



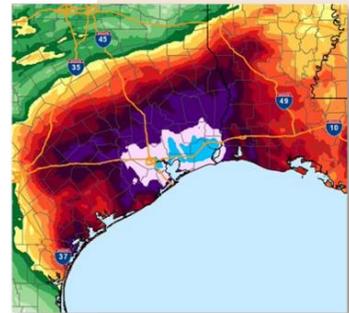
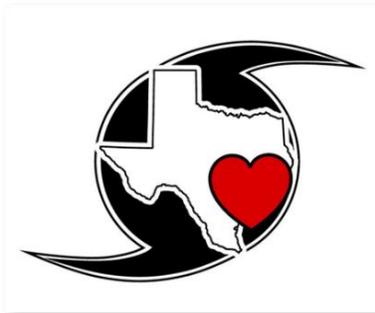
Hurricane Harvey

Fire/EMS After-Action Report

2017

“Being prepared for historic, does not prepare you for historical”

**Chief Darryl Anderson
Bellaire Fire Dept.**



The title of this document is the Harris County Hurricane Harvey 2017 Fire/EMS After-Action Report and Improvement Plan. This document was developed in conjunction with local Fire, EMS, and PSAP Agencies in Harris County, TX along with the Harris County Fire Marshal's Office (HCFMO), and is intended to provide observations about this event and recommendations to help prepare for future events.

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EXECUTIVE SUMMARY

Hurricane Harvey made landfall along the Texas coast on August 25, 2017, causing catastrophic flooding across a forty-county region. Harris County experienced a 4-day rainfall event with an average amount of 33.7 inches. Some areas received approximately 47 inches of accumulated rainfall throughout the incident, others had peak rainfall rates as high as 6.8 inches per hour.

This unprecedented weather event required local, regional, State, Federal, and civilian resources to aid in the rescue and evacuation of countless residents in Harris County. Due to the widespread geographic impacts of this hurricane, response agencies were pushed to their limits to meet the calls for service from a command and control, operational, logistical, and psychological perspective.

Following Hurricane Harvey, the Harris County Fire Marshal's Office (HCFMO) conducted a series of After-Action Review Workshops to provide fire, emergency medical, and emergency dispatch agencies in Harris County an opportunity to:

- Evaluate response activities;
- Identify operational and support areas that worked well and should be sustained in the future;
- Identify areas for improvements in response and coordination; and
- Identify and discuss lessons learned.

The intent of the Workshops was not to find fault with any response or support areas during the 2017 Hurricane Harvey response, but rather to improve future responses to large-scale flooding incidents. Based on guidance provided by the planning committee during the development of the workshops, each workshop focused on the following topics:

- Incident management, command, and control;
- Operations;
- Communications;
- Logistics and resource management; and
- Finance, Administration, and Documentation.

The purpose of this report is to summarize those discussions, to identify response strengths and areas for improvement, and to support the development of corrective actions. To aid understanding, the information is grouped by topic and discussed in terms of key findings, analysis, and recommendations.



Together, first responders and civilians rescued and evacuated over 47,500 people across Harris County from Harvey floodwaters. PHOTO: MELISSA PHILLIP/ASSOCIATED PRESS



Mike Montgomery
Fire Marshal



Rodney Reed
Assistant Chief, Op Support

Community Profile¹

Harris County TX is the nation's third most populous county with nearly 4.5 million residents, larger than 24 states. The county is home to the fourth-largest city in the United States, Houston, and 33 other municipalities, the largest medical center in the world, the largest port by export tonnage in the United States, as well as the Lyndon B. Johnson Space Center. Harris County is unique among all counties in the nation for having an unincorporated area population of more than two million residents. If it were an incorporated city, "Harris County Unincorporated" would be the second-largest city in the county and the fifth-largest city in the nation, with a population larger than that of 14 U.S. states.

Harris County covers 1,777 square miles along the upper Gulf Coast in Southeast Texas, characterized by level coastal prairie and the southern fringe of the East Texas timberlands. Elevation ranges from 55 feet above sea level, rising gradually to higher than 200 feet on the northern borders.

The soil is heavy black coastal clay in the south and sandy loam north of Buffalo Bayou. Native trees include pine and hardwoods such as oak, ash, and hickory. The average annual rainfall in Harris County is 48.19 inches and the average temperature is 69.1 Fahrenheit. The county is very vulnerable to flooding, and hurricane impacts can be catastrophic due to proximity to the Gulf Coast. Drained by 22 watersheds, the county averages a severe flooding event every three years, and has received thirty-two presidential declarations of disaster since 1975.

Despite 17.9 percent of non-institutional population below the poverty line, and an unemployment rate of 5.2 percent, Harris County weathered the recession better than most metropolitan areas, led by the energy sector, import/export trade, medical care, and finance.

Most of the County planning area is urbanized, with highly-populated residential areas, vast commercial and industrial complexes, and several critical facilities and infrastructure. However, some areas are not as densely developed, and areas of agricultural land remain. In fact, over 80,000 residents live in rural areas of the county. This diversity creates challenges for first responders in all areas of the county.



Houston is known as the "Bayou City", and Harris County averages some major flooding event every three years. PHOTO: PRESERVATION HOUSTON



Houston is now the most diverse city in the U.S. and Harris County has no racial or ethnic majority, with only 57.5 per cent of the population speaking English at home. PHOTO: BRETT COOMER, HOUSTON CHRONICLE

¹ Harris County Multi-Hazard Mitigation Plan, June 2015

Hurricane Harvey Overview

Hurricane Harvey began its development on August 11, 2017 as it tracked westward across the tropical Atlantic. The tropical wave entered the Gulf of Mexico on the afternoon of August 22 and was upgraded again to a tropical depression on the morning of August 23. Over the next 48 hours, Harvey would undergo a period of rapid intensification from a tropical depression to a category 4 hurricane. Hurricane Harvey made landfall along the Texas coast near Port Aransas with 130 mph winds around 10:00 pm on August 25. After landfall, Harvey's forward motion slowed to near 5 mph and then slowly moved north of Victoria, TX on the 26th.

Rain bands on the eastern side of the circulation of Harvey moved into southeast Texas and Harris County on the morning of August 25 and continued through much of the night into the 26th. Flash flooding developed rapidly between 8:00 pm and 11:00 pm on August 26 as tremendous rainfall rates occurred across much of Harris County. Additional rain bands continued to develop into the morning hours of the 27th 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 August 29-30; worsening 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, LA on the morning of August 30; storm effects continued across Louisiana, Alabama, Mississippi, Arkansas, Kentucky, Tennessee, and North Carolina.

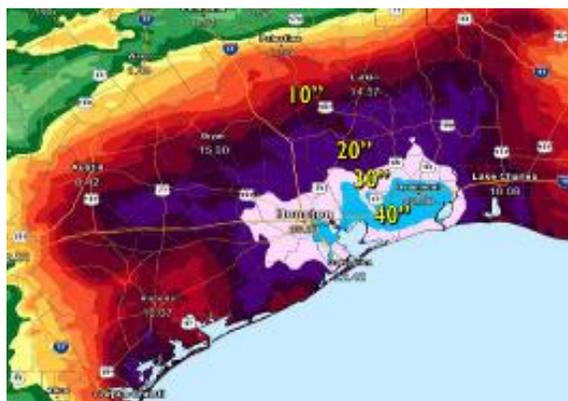
Rainfall

Total rainfall amounts ranged from 26 to 47 inches across the County for four days. The two-day amount ranged from 20 to 35 inches and the one-day total from 13 to 25 inches. The Harris County Flood Control District (HCFCD) estimated 70 percent of Harris County was flooded by at least 1.5 feet of water, with an estimated 136,000 flooded structures in the county alone, as of August 31.

The lowest totals occurred over the northern parts of the County; the highest totals focused across the southeast County along I-45, from the cities of South Houston and Pasadena, then south to Friendswood and Webster, and east to Channelview and Baytown.



In just 56 hours, Harvey grew from a regenerated tropical depression over the Gulf of Mexico into a Category 4 hurricane as it made landfall near the Texas Gulf Coast late on Aug. 25. GRAPHIC: THE WEATHER CHANNEL



1 trillion gallons of water fell during four days in Harris County, enough to cover the entire state of Texas with 3" of water per calculations. GRAPHIC: NATIONAL WEATHER SERVICE

Figure 1 shows the peak rainfall totals, as measured by HCFCG gages. Additional rainfall and waterway impacts can be found in Appendix B.

Figure 1. Peak Rainfall Totals, Harris County

Time Interval	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
Return Interval, years	1,500					5,000	12,000	50,000

Response

Major Strengths

The major strengths identified during these workshops are:

- First responders and support personnel are well-trained and professional—with a high degree of knowledge, skills, and capabilities.
- Early establishment and use of the NIMS/ICS system allowed for ease of transition from normal operations to disaster operations.
- Existing relationships and capabilities among response agencies allowed for seamless integration of response assets.
- First responders at all levels were highly adaptable and able to make critical decisions in a dynamic environment.
- All levels of incident management—on-scene command posts, department operations centers, county fire desk, and county operations center—maintained open lines of communication about situational awareness and critical resource needs.

Primary Areas for Improvement

The primary areas for improvement identified during these workshops are:

- Need for a common, shared operating picture between all levels of incident management—local, county, state, and federal.
- Need to develop protocols to speed transition from normal operations to disaster operations.
- Need to establish work/rest cycles for key organizational leaders to sustain activities across multiple operational periods.
- Need to establish unified command structures to increase effectiveness of response, use of available resources, and sharing of critical information.
- Need for specialized equipment and training to increase capability to respond to events of flooding and/or moving water.

Lessons Learned

The primary lessons learned from the response to this storm are:

- Never underestimate the potential size of an incident.
- Develop strong relationships with response partners and share information.
- Prepare meaningful Incident Action Plans and communicate them to all agencies and personnel.
- Obtain specialized equipment and have operators trained and available to use it.
- Develop and require better work/rest cycles for command level personnel.
- Adaptable and creative thought can make a significant difference in results.
- Activate Type III Incident Management Teams and other regional resources before they are needed on scene.
- Conduct medical assessments for first responders before, during, and after operations.
- Remember the need for critical incident stress management.

Conclusions

Overall, the workshops proved very successful. Participants were able to discuss several issues that were crucial to response operations across Harris County and in various public safety disciplines. Through the training capabilities, efforts of first responders, civilians, emergency management leadership, and others, the County is well-prepared to respond to future incidents.

Throughout the workshops, several opportunities for improvement, at all levels, to prepare for and respond to an incident of this size were identified. If adopted, supported, and implemented by all jurisdictions, the outcomes of these workshops will lead to improvements in local, county, and regional response efforts. The HCFMO and other fire, EMS, and dispatch agencies are ready and willing to take on that challenge.

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SECTION 1: FIRE/EMS SERVICES IN HARRIS COUNTY

Independent fire departments and EMS agencies serve Harris County

The fire service system that serves Harris County includes 54 independent fire departments that provide fire, rescue, and hazard management services to the cities and unincorporated areas of Harris County, Texas. Of these departments, 27 are independent “county” fire departments; 26 are municipal departments that also respond into unincorporated areas as part of the county’s mutual aid system. Not included are “special response” fire departments—Port of Houston Authority and Ellington Field (DoD)—or industrial fire brigades, including members of CIMA (Channel Industries Mutual Aid).

Each department has primary responsibility within a fire response zone and provides secondary coverage into other areas as part of a county-wide mutual aid system. In some areas, the fire department also provides emergency medical services (“EMS”); in others, EMS is provided by a separate service agency. Hazardous materials response is provided primarily by the City of Houston’s and Harris County’s hazardous materials response teams. In outlying parts of the county, the mutual aid system includes fire departments from surrounding counties. For clarity, those departments are not included in this document.

To differentiate departments, this report uses the term “municipal” and “county”. For the purposes of this report, a *municipal department* is one that provides service primarily *inside* corporate municipal limits. A *county department* is one that provides services to residents primarily *outside* corporate city limits.

Most municipal departments are career or combination departments. Most county departments are volunteer or combination departments that provide service through contract with a special district such as an emergency service district (ESD). Together, these county departments range from what could be considered small/rural fire companies to major suburban combination fire departments.

Role of special districts

Protected areas include rural areas with no water supply and distant fire stations, wildland-urban interface areas with estate homes on multi-acre plots, suburban “urban clusters” that resemble cities with a mix of residential, industrial, and commercial properties, and industrial-marine-urban interfaces with large petrochemical complexes, marine terminals, and urban areas. In densely populated areas, Fire Protection Services (FPS) resembles that provided by municipal departments. In rural areas, there is insufficient infrastructure or tax base to support similar service levels.

Generally, fire protection in unincorporated areas is the responsibility of a special district—a taxing authority created specifically to provide FPS. Typically, an Emergency Services District, or ESD, provides services through contract with a volunteer or combination fire department. A utility district has similar authority. In many situations, the ESD administers and operates the fire department itself; there is no contract with an outside service provider. *Figure 2* and *Figure 3* show the territories of each fire district and EMS district in the county. Districts that appear on both maps; e.g. ESD 200, provide both FPS and EMS. In blank areas of the map, municipal fire departments provide service.

