016) Jeff Lindner and Steve Fitzgerald. Immediate Report - Final

<sup>13</sup> Memorandum report (June 27, 2016) Jeff Lindner and Steve Fitzgerald. Immediate Report - Final

<sup>14</sup> Memorandum report (June 27, 2016) Jeff Lindner and Steve Fitzgerald. Immediate Report - Final

<sup>15</sup> Memorandum report (June 27, 2016) Jeff Lindner and Steve Fitzgerald. Immediate Report - Final

<sup>16</sup> Memorandum report (June 27, 2016) Jeff Lindner and Steve Fitzgerald. Immediate Report - Final

<sup>17</sup> Memorandum report (June 27, 2016) Jeff Lindner and Steve Fitzgerald. Immediate Report - Final

<sup>18</sup> Memorandum report (June 27, 2016) Jeff Lindner and Steve Fitzgerald. Immediate Report - Final

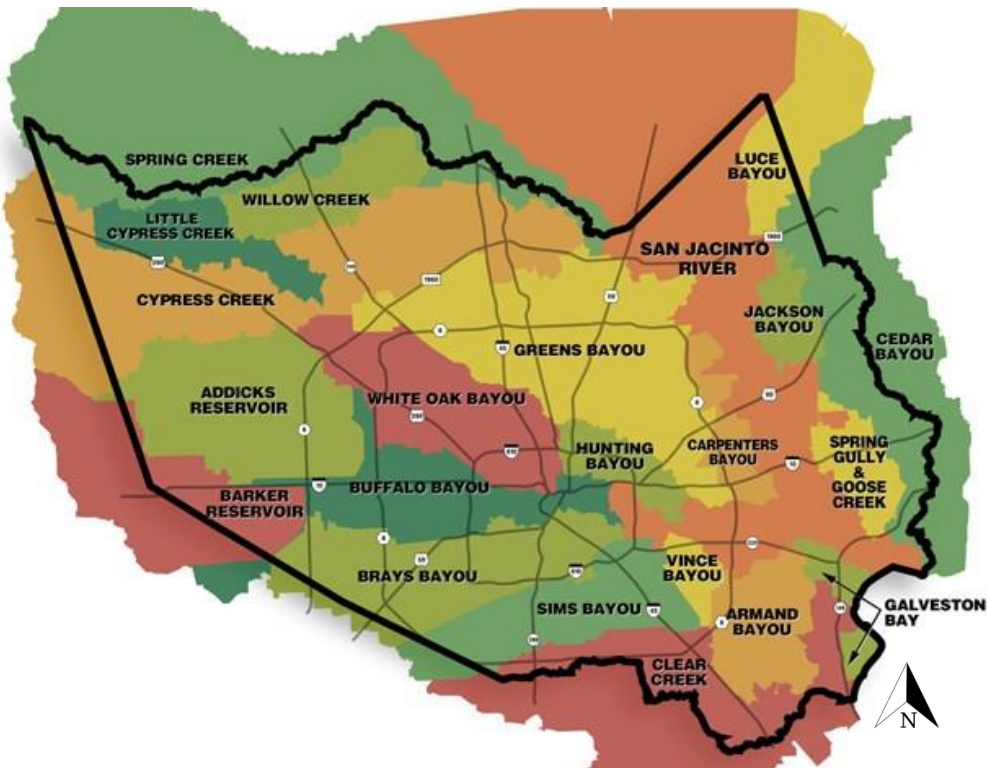
<sup>19</sup> Memorandum report (June 27, 2016) Jeff Lindner and Steve Fitzgerald. Immediate Report - Final

Table 5

**Table 5 indicates the number of flooded properties along the Addicks watershed including Cypress Creek which flooded and contributed to the water flowing to the Addicks reservoir.**

Watershed	House Flooding
Cypress Creek	2,080
Buffalo Bayou	950
Langham Creek	810
Horsepen Creek	510
South Mayde Creek	220
Bear Creek	130
<b>Total</b>	<b>4,700</b>

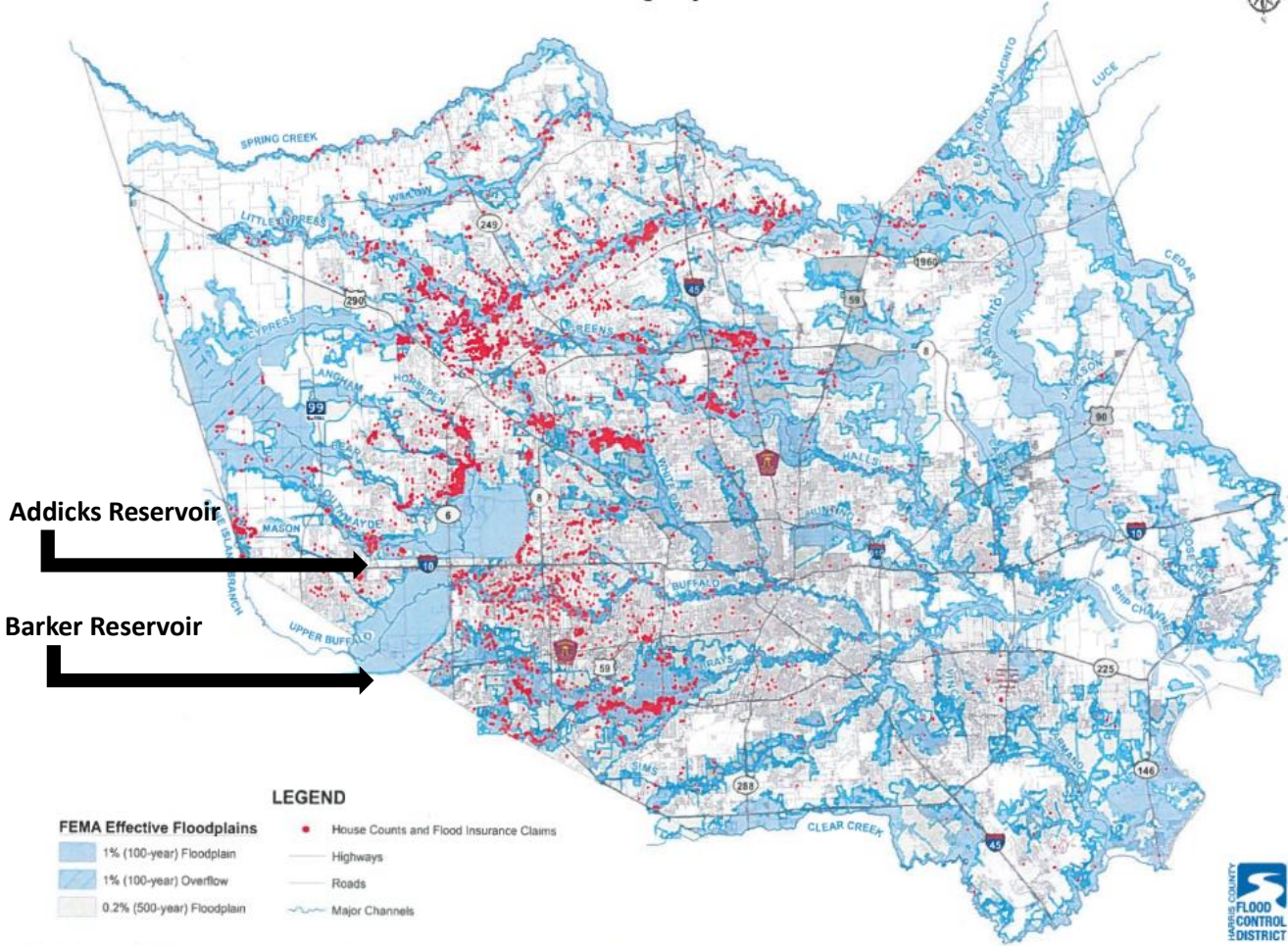
**Map locating all important reservoirs/Bayous/Creeks in the Houston Area**



<http://bigjollypolitics.com/stephen-costello-new-flood-czar/>

**Map of Houston detailing location of Addicks and Barker reservoir in relation to house flooding reports**

**House Flooding April 17-19, 2016**



<https://www.hcfd.org/press-room/current-news/2016/04/us-army-corps-of-engineers>



## 5.0 ANALYSIS

In analysing the information regarding the flood, the analysis will focus on communication, local perception and infrastructure.

