CDBG-MIT Action Plan

CITY OF HOUSTON

HOUSING AND COMMUNITY DEVELOPMENT DEPARTMENT

2100 Travis Street | 9th floor | Houston, TX 77002 | 832.394.6200

@HoustonHCDD

www.houstontx.gov/housing

Table of Contents

List of Tables

List of Figures

A. Executive Summary

1. Introduction

On February 9, 2018, the United States Congress approved Public Law 115-123, which directed the U.S. Department of Housing and Urban Development (HUD) to allocate more than $12 billion for mitigation activities proportional to the amounts that Community Development Disaster Recovery (CDBG-DR) grantees received for qualifying federally declared disasters in 2015, 2016, and 2017.

On August 30, 2019, 84 Federal Register 45838 was published, which allocated $6.875 billion in Community Development Block Grant Mitigation (CDBG-MIT) to grantees recovering from qualifying disasters in 2015, 2016, and 2017. This notice, and any subsequent notices, describes grant requirements and procedures applicable to CDBG-MIT funds only. CDBG-MIT is a new grant and the first appropriation of CDBG funds to be used specifically for mitigation activities.

CDBG-MIT activities are defined as those that increase resilience to disasters and reduce or eliminate the long-term risk of loss of life, injury, damage to and loss of property, and suffering and hardship, by lessening the impact of future disasters. These funds represent a unique and significant opportunity to carry out strategic and high-impact activities to mitigate disaster risks and reduce future losses. The grant prioritizes activities that benefit vulnerable and lower-income people and communities while targeting the most impacted and distressed areas.

There were five Presidentially declared natural disasters that occurred in Houston from 2015 to 2017, including the Memorial Day flood and the Halloween flood in 2015, the Tax Day flood and the May/June floods in 2016, and Hurricane Harvey in 2017. As a direct grantee of CDBG-DR funds supporting the long-term recovery needs from the 2015 flood events (Disaster Numbers 4223 and 4245), the City of Houston was directly allocated $61,884,000 of CDBG-MIT funds.

This document, *Houston's CDBG-MIT Action Plan* (Action Plan), includes a risk-based mitigation needs assessment that identifies and analyzes all significant current and future disaster risks and provides a basis for the proposed CDBG-MIT activities. This Action Plan also includes information about the use of CDBG-MIT funds, including prioritizing assistance for low- and moderate-income (LMI) communities. As determined through the mitigation needs assessment and public input, CDBG-MIT activities will focus on decreasing the risk of flooding in Houston through a Local Flood Mitigation Program. Table 1 provides a breakdown of how the City intends to utilize the CDBG-MIT allocation.

Table 1: CDBG-MIT Budget Allocation

Program	Total	% of Total
Local Flood Mitigation Program	$58,789,800.00	95%
Administration	$3,094,200.00	5%
Total	$61,884,000.00	100%

Source: City of Houston Housing and Community Development Department

2. Recent Flood Events

In 2015 and 2016, the Houston region received unprecedented rainfall from several storms, which led to many neighborhoods experiencing flooding multiple times over the two-year period. During Memorial Day weekend and Halloween weekend in 2015, Houston experienced severe flooding from storms that impacted the wider Gulf Coast area. The President declared both events to be major disasters. This was followed by record-breaking rainfall and severe flooding in April and June 2016, and both events were also declared as major disasters. Almost one third of the 16,000 buildings damaged in the 2015 and 2016 flood events were located outside the Federal Emergency Management Agency (FEMA) 100- and 500-year floodplains. These flood events were followed by Hurricane Harvey

in 2017, which was an unprecedented multi-day rain event. Table 2 presents the total estimated cost of residential damages incurred from each of these storm events, and the corresponding CDBG-DR funds that the City received.

Table 2: Federally Declared Disasters in Houston 2015 – 2017

Disaster	Year	Estimated Residential Damage	City of Houston CDBG-DR Funds
Memorial Day and Halloween Flood Events	2015	$524,689,073	$87,092,000
April (Tax Day) and May/June Flood Events	2016	$157,976,496	$23,486,698*
Hurricane Harvey	2017	$15,871,516,366	$1,275,878,041*

*For 2016 and 2017 disasters, the City of Houston received CDBG-DR funds from the Texas General Land Office as a subrecipient.
Source: City of Houston Housing and Community Development Department

The cumulative impact of these disasters has been devastating in Houston and the scale of damage, both physically and financially, is unparalleled. Thousands of residential and commercial buildings were damaged, some several times in the last decade. Infrastructure has been overwhelmed or destroyed, and there has been loss of life and property. Residents that have been impacted by multiple disasters have often exhausted their recovery options, leaving them more vulnerable and at risk of being further negatively impacted by future disasters. Repetitive flooding has exacerbated poverty, homelessness, health challenges, and negative economic impacts at the individual and regional scale, particularly in the most socially vulnerable communities. Houston's future will be defined by how flood risk is addressed and investment in innovative and holistic approaches to flood risk reduction will help improve health and quality of life.

3. State of Texas

Separate from this Action Plan and Houston's direct allocation of CDBG-MIT funds, the State of Texas, as administered by the Texas General Land Office (GLO), was allocated $4,297,189,000 of CDBG-MIT as a result of because of the six natural disasters that impacted Texas between 2015 and 2017 (Disaster Numbers 4223, 4245, 4266, 4269, 4272, and 4332). Although Houston was impacted by five Presidentially declared major disasters in 2015, 2016, and 2017, HUD has only directly allocated CDBG-MIT funds to the City of Houston that represent the proportion of CDBG-DR funds received resulting from the two 2015 flood events. As such, the City of Houston may be eligible to receive additional CDBG-MIT funds through the GLO-administered state allocation. Information about the State of Texas activities and projects using CDBG-MIT funds can be found here: https://recovery.texas.gov/action-plans/mitigation-funding/index.html.

B. Mitigation Needs Assessment

As required by HUD, the City of Houston developed a mitigation needs assessment based in part on the existing, approved *City of Houston Hazard Mitigation Action Plan*. In development of this mitigation needs assessment, the City reviewed: the FEMA Local Mitigation Plan Handbook, DHS Office of Infrastructure Protection, National Association of Counties, Improving Lifelines (2014), resource about wildfires from the U.S. Forest Service, and the National Interagency Coordination Center (NICC), and HUD's CPD mapping tool. This assessment addresses current and future risks including hazards, vulnerability, and impacts of disasters. It also serves to identify appropriate mitigation actions and develop the action plan that will reduce the highest risks that Houston faces.

1. Overview of the City of Houston Hazard Mitigation Action Plan

The purpose of the *City of Houston Hazard Mitigation Action Plan* (not to be confused with the "Action Plan") is to develop strategies to protect people and structures and minimize the costs of disaster response and recovery. The goal of the *Hazard Mitigation Action Plan* is to minimize or eliminate long-term risks to human life and property from known hazards by identifying and implementing cost-effective hazard mitigation actions. The participatory planning process is an opportunity for the City of Houston, other government and business stakeholders, and the general public to evaluate and develop successful hazard mitigation actions, reducing the future risk of fatalities and property damage resulting from a disaster in the Houston planning area.

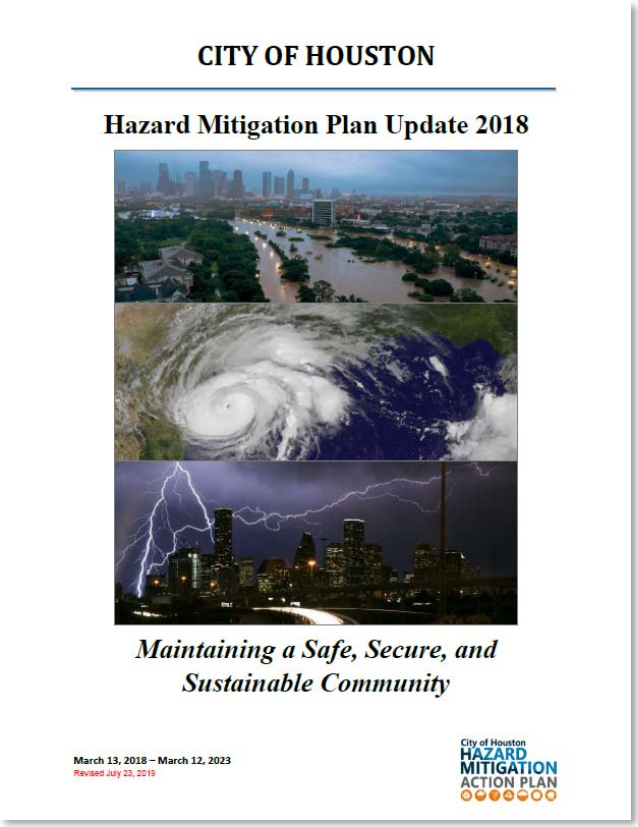


Figure 1: Hazard Mitigation Action Plan

The mission statement of the Plan is: "*Maintaining a secure and sustainable future through the revision and development of targeted hazard mitigation actions to protect life and property.*" Hazard mitigation activities are an investment in a community's safety and sustainability. It is widely accepted that the most effective hazard mitigation measures are implemented at the local government level, where decisions on the regulation and control of development are ultimately made. Elements of the Hazard Mitigation Action Plan have been used to inform this assessment, ranging from hazard identification and risk assessment to the identifcation of potential projects.