Figure 2. Fire protection districts in Harris County

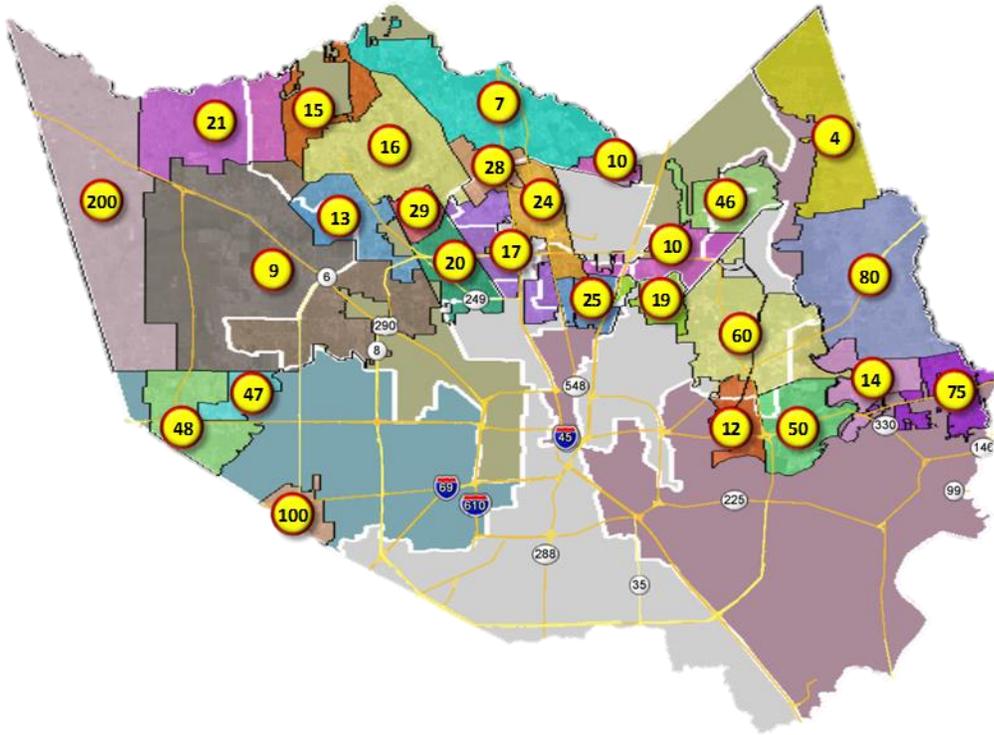
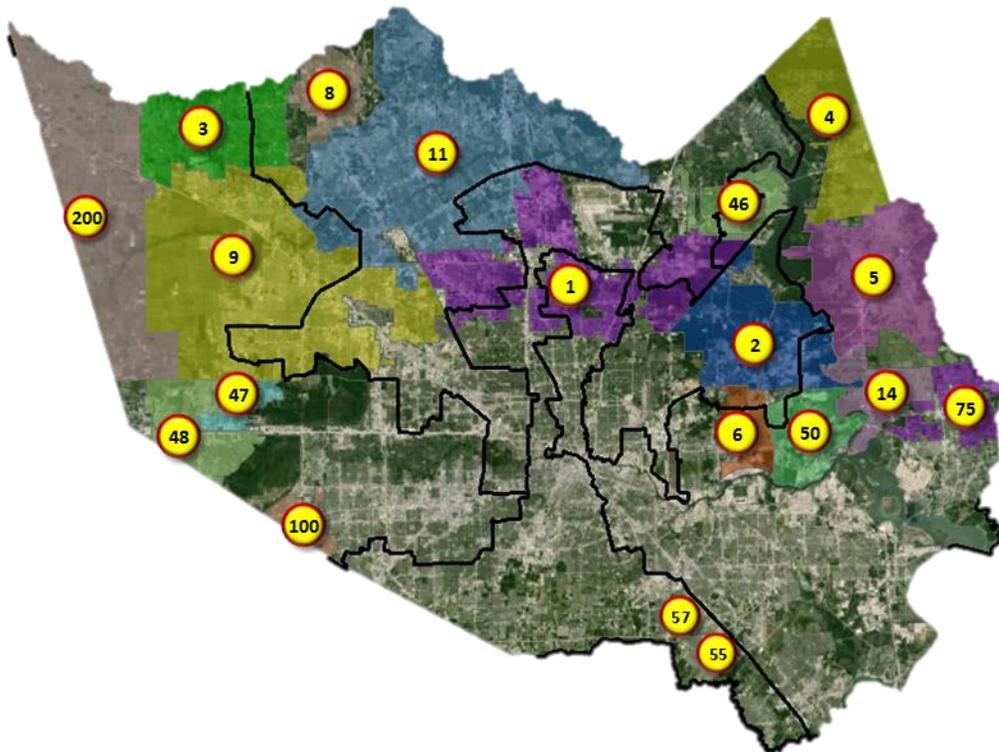


Figure 3. EMS districts in Harris County



Role of the County

There is no “County” fire department, *per se*—the county does not provide traditional emergency fire response. With the establishment of the office of County Fire Marshal in 1974, the County does provide certain fire protection services—fire inspection and code enforcement, fire and arson investigation, hazardous materials response, coordination of local fire departments, and first responder training— in the unincorporated areas of the county, and through interlocal agreement or mutual aid contract with some cities or other organizations. By Statute², a County has the discretionary authority to:

- Provide fire protection or emergency ambulance services;
- Provide services or equipment in unincorporated areas, or contract with others;
- Collect fees for fire inspections and plans review;
- Collect fees for emergency medical services (EMS)³;
- Control outdoor burning in times of drought;
- Restrict the sale or use of certain fireworks during time of drought;
- Regulate gates in gated communities and other properties; and
- Establish the Office of County Fire Marshal

Type	Service
Mandatory (Shall)	<ol style="list-style-type: none"> 1. Enforce all fire-related laws and regulations, including filing criminal charges 2. Investigate fires that occur within the county but outside municipalities 3. Coordinate firefighting and fire prevention units
Discretionary (May)	<ol style="list-style-type: none"> 4. Conduct fire and life safety inspections (shall if called on to do so) 5. Adopt and enforce a fire code (shared responsibility with County Engineering) 6. Provide emergency hazardous materials response 7. Provide training programs and operate a fire training facility 8. Furnish fire trucks and contract with others for fire protection 9. Regulate other activities—79 other State laws, administrative codes, and rules

As one of the coordinating efforts, the County has provided supplemental funding to fire departments that provide fire response to various parts of unincorporated Harris County, excluding industrial zones and areas within boundaries of other taxing authorities. Over the years, the funding formula was updated and modified, but was never intended to cover the full cost of service. Likewise, contract areas have changed due to municipal annexation or changes in fire department response areas. Today, only one fire service contract remains.⁴

² Specifically, Chapter 352 of the Local Government Code and Chapter 774 of the Health & Safety Code

³ Without changes in statute, there is no revenue available to the county, outside the general fund, for fire service contracts.

⁴ That contract is with the City of Stafford; this is a declining balance contract with a term that is expected to last another three years.

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SECTION 2: WORKSHOP METHODOLOGY

Exercise Purpose and Design

The Harris County workshops that resulted in this Hurricane Harvey After-Action Review and Improvement Plan gave participants an opportunity to discuss and evaluate the response from various agencies to Hurricane Harvey that occurred in Harris County from August 25th, 2017 to August 30th, 2017. Except where noted, responses or concerns to the Hurricane that occurred outside Harris County are not included in this report.

The workshops were designed to discuss all aspects of what worked well, what issues were identified, what lessons were learned, and what recommendations should be implemented based on the relevant topics. The primary topics outlined below were addressed from the following perspectives: Field Personnel, Departmental Operations Center, County Emergency Operations Center, and State/Federal.

Topics

- Incident management, command, and control;
- Operations;
- Communications;
- Logistics and resource management; and
- Finance, Administration, and Documentation.

Exercise Structure

Each workshop was structured as a facilitated discussion to identify strengths and issues, and to develop recommendations for improvement based on the actual events relating to the response that occurred in Harris County during Hurricane Harvey. Before the initial workshop, the HCFMO facilitation team identified general areas for discussion, prepared questions and statements to encourage open discussion and sharing of ideas, thoughts, and concerns in a non-judgmental or critical environment, and used visual aids and proven after-action review techniques to keep discussions focused and on track.

Workshop Details

Workshop Name:

Hurricane Harvey After-Action Review and Debrief

Type of Exercise:

Workshop

Workshop 1

Date: October 24, 2017
Duration: 10:00 – 12:00
Location: Harris County ESD #48
Sponsor: HCFMO

Workshop 2

Date: October 25, 2017
Duration: 09:00 – 11:00
Location: Cypress Creek Fire Dept.
Sponsor: HCFMO

Workshop 3

Date: October 26, 2017
Duration: 09:00 – 11:00
Location: Bellaire Fire Dept.
Sponsor: HCFMO

Workshop 5

Date: November 1, 2017
Duration: 09:00 – 11:00
Location: Sheldon Fire Dept.
Sponsor: HCFMO

Workshop 4

Date: October 30, 2017
Duration: 09:00 – 11:00
Location: Webster Fire Dept.
Sponsor: HCFMO

Workshop 6

Date: November 2, 2017
Duration: 09:00 – 11:00
Location: Cypress Creek EMS
Sponsor: HCFMO

Participating Organizations

A special acknowledgment and “thank you” to the following Departments and Agencies that participated in these workshops. Without their active participation and input, this project would not have been possible.

Acadian Ambulance
Aldine Fire & Rescue
Atascocita Fire Dept.
Baytown Fire Dept.
Bellaire Fire Dept.
Channelview Fire Dept.
Cloverleaf Fire Dept.
Cy-Fair Fire Dept.
Cypress Creek EMS
Cypress Creek Fire Dept.
Harris County Emergency Corps EMS
HC ESD #48 Fire Dept.
HC ESD #5

Harris County Fire Marshal’s Office
Katy Fire Dept.
Katy ISD
Montgomery County Hospital District
Northwest Fire Dept.
Ponderosa Fire Dept.
Seabrook Emergency Management
Sheldon Fire Dept.
South Lake Houston EMS
Spring Fire Dept.
Webster Fire Dept.
West University Fire Dept.
Westlake Fire Dept.

Final Report

The project concluded with recommendations and strategies intended to prepare Harris County first responders and dispatch organizations to successfully meet future demands and hazard risks during large-scale disasters.

The ultimate goal of this report is to assist responder and emergency management leadership to identify, deliver, and sustain the services needed to help make the community a safer and more disaster-resistant community. As such, this report is meant to serve as a guide for Harris County officials and emergency service leaders, and to assist with the implementation of both short- and long-term improvement recommendations. The recommendations contained in this report are based on both local and nationally-recognized guidelines and criteria, including concepts and best practices from the:

- Center for Public Safety Excellence (CPSE); and
- Commission for Fire Accreditation International (CFAI);
- Insurance Services Office (ISO);
- National Fire Protection Association (NFPA);
- Harris County and the State of Texas;
- U.S. Department of Homeland Security; and
- other generally-accepted practices for fire and police services.

A Cautionary Note

It is impossible to include all aspects and indicators of hazards and risk, both when reviewing current situations and when considering future conditions. There are simply too many variables of weather, human behavior, and impact of technological systems. HCFMO recommends that Harris County response agencies routinely and periodically review the findings and recommendations contained in this report, and update their disaster plans to ensure those plans contain the most accurate and up-to-date information available about community needs, fire/rescue service delivery, and EMS delivery, both now and in the future.

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SECTION 3: COMMAND AND CONTROL

Observations

Command and control by response agencies across Harris County, despite the multi-operational periods and wide-scale geographic impacts, was successful. Utilization of the ICS/NIMS principles allowed for organizational structures to be established and modified as the scope of the incident expanded and contracted.

Response agencies who had previously experienced significant flooding during the Memorial Day 2015 and Tax Day 2016 floods had a greater understanding of potential impacts and challenges that large-scale flooding can present. This was revealed by the early activation of command personnel and establishment of an ICS structure that allowed for the incorporation of multi-agency and multi-jurisdictional response assets.

Key Best Practices

Throughout the workshops, multiple sustains and best practices were shared. The selected best practices do not supersede any single item, but are identified because their application across a wide variety of incidents.

Best Practice #1: Agency conducted operational and safety briefings over the radio at the beginning of each operational period to ensure that all responders, even at home, were aware of the overall incident response.

Analysis: Critical during any incident is the need to share information. In Harris County many of the Fire Departments operate in volunteer, combination, or paid staffing models. By leveraging technology, such as land mobile radios, critical information can be disseminated.

Best Practice #2: Establishing an Incident Complex with geographic, operational areas along with assigned resources to validate calls for service before responding.

Analysis: Due to the wide spread impact of Hurricane Harvey, multiple Departments established incident complexes within their response jurisdiction. Appropriate resources based on terrain, population, and effects were assigned to operate in these specific areas. Dispatch Centers would provide hourly “dumps” of calls for service into the DOC. A fire department person would re-contact the requesting party to confirm their need for rescue or evacuation. Once confirmed, the calls were grouped and assigned. This process ensured that calls for service remained valid and single incident dispatching was replaced with geographic grouping of multiple calls for service. Life safety and medically-emergent calls for service still operated under single incident dispatching.

Best Practice #3: Early establishment of triage protocols by Dispatchers for response assets to determine the priority of rescue and evacuation of residences and commercial buildings.

Analysis: Minimal information is available for triaging rescues and evacuations during large-scale, resource limited flooding incidents. Multiple Departments found that by establishing triage protocols early in the incident, they could better manage operational command and control with limited resources. Generally-adopted criteria for triage were:

- Life Safety;
- Single story residences or buildings with water above electrical outlets;
- Multi story residences or buildings; and
- Everything else inside of a structure

Complete List of Things to Sustain

The list below provides a comprehensive outline of all sustains and best practices identified during the workshops.