The answer to these questions will help support a conclusion as to ‘How effective were the local flood management measures around the Addicks reservoir, during the ‘Tax Day’ floods of April 2016?’

### **Communication: the effectiveness of the communications from HCHSOEM and HCFCD prior to, during and following the event**

Prior to the Tax Day Flood event, there was little to no warning of the upcoming natural disaster. The first press release was published in the early hours of April 18, 2016. For many, this warning was too late. The severe storm system which stalled over Northwest Harris County, was difficult to predict due to the swiftness of events. As the event unfolded more press releases were released along with warning systems on mobile devices, email, and TV. All press releases related to the Tax Day Floods can be found on the HCFCD website – see section 2.0 Research. The press releases contain essential information such as flooded areas, numbers to call if in need, weather patterns, etc. They are made accessible via media conferences and/or paper reports online. No individual data for the effectiveness of communication during the Tax Day Floods can be found, although located on the HCOHSEM webpage is a published report analyzing logged communication efforts for the Tax Day Floods and the late May/June floods. During these two events, Regional Joint Information Centre (RJIC) who serves as a central location for coordinate multi-agency efforts logged the following<sup>20</sup>:

- Media Calls – 324
- Interviews – 281
- Social Media Posts – 1,257
- Harris County Alerts – 95
- Partner Updates – 48

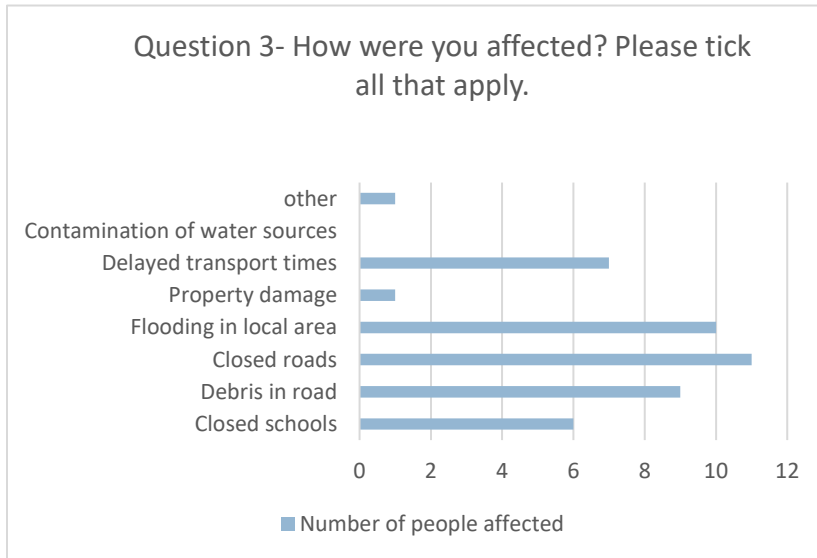
In my interview with Hailee Frazee- Communications Planner, she explained that the service’s main role during the event was one of “management and coordination.” She explained that “we worked with various partners to aid in the response phase of the incident from a strategic level. Once the lifesaving portion of response was over, we moved into the recovery phase.” (See appendix 3 for a copy of my email correspondence.)

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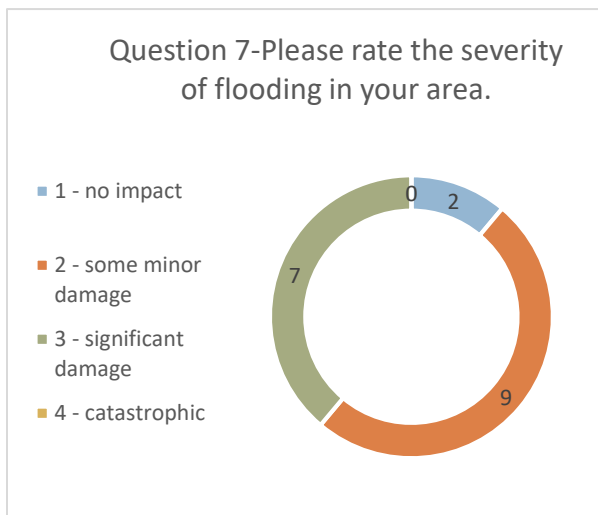
<sup>20</sup> [http://www.readyharris.org/Portals/43/PDFs/2017/2016\\_HCOHSEM\\_AR\\_web.pdf?ver=2017-06-15-085326-637](http://www.readyharris.org/Portals/43/PDFs/2017/2016_HCOHSEM_AR_web.pdf?ver=2017-06-15-085326-637)

**Local Perception: perception of the local population as to the effectiveness of the flood management at local level. (Refer to Appendix 1 & 2)**

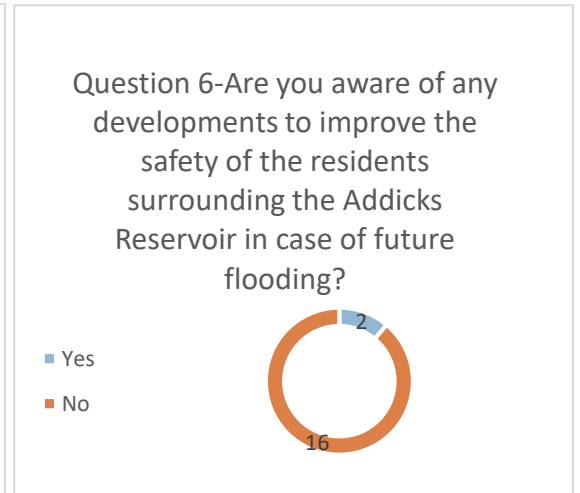
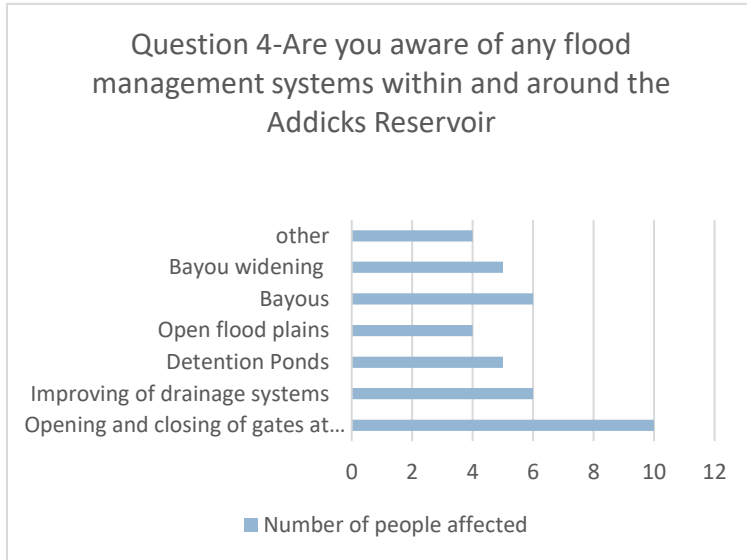
Fifteen of the eighteen people surveyed lived within 10 miles of the Addicks reservoir (Q. 1), and a total of twelve people indicated that they were directly impacted by the Tax Day flood (Q. 2). In the main, the impacts appeared to be restricted to the inconvenience caused by flooding in the area, closed roads and the closure of schools (Q. 3).