2. Houston's Risk Landscape – Current and Future Hazards

a. Geography

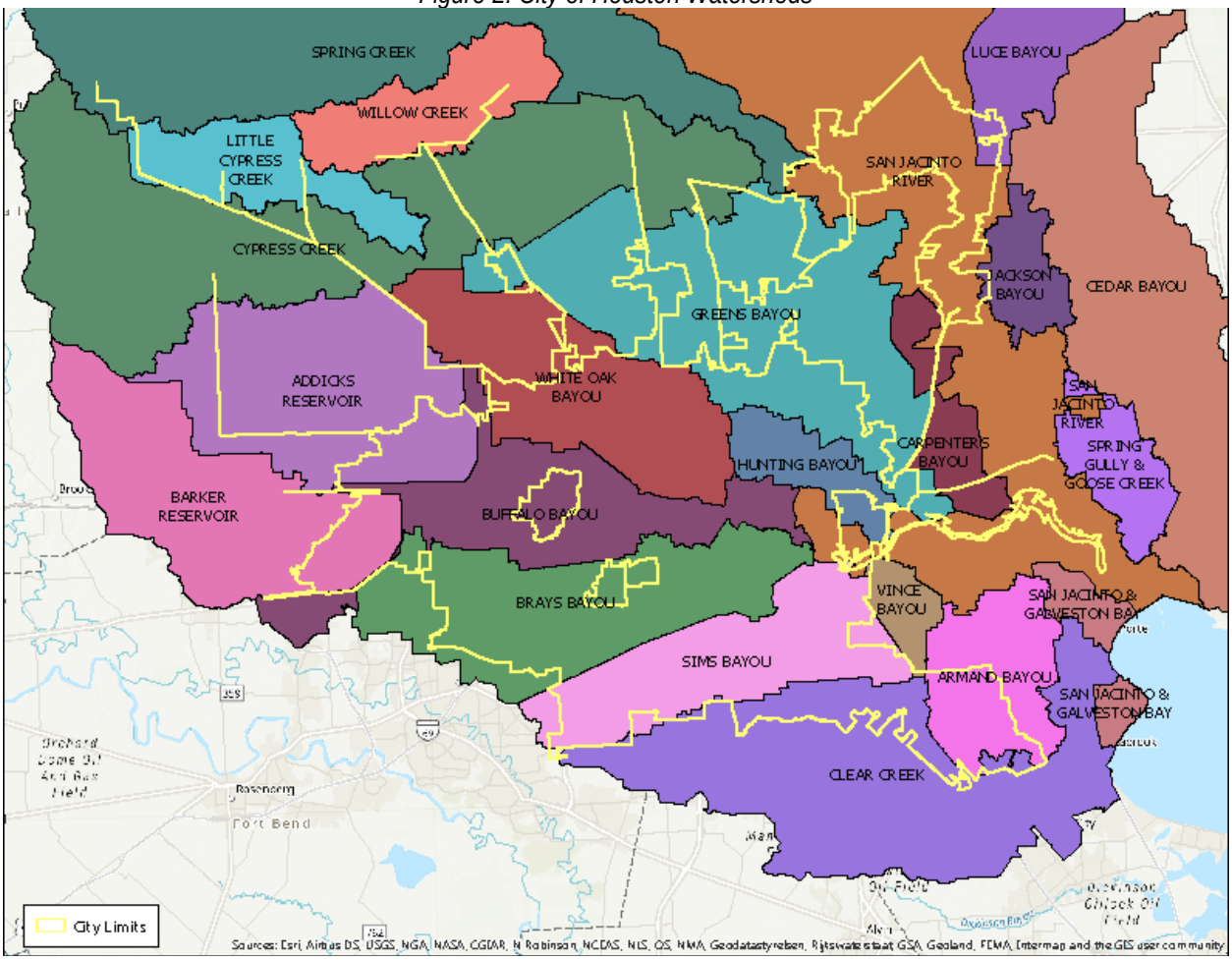
Houston was founded on August 30, 1836 near the banks of Buffalo Bayou and incorporated as a city on June 5, 1837. The city was named after former General Sam Houston, who served as president of the Republic of Texas and commanded the Battle of San Jacinto, which took place approximately 25 miles east of where the future city was established. It has continued to play a significant role in economic and cultural growth for the region. In the mid-20th

century, Houston became the home of the Texas Medical Center – the world's largest concentration of healthcare and research institutions – and NASA's Johnson Space Center, where the Mission Control Center is located. The Port of Houston also ranks first in the U.S. in international waterborne tonnage handled and second in total cargo tonnage handled.

The city has a total area of 656.3 square miles, of which 634 square miles are land and 22.3 square miles are covered by water. Most of Houston is located on the gulf coastal plan and is categorized as flat terrain. Downtown stands only 50 feet above sea level, and the highest point in far northwest Houston Is about 125 feet above sea level. The city's vegetation is classified as temperate grassland and forest. As the city grew, a large portion was developed on forested land, marshes, swamp, or prairie. The flatness of the local terrain, when combined with urban sprawl, has made flooding a recurring problem for the city.

Houston has four major bayous, and each play an important role as critical elements of the drainage infrastructure, which convey water from neighborhood to Galveston Bay. These include: 1) Buffalo Bayou, which runs west to east, through downtown, and empties into the Houston Ship Channel; 2) White Oak Bayou, which is located on the northwest side of the City; 3) Brays Bayou, which is located west-southwest of downtown; and 4) Sims Bayou, located southwest of downtown. White Oak, Brays, and Sims Bayous flow into Buffalo Bayou. The Houston Ship Channel continues towards the Gulf of Mexico. Other major waterways include the San Jacinto River, which flows through the far northeastern portion of the City and in Lake Houston. Other watersheds in the Houston metropolitan area include Cypress Creek, Greens Bayou, Hunting Bayou, Carpenters Bayou, Vince Bayou, and Armand Bayou, and Clear Creek. Figure 2 provides a map of these watersheds.

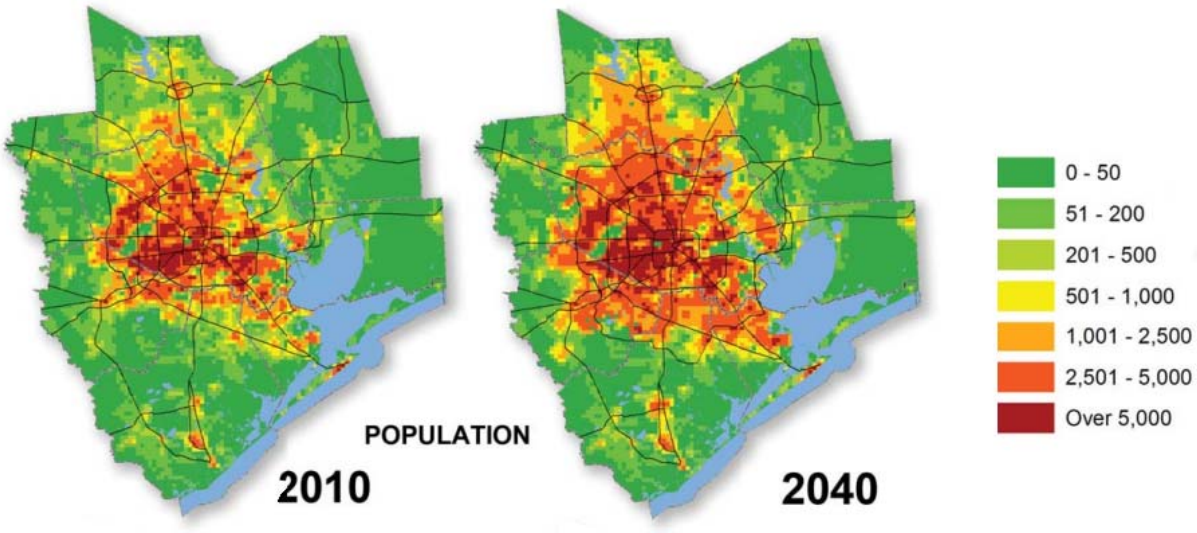
Figure 2: City of Houston Watersheds



Source: City of Houston Office of Emergency Management

According to the most recent decennial census from 2010, Houston's estimated population was 2,099,451. Overall, Houston experienced an increase in population of 560,602 people, or almost 33-percent, from 1980 to 2000. The City population continued to grow by 9.36 percent, or 170,662 people, between 2000 and 2010. Recent U.S. Census Bureau estimates show that Houston's population has grown to 2,325,502, or nearly 11 percent, between the 2000 decennial census and 2018. The Houston area growth rate is among the highest in the nation, and the overall population of the Houston-Galveston region is projected to increase from 5.8 million (2010 census figure) to 9.6 million by 2040. Figure 3 presents the projected estimated growth for the Houston-Galveston region by 2040.

Figure 3: H-GAC Population Growth Estimate[1]



3. Hazard Analysis and Lifeline Assessment

The most recent comprehensive hazard identification and risk assessment for mitigation planning was completed, along with the required plan update, in 2017. Upon a review of the full range of natural hazards suggested under the Federal Emergency Management Agency (FEMA) planning guidance, the City of Houston identified 12 hazard types that could occur in the region. Of the hazards identified, 11 natural hazards and 1 quasi-technological hazard (dam failure) were identified as significant and therefore included in the *City of Houston Hazard Mitigation Action Plan*. This data is presented in Table 3. The potential hazard is further defined in Table 4.

Table 3: Hazard Identification Overview

Hazard	Frequency of Occurrence	Potential Severity	Ranking
Flood	Highly Likely	Substantial	High
Hurricane	Highly Likely	Major	High
Extreme Heat	Highly Likely	Substantial	High
Thunderstorm Wind	Highly Likely	Substantial	High
Lightning	Highly Likely	Substantial	Moderate
Tornado	Likely	Substantial	Moderate
Expansive Soils	Likely	Limited	Low
Hail	Highly Likely	Limited	Low
Wildfire	Highly Likely	Minor	Low
Drought	Highly Likely	Limited	Low
Dam Failure	Unlikely	Substantial	Low
Winter Storm	Likely	Limited	Low

Source: *City of Houston Hazard Mitigation Plan Update 2018*

[1] Source: Houston-Galveston Area Council – Regional Transportation Plan http://www.h-gac.com/regional-transportation-plan/2040/documents/2040-RTP-revised-April-2016.pdf

Table 4: Impact Statements

Potential Severity	Description
Substantial	Multiple deaths. Complete shutdown of facilities for 30 days or more. More than 50 percent of property destroyed or with major damage.
Major	Injuries and illnesses resulting in permanent disability. Complete shutdown of critical facilities for at least 2 weeks. More than 25 percent of property destroyed or with major damage.
Minor	Injuries and illnesses do not result in permanent disability. Complete shutdown of critical facilities for more than 1 week. More than 10 percent of property destroyed or with major damage.
Limited	Injuries and illnesses are treatable with first aid. Shutdown of critical facilities and services for 24 hours or less. Less than 10 percent of property destroyed or with major damage.