- **Situational Awareness**
 - Previous incidents allowed for a "real-life" understanding and knowledge of areas that would be impacted;
 - Agency conducted operational and safety briefings over the radio at the beginning of each operational period to ensure that all responders, even at home, were aware of the overall incident response;
 - Predeveloped Incident Action Plans allowed for easier development and understanding during the response;
 - Did not chase 911 calls, established an Incident Complex with geographic operational areas along with assigned resources; and
 - Multiple ESDs joined together during the storm to make better use of personnel and assets.
- **Operational Management**
 - Split the department into "Normal Operations" and "Disaster Operations" for resources and command;
 - Informed community to police up area (especially around drains) and notified TxDOT to remove silt fences around road construction in advance of the storm;
 - Establishing the EOC/DOC early was successful and helped manage the incident;
 - Established a true ICS/NIMS organization to manage the incident;
 - Municipality: Developed and implemented a plan for their command post addressing refuges and shelter locations before the storm;
 - Municipality: Established unified command with Fire/EMS/LE/Public Works;
 - Senior Administration Official (e.g. County Judge, City Manager) were instrumental in breaking down operational silos;

- Accounted for addresses that had been previously responded to, to ensure no duplication of response efforts;
- Early establishment of calls for service triage procedures: Life Safety > 1 story residence (water above electrical outlets) > 2 story residence > everything else; and
- Prioritized vehicles for response in areas of concern, a Type 6 Engine was sent versus a Type 1 engine because of cost of replacement.
- **Personnel Management**
 - Increasing staffing, while ensuring that it doesn't overload your station and logistics; and
 - Called in additional personnel early, two-days before the storm.
- **Information flow**
 - Allowed dispatchers to automatically dispatch resources to incidents without going through Command based on a set of criteria established by command; and
 - Information flow allowed for changes of strategic and operational plans.
- **Communications**
 - Managing "rumors" and misinformation through the Department PIOs; and
 - Incident was well publicized and allowed for greater preparation.

Critical Improvements

Although multiple areas of improvements were identified, the following were considered as critical improvements with which to focus primary analysis and recommendations. The selected critical improvements have the widest impacts across response agencies in Harris County regardless of political or organizational structure.

Improvement # 1: The need for a shared, common operating picture between local response agencies. The ability to share information with regional, state, and federal agencies would be ideal (but not mandatory).

Analysis: Critical during large-scale, resource taxing incidents is the ability to share information. Sharing information up to and from the County EOC is vital for situational awareness, however, the need to share information laterally among response agencies is pivotal. During Hurricane Harvey, the Fire Desk attempted to share vital information across the County for all response agencies. This included GIS information, STEAR data, and operational weather updates. Two issues occurred that negatively impacted the sharing of information.

Access to e-mail was a fail point during emergency operations. Department e-mail servers were interrupted due information saturation or infrastructure impacts. The lack of a common, interface to visualize shared data, the use of proprietary software (e.g. WebEOC, STINGER, Responder360, Digital Sandbox, CAD interfaces), and non-linked permission and visibility settings did not allow for a shared view among response agencies. Together, these issues kept information from being readily

available, and prevented response agencies from understanding the impacts Harvey was having on other response agencies across Harris County.

Recommendation: Harris County Fire/EMS Agencies look to identify an operationally consistent and cost-effective solution that allows for the sharing of information in both text and visual format. The solution should allow for device independent deployment models (*functionality may be decreased on some devices*) but meet the individual response needs to be applied across a variety of incident and event types and sizes.

Improvement # 2: The need to place a fire representative at the Dispatch Center to assist in understanding operational scope and resource allocation.

Analysis: In unincorporated Harris County, there are multiple Dispatch Centers that provide services to Fire/EMS agencies. During normal operations, Dispatch Centers utilize “box assignments” or “run cards” to dictate the operational assets that are dispatched to an incident. During Hurricane Harvey, Dispatch Centers operated under normal operations. This created issues from a command and control perspective because automatic/mutual aid resources were being deployed outside of their response jurisdiction. Based on these issues, many of the Fire/EMS agencies had the Dispatch Center push calls down to the DOC to allow for better command and control of their incidents, calls for service, and resource allocation. This process created issues when critical “life-safety” calls were bunched into the growing numbers of calls for service.

Recommendation: Place an executive or command level person at the Dispatch Centers to provide operational understanding, on behalf, of the multiple response agencies that they dispatch for. Critical calls for service can be easily flagged and prioritized to the respective response agencies along with critical resource allocations.

Improvement # 3: The need for better coordination and management between public safety agencies.

Analysis: Harris County represents a unique public safety challenge; with 54 Fire/EMS agencies, 7 stand-alone EMS agencies, and over 100 law enforcement agencies. During Hurricane Harvey, response agencies leveraged their available resources to conduct operations around the ESF #9 Search and Rescue function. Because computer aided dispatch information is not shared across agencies and because of the substantial number of calls for service, response agencies operated within their own organizational structure and not within a unified response structure between each other’s co-response jurisdiction. The limited resources that were available ended up duplicating their efforts for search and rescue creating command and control issues for agencies and personnel operating in those areas.

Recommendation: The early establishment of an on-scene, Unified Command Post (Fire/EMS/Law Enforcement) is critical to maintaining the safety of residents and responders while ensuring unity of effort. With the goal being for all agencies to coordinate response efforts, the simple sharing of information at the “command-level” would be a viable starting point.

Complete List of Improvements

The list below provides a comprehensive outline of all improvement objectives identified during the workshops.

- **Situational Awareness**
 - Lack of a common operating picture that can be shared both horizontally with other response agencies and vertically with County, State, and Federal partners;
 - Placing a fire representative at the PSAP to assist with resource allocation and operational understanding between the Dispatchers and response personnel;
 - Need to capture better operational statistics such as the locations and number of people evacuated or rescued to help guide command level decisions;
 - Science behind meteorology deals in percentages and educated deductions. This creates issues with determining operational plans; and
 - External influences during the incident.
- **Operational Management**
 - Better coordination and management of multiple public safety agencies and civilians operating within the area;
 - Need to establish realistic expectations with the public on incidents of this size;
 - Need to establish relationships with NGO, VOAD, and others for resources and areas of refuge;
 - Need for better resource accountability and resource request processes; and
 - Need to establish the DOC and formal ICS structure earlier in the response.
- **Personnel Management**
 - Staffing issues (full vs. part-time); and
 - Overworking of command level personnel.
- **Information flow**
 - Need for more enhanced information flow to the local level through a variety of mediums;
 - Need for map/GIS data, which allows for a picture to say a thousand words;
 - Need for information involving critical infrastructure to be communicated to the response agencies before being released to public (i.e. Corps of Engineers); and
 - Confusion with the term, “above ground level” from the NWS when trying to convey information about water levels through the PIOs to the public.
- **Communications**
 - Ability to communicate strategically and operationally with State & Federal response partners; and
 - Ability to communicate with State & Federal air assets.

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SECTION 4: OPERATIONS

Observations

Operations during Hurricane Harvey posed a multitude of unique challenges that many first responders had never experienced before. Several factors—the incident lasted multiple operational periods, the high volume of calls for service, and limited resources—created a complex operational environment. Coupled with these issues was the fact that many of the first responders’ homes and families were being directly affected by the flooding.

Due to the experience, professionalism, training, and critical decision making by first responders many of those operational gaps were quickly overcome. Operational statistics reported by Fire, EMS, and Dispatch Centers in Harris County showed the following data over the course of seven (7) days:

Reported Call Volume by reporting Dispatch Facility							
Dispatch Center	25 Aug.	26 Aug.	27 Aug.	28 Aug.	29 Aug.	30 Aug.	31 Aug.
CyFair FD	73	100	136	498	479	150	98
Cypress Creek Comm. Center	261	333	1,197	1,786	1,091	408	350
HC-ESD #1	138	156	783	1,239	522	270	210
Sub-Total	472	589	2,116	3,523	2,092	828	658
Houston Fire	~ 15,000						
HC-Fire Desk	~ 500						
Others	Not Reported						
Total	~ 26,000						

**Information provided during AAR Request for Statistics*

Personnel Rescued (Estimates)		
Information	#	# Persons Rescued
Total Fire Depts. Reporting	50	47,596
Incorporated Fire Depts.	24	26,175
Unincorporated Fire Depts.	26	21,421
Fire Desk - Specific Information		
Requests for Air Assets		250 +
Civilian Responders		1,000 +

**Information provided during AAR Request for Statistics*

Key Best Practices

Throughout the workshops, multiple sustains and best practices were shared. The selected best practices do not supersede any single item, but are identified because of their application across a wide variety of incidents.

Best Practice #1: Fire/EMS Agencies contacted county provided STEAR (State of Texas Emergency Assistance Registry) registrants early into the incident.

Analysis: Harris County OHSEM maintains a list of residents who have registered through the State's STEAR program (211). The information was provided to Fire/EMS agencies who were then able to contact these persons to confirm they were still at the same address, still needed assistance, and that they understood the Agency's plans as the intensity of the storm progressed. This information was also beneficial during response operations so that responders would have a full understanding of the resources needed to provide assistance.

Best Practice #2: Establishment of an operational rescue plan that was briefed to all responders for what to do with the residents following rescue or evacuation.

Analysis: Multiple response partners developed plans for what to do with displaced persons following a rescue or evacuation. One municipality established a "lily pad" approach where once persons were rescued/evacuated they would be brought to a designated location. From there, dry clothes would be offered, and persons would be allowed to develop a plan for themselves. For this municipality, of the 300 people brought to the "lily pad" only 40 people ended up being transported to a County sponsored shelter. This approach shows that the traditional "shelter" may not always be needed by a community. However, having a dry and warm place to develop their own plan of action can reduce the overall impacts to shelter operations, leaving the shelter accessible to those persons who are in true need.

Best Practice #3: Establishment of a county-wide communications plan to allocate interoperability talk groups for tactical operations and air-to-ground communications.

Analysis: Although Harris County hosts a robust radio trunking system, normal operations



allows for first responders to utilize any of the 48 trunked talk groups or 13 simplex channels. To ensure better interoperable communications among agencies, 3 talk groups and 1 simplex channel were assigned to each of the four geographic regions for tactical operations. The plan also included 3 talk groups and 1 simplex channel assigned to each region for air-to-ground communications. Although some normal challenges were faced with communications from the end-user, having this communications plan, especially in a visual format, aided response operations.

Complete List of Things to Sustain

The list below provides a comprehensive outline of all sustains and best practices identified during the workshops.

- **Operational Management**
 - Established an operational rescue plan (Rescue people - Move them to a “lily pad” (designated location) for 1-3 days - Had around 300 people at the lily pad, only 40 transported to a shelter - Move them to a County shelter);
 - Break down operational periods to maximize response and crew rest (2 x 12-hr periods);
 - Established casualty collection point at church, put medics there to assist in triage and basic care or stabilization;
 - Leveraged stand-alone Emergency Room (“Doc in a Box”) for medical assistance and patient stabilization;
 - Staged EMS at CCP and brought patients to them which allowed for better resource management of medical personnel;
 - Victims stranded in cars along feeder roads were brought to high ground overpasses and put into other vehicles, that were also stuck, for temporary shelter so rescuers could operate more efficiently in the area;
 - Utilization of TIFMAS resources to back fill responders after the incident; and
 - Contacted all STEAR registrants in jurisdiction to confirm if they were still in need of assistance or if they were going to remain at the address on record.
- **Operational Resource Management**
 - Previous incidents allowed for a "real-life" understanding and knowledge of areas that would be impacted and what the operational needs would be;
 - Conducted operational and safety briefings over the radio at the beginning of each operational period to ensure that all responders, even at home, were aware of the overall incident response;
 - Predeveloped Incident Action Plans allowed for easier development and understanding during the response;
 - Did not chase 911 calls, established Incident Complex with geographic operational areas along with assigned resources; and
 - ESDs joined together during the storm to make better use of personnel and assets.
- **Operational Communications**
 - Established County-wide communications plan for interoperability talk groups for tactical operations and air-to-ground operations;
 - Under unified operations, moved from individual agency specific talk groups to single operational talk group; and
 - Communicating with all responders (ex: conduct operational briefing over radio so even volunteers could hear).

- **Operational Policy**

- Had policies in place for rescue operations that were understood by all responders;
- Verified calls for service before dispatching resources (Receive call, contact calling party, validate/triage, and then dispatch); and
- Established "Hub High" protocol for apparatus operations in flooded environment.

Critical Improvements

Although multiple areas of improvements were identified, the following were considered critical improvements to focus primary analysis and recommendations on. The selected critical improvements have the widest impacts across response agencies in Harris County regardless of political or organizational structure.

Improvement # 1: The need for better coordination and control of State and Federal resources.

Analysis: Due to the wide-spread geographic impacts of Hurricane Harvey, there was a need to incorporate State and Federal assets into the local response. Early in the incident, resources requested through the State were slow to deploy into Harris County due to the initial landfall taking place near Rockport. However, as the State stood up their staging locations, they began directing resources directly to impacted areas rather than coordinating with the locals. This was also true of Federal resources bypassing County government and directing resources to where they believed resources should be deployed.

The lack of coordination also created issues as State and Federal resources reached the outer edges of the County and were unable to reach their staging locations. Ad hoc staging locations were set up, but local coordinating officials were unaware of their existence. So, when response agencies in those areas requested resources there was no way to know they were available for deployment.

Coupled with these coordination issues was the use of "back door" communications to bypass the established resource request system.

Recommendation: "All incident start local and end local." The State has established a process for resource requests and resource coordination. Even when an incident is of the size and magnitude of a Hurricane Harvey, the process should be adhered to. It is critical State and Federal resources fold into the normal local response plans and operations.

Improvement # 2: Duplication of response efforts by various response agencies for rescues or evacuations.

Analysis: During Hurricane Harvey, critical water rescue and evacuation resources were limited. One identifiable issue was that, residents would call 911 and request assistance from law enforcement. The resident would then hang up and call 911 again, and would request assistance from Fire/EMS. This issue created problems when multiple entities (Fire/EMS/Law Enforcement) would dispatch resources to the

single call for service, only to arrive and be notified that the calling party had been rescued by another response agency. These issues were also compounded by “civilian responders” who began assisting without being coordinated through the County. Although this desire to help by all response parties was important, it created significant challenges.