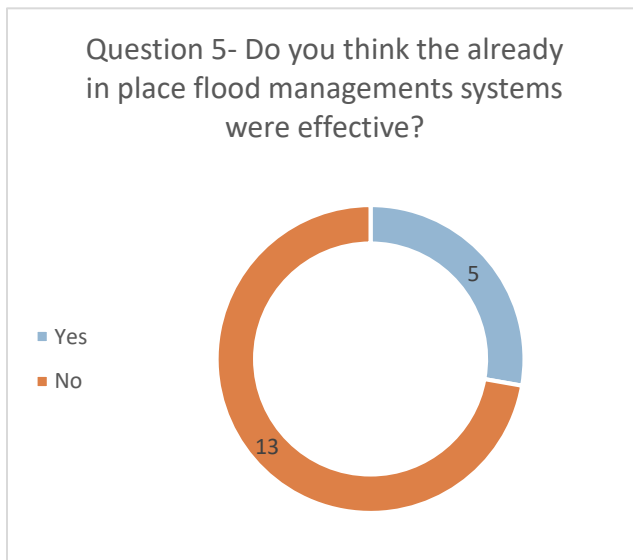
Only one person indicated that they experienced flooding to property (Q. 3). This is somewhat at odds with some people's responses to question 7, as seven people indicated that they experienced significant damage locally. Most, nine people, indicated that the damage in their area was 'minor' (Q. 7).



All the people surveyed were aware of some of the flood management systems associated with the Addicks Reservoir designed to reduce flooding such as Bayous, flood ponds and opening and closing of the dam gates (Q. 4), but most of the sample, sixteen people, were not aware of any ongoing projects to improve the safety of local residents (Q. 6).



Thirteen of the eighteen people indicated that they did not consider that the 'in place flood management systems' were effective (Q. 5).



This appeared to reflect the localized impact of the flooding and the inconvenience caused by street flooding and school closures. There was also a perception that their neighborhood had been flooded to keep downtown Houston from flooding. However, thirteen of the respondents also indicated that they considered the response of the city to the flooding was adequate, whilst four people thought the response was poor (Q. 8). Twelve people agreed that they had been provided with preventative advice (Q.10).

Eleven of the respondents had flood insurance (Q. 9a), though only one person claimed on their insurance (Q. 9b); this likely being the individual that indicated their property had suffered from property damage. However, fourteen

respondents indicated that they had not previously claimed on flood insurance (Q. 9c).

Analysis of the responses indicates that although local people did experience inconvenience related to local street flooding, closed roads and local school closures; most did not experience property damage; and most had not claimed on flood insurance in the past, though they held flood insurance. People appeared to be aware of the basic infrastructure related to the flood control around Addicks' though similarly most were not aware of any ongoing flood mitigation projects. People's perception of the effectiveness of the flood management systems appeared to be swayed by the inconvenience of the local street flooding, rather than the reality of experiencing actual property damage due to flooding. People certainly appeared to be looking at the local picture, rather than the larger overall capacity, damage prevention and effectiveness of the Addicks Reservoir and dam, creeks, bayous and the flooding management system.

**Infrastructure: The effectiveness of the infrastructure in controlling flooding in and around a 10-mile radius of Addicks reservoir**

There was localized flooding in and around the Addicks watershed, the associated bayous, and the Addicks reservoir itself. During the storm, the integrity of the reservoir held and no water was released into Buffalo Bayou. Over 9,000 houses and 40,000 vehicles experienced flooding in Harris county, and 2,600 houses were reported as being flooded in the areas directly associated with the Addicks reservoir and its watershed. The inflow of water from the storm to the Addicks watershed, which includes overspill from the Cypress watershed reached historic levels with over 16 inches of rain falling in 12-hours in some areas. This led to a 1 in 900 -year event in Langham Creek, the main inflow channel into the Addicks reservoir. The maximum inflow peaked at 49,150 cfs (2.2 million gallons per second). The pool level in Addicks reservoir reached an historic high at 102.65-ft<sup>21</sup>. The U.S. Corps of Engineers released record rates of water from both Addicks and Barker (4,000 cfs) dams to control the water level in the reservoirs and maintain the integrity of the dams following the storm. This likely contributed to some of the localized downstream flooding around the dam and Buffalo Bayou. It is clear the Addicks reservoir and dam performed as required, and prevented catastrophic flooding both locally and to the city of Houston. Inflow rates into the reservoir peaked at record levels with a rate of over twelve times that which was eventually released from the dam<sup>22</sup>.

When I asked Mr. Richard Long of the USACE if he felt the reservoir coped he responded by saying, “The answer is a resounding YES! Each year we perform an economic analysis of the flood damages prevented realized from the operations of the dams and reservoirs. In fiscal year 2016 (October 1<sup>st</sup>, 2015 thru September 30, 2016), the year of the Tax Day flood, our research showed that approx. \$5.7 billion in damages was prevented downstream of the projects as a result of the operations of the dams and reservoirs. Over the life of the projects approx. \$16.6 billion in damages have been prevented as a result of the operations of the dams and reservoirs.”



*An aerial image of the Addicks dam and reservoir wall*



*An aerial image of the Addicks dam and reservoir wall*

Both images courtesy of <https://www.google.com/earth/>

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<sup>21</sup> Memorandum report (June 27, 2016) Jeff Lindner and Steve Fitzgerald. Immediate Report - Final

<sup>22</sup> Memorandum report (June 27, 2016) Jeff Lindner and Steve Fitzgerald. Immediate Report - Final

## 6.0 CONCLUSION

Based on the research, it appears that the flood management systems in and around the Addick's reservoir were effective. Despite record inflow rates and pool elevations, the integrity of the reservoir was maintained and only following the storm, as the watershed continued to drain into the reservoir, was water released in a controlled manner into Buffalo Bayou. There was local flooding in and around the reservoir and this did cause some localized street flooding but structural flooding appeared limited. Communications prior to the event appear to have been very limited as it appears that the storm caught many by surprise. However, the HCFCD published significant updates during and following the event.

In my view, the efficiency and management of the operation is commendable. The maintenance of the water control structures to ensure seepage does not occur around the existing water control structures and the building of the new dam is evidence of continued assessment, maintenance and planning for the future.

However, I do feel that the following issues do need to be considered:

1. Strict enforcement in the planning of new developments with environmental assessment and provision of flood control measures.
2. Better street and road drainage in and around the Addicks floodplain.
3. Continues assessment of all hard and soft engineering structures and recommendations needed as required.
4. Support and advice for local residents with regard to flood insurance and easy access to flood maps.
5. Increased publicity and promotion of studies and work undertaken by all services involved in the flood management in and around the Addicks reservoir.

Of course, it would be ideal to extend the existing reservoir or build another reservoir upstream, but of course this is extremely expensive and consideration needs to be taken for the many residents who live and work adjacent to the reservoir.

In summary, based on my analysis, I do feel that the flood measures in and around the Addicks reservoir were effective in light of the Tax Day flood in April 2016.

## 7.0 EVALUATION

Despite redefining my research question, I still struggled with an enormous amount of information, and hence was concerned that I had to leave out useful and pertinent information to remain within the word count. I reduced my essay word count many times, and in hindsight, I should have made my question even more specific, perhaps just focusing on the Addicks reservoir instead of including the 10 mile surrounding floodplain.

In addition, if I was to repeat my investigation, I would focus on my data collection. Firstly, I would attempt to get a larger sample as my sample was too small. I would do more preliminary research to look for accessible sites for data collection and do my sample over a period of a week, including a weekend in order to target people who work during the week. The Dog Park was an ideal area as the people were within the target area and the audience was engaging and happy to talk; as often dog walkers are. However, it was the same people who used the park on both days and my sample size was therefore reduced. Other areas proved too difficult to sample due to local bylaws.

With regard to the questionnaire, I would give more explanation (written and verbal) to reduce the risk of omission and confusion.

This study was thoroughly enjoyable and very interesting to investigate. The support from the professionals involved who assisted me was invaluable, and to them, I am very grateful.

## 8.0 POSTSCRIPT

My conclusions were based on my investigation and data analysis. However, I would like to add that the U.S Army Corps of Engineers and the HCFCD are hoping to undertake a Section 216 Study in the coming years depending on the authorizing and funding from Congress.

This study will look at the operations of both Addicks and Barker Dams and Reservoirs and will evaluate their conditions, operations and performance as it relates to the changes in the community, the operations and the structures themselves over the past 70 years. This has been planned for many years. The purpose of the study is not to evaluate the project's operations during the Tax Day flood but to evaluate the overall operations of the projects as it relates to the numerous changes that has occurred to the projects and the surrounding community over time.