Source: *City of Houston Hazard Mitigation Plan Update 2018*

The CDBG-Mitigation risk assessment, addresses all hazards identified in the *City of Houston Hazard Mitigation Action Plan*. More detailed analyses are provided on hazards which have impacted Houston significantly in recent years, including flooding, hurricane, and dam-related hazards, as well as including information about sea level rise, which is not directly addressed in the current approved plan. These are the risks that are considered to have the highest potential for consequences for the City of Houston.

FEMA recently defined Community Lifelines for the purposes of incident response, allowing the federal government to better understand the impacts of hazards and disasters in states and local jurisdictions. While the *City of Houston Hazard Mitigation Action Plan* does not currently evaluate hazards using these lifelines, future risk assessments and plans will include lifeline assessments to align with this federal initiative. The lifelines assessed, including their components are shown in Table 5.

Table 5: Community Lifeline Components

Safety & Security	Food, Water, Sheltering	Communications
Law Enforcement/Security	Food	Infrastructure
Fire Service	Water	Responder Communications
Search and Rescue	Shelter	Alerts, Warnings, Messages
Government Service	Agriculture	Finance
Community Safety		911 and Dispatch
Transportation	**Health and Medical**	**Hazardous Material (Mgmt)**
Highway/Roadway/Motor Vehicle	Medical Care	Facilities
Mass Transit	Public Health	HAZMAT, Pollutants, Contaminants
Railway	Patient Movement	**Energy**
Aviation	Medical Supply Chain	Power Grid
Maritime	Fatality Management	Fuel

Source: FEMA Community Lifelines Toolkit 2.0

Ensuring the resiliency of Community Lifelines is an important concept in all phases of emergency management, including mitigation. To quantitatively assess lifelines, the City of Houston is evaluating known facilities and infrastructure to support each lifeline and conducting geographic assessments of each with known hazard zones. The quantitative assessment is limited to flood risks (both inland and coastal), and supporting maps are presented in

Appendix 2. A preliminary assessment of each lifeline by hazard is provided in this section using vulnerability and consequence/impact assessments for each of the seven community lifelines. The classifications of vulnerability and consequences are shown in Table 6 and Table 7, respectively. These assessments are presented at the end of each hazard section. Consequence analysis may include all components of a lifeline or be isolated to one or two components or subcomponents that are critical in a given hazard condition.

Table 6: Vulnerability Classifications

Vulnerability	Description
High Vulnerability	Geographically widespread exposure of facilities and systems to the damaging effects of a hazard AND the lifeline has low resilience to a hazard.
Moderate Vulnerability	The geographic exposure of facilities and systems to a hazard is widespread OR the lifeline has a low resilience to a hazard and the hazard is geographically isolated.
Low Vulnerability	Exposure of facilities and systems related to a community lifeline are geographically isolated or the system itself has significant resilience to the hazard.

Source: City of Houston OEM

Table 7: Consequence Classifications

Consequence	Description
Low Impact to Lifeline/Services	In the worst, most probable hazard situation, services and infrastructure are fully functioning within hours of onset of the hazard condition.
Moderate Impact to Lifeline/Services	In the worst, most probable hazard situation, services and infrastructure are functioning within days of onset of the hazard condition.
Significant Impact to Lifeline/Services	In the worst, most probable hazard situation, services and infrastructure are functioning within weeks of onset of the hazard condition.

Source: City of Houston OEM

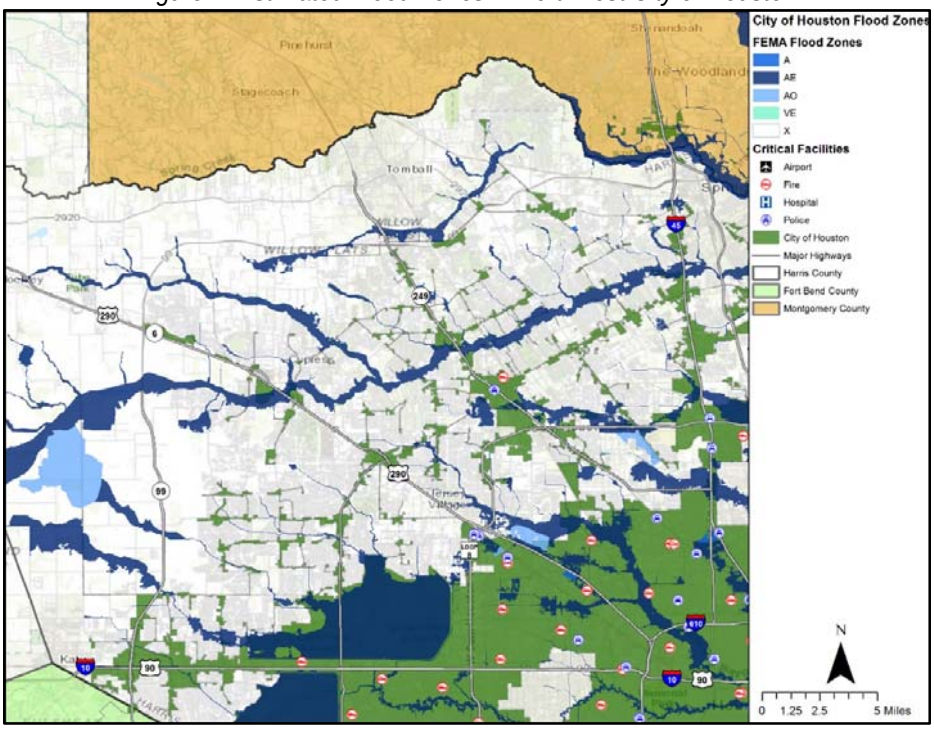
a. Flood

According the City's *Hazard Mitigation Action Plan*, flooding is the foremost hazard that threatens the City of Houston. The severity of a flood event is determined by a combination of several major factors, including: stream and river basin topography and physiography; precipitation and weather patterns; antecedent; recent soil moisture conditions; the degree of vegetative clearing and impervious surfaces; and drainage system capacity and condition of infrastructure. Floods can be short-term or long-term in duration, ranging from several hours to several days.

FEMA's Flood Insurance Rate Maps (FIRMs) are used to regulate new development and to control the improvement and repair of substantially-damaged buildings. Flood Insurance Studies (FIS) are often developed in conjunction with FIRMs. The FIS typically contains a narrative of the flood history of a community and discusses the engineering methods used to develop the FIRMs. The FIS also contains flood profiles for studied flooding sources and can be used to determine Base Flood Elevations (BFEs) for some areas.

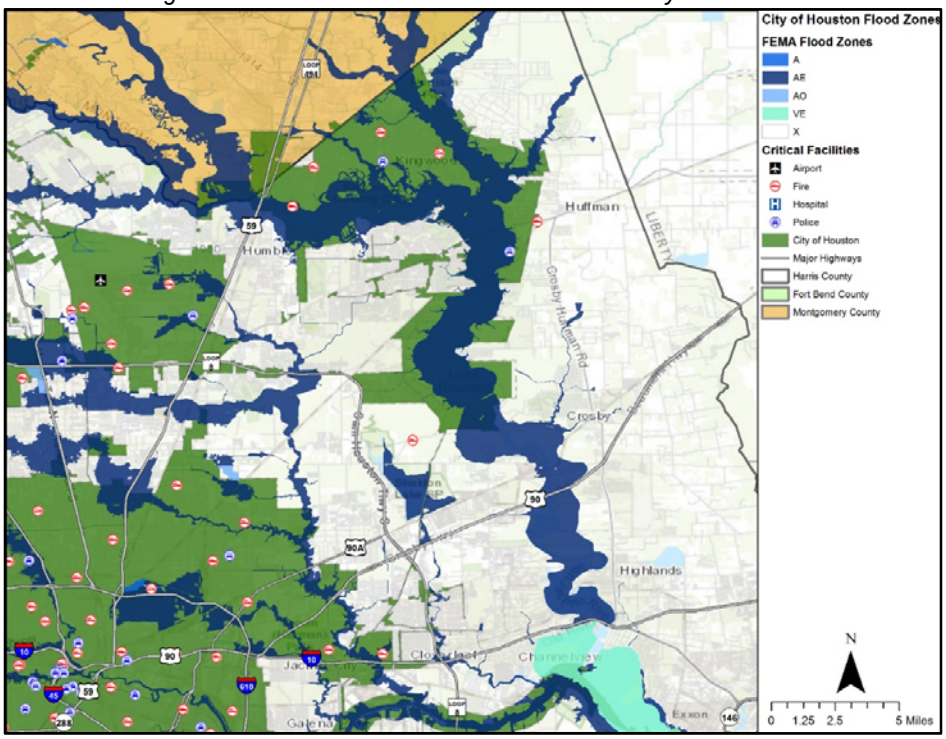
The revised FIS for the City of Houston is dated August 18, 2014. This FIS compiles all previous flood information and includes data collected on numerous waterways. Thousands of residential homes are located in the identified flood hazard area. Figures 4 through 7 present the FEMA-estimated flood zones, developed through the FIRM and FIS process, for different sections of the City. Flood hazard areas are designated as any FEMA Flood Zone other than X, shown in the Legend in each Figure.