Recommendation: Operational coordination of response agencies is paramount during large scale incidents especially when resources are limited. In Harris County, the fire response jurisdiction serves as a primary entity for ESF #9 Search and Rescue. Response agencies from the County, State, Federal, and civilian should push their response resources down to the fire jurisdiction’s incident command. Establishing a unified command and providing better incident coordination and resource response is necessary for a successful operation.

Improvement # 3: Lack of training in high water vehicle operations for First Responders in a flooded environment has been identified as a gap.

Analysis: Following the Memorial Day and Tax Day flood, First Responder Agencies utilized federal and state programs to acquire military style high water rescue vehicles; e.g. LMTV or 2.5 ton. Although the technical manual for these vehicles provides some guidance for operating in a high-water environment, no dedicated training exists. The U.S. military has limited training information for operating these resources in a suburban or urban environment with high water. These resources are pivotal during rescue and evacuation operations because of their high passenger capacity. (Pre-Harvey resource capacity in Appendix D).

Recommendation: Federal or State agency should develop training (classroom & practical) for operational considerations for this equipment in a variety of environments. Consider developing a commissioned credential through SFFMA, TCFP, and TCOLE.

[Complete List of Improvements](#)

The list below provides a comprehensive outline of recommended improvements identified during the workshops.

- **Operational Management**
 - Better coordination and control of resources from the State and Federal agencies;
 - Lack of training on operating HWV and Boats in flood environments;
 - Responders who were dispatched to calls for service were continuously overrun with response needs while still in route to the primary location. This created issues both in operational management and public perception;
 - Resolve competition for resources between other jurisdictions vs. County vs. State vs. Federal vs. ESF Functions; and
 - Better control of air assets (availability, sourcing, filling missions, and status notification).

- **Operational Resource Management**

- Strategic response/objectives were being pushed or driven by tactical operations;
- Lack of PPE being used by Law Enforcement and limited PPE available for residents;
- Decisions to cease operations during low visibility and nighttime created issues among responders and the public;
- Duplication of efforts for rescues or evacuations (Fire vs. LE vs. Others);
- The need to ensure decontamination operations were conducted on Responders following operations in flooded areas;
- Lack of reliable information on primary and arterial road closures created response concerns, primarily among EMS;
- Having to re-rescue people from what was previously high ground because it was now flooding;
- Even though outside temperatures were warm, the cold water and damaging effects on first responders; and
- Not enough "hard" down time for first responders.

- **Operational Communications**

- Inside unified response, use of organic unit identification created issues in understanding who was communicating over the radio. Primarily with Law Enforcement operating with Fire/Rescue resources would not use their resource identification, but their normal single unit identification;
- Better job of coordinating communications among public safety entities; and
- Better use of simplex channels for operations.

- **Operational Policy**

- Better education on STEAR Program for responder agencies and the public (what it means and actions that may need to be taken);
- Better job of providing medical evaluation for first responders during the incident and through follow ups after the incident;
- Clearly defining rising water vs. flooding vs. swift water; and
- Clearly defining rescues vs. evacuations.

SECTION 5: COMMUNICATIONS

During Hurricane Harvey, the Fire/EMS Dispatchers at Public safety assess Points (PSAP) played a critical role. A workshop was held specifically for those agencies to identify key lessons learned and areas of improvement from the dispatch center perspective.

Observations

Hurricane Harvey set a record level of calls for service throughout Harris County. The multiple Dispatch Centers in Harris County served as the first point of contact for many of our residents. Although rescues and evacuations accounted for the majority of calls for service, Dispatchers still had to manage normal calls for service (e.g. cardiac-arrests, sick patients, and house fires). The Dispatchers throughout Harris County were pivotal in ensuring calls for service were pushed to First Responders but also served as primary points of information for First Responders and as a critical communication link to other Agencies.

Key Best Practices

Throughout the workshops, multiple sustains and best practices were shared. The selected best practices do not supersede any single item, but are identified because of their application across a wide variety of incidents.

Best Practice #1: The creation of a “nature code” that allows for the bypassing of ProQA or other dispatch protocols.

Analysis: The volume of calls for service and the need to follow a regimented process for dispatching created issues during Hurricane Harvey. Dispatch Centers adapted by developing nature codes that allowed the call taker to obtain basic information and load it into the computer system for dispatching purposes without the need for following a standard dispatch protocol. Not all calls for service fell into this nature code. They were primarily requests for rescue and evacuation. Other calls for service followed normal dispatch protocols.

Best Practice #2: Having a law enforcement dispatcher in the fire/EMS dispatch centers.

Analysis: Harris County creates unique challenges in that there are multiple dispatch centers that do not operate on a common computer aided dispatch software. Therefore, the ability to share information across platforms is a critical gap. Previously identified during the Tax Day flooding was the need to incorporate law enforcement (Harris County Sheriff’s Office) dispatchers into the Fire/EMS Dispatch Centers to assist with calls for service, deconfliction, and resource coordination.

Early into the incident HCSO Dispatchers worked with Fire/EMS Dispatchers to deconflict calls for service when they same request was being received by fire and law enforcement. The dispatchers also aided in critical voice communications with resources in the field that were not operating on a common talk group or channel.

Best Practice #3: Transitioning to “get to the call when you can get to the call” approach.

Analysis: Due to the widespread geographic impact of Hurricane Harvey, Dispatch Centers quickly became overwhelmed by the amount of calls for service. Similar to the transition from emergency response to disaster response is the ability for a Dispatch Center to transition from normal protocols to disaster protocols.

Complete List of Things to Sustain

Listed below is a comprehensive outline of all sustains and best practices identified during the workshops.

- **Dispatch Center Staffing**
 - A 12-hr operational period was established with the flexibility to adjust to an 8-hr period during peak volume, then return to a 12-hr period as needed;
 - Understanding staffing requirements from previous incidents (Increased 2, but were limited in answering points);
 - Secured hotel rooms for dispatchers to rehab rather than staying at the dispatch center 24/7; and
 - Initiated a mandatory “All Call” of all Employees.
- **Dispatching Considerations**
 - The creation of a “nature code” that allows for the bypassing of ProQA or other dispatch protocols;
 - The ability to triage medical calls in the Dispatch Center with dedicated EMS personnel collocated with the Dispatchers; and
 - Transitioning to the “get to the call when you can get to the call” approach.
- **Dispatch Coordination**
 - Having law enforcement dispatchers in the fire/EMS dispatch centers;
 - Coordinating with Chief Officers at the command post rather than response personnel in the field; and
 - The utilization of the land mobile radio system to communicate between dispatchers to push calls for service to the appropriate dispatch center.

Critical Improvements

Although multiple areas of improvements were identified, the following were considered critical improvements to focus primary analysis and recommendations on. The selected critical improvements have the widest impacts across response agencies in Harris County regardless of political or organizational structure.

Improvement # 1: There is a need for better knowledge by Dispatchers concerning impassible roads into the City of Houston, the Texas Medical Center, and Shelter locations. This lack of knowledge created complications for transporting ambulances needing directions.

Analysis: The Dispatch Centers served as an information portal during Hurricane Harvey to provide critical information to responders in the field. As response agencies were transporting patients to hospitals and shelters, they would ask for information on road closures. Due to limited information on passable roadways, the dispatch centers were unable to convey this critical information.

Recommendation: A common operating picture software should be developed or purchased so critical information can be shared across public safety agencies, public works, and transportation agencies.

Complete List of Improvements

Listed below is a comprehensive outline of recommended improvements identified during the workshops.

- **Dispatch Center Staffing**
 - Dispatchers who rehabbed at the Dispatch Center would come off shift, but quickly return into the Dispatch Center without adequate rest; and
 - There is a need for a better rotation of supervisors.
- **Dispatching Considerations**
 - As outside response assets came in to assist Fire Departments, the Dispatch Centers struggled with rostering those resource in the CAD system;
 - This issue was experienced primarily with TIFMAS assets that provided coverage for Fire Departments following Hurricane Harvey;
 - Limited information available to Dispatchers concerning impassible roads into the City of Houston, the Texas Medical Center, and Shelter locations created complications for transporting ambulances who were needing directions;
 - Requirement to have everything recorded from a liability standpoint (Legal and internal); and
 - Dispatchers did not have a clear understanding of the requirements for requesting air assets for critical rescues.
- **Dispatch Coordination**
 - There is a need for a better understanding of the resource request process between the Fire Departments and the County; and
 - There is a need to re-establish a common communications talk group between dispatch centers for critical information to be shared.
- **Other Considerations**
 - There are not enough answering points in the Dispatch Center. Dispatch Centers had enough personnel on hand to staff additional answering points if they were available.

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Observations

Logistical operations during Hurricane Harvey presented a series of unique challenges that most response agencies are, typically, not familiar with. One of the primary challenges experienced was to remain self-sufficient over the course of multiple days due to the impacts to commerce and transportation. Additional logistical issues were experienced, but the ingenuity of our first responder community allowed for them to be overcome or managed.

Key Best Practices

Throughout the workshops, multiple sustains and best practices were shared. The selected best practices do not supersede any single item, but are identified because of their application across a wide variety of incidents.

Best Practice #1: Establishing a base of operations (incident base + camp) at a designated facility in order to consolidate logistical resources, support functions, and sleeping quarters.

Analysis: Many Fire Departments in Harris County operate under a combination or volunteer staffing system. Therefore, the predictability of personnel being available is not guaranteed. These staffing issues coupled with the extended duration of the incident prompted multiple departments to establish a base of operations (BOO). The BOO allowed for the consolidation of required water rescue assets, communications personnel, quartermaster, vehicle mechanics, lodging, food supplies, fuel, and medical support personnel. By consolidating these functions into a single point, “available” responders were able to roster for the incident at a single location. Support functions present at the BOO ensured that responders had the appropriate equipment and assets were being maintained consistently. The presence of medical screening at the BOO allowed for constant oversight into the physiological effects of responders without causing unnecessary impacts on local hospitals and trauma facilities.

Best Practice #2: Fire/EMS Agencies issued directives for personnel to maintain operational support through use of the local economy rather than impacting internal resources and supplies.

Analysis: Due to the initial landfall of Hurricane Harvey in the Rockport area, and the forecasting models, Harris County Agencies had ample time to gain an understanding of the time and duration of the impact that Harris County would experience. Many Agencies directed their responders to utilize the local economy for food, supplies, and fuel in order to conserve resource caches within the Department to the extent possible pre and during the incident.

Best Practice #3: Established a public information campaign to manage food donations from the public.

Analysis: Due to the duration of Hurricane Harvey and the overwhelming support of local residents and restaurants, many of the response agencies became overwhelmed by food donations. In a proactive effort, Fire Departments established a public information campaign using multiple mass communication means to educate and coordinate the donations of food. The campaign helped minimize food waste and the overwhelming volume of trash that became a problem for waste management. With this coordinated effort, the Fire Departments were able to support local areas of refuge and neighboring response agencies that were not receiving similar support.

Complete List of Things to Sustain

The list below provides a comprehensive outline of all sustains and best practices that were identified during the workshops.

- **Logistical Pre-Planning**
 - Purchased water rescue and evacuation assets prior to Hurricane Harvey due to previous flooding incidents; and
 - Pre-Incident purchases from the local economy including food, fuel, and operational response resources (life jackets, hip-waders, etc....).
- **Logistical Management**
 - Leveraged local partnerships that assisted in resource procurement when regional, state, and federal resources were unavailable due to mobility issues;
 - Municipality: Utilized Parks and Rec. Division to cook and feed personnel during the incident;
 - Established a base of operations (incident base + camp) at a designated facility in order to consolidate logistical resources, support functions, and sleeping quarters. Had departmental mechanics available through the incident to support logistical requirements; and
 - Relied on the local economy for as long as possible to prevent impacting departmental resources.
- **Functional Resources**
 - Utilized ISD busses to deliver supplies to local areas of refuge and response stations;
 - Established decon and personal hygiene protocols for first responders, including mandatory medical screening following each operational period; and
 - Fueled all assets prior to the incident.
- **Donations Management**
 - Established a public information campaign to manage food donations from the public and allowed Public Information Officers to coordinate those efforts; and

- Monitored refrigerated foods to prevent public health concerns of first responders.

Critical Improvements

Although multiple areas of improvements were identified, the following were considered critical improvements to focus primary analysis and recommendations on. The selected critical improvements have the widest impacts across response agencies in Harris County regardless of political or organizational structure.

Improvement # 1: Need an easier way for Departments operating in the field to request resources with real time updates on the status of resource requests.

Analysis: Depending on the jurisdiction, Departments may not have access to the State resource request software, WebEOC. The software is primarily meant for municipalities and counties to request regional, State, and Federal resources and is not set up for unincorporated areas. The current process for submitting resource requests requires they be submitted through email, phone, or radio into the HC-Fire Desk. The availability of the resource is checked by the Fire Desk and the status is conveyed to the requestor. The request is either filled or entered into WebEOC on a STAR request form. During Hurricane Harvey, the HC-Fire Desk was overwhelmed with phone and email requests for resources. Fire Desk personnel were unable to manage all the requests. Additionally, when a request was submitted into WebEOC there was no real-time feedback provided to the requesting entity. Some information was available through the STAR board, but the local requestor was totally reliant upon the HC-Fire Desk to track the status of the resource while they were doing the same for 26+ response agencies.

Recommendation: Develop or purchase a software solution that provides a resource availability board that can be displayed in a “Bring your own device” environment. The system should allow responders in the field to request available resources or to submit a request for resources have not been rostered. It also should provide real-time feedback on their resource request to include “requested”, “dispatched”, “in route”, “on scene”, “cancelled”, or “unfilled”.

Improvement # 2: Back channel or back door resource requests through County, State, or through State Programs.