At the time of writing this essay Houston was overwhelmed by Hurricane Harvey. A peak of over 49 inches of rain fell on Houston and the surrounding areas over a 3-day period. Both the Addicks and Barker Reservoirs reached historic high water levels, and although the city and surrounding areas experienced devastating floods, the reservoirs and dams clearly prevented a catastrophe for Houston.

## **Appendix 1**

Copy of blank Questionnaire



**Questionnaire regarding flood management systems within and around the Addicks reservoir during the Tax Day flooding in April 2016**

1. Do you live within 10 miles of the Addicks reservoir, and/or within the Addicks floodplain?

Yes

Would you mind sharing which neighborhood? :

No

2. Were you directly affected by the Tax Day floods of April 2016

Yes – please go to question 3

No

3. How were you affected? Please tick all that apply

Closed schools

Debris in the road

Closed roads

Flooding of local area

Property damage

Delayed transportation times

Contaminated water source

Other – please specify below

4. Are you aware of any flood management systems within and around the Addicks reservoir? – please describe

Opening and closing of gates at Addicks reservoir

Improving of drainage systems

Detention Ponds

Open flood plain

Bayous

Bayou widening

Other

5. Do you think the already in place flood management systems were effective?

Yes

No

Why? Please explain:

6. Are you aware of any development to improve the safety of the residents surrounding the Addicks reservoir, in case of future flooding?

7. On a scale of 1-4 how would you rate the severity of the flooding in your area? Please circle one

- 1 no impact
- 2 some minor damage
- 3 Significant damage
- 4 Catastrophic

8. How do you feel about the response to the flooding on behalf of the city of Houston on a scale of 1-4?

- 1 poor
- 2 satisfactory
- 3 good
- 4 excellent

Please state why you think this

9. These question is related to insurance

Do you have flood insurance?

(yes / no)

Did you claim on your flood insurance insurance for flooding during the Tax Day floods?

(yes / no)

Have you had to claimed on your flood insurance for flooding before the Tax Day floods?

(yes / no)

10. Have you ever been given any preventative advice for flooding?

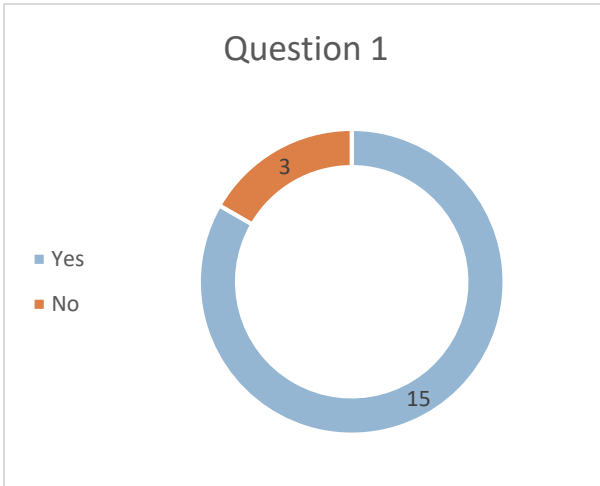
(yes / no)

If so, do you mind sharing who from?

## **Appendix 2**

### Data Analysis of Questionnaires

**1. Do you live within 10 miles of the Addicks reservoir, and/or within the Addicks floodplain?**

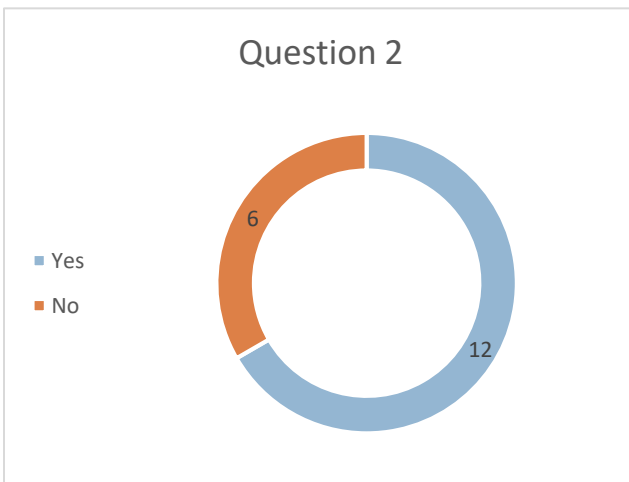


This Data shows that I am in a good location to continue asking questions as they will be answered as needed. Locations included Spring Valley, Deerfield Valley and lakes on Eldridge North.

**Housing estates said to be affected:**

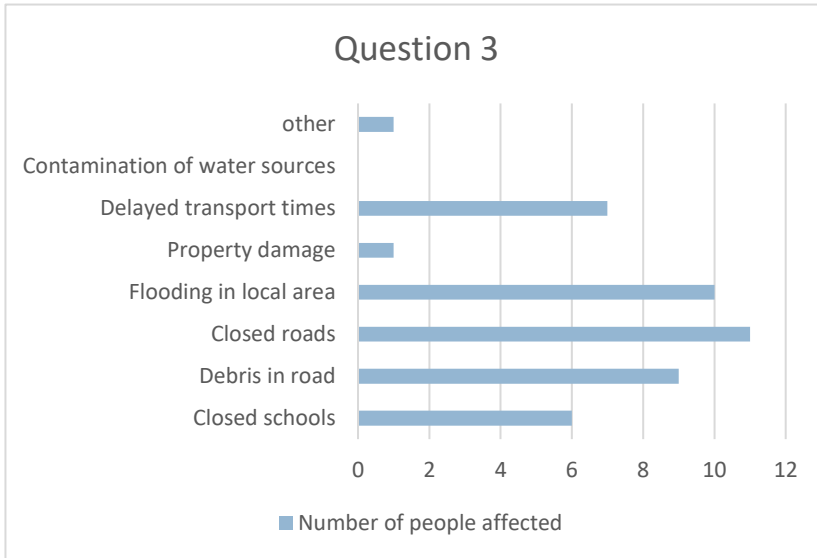
Lakes on Eldridge North, Deerfield Village, Spring Valley

**2. Were you directly affected by the Tax Day floods of April 2016?**



2/3 of the people I asked were affected in some way. If the person answered 'yes' to if they were affected, they were then asked to go onto question 3.

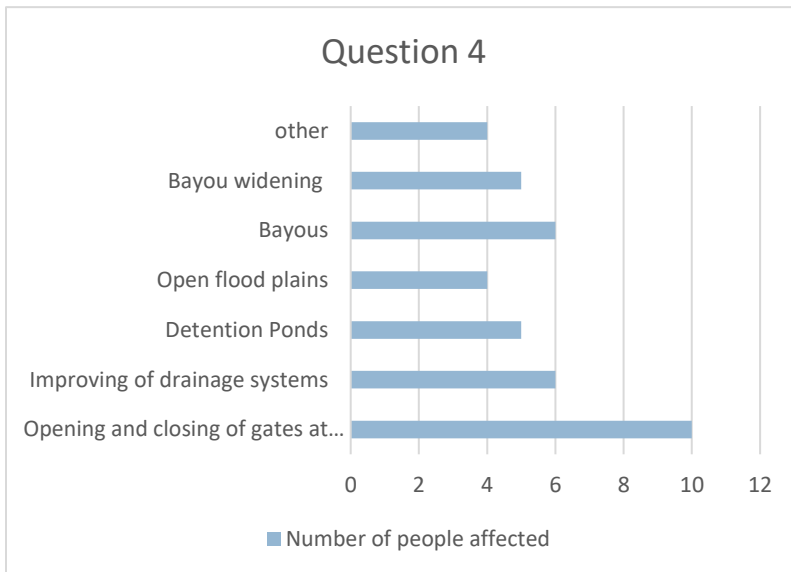
**3. How were you affected? Please tick all that apply**



The data shows the most people were affected by closed roads. From secondary research, I know that Hwy 6, N. Eldridge Pkwy, and Clay road experienced severe street flooding. Closed roads is related to poor access to schools, debris in road, and delayed transport times.