Figure 4: Estimated Flood Zones in Northwest City of Houston



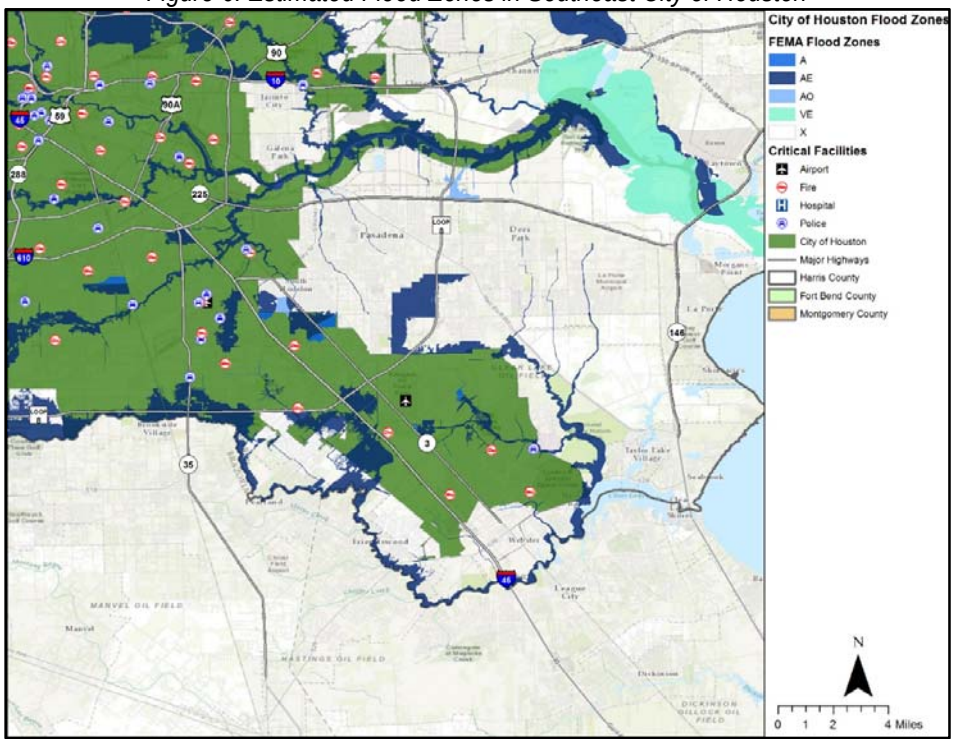
Source: City of Houston OEM

Figure 5: Estimated Flood Zones in Northeast City of Houston



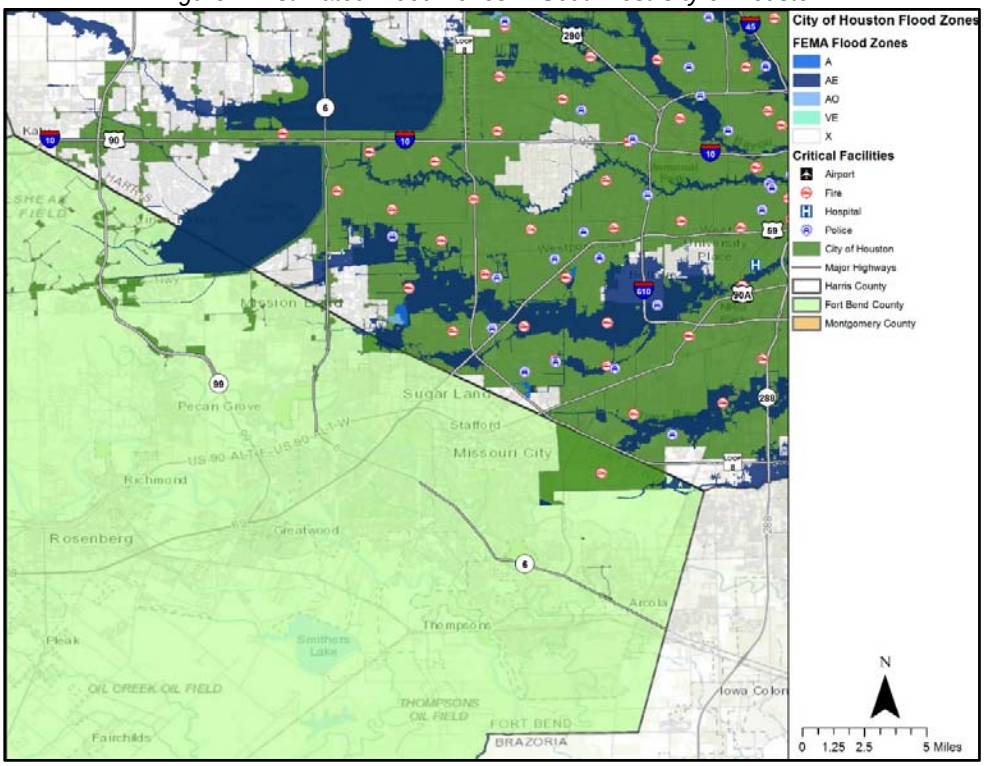
Source: City of Houston OEM

Figure 6: Estimated Flood Zones in Southeast City of Houston



Source: City of Houston OEM

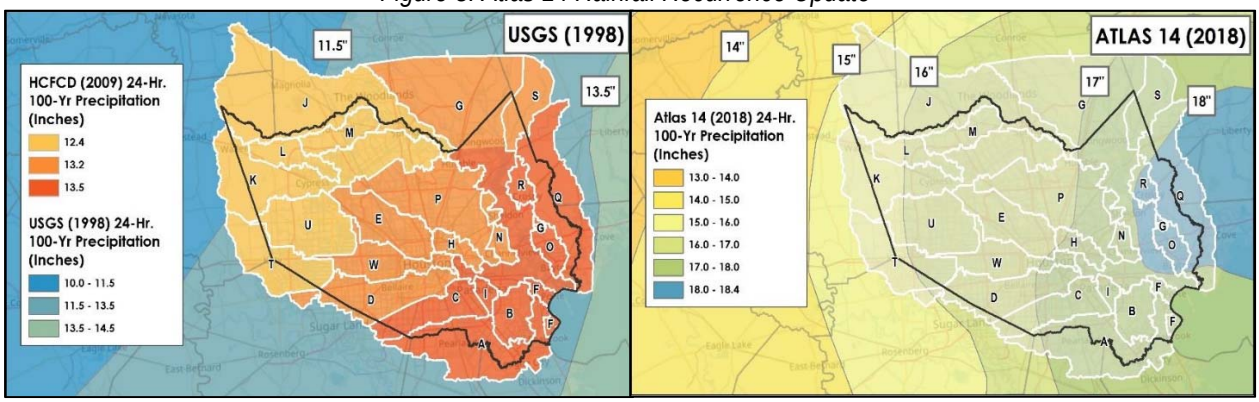
Figure 7: Estimated Flood Zones in Southwest City of Houston



Source: City of Houston OEM

FIRMs do not account for all the complexities of drainage patterns in a rapidly developing environment and are an incomplete snapshot of flood risk in the Houston area. The Harris County Flood Control District (HCFCD) and FEMA are currently partnering on a flood hazard assessment project to produce a comprehensive set of maps that will include previously unmapped urban flood hazards. This assessment will incorporate the National Oceanic and Atmospheric Administration's (NOAA) Atlas 14 results, which include increased estimates of the precipitation amounts in a standard return period (i.e., 100-year interval).[2] HCFCD's project will culminate in the development of new FIRMs and other flood risk projects, which will be delivered to FEMA for review by the end of 2021. Figure 8 presents the updated Atlas 14 rainfall data for Harris County for the 24-hour, 100-year storm.

Figure 8: Atlas 14 Rainfall Recurrence Update



Source: NCDC Storm Data

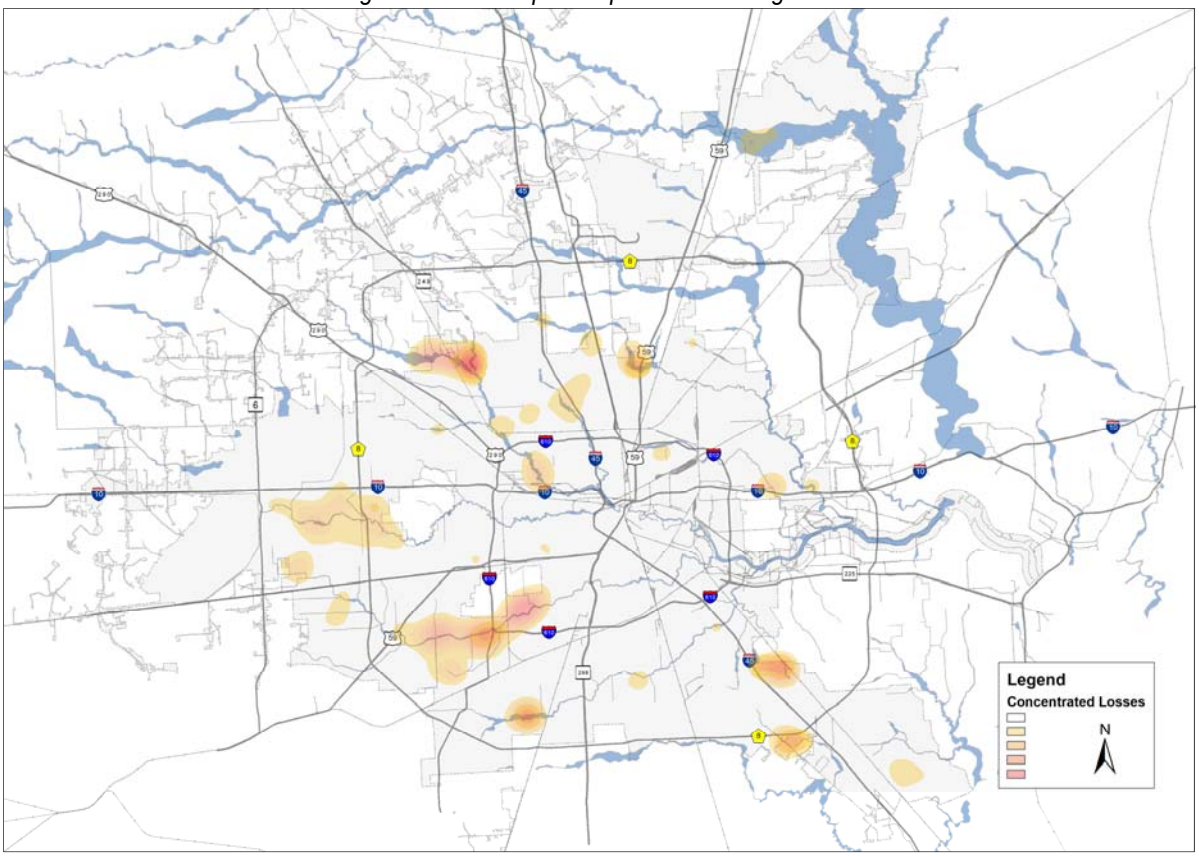
As the Texas Water Development Board (TWDB) noted in its 2019 Flood Report to the Legislature, "The (Atlas 14) data showed that in areas with significant increases in estimated rainfall, flood risks are likely to be greater than previously thought." Data for the Houston area indicates a 30 percent increase in estimated rainfall during extreme events. As TWDB indicates, flood risks are likely to be greater than previously thought.