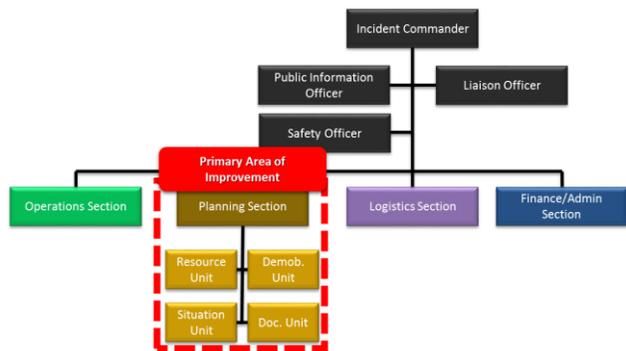
Analysis: The availability of resources during Hurricane Harvey was a significant issue for the initial 72 hours of Harris County’s impact. Automatic and mutual aid response assets were unavailable due to the wide spread geographic impact of the region. Along with local resource availability issues, the State was receiving requests for resources all along the Texas Gulf Coast. Each jurisdiction was experiencing their own internal disaster and those who were minimally affected were unable to provide resources due to mobility issues. These issues created an environment where the prescribed process for resource requests were being circumnavigated by local responders via

back channels to various State and Federal officials. The process for resource allocation through “back channel” communications greatly reduced the ability of personnel, at the local level, who were involved in determining the operational priority of resources. However, back channel communications outperformed formal prescribed methods for resource requests.

Recommendation: Local response agencies should follow local basic plans and the State’s plan for resource requests. State and Federal Officials should enforce plans for resource ordering.

Improvement # 3: Need for response agency planning to be self-sufficient, including all needed operational resources and support, for 72 hours.

Analysis: Hurricane Harvey exposed a critical gap for response agencies in terms of self-sustainability and planning. Public outreach campaigns stress the need for civilians to have “get a kit, make a plan, stay informed, and get involved”. These programs stress the importance of self-reliance during large scale incidents. Our response agencies practice these same concepts as far as logical and economic feasibility goes. Departments routinely rely on each other through mutual aid or automatic aid to bridge response gaps. Hurricane Harvey’s effects neutralized those practices and forced response agencies to rely on what was available within their own jurisdiction.



A critical piece, when shifting from normal operations to disaster operations, is the enhanced need for critical resources. Efforts can be made to build resource caches and purchase additional assets, but due to the potential infrequency of large-scale disasters this can become taxing for any agency. However, if agencies work at being self-sufficient for 72 hours as a moving target before and during a disaster the need for planning

comes very important. In incidents where resources are limited, the local economy and infrastructure is unavailable, and mobility concerns exists the need to rely on County, State, and the Federal government becomes the only viable option. Such as, getting assets immediately or “ASAP” may be impractical. So when normal operations transition to disaster operations, the need for a Planning Section in the ICS structure becomes invaluable for forecasting future operational needs 48 to 72 hours out.

Recommendation: Response agencies should conduct assessments of internal critical resource needs for the first 72 hours that can be maintained by the agency. Response agencies should look at identifying personnel to be trained in the FEMA All-Hazards Planning Section Chief position. During a disaster, each local response agency should establish and staff a Planning Section (including a situation unit, a resource unit, a demob unit, and a documentation unit), to coordinate with other local, County, and State Agencies.

Complete List of Improvements

Listed below is a comprehensive outline of recommended improvements identified during the workshops.

- **Logistical Pre-Planning**
 - Consider freeze dried foods to be used during disaster operations to increase the shelf-life of purchases;
 - Plan for additional dumpsters to be in place and develop a waste management plan for Fire Stations; and
 - Potential for the County to purchase standardized High-Water Vehicles and distribute to FDs for operations.
- **Logistical Management**
 - For large scale complex disasters, Departments should develop an understanding that they will be on their own for at least 72 hours;
 - Better regional staging for County and State assets;
 - Better resource tracking within the operating area to include organic assets and other available resources; and
 - Establishment of a food unit leader for better food management operations.
- **Resource Request Management**
 - There is a need for response partners to have a better knowledge of resource availability through an electronic medium rather than relying on emails and phone calls;
 - Need an easier way for Departments operating in the field to request resources and have real time updates on the status of their resource request;
 - The current system for resource requests (WebEOC) requires constant monitoring to track status of resource requests. A need for a better way to "close the loop" on resource requests is needed;
 - State personnel who deny resource requests without explanation forces Departments to utilize back-door connections to circumvent the established system; and
 - Back channel resource requests may help those with the relationships, however, those persons doing so need to understand the impacts of their actions on jurisdictions that have a greater need and should utilize the prescribed process.
- **Functional Resources**
 - There is a lack of FEMA Resource Typing for High Water Rescue Vehicles;
 - Civilian responders became an additional burden on response agencies due to their lack of self-sustainability and reliance on commercially available fuel sources; and
 - There were not enough rescue resources to meet the demand for calls for service.
- **Donations Management**
 - Better utilization of CERT volunteers to fill support functions within the response.

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Observation

During any large-scale disaster, the importance of accurate accounting and documentation are critical to recovering expenses and costs. Harris County has experienced multiple large-scale incidents in the past that have reached the disaster declaration level and therefore opened additional funding avenues for response agencies. Due to the frequency of such declarations many response agencies have become accustomed to the requirements from the State and Federal government for cost recovery. However, due to the wide spread impacts and duration of Hurricane Harvey some response agencies experienced additional challenges.

Key Best Practices

Throughout the workshops, multiple sustains and best practices were shared. The selected best practices do not supersede any single item, but are identified because of their application across a wide variety of incidents.

Best Practice #1: The utilization of Fire Department Administrative Staff during the incident to track costs, assist with documentation, and ensure that responders were documenting their activities appropriately.

Analysis: Many times during an incident, agencies focus on credentialed or certified responders and forget the importance that support personnel in their agency can provide. Many Fire Departments recalled not only their responders but also their support personnel early into the incident. Through pre-incident training and education, administrative staff understood the required documentation and their expanded role during disaster situations. Often these administrative personnel will be the same people who will be assisting in cost recovery; so, involving them early into the incident increases their familiarity during the recovery process.

Complete List of Sustains and Best Practices

Listed below is a comprehensive outline of all sustains and best practices identified during the workshops.

- **Position Staffing**
 - Utilization of Fire Department Administrative Staff during the incident to track costs, assist in documentation, and ensure that responders were documenting their activities appropriately; and
 - Staffing the Finance/Admin Section Chief position early in the incident.
- **Documentation**
 - Preposition documentation collection points throughout the Fire Station and provide a “crash course” in documentation requirements before the incident; and

- The understanding of previous incidents provided an in-depth knowledge on how to do a better job in tracking costs.
- **Additional Support**
 - Having flood insurance on Fire Stations allowed for a quicker recovery; and
 - Support from agencies such as VFIS (Volunteer Firemen’s Insurance Services) and the Texas A&M Forest Service allowed for a quick recovery of assets and resources.

Critical Improvements

Although multiple areas of improvements were identified, the following were considered critical improvements to focus primary analysis and recommendations on. The selected critical improvements have the widest impacts across response agencies in Harris County regardless of political or organizational structure.

Improvement # 1: There is a need for additional training on the FEMA reimbursement process and required documentation and cost tracking.

Analysis: Multiple response agencies activated administrative staff to aid in the Finance and Admin section for the response. However, many of the personnel that assisted had no formal training, outside of their respective employment, on how to deal with disaster reimbursement and accounting. Many agencies lack policies and procedures for disaster response that are understood and trained on by personnel. Hurricane Harvey left many Fire Departments ill prepared and scrambling to compile required documentation. Additionally, not having trained personnel in the operations center allowed for critical errors to occur early in the incident that could have been avoided.

Recommendation: Departments should incorporate FEMA Finance/Admin Section Chief into the training schedule along with the Disaster Accounting 101 (T-600) course available through www.preparingtexas.org. Along with training at the Unit Leader level across all positions of the ICS organizational chart.

Complete List of Improvements

The list below provides a comprehensive outline of recommended improvements identified during the workshops.

- **Training**
 - There is a need for better training on the FEMA reimbursement process and required documentation and cost tracking.
- **Staffed Position**
 - The Finance/Admin Section Chief was not integrated into the command structure early in the incident. This created issues early in the incident while small could have been corrected avoiding significant gaps for reimbursement during recovery.

- **Documentation**
 - There is a need for a better understanding of the County Disaster Summary Outlines vs. FEMA Reimbursement Paperwork; and
 - There were too many people asking for the same information during recovery (County vs. State [TDEM & TFS] vs. FEMA). It was unclear on who the response agencies should be coordinating with to ensure their Departmental cost recovery needs were documented.
- **Support**
 - A better understanding is needed about paying of volunteers (Fire/EMS) through the FEMA System versus the State System (DSHS); and
 - ESDs' need to be able to participate in mitigation strategies at the County level in order to leverage federal funding.

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SECTION 8: LESSONS LEARNED

Hurricane Harvey brought to light several lessons learned for first responder agencies throughout Harris County. Many of them have been captured throughout this document, but during the workshops the following items were identified specifically:

Never underestimate the potential size of an incident.

Hurricane Harvey impact predictions differed significantly. Early estimates showed 10-15” of widespread rain then increasing exponentially to the 30-40” that was realized. Planning for a worst-case scenario and then reducing your preparations based on reality is much easier than trying to ramp up operations when transportation and mobility capabilities are severely affected.

Importance of developing relationships with response partners and sharing of information.

Critical during large-scale incidents are the relationships that are established during normal operations. Harris County Fire Chiefs meet monthly at geographically assigned meetings and then quarterly for county-wide meetings. During those meetings, critical information is discussed and exchanged and individual departmental plans and actions can be shared. Those meetings also help remove the “vacuum” experienced when failing to interact with other response partners. Due to the size and complexity of Harris County, those meetings also allow for lessons learned from one part of the County to be shared with others.

Incident Action Plan development was the key to successful operations.

By following the principles outlined in NIMS, the development of an incident action plan forces the response agency to look past what is currently happening and what will happen in the coming operational periods. With this process, Departments can begin to forecast their needs, share critical information, and ensure that all responders are operating under the same set of established objectives.

Highlighted the importance of purchasing specialized equipment.

Harris County has experienced record flooding incidents in 2015, 2016, and now in 2017. These incidents along with the growing demands on public safety and tight budgets have increased the pressure on executive leadership to do more with less. Incidents such as Hurricane Harvey have shown the importance of investing in specialized equipment to meet the needs for large-scale evacuations and rescues during flooding situations.

Developing better command staff work/rest cycles.

Typical public safety incidents require command level personnel to operate, on average, less than 24 hours. However, during disasters like Hurricane Harvey, command level personnel became heavily taxed over the course of five to six days. Organizations should have enough command level trained staff to allow for a balanced work/rest cycle. A well-rested staff is critical for decisions that are not jaded by a lack of rest.

Adaptability during the incident is key.

Adherence to strict, hierarchical organizational decision making is practical during normal operations. But during disasters, the adaptability of response personnel in the field is key. By establishing response objectives, developing an incident action plan, and conducting operational briefings; the Incident Commander can provide sideboards for response personnel. During Hurricane Harvey the freedom to conduct “out of the box” thinking within a set of established sideboards allowed for safer responses with greater results.

Activation of Type III Incident Management Teams.

Fire and EMS Departments train their personnel in a variety of NIMS/ICS courses and position specific classes. However, transitioning from normal operations to disaster operations can create some challenges such as responding to the current incident versus managing the on-going incidents. Utilization of IMTs can aid in this transition and provide critical knowledge and relief.

Importance of medical assessments for first responders.

First Responder care during an incident is critical to ensuring that limited resources remain operationally viable throughout the incident. Hurricane Harvey’s flood waters contained a public health nightmare with a mixture of bodily waste, chemicals, and everything else soluble or insoluble in water. Ensuring the dedicated medical resources are assigned to provide care to the responders during the response and to provide medical screening following each operational period is instrumental to ensuring a healthy response force.

Cannot forget about the importance of critical incident stress management.

Hurricane Harvey affected a large population of the State of Texas and especially in Harris County. The brave men and women who committed themselves to rescue after rescue, call-for-service after call-for-service were also being personally affected. Their homes were impacted, their friends and families were displaced, their friends and families were calling for help, along with the look of despair on every person’s face that they rescued or could not reach. The accumulating stress over the six days’ response plus the subsequent stress of recovery has placed an untold burden upon these individuals. Departments should always be cognizant of the importance of critical incident stress debriefings and mental health support for their responders.

SECTION 9: IMPROVEMENT PLAN

Conducting improvement planning following a major incident is critical in ensuring that lessons learned are developed into measurable follow-on actions. Timelines for implementing an improvement plan vary based on availability of funding, requirement of resources, and other political consideration. During the workshops, the following list of improvement areas were identified and then classified into immediate and long-term actions.

Immediate Improvement Actions

The following items have been identified as immediate improvement action items by responsible agency or jurisdiction.

Command and Control

Information sharing	Increase stakeholder communications pre-incident.	All Agencies/Jurisdictions
Collaboration	Establish relationships with atypical entities for disaster response.	Fire / EMS
Documentation dissemination	Leverage technology for information development and sharing.	All Agencies/Jurisdictions
Pre-Incident	Predevelop incident action plans and resource requests.	Fire / EMS
Personnel Management	Ensure earlier activation of Departmental resources.	Fire / EMS
Asset Management	Deploy supervisors with assets outside jurisdiction.	Fire / EMS
Information flow	Increase speed of information flow from County EOC.	Harris County
Coordination	Implement Regional Resource Coordination program.	Harris County

Operations

Information dissemination	Information sharing at all levels.	All Agencies/Jurisdictions
Responder safety	Protocols for decon and medical screening.	Fire/EMS
Policies and Procedures	Update based on lessons learned.	All Agencies/Jurisdictions
Coordination	Sign onto Harris County Basic Plan	Fire/EMS
Personnel Management	Educate Dispatchers on Fire Desk operations	Harris County

Logistics

Procurement	Purchase specialized response equipment.	Fire/EMS
Staffing	Evaluate staffing levels.	Fire/EMS
Consolidation	Implement logistical caches and rotation plan.	All Agencies/Jurisdictions
Coordination	Enhance resource ordering and notification process.	Fire/EMS

Training

Field Staff	Disaster response operations familiarization	All Agencies/Jurisdictions
Responders	Response operations for rising, flooding, and swift water.	Fire/EMS
Operators	Boat operations for rising, flooding, and swift water.	Fire/EMS
Command Staff	Position specific and Command & Control of type I-III incidents.	All Agencies/Jurisdictions

Long-Term Improvement Actions

The following items have been identified as long-term improvement action items; along with the responsible agency.