Other: Power outage

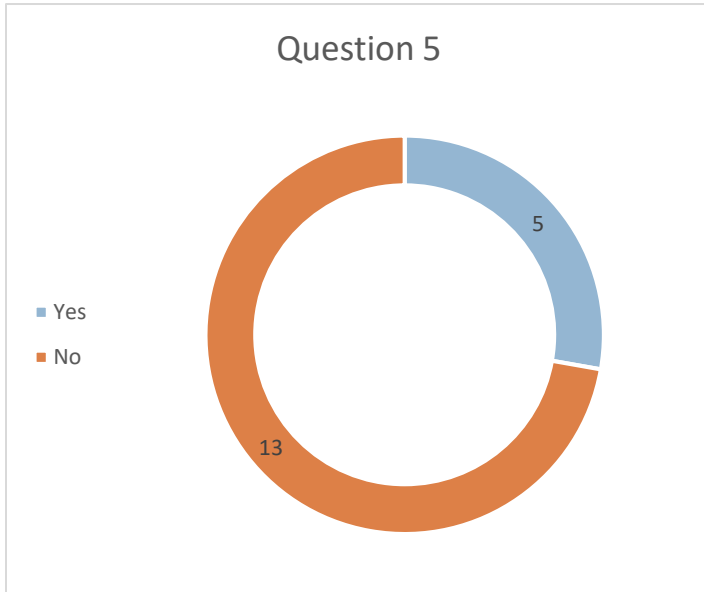
**4. Are you aware of any flood management systems within and around the Addick's reservoir?**



10/18 people were aware of the gates but few knew about bayou widening and open flood plains. 4 people put other but did not list what the 'other' precautions were. My sample had a good level of knowledge, but I was surprised the result was not higher as the management systems are clearly documented on public websites and communications.

No answers were elaborated for 'other'

5. Do you think the already in place flood management systems were effective?



13/18 did not feel the systems were effective as they had a direct effect on themselves. However, I believe my sample were not totally aware of how the flood measures and Addicks reservoir prevented serious flooding around the area and downstream. Roads and public areas were flooded in the Bear Creek area.

Comments on 'why'

"They lessened effects but need improvements"

"It took over a month to open streets and parks"

"effective for Houston"

"Neighbourhoods close to Addick's reservoir were flooded to keep Downtown Houston safe. A method to keep both from flooding would be better"

"Clearly, too much rainwater to cope with. Eldridge closed for weeks"

"High water levels and poor drainage. Roads and schools closed. Inability to cope with high water levels"

"Houston's ability to manage floods has been ineffective"

"Not enough"

"Excessive flood still in effect"

"B/c of the floods in 2016 and constant other flooding events in Houston. Disclaimer: I don't know where Addick's reservoir is"

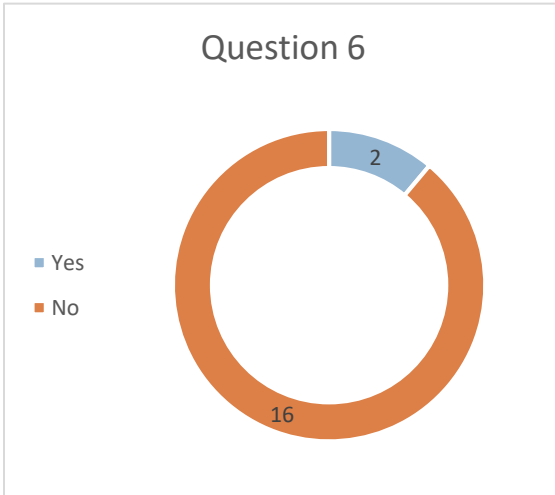
"Flood water did not reach downtown Houston"

"Other areas did flood; other homes were flooded. Area's under highways filled with water"

"My location was not compromised"

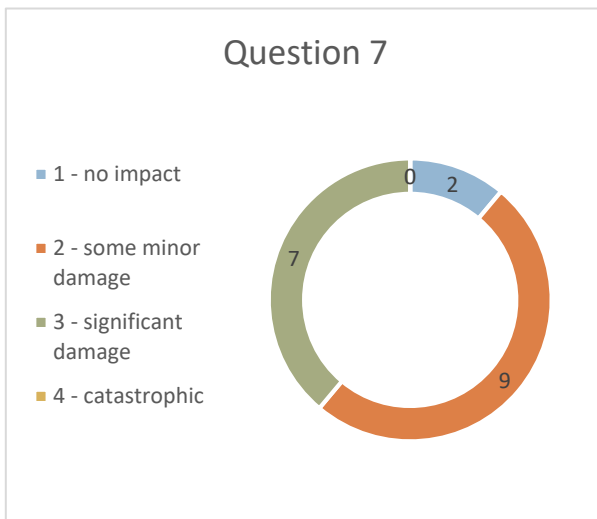
"The flood was still very severe, and affected us for weeks"

**6. Are you aware of any development to improve the safety of the residents surrounding the Addicks reservoir, in case of future flooding?**



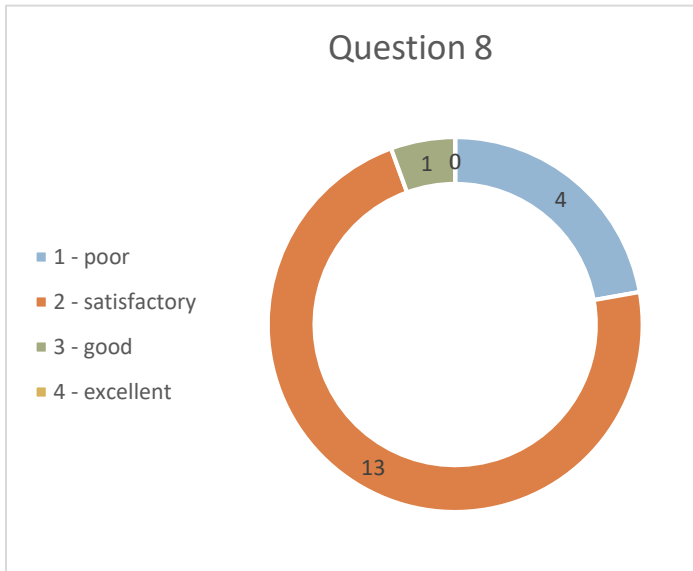
16/18 people said they have not heard of any future development, where as I know there is, highlighting a need for increased media and communication. For example, the water control structures are being replaced in the existing dam to ensure integrity. The existing dam at Addicks is also being decommissioned and a new one is being put in its place. There are also ongoing projects to widen bayous and keep the drainage systems clog free. The people that answered yes to this question were aware of detention ponds being built in new suburbs to keep the water away from housing.

**7. On a scale of 1-4 how would you rate the severity of the flooding in your area? 1 – no impact, 2 – some minor damage, 3 – significant damage, 4 – catastrophic**



A question of controversy as there is no defined lines between the choices. Opinions vary on the severity of flooding. Most people felt that the flooding was minor/significant, with nobody saying it was catastrophic. Living near a reservoir, you are more than likely to experience floods. The fact that these floods were not catastrophic is positive, highlighting preventative measures in place were effective to some degree.

**8. How do you feel about the response to the flooding on behalf of the City of Houston on a scale of 1-4?**



The sample seemed satisfied on the issue of response. Nobody thought it was excellent and one person thought it was good. For this I am unsure, but it may highlight possible issues of what needs to be improved and better communication to inform of current projects and plans taking place.

**Poor:**

'Drainage is slow'

'Too many houses flooded. City needs to look at improving drainage and limit building of new development on existing flood plains.'

'More needs to be done to address increasing rain water, increased population and ageing infrastructure.'

'No long term solution to issue to problem'

**Satisfactory:**

'freeway issues.'

'I don't know.'

'Did what they could do with their resources.'

'Took a long time to clear, not preventative measures taken.'

'Laredo city. Lots to do, limited time and workers.'