The Harris County Flood Control District has reviewed recent storms within the new parameters outlined by the Atlas 14 study. Since 2016, a three-year time period, Houston has experienced a 50-year storm, two 100-year storms, and a 500-year storm. If the timeline is extended to twenty years and includes Tropical Storm Allison, Houston has experienced two storms with a 500-year probability of recurrence.

Figure 9 below shows the intensity of repetitive flood losses in Houston.

[2] Source: Harris County Modeling Assessment and Awareness Project. http://www.maapnext.org/

Figure 9: Heat Map of Repetitive Flooding in Houston



Source: Houston Public Works

Flooding is the deadliest natural disasters that occur in the U.S. each year, and it poses a constant and significant threat to the health and safety of the people in the City of Houston. Impacts to the community can include:

- Flood-related rescues may be necessary due to swift water and low water crossings, or in flooded neighborhoods where roads have become impassable, which places first responders in harm's way. This increases the risk to first responders.
- Evacuations may be required for entire neighborhoods because of rising floodwaters, further taxing limited response capabilities and increasing sheltering needs for displaced residents.
- Health risks and threats to residents are elevated after flood waters have receded due to contamination (untreated sewage and hazardous chemicals) and mold growth typical in flooded buildings and homes.
- Significant flood events often result in widespread power outages, increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outages can also result in an increase in structure fires and/or carbon monoxide poisoning, as individuals attempt to cook or heat their home with alternative, unsafe cooking or heating devices, such as grills.
- Floods can destroy or make residential structures uninhabitable, requiring shelter or relocation of residents in the aftermath of the event.
- First responders are exposed to downed power lines, contaminated and potentially unstable debris, hazardous materials, and generally unsafe conditions, elevating the risk of injury to first responders and potentially diminishing emergency response capabilities.
- Emergency operations and services may be significantly impacted due to damaged facilities.

- Significant flooding can result in the inability of emergency response vehicles to access areas of the community.
- Critical staff may suffer personal losses or otherwise be impacted by a flood event and be unable to report for duty, limiting response capabilities.
- City or county departments may be flooded, delaying response and recovery efforts for the entire community.
- Private sector entities that the City and its residents rely on, such as utility providers, financial institutions, and medical care providers, may not be fully operational and may require assistance from neighboring communities until full services can be restored.
- Damage to infrastructure may slow economic recovery since repairs may be extensive and lengthy.
- Some businesses not directly damaged by the flood may be negatively impacted while utilities are being restored or water recedes, further slowing economic recovery.
- When the community is affected by significant property damage it is anticipated that funding would be required for infrastructure repair and restoration, temporary services and facilities, overtime pay for responders, as well as normal day-to-day operating expenses.
- Displaced residents may not be able to immediately return to work, further slowing economic recovery.
- Residential structures substantially damaged by a flood may not be rebuilt for years and uninsured or underinsured residential structures may never be rebuilt, reducing the tax base for the community.
- Large floods may result in a dramatic population fluctuation, as people are unable to return to their homes or jobs and must seek shelter and/or work outside of the affected area.
- Businesses that are uninsured or underinsured may have difficulty reopening, which results in a net loss of jobs for the community and a potential increase in the unemployment rate.
- Flooding may cause significant disruptions of clean water and sewer services, elevating health risks and delaying recovery efforts.
- The psychosocial effects on flood victims and their families can traumatize them for long periods of time, creating long-term increases in medical treatment and services.
- Extensive or repetitive flooding can lead to decreases in property value for the affected community.
- Flood poses a potential catastrophic risk to annual and perennial crop production and overall crop quality, leading to higher food costs.
- Flood-related declines in production may lead to an increase in unemployment.
- The City of Houston includes 52,912 acres of total park space. Recreation activities throughout the City's parks may be unavailable, and tourism can be unappealing for years following a large flood event, devastating directly-related local businesses and negatively impacting economic recovery.
- Flooding exacerbates the housing inequality crisis and further reduces the City's accessibility of affordable housing structures.
- Significant sediment redeposition throughout the community alters the natural waterways, increases erosion, and impairs the Houston Ship Channel.
- Flooding increases pollutants and toxicants into the local waterways, affecting the ecosystem, residential use, and quality of life in the community.

A summary assessment of flood hazard vulnerability and impacts to the community lifelines is presented in Table 8. Further, quantitative data supports this analysis for several components, and their subcomponents, of multiple community lifelines. This is presented in Table 9.

Table 8: Flood Vulnerability and Consequence Summary by Lifeline

Flood	Vulnerability	Consequence
Safety and Security	High Vulnerability	Moderate Impact to Lifeline/Services
Food, Water, Sheltering	High Vulnerability	Significant Impact to Lifeline/Services
Communications	Moderate Vulnerability	Moderate Impact to Lifeline/Services
Transportation	High Vulnerability	Significant Impact to Lifeline/Services
Health and Medical	Moderate Vulnerability	Significant Impact to Lifeline/Services
Hazardous Material (Mgmt)	High Vulnerability	Significant Impact to Lifeline/Services
Energy (Power and Fuel)	High Vulnerability	Significant Impact to Lifeline/Services

Table 9: Facilities and Infrastructure by Lifeline in Specific Flood Hazard Areas

Fire Stations	Lifeline: Safety & Security
.2 PCT Annual Chance Flood Hazard	9
A (Special Areas)	1
AE (1% Flood Event)	13
AO (1% Shallow Flooding)	0
VE (1% Coastal)	0
Not in Floodzone	71
Law Enforcement Facilities	**Lifeline: Safety & Security**
.2 PCT Annual Chance Flood Hazard	2
A (Special Areas)	0
AE (1% Flood Event)	1
AO (1% Shallow Flooding)	3
VE (1% Coastal)	0
Not in Floodzone	16
Evacuation Routes (miles)	**Lifeline: Food, Water, Sheltering**
.2 PCT Annual Chance Flood Hazard	34.4
A (Special Areas)	0.01
AE (1% Flood Event)	34.8
AO (1% Shallow Flooding)	0.02
VE (1% Coastal)	0
Not in Floodzone	782.7

Water Mains (miles)	Lifeline: Food, Water, Sheltering
.2 PCT Annual Chance Flood Hazard	41.6
A (Special Areas)	2.7
AE (1% Flood Event)	57.2
AO (1% Shallow Flooding)	0.1
VE (1% Coastal)	0
Not in Floodzone	343.1
Schools	**Lifeline: Food, Water, Sheltering**
.2 PCT Annual Chance Flood Hazard	128
A (Special Areas)	7
AE (1% Flood Event)	79
AO (1% Shallow Flooding)	2
VE (1% Coastal)	0
Not in Floodzone	1046
Hospitals	**Lifeline: Health & Medical**
.2 PCT Annual Chance Flood Hazard	17
A (Special Areas)	0
AE (1% Flood Event)	14
AO (1% Shallow Flooding)	0
VE (1% Coastal)	0
Not in Floodzone	74

Source: City of Houston OEM

b. Hurricane

The location of the City of Houston near the Gulf coast increases vulnerability to direct and indirect factors related to a hurricane event, such as high-force winds, storm surge, and flooding. While the City is not located directly along the Gulf coast, the southeast jurisdictional boundary is located approximately 20 miles from the coast, making it susceptible to hurricanes. Hurricanes and/or tropical storms can impact Houston during the official Atlantic U.S. hurricane season, which occurs between June 1 and November 30 each year. The City of Houston planning area is in a moderate- to high-risk area for hurricane wind speeds up to 155 miles per hour (mph). There are 43 tropical cyclones on record that have occurred within 50 miles of the City of Houston.