Command and Control

Information sharing	Shared common operating picture software.	All Agencies/Jurisdictions
Management	Integration plan for civilian responders.	All Agencies/Jurisdictions
Local Coordination	Increase coordination with law enforcement.	Fire/EMS
State Coordination	Increase State coordination at local level.	Harris County

Operations

Operational plans	Non-conventional response to conventional incidents (i.e. fires in flooded areas)	Fire/EMS
PSAP management	Additional answering points at PSAP.	Harris County/PSAP
Coordination	Increase ESF #8 and ESF #9 coordination.	Harris County
State Coordination	Increased county to county communications.	Harris County

Logistics

Communications	Regional incident communications plan.	Harris County
Information management	Resolve or replace WebEOC.	Harris County

Policy

Shelter considerations	Legislation for shelter operations.	All Agencies/Jurisdictions
Developmental permitting	Flood control permitting requirements.	Harris County
Inspections	Increase HC-Flood Control inspections.	Harris County
Management	Cleaning and maintaining of waterways.	Harris County

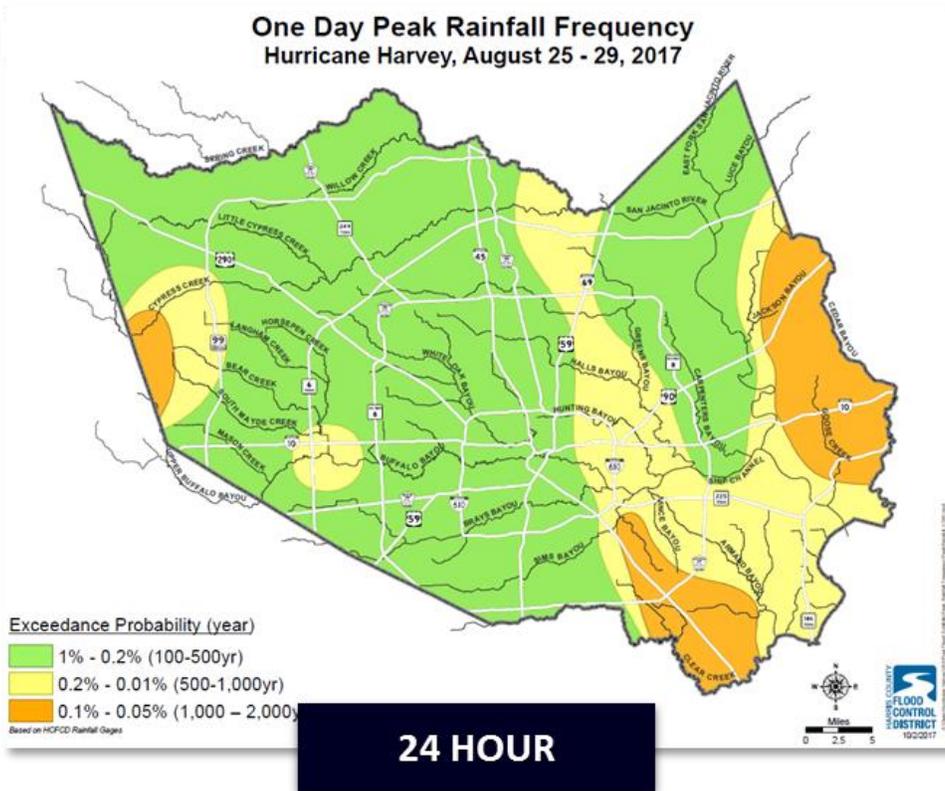
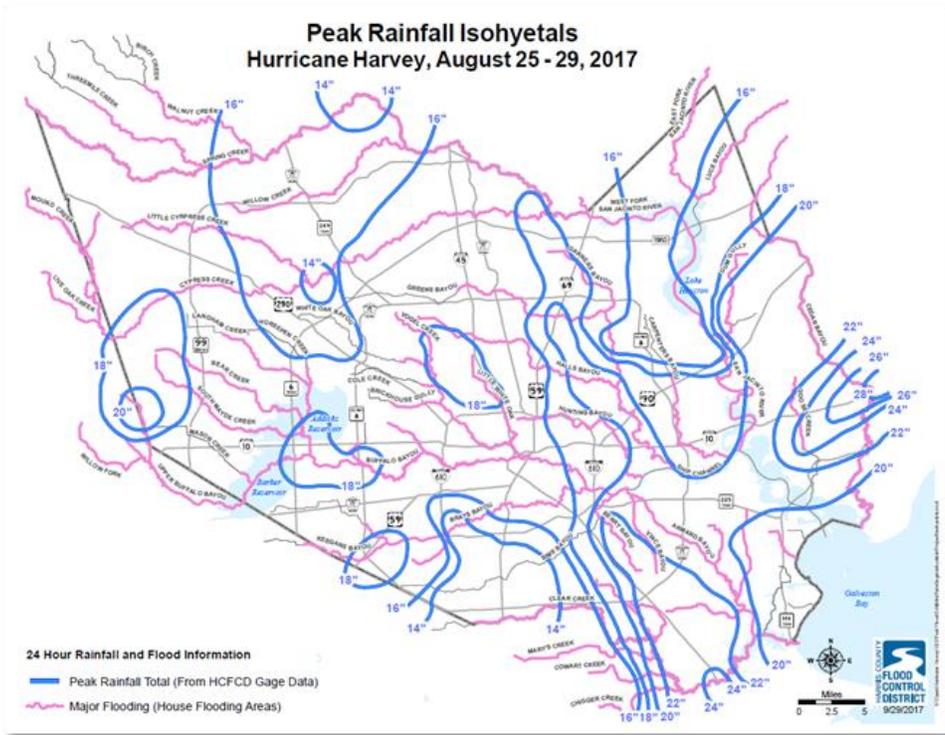
APPENDIX A: REPORTED RESPONSE DATA

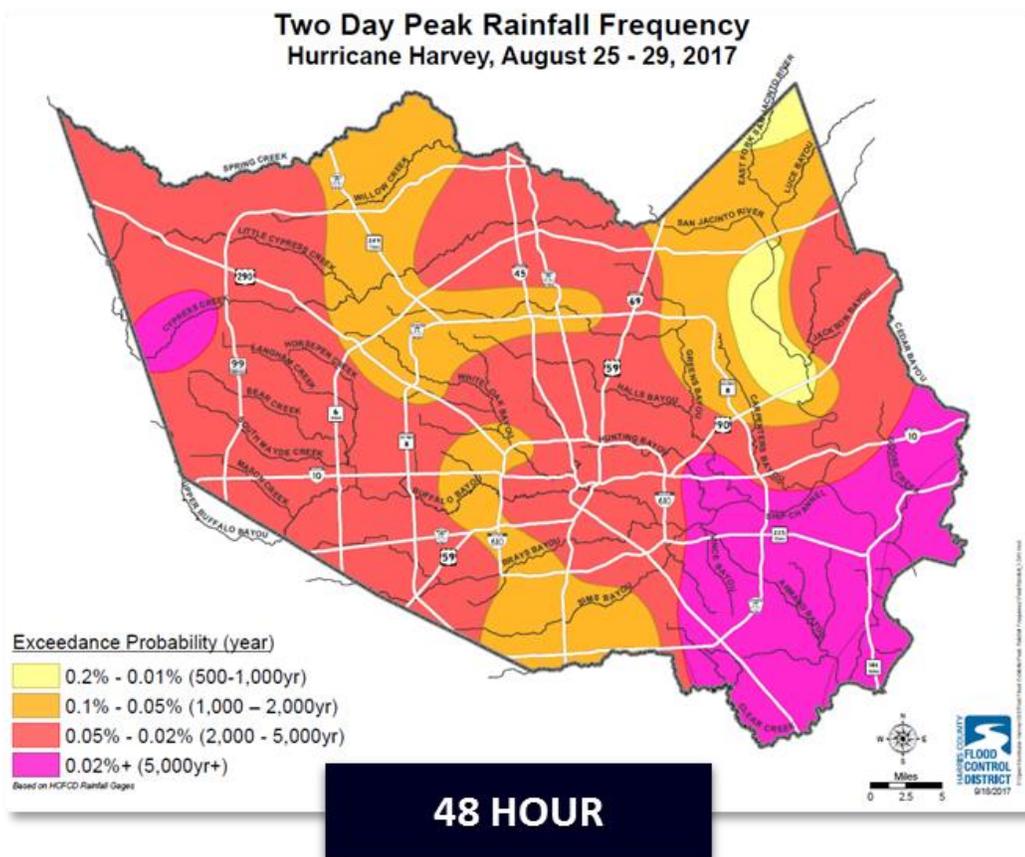
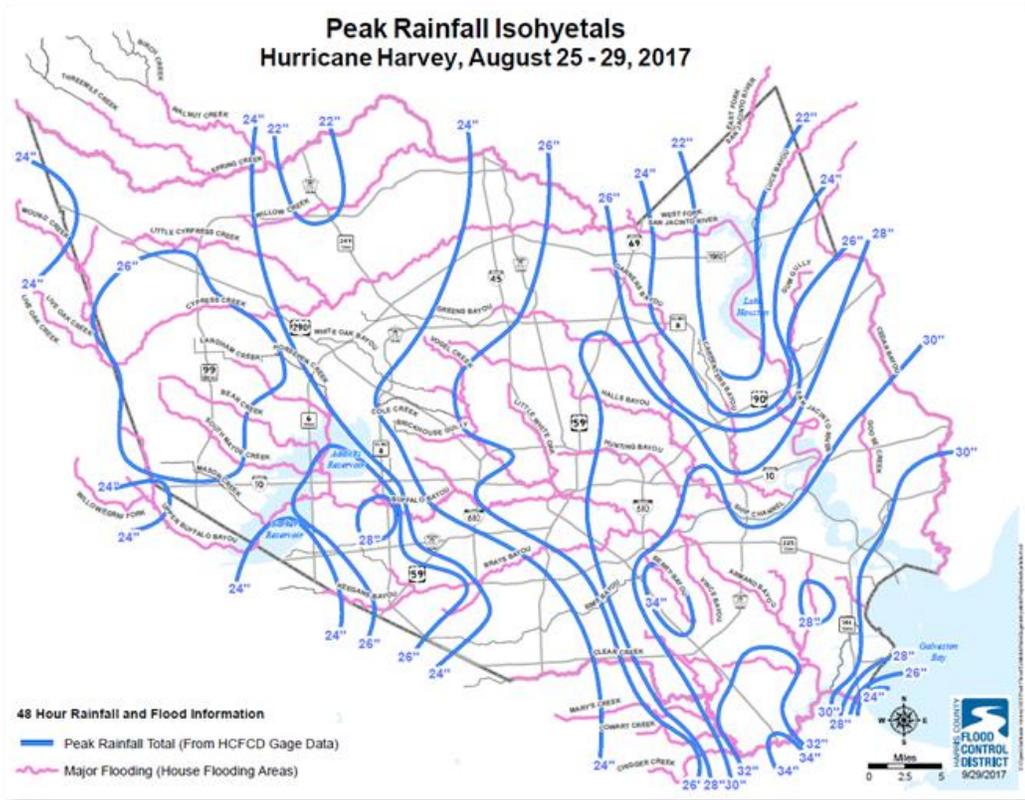
Reported Call Volume by reporting Dispatch Facility							
Dispatch Center	25 Aug.	26 Aug.	27 Aug.	28 Aug.	29 Aug.	30 Aug.	31 Aug.
CyFair FD	73	100	136	498	479	150	98
Cypress Creek Comm. Center	261	333	1,197	1,786	1,091	408	350
HC-ESD #1	138	156	783	1,239	522	270	210
Sub-Total	472	589	2,116	3,523	2,092	828	658
Houston Fire	~ 15,000						
HC-Fire Desk	~ 500						
Others	Not Reported						
Total	~ 26,000						