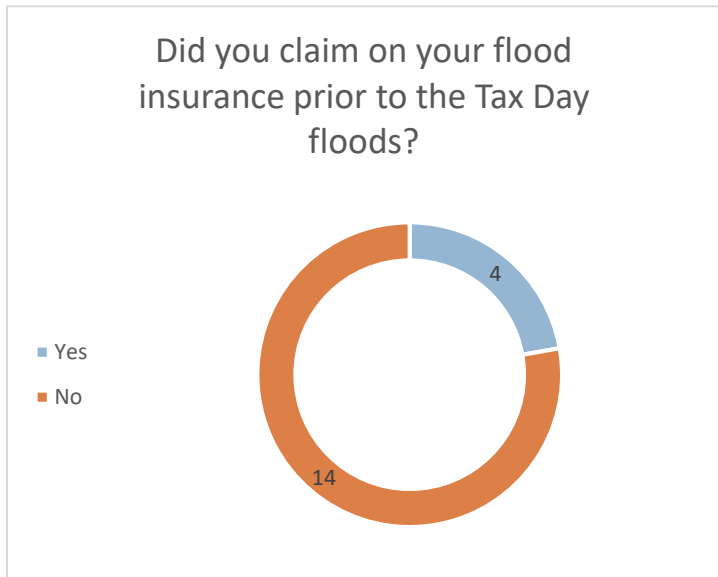
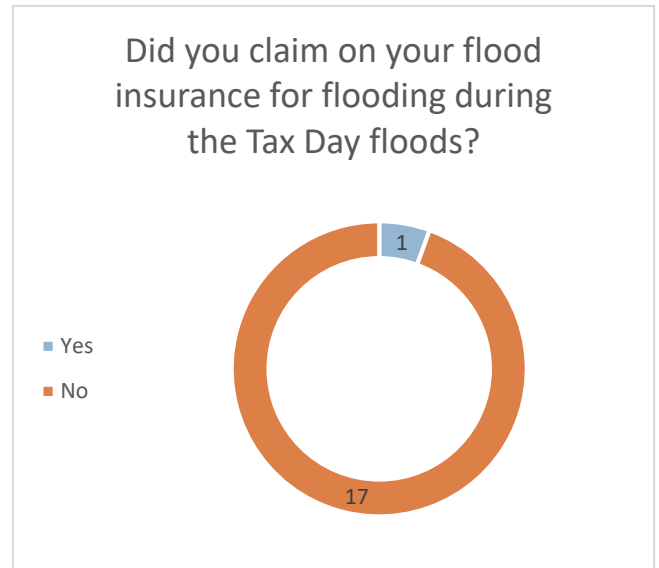
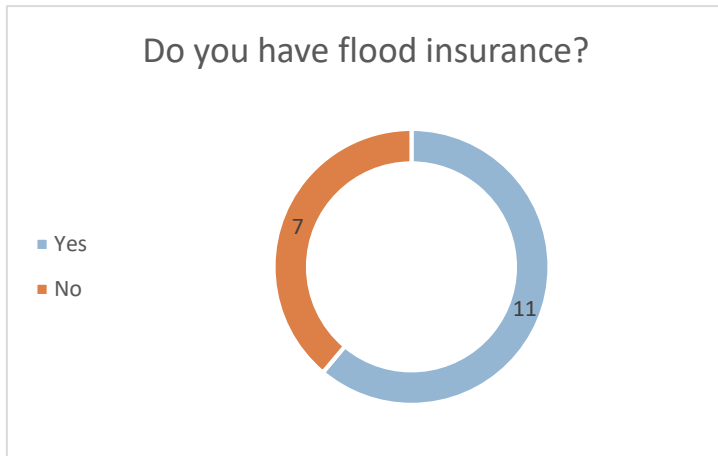
'Flooding still in effect.'

**Good:**

'Emergency services were visible after care support triggered.'

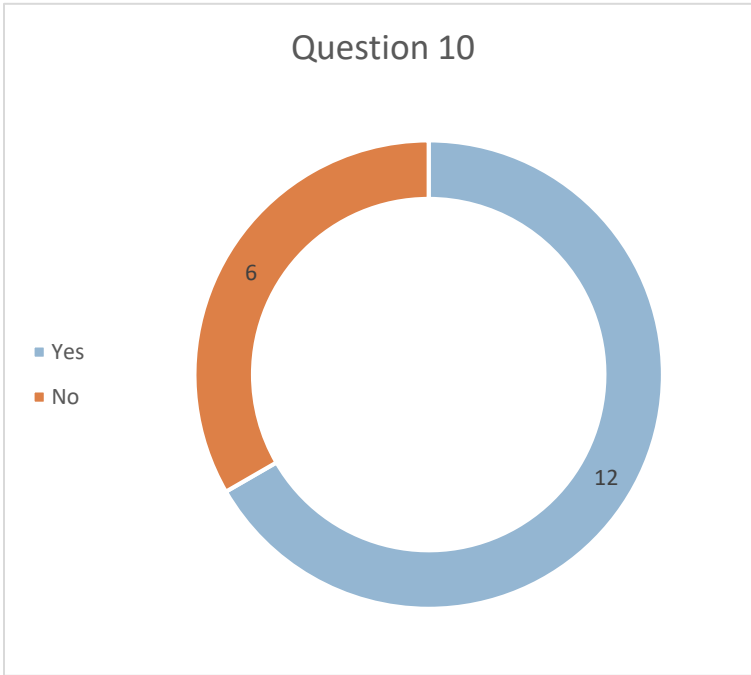


9. **These questions are related to flood insurance. Do you have flood insurance? Did you claim on your flood insurance for flooding during the Tax Day floods? Have you had to claim on your flood insurance prior to the Tax Day**



Question 9 was divided into 3 sections. 11/18 had flood insurance, meaning 38% people did not, a serious matter if you know your location is prone to flooding. Maybe these people are unaware of the insurance and need information, or they cannot afford it. 17/18 did not claim on their insurance during the Tax Day floods. Either they weren't affected, didn't have flood insurance, or didn't know how to claim. Again, if any of these are the case, except not being affected, information and support should be given. The last question is specific to pre-Tax Day floods, with only 4 people having claimed. We don't know how long the claim was before the April 2016 floods, but it gives an indication of how few people claim. Maybe this is a good thing as the preventative measures are effective.

**10. Have you ever been given any preventative advice?**



Preventative advice can include anything to help you prepare. This may include information on the news, amber alerts on your phone, websites and newspapers. 2/3rds of people had some preventative advice with 6 people saying they didn't. This could be due to poor communication, the person being surveyed not being to think of any right there and then, or just the fact that they have not had any. Everybody in Houston needs information and advice as it is essential in a flooding emergency.

**If you have been given any preventative advice, from where?**

- News
- City of Houston
- County
- Neighbors/friends
- Government
- Emergency Flood system on TV
- Internet

## **Appendix 3**

### E-mail Correspondence

Red – Hallie Frazee / Black – XXX XXXXX / Blue - Steve Franks / Orange - Jeff Lindner / Green – Richard Long

**Full email correspondence between professionals from Harris County Office of Homeland Security & Emergency Management and U.S. Army Corps of Engineers, Galveston District team.**

*Previously, Initial contact was made through the Harris County Office of Homeland Security & Emergency Management website. Hallie Frazee responded to my request in regarding to the Tax Day flooding.'*

Hi XXXXXXXX,

I got your information about your call to our office regarding the Tax Day Flooding. Is there a good time to call you that we can go over your questions (I see that you're a student, so I don't want to interrupt your classes)?

Is this for a school project? Do you just have questions, or were you also looking for photos/resources that our office might have?

Please let me know when we can talk. We're happy to help in any way we can.

Thanks,

**Hallie Frazee, MSJ**

Communications Planner

**Harris County Office of Homeland  
Security & Emergency Management**

Dear Ms. Frazee,

Thank you very much for your prompt response. At the moment I am on my 2-week Easter break as I go to school at the British International School of Houston. I do have some questions which revolve around my primary research question. The question I am answering for my Extended essay is, 'To what extent can we assume that local flood management measures were effective in light of the flooding in April 2016 in the areas adjacent to the Addicks reservoir.'

I was wondering if you have any data, diagrams, photographs or information on the Tax Day flooding of April 2016? If so this would be really useful. If possible can we arrange to call sometime between 9-11am tomorrow morning. If not I am also available any time on Thursday.

I have attached my questions for your information.