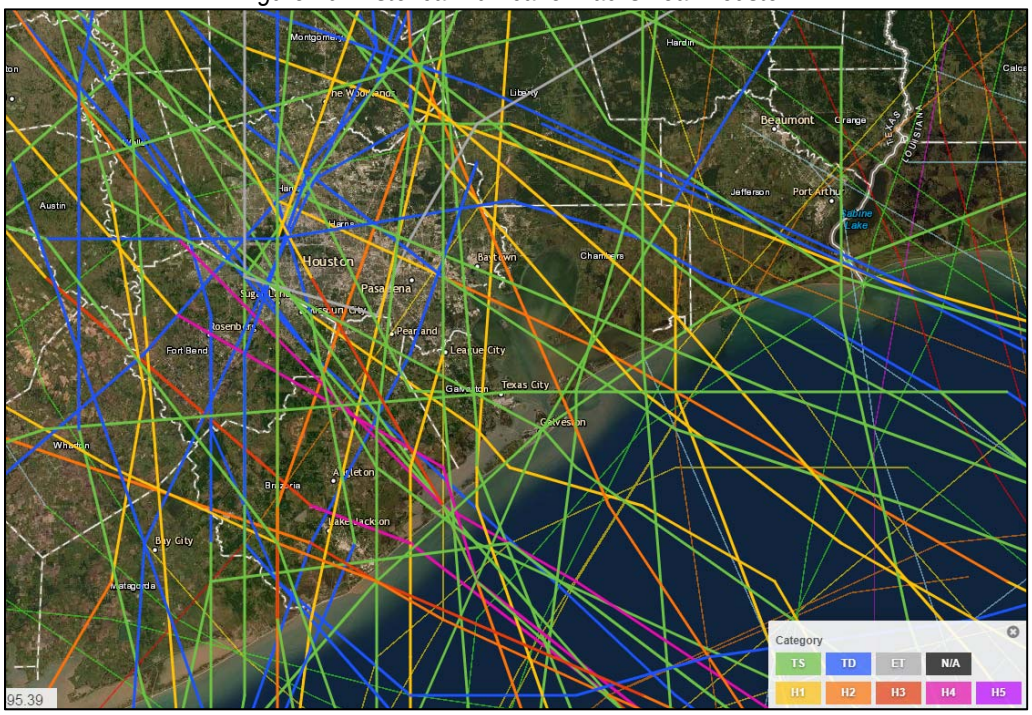
Hurricanes are categorized according to the strength and intensity of their winds using the Saffir-Simpson Hurricane Scale, as shown in Table 10. A Category 1 storm has the lowest wind speeds, while a Category 5 hurricane has the highest. However, a lower category storm can inflict greater damage than higher category storms depending on location, storm surge, regional weather patterns, and speed. Figure 10 presents historical tracking of tropical storms and hurricanes that have occurred in the City of Houston planning area.

Table 10: Saffir-Simpson Scale

Category	Maximum Sustained Wind Speed (mph)	Minimum Surface Pressure (millibars)	Storm Surge (feet)
1	74 – 95	Greater than 980	3 – 5
2	96 – 110	979 – 965	6 – 8
3	111 – 130	964 – 945	9 – 12
4	131 – 155	944 – 920	13 – 18
5	155 +	Less than 920	19+

Source: https://www.nhc.noaa.gov/aboutsshws.php

Figure 10: Historical Hurricane Tracks near Houston



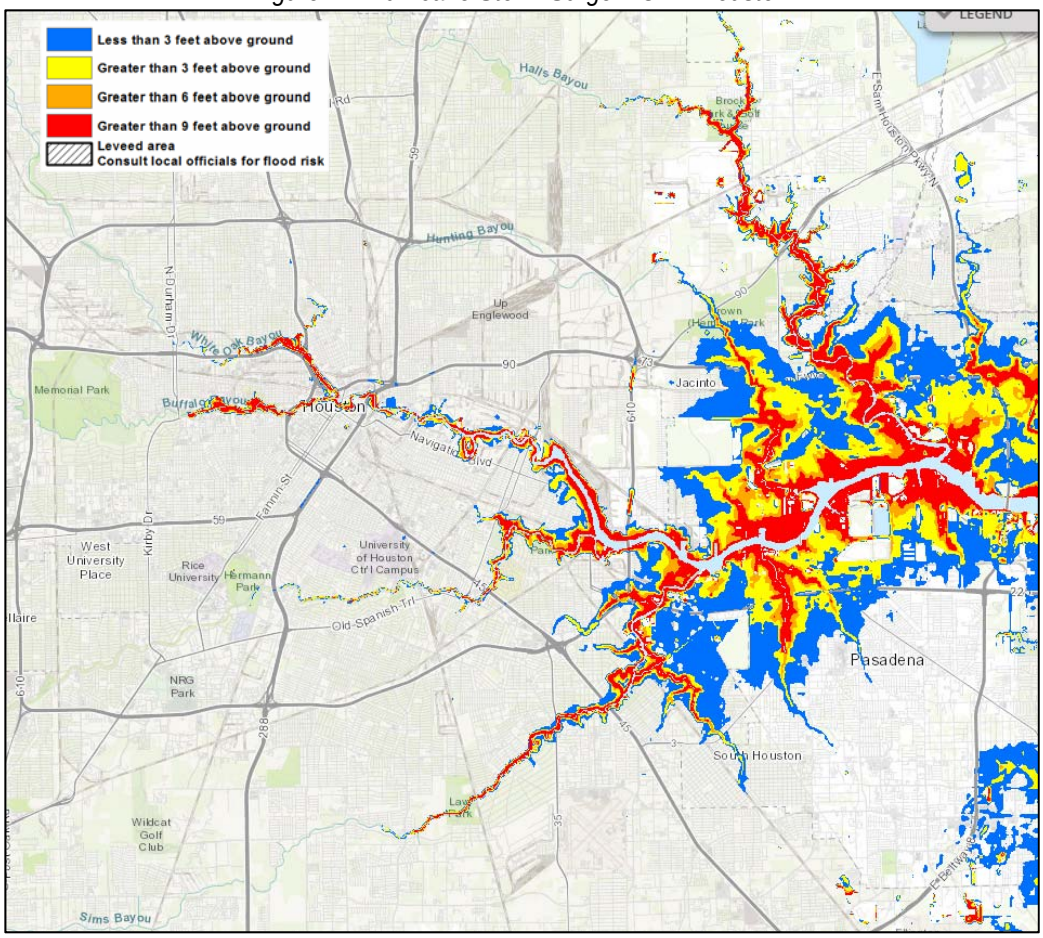
Source: https://coast.noaa.gov/hurricanes/

Hurricanes and Tropical Storms can cause major damage to large areas; all existing buildings, facilities, and populations are equally exposed and vulnerable to this hazard and could potentially be impacted. Approximately 58 percent of single family residential homes, representing about 539,639 structures in the city, were built before 1980.[3] These structures are more susceptible to storm damage due to the outdated and less stringent construction standards and building codes.

Houston also has multiple mobile or manufactured home parks. These parks are typically more vulnerable to hurricane events than typical site-built structures if they are not properly anchored or properly maintained. The 2010 U.S. Census data indicates a total of 8,716 manufactured homes are located in the City of Houston.

[3] Source: U.S. Census Bureau data estimates for 2015.

Figure 11: Hurricane Storm Surge Risk in Houston



Source: NOAA, National Storm Surge Hazard Maps: https://noaa.maps.arcgis.com/home/index.html

Figure 11 presents the risk associated with storm surge that could be produced by a hurricane. It should be noted that storm surge is not entirely dependent on the strength of the storm but can vary depending on the size or speed of the storm.

Hurricane events have the potential to pose a significant risk to people and can create dangerous and difficult situations for public health and safety officials. In addition to aforementioned effects of widespread flooding previously described, impacts of hurricanes to Houston community can include:

- Individuals exposed to the storm can be struck by flying debris, falling limbs, or downed trees causing serious injury or death.
- Structures can be damaged or crushed by falling trees, which can result in physical harm to the occupants.
- Driving conditions may be dangerous during a hurricane event, especially over elevated bridges, increasing the risk of injury and accidents during evacuations if not timed properly.
- Emergency evacuations may be necessary prior to a hurricane making landfall, requiring emergency responders, evacuation routing, and temporary shelters.
- Significant debris and downed trees can result in emergency response vehicles being unable to access areas of the community.

- Downed power lines may result in roadways being unsafe for use, which may prevent first responders from answering calls for assistance or rescue.
- During hurricane landfall, first responders may be prevented from responding to calls as the winds may reach a speed in which their vehicles and equipment are unsafe to operate.
- Hurricane events often result in widespread power outages, increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outages can also result in an increase in structure fires and carbon monoxide poisoning as individuals attempt to cook or heat their homes with alternative, unsafe cooking or heating devices, such as grills.
- Extreme hurricane events may rupture gas lines and down trees and power lines, increasing the risk of structure fires during and after a storm event.
- Extreme hurricane events may lead to prolonged evacuations during search and rescue, and immediate recovery efforts requiring additional emergency personnel and resources to prevent entry, protect citizens, and protect property.
- First responders are exposed to downed power lines, unstable and unusual debris, hazardous materials, and generally unsafe conditions.
- Emergency operations and services may be significantly impacted due to damaged facilities and/or loss of communications.
- Critical staff may be unable to report for duty, limiting response capabilities.
- City or county departments may be damaged, delaying response and recovery efforts for the entire community.
- Private sector entities that the City and its residents rely on, such as utility providers, financial institutions, and medical care providers, may not be fully operational and may require assistance from neighboring communities until full services can be restored.
- Economic disruption negatively impacts the programs and services provided by the community due to short- and long-term loss in revenue.
- Some businesses not directly damaged by the hurricane may be negatively impacted while roads are cleared and utilities are being restored, further slowing economic recovery.
- Older structures built to less stringent building codes may suffer greater damage as they are typically more vulnerable to hurricane damage.
- Large scale hurricanes can have significant economic impact on the affected area, as it must now fund expenses such as infrastructure repair and restoration, temporary services and facilities, overtime pay for responders, as well as normal day-to-day operating expenses.
- Businesses that are more reliant on utility infrastructure than others may suffer greater damages without a backup power source.

The economic and financial impacts of a hurricane will depend entirely on the scale of the event, an inventory of damage, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning performed by the counties, communities, local businesses, and residents will also contribute to the overall economic and financial conditions in the aftermath of any hurricane event.

A summary assessment of hurricane hazard vulnerability and impacts to the community lifelines is presented in Table 11.