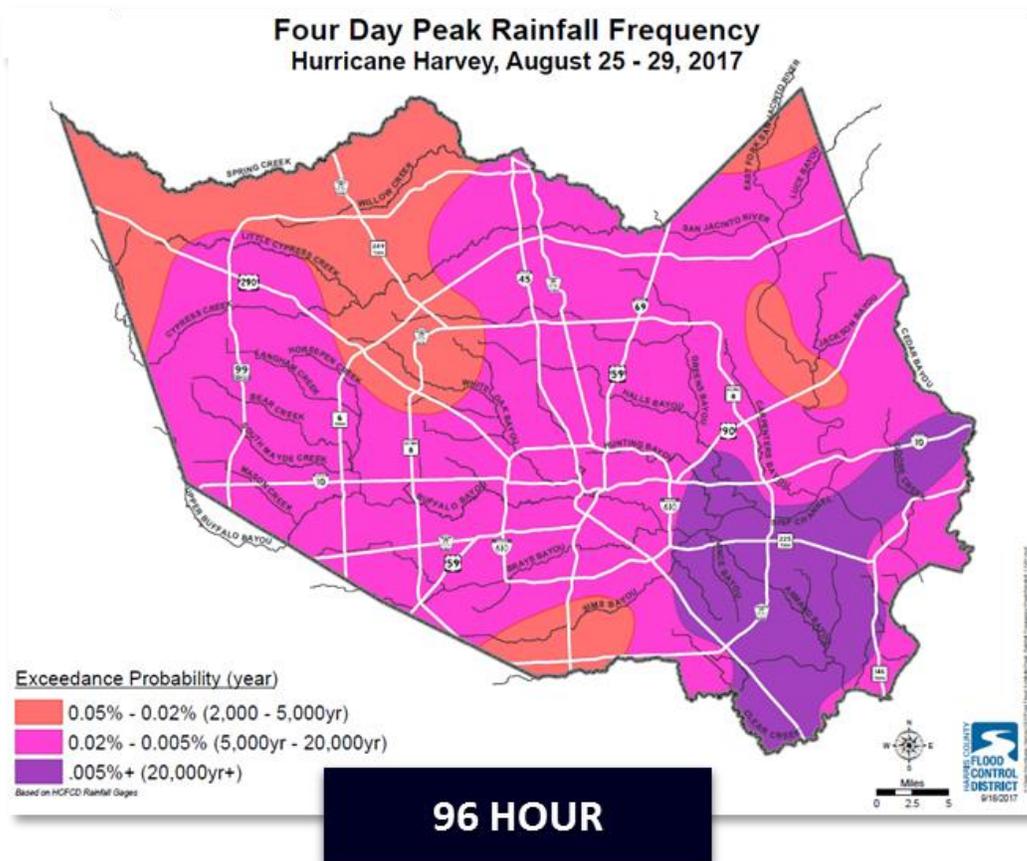
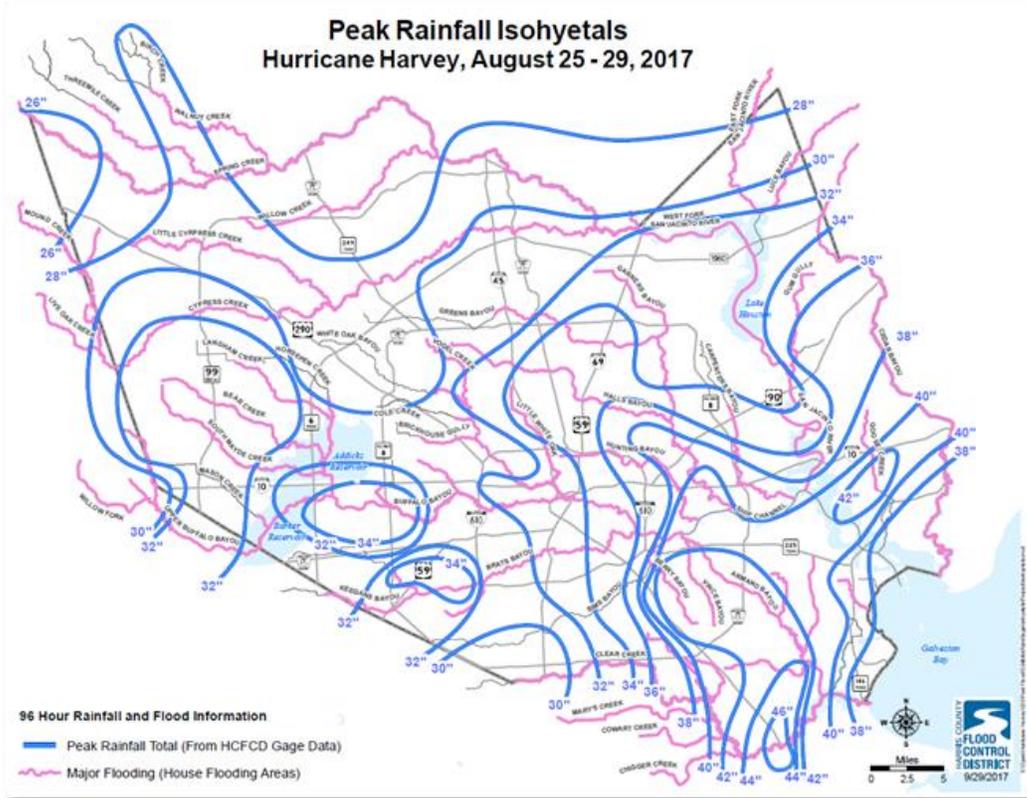
Personnel Rescued (Estimates)		
Information	#	# Persons Rescued
Total Fire Depts. Reporting	50	47,596
Incorporated Fire Depts.	24	26,175
Unincorporated Fire Depts.	26	21,421
Fire Desk - Specific Information		
Requests for Air Assets		250 +
Civilian Responders		1,000 +

Information as reported in September 2017, by Fire Departments and Dispatch Centers

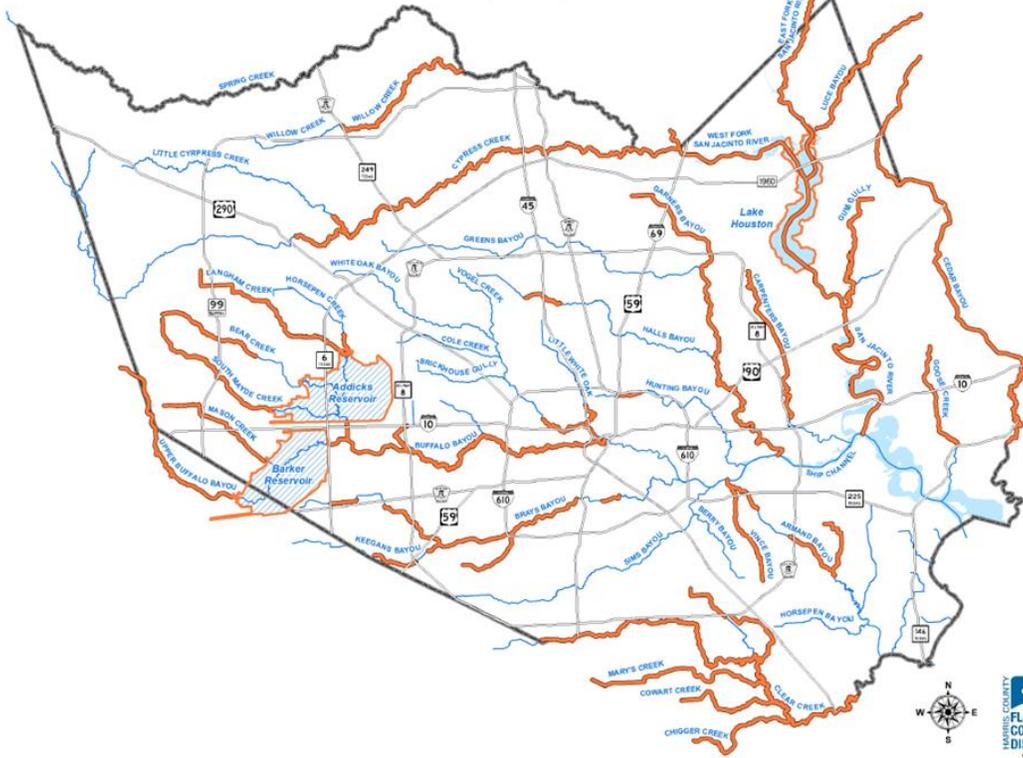
APPENDIX B: RAINFALL & WATERSHED IMPACT



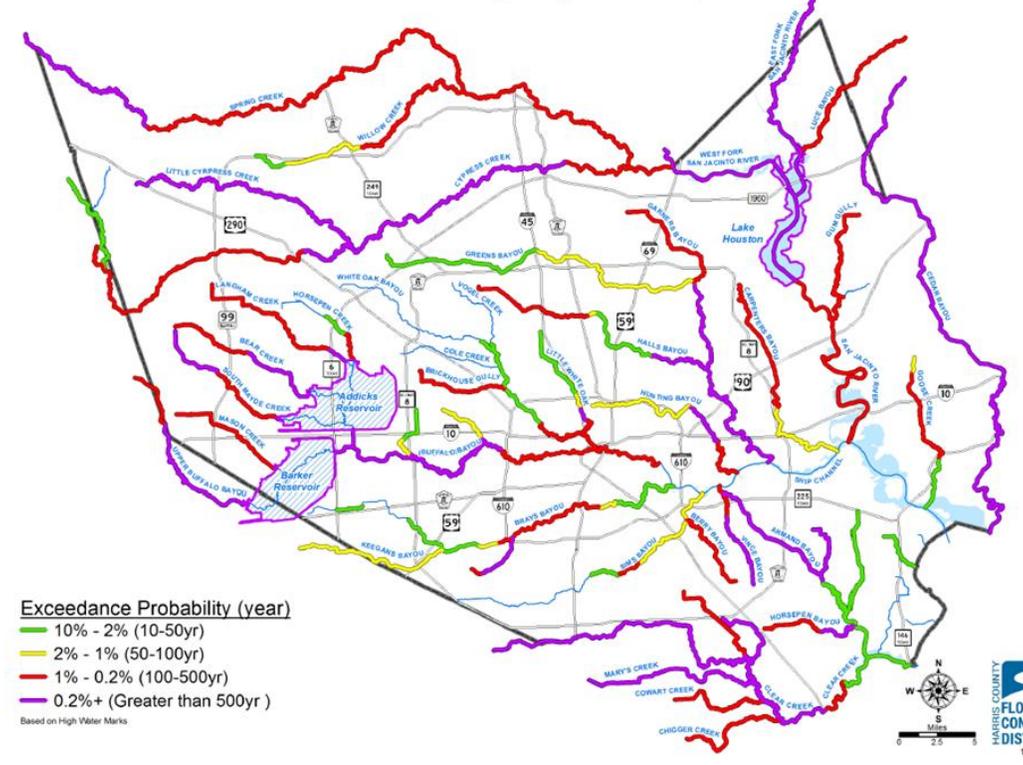




Record Flood Levels Hurricane Harvey, August 25 - 29, 2017



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



APPENDIX C: RAINFALL COMPARISONS

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"
Return Interval	1,500					5,000	12,000	50,000

Hurricane Harvey – Storm and Flood Information (10/10/2017)

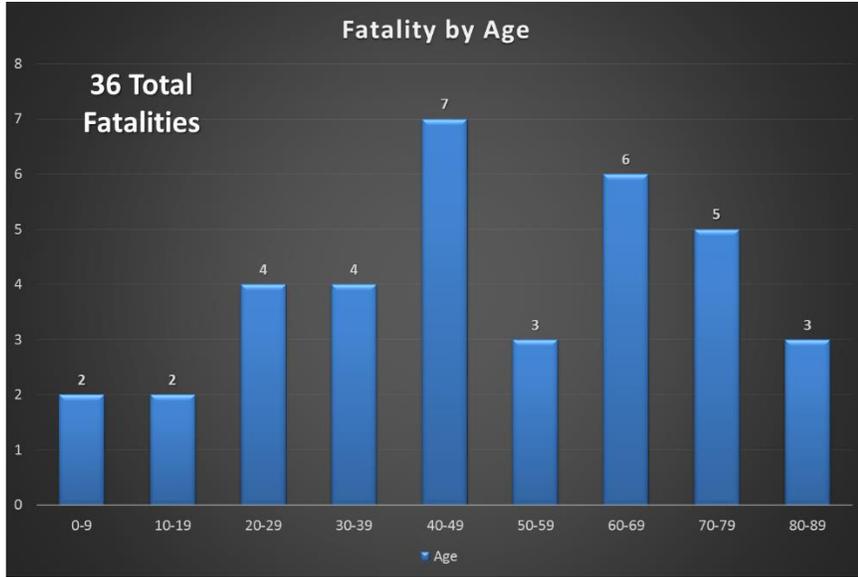
Duration	Harvey (2017)	Allison (2001)	Tax Day (2016)	October (1994)
1-hr	6.8"	5.7"	4.7"	3.7"
2-hr	11.9"	9.9"	7.3"	4.7"
3-hr	14.8"	13.5"	8.3"	5.3"
6-hr	18.9"	21.2"	13.9"	7.2"
12-hr	20.9"	28.3"	16.7"	12.0"
1-day	25.6"	28.4"	17.4"	20.9"
2-day	35.2"	28.5"	17.5"	23.1"
4-day	47.4"	38.5"	N/A	28.9"

APPENDIX D: HARRIS COUNTY RESOURCE INCREASE (PRE-HARVEY)

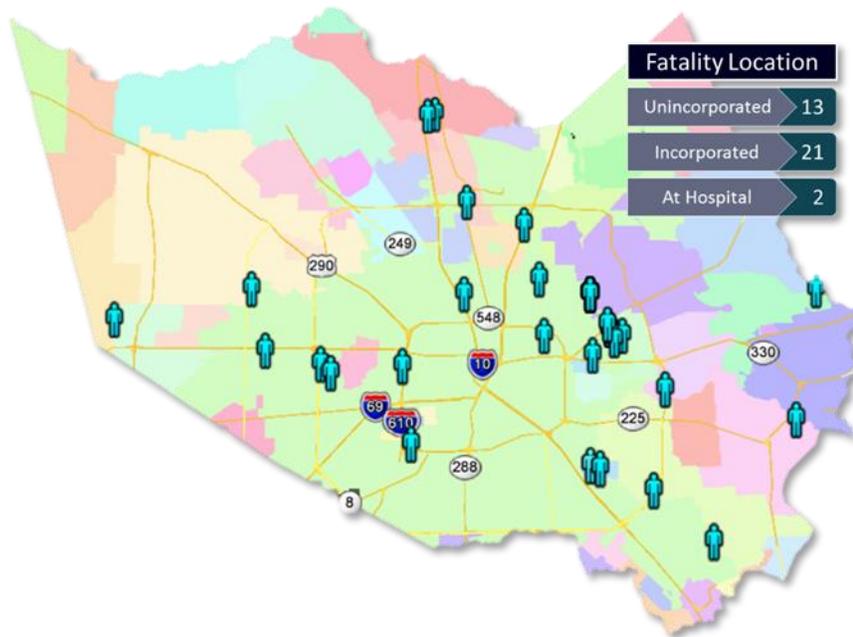
RESOURCE TYPE	# OF RESOURCES	INCREASE SINCE MAY '16 FLOODS	
Flat Bottom 	41	64	+ 23
Inflatable 	9	9	-
Deep Hull 	4	4	-
FMTV 	16	20	+ 4
Sub-Total FD/ESD	61	88	+ 27
Sub-Total LE	33	42	+ 9
Total	94	130	+ 36