Thank you once again,

XXX XXXXX

Hi XXXXXXXX,

How soon do you need the information for your paper? I want to gather all of the info and send it to you prior to talking so I can go over it with you. Does that sound alright?

Unfortunately, I have meetings tomorrow morning and will be busy on Thursday. Could we talk sometime early next week? If you need it before next week, I can try and find some time on my calendar for Thursday.

Thanks,

**Hallie Frazee, MSJ**

Communications Planner

**Harris County Office of Homeland  
Security & Emergency Management**

Dear Ms Frazee,

Sure, no problem next week is fine. Thank you so much for all your doing. Perhaps you could let me know when next week will best for you.

Kind regards,

XXX XXXXX

Dear Ms. Frazee,

Firstly, I would just like to say thank you for all you are doing concerning my Geography Extended Essay project and for putting me in touch with Ms. Franks, who is also hopefully going to be able to help me with some of my questions. In addition to my last email, I am now available all next week to discuss any possible secondary data such as facts, figures, and pictures. For this I am grateful.

I am trying to arrange a visit for some time this week to the Harris County Office of Homeland Security and Emergency Management Office. I am wondering if it will be possible to meet up with yourself and Ms. Franks if I'm able to arrange a visit this week.

Kind Regards

XXX XXXXX

Good Morning XXXXXXXX,

We received your inquiry from 'HCOHSEM ask' regarding your school project. First, I would like to say I am very impressed with your overarching theme and subsequent questions. Hopefully you get some good feedback. I want to address a few things for you.

1. You are more than welcome to come and take a look at our Emergency Operations Center (EOC), and receive a tour that will explain what our office does during an emergency. Feel free to bring some of your interested classmates as well. You just need to schedule this with our community liaison by going to the following website and completing a request form. Use this link, <http://readyharris.org/> and select “request a presentation/tour” under the contact header. Fill it out to the best of your ability, and when you get to the presentation type, select “TranStar tour”.

2. During and after an incident our office manages and coordinates response and recovery activities with many other agencies. Some of the questions you are asking are geared more towards specific agencies that would have that specific data. While we can answer 1, 2, 7, 8, and 9 – some of the other questions will need to be forwarded on to other agencies.

a. That being said, we can send you the answers to the above questions *as they relate to HCOHSEM*, however they may not connect properly with the other questions. Each agency has a different way of doing things regarding communication.

3. While we work regularly with Harris County Flood Control, their answers are going to be more agency specific and I believe they will be able to answer your specific inquiries regarding the Addicks reservoir. If not, they can forward you on to the ACE, who manages the reservoirs.

4. So, I have sent an email over to flood control, once they get back with me I will connect you with the appropriate persons. Also, please let me know if you would like Harris County Office of Homeland Security and Emergency Management’s answers to a few of your questions, and how we communicate with the 4.7 million residents of Harris County *in addition* to the appropriate agencies answers to your questions.

I hope I have covered what you need, and how you should proceed. Once I have a contact for you from the appropriate agency for your questions, I will let you know.

If you have not heard from me by the middle of next week, please feel free to reach out directly to me as a reminder.

Let me know if you have any further questions.

Sincerely,

**Stevee M. Franks, MS**

Dear Ms. Franks,

Firstly, I would like to say thank you for all your support so far on my project. As per your previous email I have followed the link to request a tour. Hopefully if this is possible I would prefer the beginning of the week so I can use the rest of the week to analyse, sort and break down any information. I wonder then if it would be possible to meet with yourself to discuss my questions.

In addition to all of this, I would just like to say thank you for putting me in touch with Mr. Lindner from Flood Control. Furthermore, I have been in contact with Mr. Rudy Palomo and Mr. Jesse Morales, both from the engineering department at HCPID. Mr. Palomo is soon getting back to me regarding some secondary data collection regarding facts and figures of property that was damaged within the Addicks and Addicks floodplain area. Mr. Morales has been in contact with myself regarding permits and infrastructure regulations, which was also very useful. I will email Mr. Lindner separately as I have some separate specific questions for the Flood Control Team. I will also send the questions to Mr. Palomo.

In addition, I would be very grateful if you could put me in touch with a member of the Addicks Reservoir management team. I have tried to contact them many times and sent two separate requests on their enquiry form. A meeting and a possible visit to the reservoir would be very helpful.

Once again, thanks for all your support.

Kind Regards

XXX XXXXX

XXXXXXXX,

I will be out of the office Monday and Tuesday and have a full schedule the rest of the week. Let's plan to do a phone call either tomorrow (Monday) to discuss your questions. Let me know what time you can talk tomorrow.

Also, the person to contact for information on Addicks and Barker operations is Richard Long (cced)

Jeff Lindner

Director Hydrologic Operations Division/Meteorologist

Harris County Flood Control District

Dear Mr. Lindner,

Thank you for getting back to me so promptly. I really appreciate this. I have attached specific questions for the flood control department which I hope we can discuss together. I am available all day tomorrow and will fit around you.

I have cc'd Mr. Morales in this email as well so he has a copy of the questions also.

Kind regards,

XXX XXXXX

XXXXXXX,

Here is a report I put together detailing the Tax Day Flood.

Jeff Lindner

Director Hydrologic Operations Division/Meteorologist

Harris County Flood Control District

Dear Mr. Lindner,

Thank you so much for your previous email. The report you sent is extremely useful and will help me greatly through my Extended Essay project. It covers every question perfectly with plenty of data and statistics which I will use and cite you on. I have contacted Richard Long at Addicks and hopefully he will be able to advise me on any further recommendations to the reservoir and surrounding flood plain.

Many thanks once again for this report and all your help,

Kind regards

XXX XXXXX

Feel free to give me a call if you have any other questions

Good Morning XXX,

I would be happy to meet with you whenever you come in, just let me know the date and time and we can work something out. I am glad you are getting all your questions answered, I hope they help with your project.

I will work on getting you a contact for Addicks, but I am not sure how successful I will be.

Feel free to contact me if you have any other questions or concerns. I look forward to speaking with you at your upcoming tour.

Sincerely,

**Stevee M. Franks, MS**

Dear Ms. Franks,

Thank you for your email. At the moment I haven't had any confirmation on dates or times to visit, but when and if I do I'll be sure to be you know. I have also contacted Richard Long from the army corps of engineers at Addicks but had no response as of yet. In the meantime, you said you could answer questions 1, 2, 7, 8, 9. Do you think you could possibly help me answer these as I go back to school on Monday and will have limited time. I would be really grateful if you could send me a written response to those questions.



Once again thank you for all your help.

Kind regards,  
XXX XXXXX

Hey XXXXXXXX,

I cannot remember if we forwarded these on to you. If not, here you go!

**Stevee M. Franks, MS**

Dear Ms. Franks,

Thank you for answering my questions on the Tax Day flooding concerning Harris Homeland security and Emergency Management. I appreciate this greatly as it means I can now move on to my EE towards the writing stage. Thank you so much for all time and effort you have put forth.

Kind regards,  
XXX XXXXX

You're welcome XXXXXXXX, let me know when you're going to come in for a tour, and we can sit down if you have any more questions.

Good luck on your paper.

Sincerely,

**Stevee M. Franks, MS**

**Recovery Specialist**

**Harris County Office of Homeland Security**

**& Emergency Management**

Dear Mr. Long,

My name is XXXXXXXX XXXXX and I am a 17-year-old student at the British International School of Houston, currently studying the IB diploma course.

Currently I am working on my extended essay which is a 4000-word essay on a subject of my choice. I have chosen to study "To what extent can we assume that local flood management measures were effective in light of the flooding in April 2016 in the areas adjacent to the Addicks Reservoir, Houston?"

I have been put in contact with yourself by Mr. Jeff Lindner at Harris County Public Infrastructure Department - flood control, and he thought that you may be able to help me with my study.

I have included a set of questions which I have devised and I would be really grateful if you could assist me. I am on my Easter holiday this week (as I attend the British school, we follow the British holidays), so I wonder if it would be possible to catch up with you this week either by phone, email or a visit to the department.

Thank you so much,  
Kind regards,  
XXX XXXXX

Good Morning XXX,

I was out all last week also and just not getting back to e-mail. Give me a little time to catchup and I will get back with you soon. Please give me a time line on when your "drop dead date" is on visiting with me and when your paper is due.