Table 11: Hurricane Vulnerability and Consequence Summary by Lifeline

Hurricane	Vulnerability	Consequence
Safety and Security	High Vulnerability	Significant Impact to Lifeline/Services
Food, Water, Sheltering	High Vulnerability	Significant Impact to Lifeline/Services
Communications	High Vulnerability	Significant Impact to Lifeline/Services
Transportation	High Vulnerability	Significant Impact to Lifeline/Services
Health and Medical	Moderate Vulnerability	Significant Impact to Lifeline/Services
Hazardous Material (Mgmt)	High Vulnerability	Significant Impact to Lifeline/Services
Energy (Power and Fuel)	High Vulnerability	Significant Impact to Lifeline/Services

c. Extreme Heat

Extreme heat is the condition where temperatures hover ten degrees or more above the average temperature in a region for an extended period. Extreme heat is often associated with conditions of high humidity. When these conditions persist over a long period of time, it is defined as a heat wave. Extreme heat during the summer months is a common occurrence throughout the State of Texas, and the City of Houston is no exception. In addition, the City of Houston experiences urban heat islands, primarily in downtown areas, due to an increase of asphalt and concrete. According to historical records the City of Houston planning area has experienced 63 events in a 21-year reporting period. This provides a frequency of occurrence of approximately 3 events every year. This frequency supports a highly likely probability of future events.

The greatest risk from extreme heat is to public health and safety. Potential impacts to the community may include:

- Vulnerable populations, particularly the elderly and children under 5, can face serious or life-threatening health problems from exposure to extreme heat including hyperthermia; heat cramps; heat exhaustion; and heat stroke (or sunstroke).
- Response personnel including utility workers, public works personnel, and any other professions where individuals are required to work outside, are more subject to extreme heat related illnesses since their exposure would typically be greater.
- High energy demand periods can outpace the supply of energy, potentially creating the need for rolling brownouts, which would elevate the risk of illness to vulnerable residents.
- Highways and roads may be damaged by excessive heat causing asphalt roads to soften and concrete roads to shift or buckle.
- Vehicle engines and cooling systems typically run harder during extreme heat events, resulting in increases in mechanical failures.
- Extreme heat events during times of drought can exacerbate the environmental impacts associated with drought, decreasing water and air quality, and further degrading wildlife habitat.
- Extreme heat increases ground-level ozone (smog), increasing the risk of respiratory illnesses.
- Tourism and recreational activities predominant in the City of Houston may be negatively impacted during extreme heat events, reducing seasonal revenue.
- Food suppliers can anticipate an increase in food costs due to increases in production costs and crop and livestock losses.
- Fisheries may be negatively impacted by extreme heat, suffering damage to fish habitats (either natural or man-made), and a loss of fish and/or other aquatic organisms due to decreased water flows or availability.
- Negatively impacted water suppliers may face increased costs resulting from the transport of water or developing supplemental water resources.
- Outdoor activities may see an increase in school injury or illness during extreme heat events.

The economic and financial impacts of extreme heat on the community will depend on the duration of the event, demand for energy, drought associated with extreme heat, and many other factors. The level of preparedness and the amount of planning done by the jurisdiction, local businesses, and citizens will impact the overall economic and financial conditions before, during, and after an extreme heat event.

A summary assessment of extreme heat hazard vulnerability and impacts to the community lifelines is presented in Table 12.

Table 12: Extreme Heat Vulnerability and Consequence Summary by Lifeline

Extreme Heat	Vulnerability	Consequence
Safety and Security	Moderate Vulnerability	Low Impact to Lifeline/Services
Food, Water, Sheltering	Moderate Vulnerability	Low Impact to Lifeline/Services
Communications	Moderate Vulnerability	Low Impact to Lifeline/Services
Transportation	Low Vulnerability	Low Impact to Lifeline/Services
Health and Medical	Low Vulnerability	Low Impact to Lifeline/Services
Hazardous Material (Mgmt)	Moderate Vulnerability	Low Impact to Lifeline/Services
Energy (Power and Fuel)	High Vulnerability	Moderate Impact to Lifeline/Services

d. Thunderstorm Wind

Thunderstorms create extreme wind events which include straight line winds. Wind is the horizontal motion of the air past a given point, beginning with differences in air pressures. Pressure that is higher at one place than another sets up a force pushing from the high toward the low pressure; the greater the difference in pressures, the stronger the force. The distance between the area of high pressure and the area of low pressure also determines how fast the moving air is accelerated.

Straight line winds are responsible for most thunderstorm wind damages. One type of straight line wind, the downburst, is a small area of rapidly descending air beneath a thunderstorm. A downburst can cause damage equivalent to a strong tornado and make air travel extremely hazardous.
Most thunderstorm winds occur during the spring, in the months of March, April, and May, and in the fall, during the month of September. Based on available records of historic events, 170 events, including those since the last update of the plan, in a 22-year reporting period provide a frequency of occurrence of 7 to 8 events every year. Even though the intensity of thunderstorm wind events is not always damaging for the City of Houston planning area, the frequency of occurrence for a thunderstorm wind event is highly likely, meaning that an event is probable within the next year for the Houston planning area.

Thunderstorm wind events have the potential to pose a significant risk to people and can create dangerous and difficult situations for public health and safety officials. Impacts to the planning area can include:

- Individuals exposed to the storm can be struck by flying debris, falling limbs, or downed trees, causing serious injury or death.
- Structures can be damaged or crushed by falling trees, which can result in physical harm to the occupants.
- Significant debris and downed trees can result in emergency response vehicles being unable to access areas of the community.
- Downed power lines may result in roadways being unsafe for use, which may prevent first responders from answering calls for assistance or rescue.
- During exceptionally heavy wind events, first responders may be prevented from responding to calls, as the winds may reach a speed in which their vehicles and equipment are unsafe to operate.

- Thunderstorm wind events often result in widespread power outages, increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outages often result in an increase in structure fires and carbon monoxide poisoning, as individuals attempt to cook or heat their homes with alternate, unsafe cooking or heating devices, such as grills.
- First responders are exposed to downed power lines, unstable and unusual debris, hazardous materials, and generally unsafe conditions.
- Emergency operations and services may be significantly impacted due to damaged facilities and/or loss of communications.
- Critical staff may be unable to report for duty, limiting response capabilities.
- City or county departments may be damaged, delaying response and recovery efforts for the entire community.
- Private sector entities that the City and its residents rely on, such as utility providers, financial institutions, and medical care providers may not be fully operational and may require assistance from neighboring communities until full services can be restored.
- Economic disruption negatively impacts the programs and services provided by the community due to short- and long-term loss in revenue.
- Some businesses not directly damaged by thunderstorm wind events may be negatively impacted while roads are cleared and utilities are being restored, further slowing economic recovery.
- Older structures built to less stringent building codes may suffer greater damage as they are typically more vulnerable to thunderstorm winds.
- Large scale wind events can have significant economic impact on the affected area, as it must now fund expenses such as infrastructure repair and restoration, temporary services and facilities, overtime pay for responders, as well as normal day-to-day operating expenses.
- Businesses that are more reliant on utility infrastructure than others may suffer greater damages without a backup power source.
- The City of Houston includes 52,912 acres of total park space. A large thunderstorm wind event could impact recreational activities, placing visitors and residents in imminent danger, potentially requiring emergency services or evacuation. Recreational areas and parks may be damaged or inaccessible due to downed trees or debris, causing temporary impacts to area businesses.

The economic and financial impacts of thunderstorm winds on the area will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning done by the community, local businesses, and citizens will also contribute to the overall economic and financial conditions in the aftermath of any thunderstorm wind event.

A summary assessment of thunderstorm wind hazard vulnerability and impacts to the community lifelines is presented in Table 13.

Table 13: Thunderstorm Wind Vulnerability and Consequence Summary by Lifeline

Thunderstorm Wind	Vulnerability	Consequence
Safety and Security	Low Vulnerability	Low Impact to Lifeline/Services
Food, Water, Sheltering	Moderate Vulnerability	Low Impact to Lifeline/Services
Communications	High Vulnerability	Moderate Impact to Lifeline/Services
Transportation	Low Vulnerability	Moderate Impact to Lifeline/Services
Health and Medical	Low Vulnerability	Low Impact to Lifeline/Services
Hazardous Material (Mgmt)	Moderate Vulnerability	Moderate Impact to Lifeline/Services
Energy (Power and Fuel)	Moderate Vulnerability	Significant Impact to Lifeline/Services

e. Lightning

Lightning is a discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm, creating a "bolt" when the buildup of charges becomes strong enough. This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Lightning rapidly heats the sky as it flashes but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes the thunder which often accompanies lightning strikes. While most often affiliated with severe thunderstorms, lightning often strikes outside of heavy rain and might occur as far as 10 miles away from any rainfall.

According to Federal Emergency Management Agency (FEMA), an average of 300 people are injured and 80 people are killed in the United States each year by lightning. Direct lightning strikes also have the ability to cause significant damage to buildings, critical facilities, and infrastructure. Lightning is also responsible for igniting wildfires that can result in widespread damages to property before firefighters have the ability to contain and suppress the resultant fire.

Based on historical records, the U.S. National Lightning Detection Network, and input from the planning team, the probability of occurrence for future lightning events in the City of Houston planning area is considered highly likely, or an event probable in the next year. According to NOAA, the City of Houston planning area is in a part of the country that experiences 12 to 28 lightning flashes per square mile per year (approximately 7,524 to 17,556 flashes per year). Given this estimated frequency of occurrence, it can be expected that future lightning events will continue to threaten life and cause minor property damages throughout the planning area.

Lightning events have the potential to pose a significant risk to people and can create dangerous and difficult situations for public health and safety officials. Impacts to the planning area can include:

- The City of Houston includes 52,912 acres of total park space. Lightning events could impact recreational activities, placing residents and visitors in imminent danger, potentially requiring emergency services or park evacuation.
- Individuals exposed to the storm can be directly struck, posing significant health risks and potential death.
- Structures can be damaged or crushed by falling trees damaged by lightning, which can result in physical harm to the occupants.
- Lightning strikes can result in widespread power outages, increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outages often result in an increase in structure fires and carbon monoxide poisoning, as individuals attempt to cook or heat their homes with alternate, unsafe cooking or heating devices, such as grills.