APPENDIX E: HARRIS COUNTY FATALITIES

Fatalities by Age

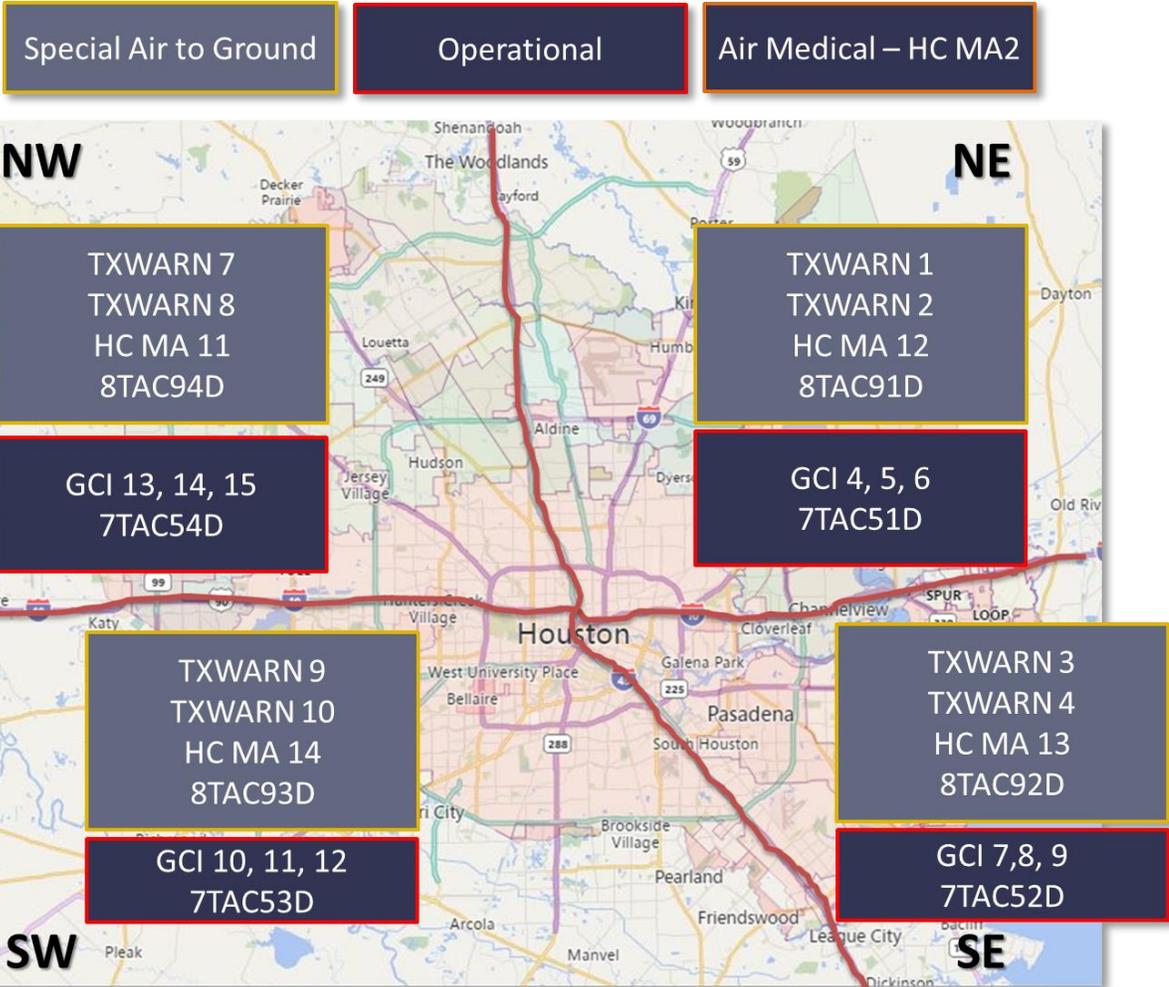


Fatalities by Location



Fatality information as of September 2017, from the Harris County Institute of Forensic Sciences

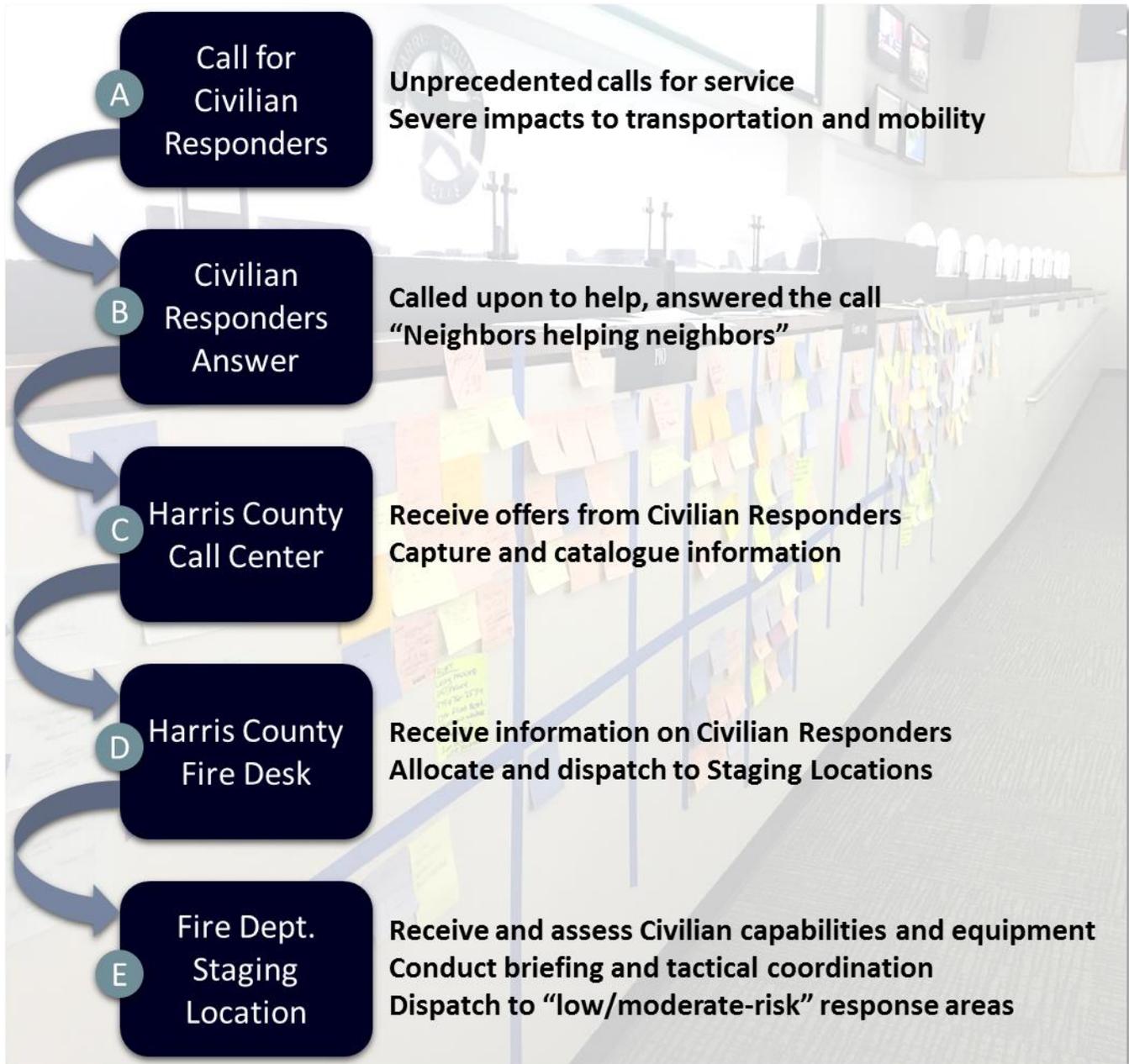
APPENDIX F: HC-VISUAL ICS 205



APPENDIX G: CIVILIAN RESPONDERS

Civilian Responders played a vital role in minimizing loss of life during Hurricane Harvey. The Civilians that donated their time and resources to Harris County will serve as the model for “neighbors helping neighbors”.

Civilian Responder Process



A. Call for Civilian Responders

The wide-spread geographic impacts of Hurricane Harvey to Harris County created significant mobility issues. These issues prevented the State and Federal assets which had been requested, from reaching their target locations or designated staging area in Harris County. Faced with these challenges, the HC-Fire Desk met with the County Judge to put out a call for residents to come assist First Responders in a “neighbor helping neighbor” approach.



“We can’t wait for assets to come from outside. We have always been known as a community where neighbors help neighbors. So those of you who have boats and high water vehicles that can be used in neighborhoods to help move people out of harm’s way, we need your help. In asking for public help, by all means understand the safety requirements...”. *County Judge Ed Emmett*

B. Civilian Responders Answer

Civilians were encouraged to contact the Harris County Call Center, located at Transtar, to report their availability.

C. Harris County Call Center

Personnel operating the Call Center were directed to obtain specific information from civilian reporting their availability:

- **Civilian Name**
- **24-hr contact number**
- **Available resource (e.g. boat, jet ski, high water vehicle)**
- **Current or future location of the civilian**
- **Any other additional informational, such as certifications or specialty equipment**

The Call Center personnel then advised the civilian that there was no reimbursement or liability assumed by Harris County. The civilians were informed that the HC-Fire Desk would be contacting them as needed and upon request from local Fire Departments.

D. Harris County Fire Desk

Call Center personnel would hand deliver “sticky” notes with the information collected. A CERT Volunteer assisting the HC-Fire Desk, would divide the resources between watercraft, high water vehicle, or other. The resources were then geographically divided by quadrants (e.g. NW, NE, SW, SE, or out of County).

As requests for resources came in from the field, the HC-Fire Desk would first attempt to fill the request with public safety resources. If there were no public safety resources available, a civilian resource would be contacted. The civilian was given specific information on who to contact and where the requesting agency’s staging location would be.

Civilians who had reported they had high water vehicles or large moving trucks were contacted to check their availability. Some of those resources were used to conduct supply and re-supply missions. Many

were willing to support supply missions to shelters or areas of refuge, but some wanted to deploy their asset in support of rescues and evacuations.

Note: Some of the first supplies delivered to local shelters was by Civilian Responders.

E. Fire Department Staging Location

Upon arrival at the Fire Department staging location, the civilian resource was inspected for required safety equipment and serviceability. Many of the staging locations had additional safety equipment (e.g. USCG approved floatation devices, throw bags) on hand that was issued to the civilian responders.

A tactical briefing was then conducted to orient the civilian to the area of operation. Specific information on communications, areas of concern, and civilian drop off locations were provided. Based on the availability of personnel, many Fire Departments placed a firefighter with the civilian responder to aid in operations and to maintain communications with the incident command post. Others were directed into low/moderate risk areas, primarily flood or rising water, to begin conducting evacuations.

This coordinated approach allowed for technically trained first responders to focus on high-risk areas such as swift or moving water, to conduct rescues while civilian responders conducted operations elsewhere.

Civilian Responders

Although an exact count of civilian responders, coordinated and uncoordinated, that deployed during Hurricane Harvey is unknown, it is projected that over 1,000 civilians selflessly donated their time and equipment to help the residents of Harris County. The documentation recovered from the HC-Fire Desk (many of it thrown away during operations) shows that civilians from over 16 different States contacted the Call Center to offer assistance. Military personnel from the U.S. Army Special Forces and U.S. Navy Seals voluntarily deployed from Missouri and Virginia to also serve. The residents and first responders of Harris County will forever be grateful for their call to duty.



APPENDIX H: ACRONYMS

A

AAR – After-Action Review

ASAP – As soon as possible

B

BOO – Base of operations

C

CAD – Computer aided dispatch

CCP – Casualty collection point

CERT – Community Emergency Response Team

Channel – radio talk path

D

DOC – Department Operations Center

DSHS – Texas Department of State Health Services

E

EMS – Emergency Medical Services

EOC – Emergency Operations Center

ESD – Emergency Services District

ESF – Emergency Support Function

#8 – Public Health and Medical Services

#9 – Search and Rescue

F

FEMA – Federal Emergency Management Agency

FPS – Fire Protection Services

G

GIS – Geographic information system

H

HC-FC – Harris County Flood Control District

HCFMO – Harris County Fire Marshal's Office

HCOHSEM – Harris County Office of Homeland Security and Emergency Management

HCSO – Harris County Sheriff's Office

HWV – High water vehicle

I

ICP – Incident command post

ICS – Incident command system

ISD – Independent School District

L

LE – Law Enforcement

LMTV – Light medium tactical vehicle

N

NGO – Non-governmental Organization

NIMS – National Incident Management System

NWS – National Weather Service

O

OEM – Office of Emergency Management

P

PIO – Public Information Officer

PPE – Personal protective equipment

ProQA – Proprietary dispatch software

PSAP – Public Safety Answering Point

S

SFFMA – State Firefighters’ and Fire Marshals’ Association of Texas

STAR – State of Texas Assistance Request

STEAR – State of Texas Emergency Assistance Registry

T

Talk group – Virtual radio channel (700-800 MHz trunking system)

TCFP – Texas Commission on Fire Protection

TCOLE – Texas Commission on Law Enforcement

TDEM – Texas Division of Emergency Management

TFS – Texas A&M Forest Service

TIFMAS – Texas Intrastate Fire Mutual Aid System

TxDOT – Texas Department of Transportation

V

VFIS – Volunteer Firefighters’ Insurance Services

VOAD – Voluntary Organizations Action in Disaster