Thanks, Richard

Dear Mr. Long,

Thank you for getting back to me and agreeing to help me with my essay. I really appreciate your support. Due to a heavy course load and school schedule I will not be available until my next holiday which will be memorial weekend. My school will be closed for 3 days so I will be available Monday 29th May, Tuesday 30th May or Wednesday 31st May. I am wondering if you will be available on any of these days?

I would really appreciate if I could meet you to discuss the answers to my questions, and to visit the flood gates and water meters, as I would like to take some photos for my primary data.

With regards to my questions I would be grateful if you could give a written response to my questions by the 3rd week of May, as I need to start writing my essay up ASAP.

Kind regards,  
XXX XXXXX

Dear Mr. Long,

Just wanting to touch base with you with reference to my previous email. I would be grateful if you could confirm a visit on any of the 3 days which I mentioned and I hope you could give a written response to my questions sometime this week. I am getting some pressure from school to get all my data submitted.

Kind regards,  
XXX XXXXX

Good Morning XXX,

Sorry for the delay in getting back with you. I did not realize that you had some mid-point reviews of your project.

In your e-mails you mentioned that you would like a project briefing and/or tour and that you were available on Monday thru Wednesday, May 29 thru May 31. Monday is Memorial Day and a Federal Holiday so our office will be closed. I have a window of time around the middle of the day on Tuesday (11:00 to 2:30) and after 10:30 on Wednesday. Please let me know which day and time will fit your schedule best.

Now to your questions;

- I work for the U.S. Army Corps of Engineers, the construction branch of the U.S. Army.
- The Corps has two major areas of responsibility: Military Construction for our fighting forces on the Military side and management of the nation's water resources on the Civil Works side. We are on the Civil Works side. Those Civil Works missions include Flood Risk Management, Navigation, Hydro Power, Water Supply, Environmental Restoration and Recreation.
- The Corps of Engineers was first formed by General George Washington in 1775 to provide engineering services to the Continental Army.
- I am a Natural Resource Management Specialist with my primary role of serving as the subject matter expert on Addicks and Barker Dams and Reservoirs. In this roll I serve as one of the primary project spokesman for the project and also serve as the liaison between our Operations Division and Public Affairs, Hydraulics & Hydrology, Construction and Real Estate.

1. The actual number of homes within the maximum possible pools for Addicks and Barker Reservoirs has not been determined. Both reservoirs combined can hold approx. 32,700 surface acres of water at full pool. The Corps only acquired approx. 25,100 acres at the time of construction in the 1940's. The difference is 7,600 acres of privately owned land containing single family homes, multifamily homes, business and related private structures and supporting infrastructure.

2. The answer is a resounding YES! Each year we perform an economic analysis of the flood damages prevented realized from the operations of the dams and reservoirs. In fiscal year 2016 (October 1, 2015 thru September 30, 2016), the year of the Tax Day Flood, our research showed that approx. \$5.7 billion in damages was prevented downstream of the projects as a results of the operations of the dams

and reservoirs. Over the life of the projects approx. \$16.6 billion in damages have been prevented as a result of the operations of the dams and reservoirs.

3. Before the Tax Day Flood neither Addicks or Barker Reservoirs had ever exceeded the limits of government owned property and never came close to exceeding the capacity of the dams.

4. During the Tax Day Flood event both Addicks and Barker Reservoirs saw “Pools of Record” or the largest pools ever experienced at the projects. The pool in Addicks Reservoir exceeded government owned property in a very few areas and flooded some streets on the North side of the project but did not directly impact any homes. The pool in Barker Reservoir peeked right at the government property line but did not exceed the limits of government owned land. However, the capacity of the dams was not threatened.

5. Currently work is underway to replace the water control structures, the location where water is released from the dams, at both Addicks and Barker Dams. The purpose of this construction is to ensure the integrity of the dams in the years to come. This work is necessary to ensure that seepage does not occur in and around the old existing water control structures, a weakness discovered during a recent review of the dams capabilities. This \$75 million project began in early 2016 and is scheduled to be completed in early 2020.

6. The Corps hopes to undertake what we call a Section 216 Study in the coming years depending on the authorization and funding from Congress. This study will look at the operations of both Addicks and Barker Dams and Reservoirs and evaluate their conditions, operations and performance as it relates to the changes in the community, the operations and the structures themselves over the past 70 years. The study will allow the Corps to look at any changes that may be necessary to the operations and/or dams as it relates to the management of floodwater that are stored behind the dams in situations such as the Tax Day Flood. It is estimated that this study will take 3 years to complete and cost \$3 million but it cannot begin until authorization from Washington D.C. has been obtained.

7. The Corps team that operates and manages Addicks and Barker Dams and Reservoirs is always vigilant when it comes to the maintenance and operations of the projects when they are holding flood waters and when they are dry. This vigilance prevents minor “glitches” from becoming issues of concern with the dams and reservoir. We are also always mindful of the residents upstream and manage the reservoirs to the best of our ability while always being mindful of the primary mission of the projects of reducing the impact of flooding downstream.

I hope I have been able to answer your questions. As of the close of business today I will be unavailable until Tuesday morning, May 30. If you have any additional questions while I am out please direct them to Chuck Ciliske. Please let both of us know when you would like to visit the project so we will be better able to accommodate your visit. We would also be interested in seeing the results of your work.

Good luck on your project,

Richard

Dear Mr. Long and Mr. Ciliske,

Thank you for your email, and thank you so much for your support.

If you don't mind, I now have 3 further questions in response to your answers. I'd really appreciate it if you could give me a written response then I can put your response in my essay.

1. You say there is current work underway to replace the water control structures and that this began in early 2016. Was this work started before the Tax Day floods and did the organisation therefore have a concern that there may be a potential issue if there was to be a flood event? Or was the work started after the Tax Day floods, and is the organisation therefore concerned it would not withstand another catastrophic weather event?

I would be really grateful if I could visit the water control structures when I visit and take a few photos. It would be so helpful for my primary data.

2. You talk about the Section 216 study. Is this a result of the Tax Day flood or is this a scheduled study which was planned before the occurrence of the Tax Day flooding? Is there a concern that the Addicks reservoir and dam would not withstand another severe weather event?

3. In light of the Tax day floods are there any particular areas or structures that you would like to change, develop or build?

Again I'm sorry for further questions, but your answers highlighted some areas that I wanted to develop.

Thank you for agreeing to meet with me. If it's still convenient with you I wonder if we could meet on Tuesday May 30th at 11:00am ?

Thanks again

Kind regards,

XXX XXXXX

Good Morning Again,

Below are responses to your additional questions.

1. The work did begin before the Tax Day Flood. No additional work has taken place or is scheduled to take place as a result of the flood. As I stated previously, the Tax Day Flood resulted in "Pools of Record" for both Addicks and Barker Reservoirs. Any time a reservoir goes into a pool of record, or any unusually large pool, the operators of a project has increased concerns and the level of inspection of the dam and related structures increases to match that level of concern. This also occurred at Addicks and Barker. Our level of inspection increased to match the size of the pool and the concerns which goes along with that concern. However, we had full confidence in the structures and their ability to function properly during the flood. This was partly due to the fact that the Corps instituted Interim Risk Reduction Measures (IRRM) on both dams during the 2010 thru 2013 time frame in order to insure the integrity of the dams throughout the study period and on through the construction period. These IRRMs consisted of both repair measures and operational changes to the project.

2. The Section 216 study has been planned for many years. The purpose of the study is not to evaluate the project's operations during the Tax Day Flood but to evaluate the overall operations of the projects as it relates to the numerous changes that has occurred to the projects and the surrounding community over time. However, information gained from the flood will be used during the study to better evaluate the performance of the projects.

3. That is what the 216 study will do. It is hoped that the results of the 216 study will allow us to find ways to better operate the projects in the years to come. These changes may be simply operational changes or they may be structural changes.

I hope this answers the rest of your questions.

Thanks, Richard

Natural Resource Management Specialist

U.S. Army Corps of Engineers, Galveston District