- Lightning strikes can be associated with structure fires and wildfires, creating additional risk to residents and first responders.
- Emergency operations and services may be significantly impacted due to power outages and/or loss of communications.
- City departments may be damaged, delaying response and recovery efforts for the entire community.
- Economic disruption due to power outages and fires negatively impacts the programs and services provided by the community due to short and long-term loss in revenue.
- Some businesses not directly damaged by lightning events may be negatively impacted while utilities are being restored, further slowing economic recovery.
- Businesses that are more reliant on utility infrastructure than others may suffer greater damages without a backup power source.

The economic and financial impacts of lightning on the area will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning done by the community, local businesses, and citizens will also contribute to the overall economic and financial conditions in the aftermath of any lightning event.

A summary assessment of lightning hazard vulnerability and impacts to the community lifelines is presented in Table 14.

Table 14: Lightning Vulnerability and Consequence Summary by Lifeline

Lightning	Vulnerability	Consequence
Safety and Security	Moderate Vulnerability	Low Impact to Lifeline/Services
Food, Water, Sheltering	Moderate Vulnerability	Low Impact to Lifeline/Services
Communications	Moderate Vulnerability	Moderate Impact to Lifeline/Services
Transportation	Low Vulnerability	Low Impact to Lifeline/Services
Health and Medical	Moderate Vulnerability	Low Impact to Lifeline/Services
Hazardous Material (Mgmt)	Moderate Vulnerability	Moderate Impact to Lifeline/Services
Energy (Power and Fuel)	High Vulnerability	Moderate Impact to Lifeline/Services

f. Tornado

A tornado is a rapidly rotating column of air extending between, and in contact with, a cloud and the surface of the earth.[4] Tornadoes are among the most violent storms on the planet; the most violent tornadoes are capable of tremendous destruction, with wind speeds of 250 miles per hour (mph) or more. In extreme cases, winds may approach 300 mph. Damage paths can be in excess of one mile wide and 50 miles long.

The most powerful tornadoes are produced by "supercell thunderstorms." Supercell thunderstorms are created when horizontal wind shears (winds moving in different directions at different altitudes) begin to rotate the storm. This horizontal rotation can be tilted vertically by violent updrafts, and the rotation radius can shrink, forming a vertical column of very quickly swirling air. This rotating air can eventually reach the ground, forming a tornado.

Tornado magnitudes prior to 2005 were determined using the traditional version of the Fujita Scale. Since February 2007, the Fujita Scale has been replaced by the Enhanced Fujita Scale (Table 15), which retains the same basic design and six strength categories as the previous scale. The newer scale reflects more refined assessments of

[4] Source: https://www.weather.gov/phi/TornadoDefinition

tornado damage surveys, standardization, and damage consideration to a wider range of structures. For the purposes of this plan, those tornadoes that occurred prior to the adoption of the EF scale will still be mentioned in the Fujita Scale for historical reference.

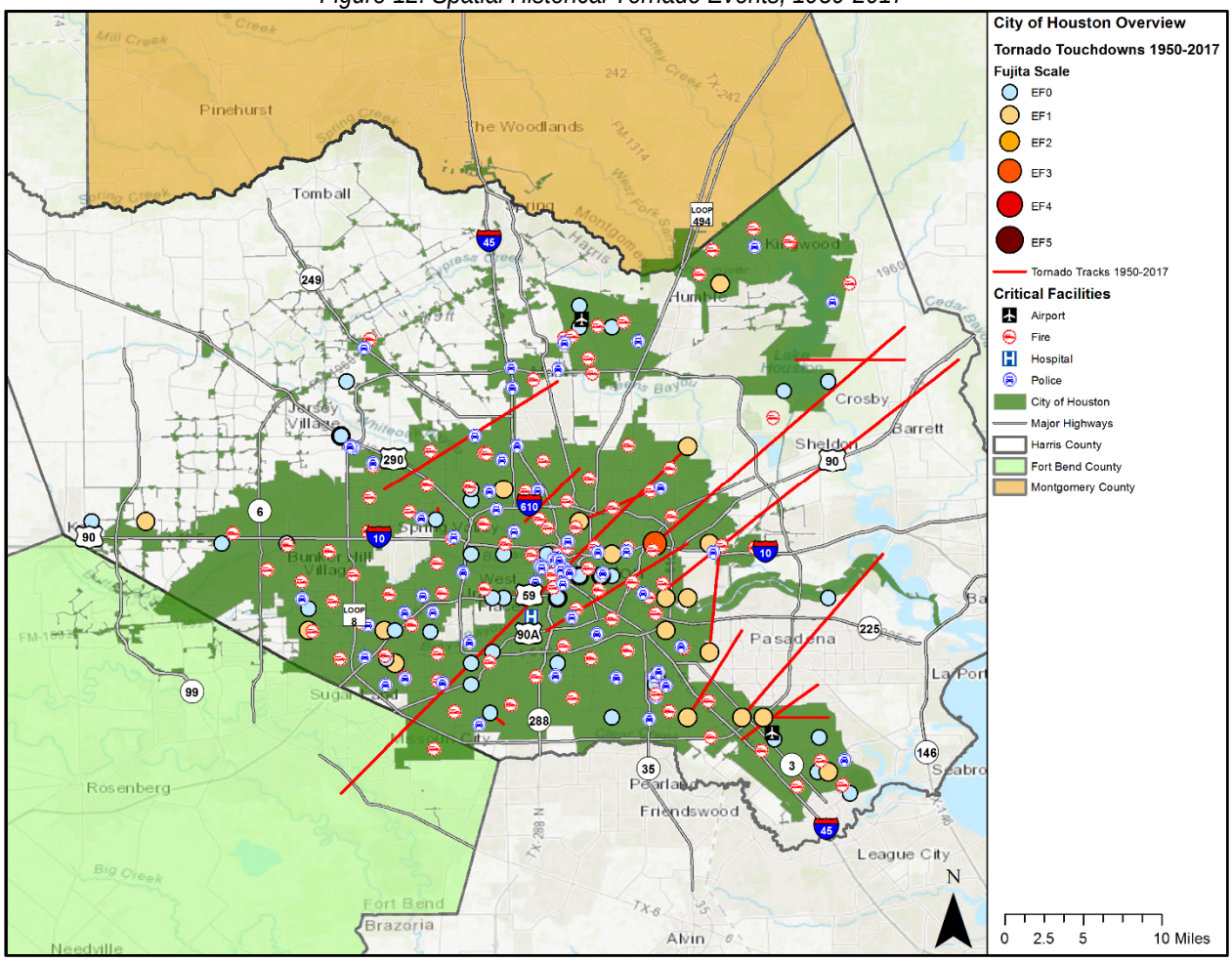
Table 15: Enhanced Fujita Scale for Tornadoes

Storm Category	Damage Level	3 Second Gust (MPH)	Description of Damages	Photo Example
EF0	Gale	65 – 85	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.	
EF1	Weak	86 – 110	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off roads; attached garages may be destroyed.	
EF2	Strong	111 – 135	Considerable damage; roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.	
EF3	Severe	136 – 165	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.	
EF4	Devastating	166 – 200	Well-constructed homes leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.	
EF5	Incredible	200+	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles flying through the air in excess of 330 yards; trees debarked; steel reinforced concrete badly damaged.	

Source: *City of Houston Hazard Mitigation Plan Update 2018*

Both the Fujita Scale and Enhanced Fujita Scale should be referenced in reviewing previous occurrences since tornado events prior to 2007 will follow the original Fujita Scale. The largest magnitude reported within the planning area is F2 on the Fujita Scale, a "Significant Tornado." Based on the planning area's location in within wind risk rating zones, the planning area could experience anywhere from an EF0 to an EF4 depending on the wind speed. An EF4 is considered to be the worst, most probable tornado type for the City of Houston. Historical tornado tracks are presented in Figure 12.

Figure 12: Spatial Historical Tornado Events, 1950-2017



Source: *City of Houston Hazard Mitigation Plan Update 2018*

Tornadoes have the potential to pose a significant risk to the population and can create dangerous situations. Often providing and preserving public health and safety is difficult. Impacts to the planning area can include:

- Individuals exposed to the storm can be struck by flying debris, falling limbs, or downed trees, causing serious injury or death.
- Structures can be damaged or crushed by falling trees, which can result in physical harm to the occupants.
- Manufactured homes may suffer substantial damage as they would be more vulnerable than typical site-built structures.
- Significant debris and downed trees can result in emergency response vehicles being unable to access areas of the community.
- Downed power lines may result in roadways being unsafe for use, which may prevent first responders from answering calls for assistance or rescue.
- Tornadoes often result in widespread power outages, increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outages can result in an increase in structure fires and/or carbon monoxide poisoning, as individuals attempt to cook or heat their home with alternate, unsafe cooking or heating devices, such as grills.

- Tornadoes can destroy or make residential structures uninhabitable, requiring shelter or relocation of residents in the aftermath of the event.
- First responders must enter the damage area shortly after the tornado passes to begin rescue operations and to organize cleanup and assessments efforts. Therefore, they are exposed to downed power lines, unstable and unusual debris, hazardous materials, and generally unsafe conditions, elevating the risk of injury to first responders and potentially diminishing emergency response capabilities.
- Emergency operations and services may be significantly impacted due to damaged facilities, loss of communications, and damaged emergency vehicles and equipment.
- City or county departments may be damaged or destroyed, delaying response and recovery efforts for the entire community.
- Private sector entities that jurisdictions rely on, such as utility providers, financial institutions, and medical care providers may not be fully operational and may require assistance from neighboring communities until full services can be restored.
- Economic disruption negatively impacts the programs and services provided by the community due to short and long-term loss in revenue.
- Damage to infrastructure may slow economic recovery since repairs may be extensive and lengthy.
- Some businesses not directly damaged by the tornado may be negatively impacted while roads and utilities are being restored, further slowing economic recovery.
- When the community is affected by significant property damage it is anticipated that funding would be required for infrastructure repair and restoration, temporary services and facilities, overtime pay for responders, as well as normal day-to-day operating expenses.
- Displaced residents may not be able to immediately return to work, further slowing economic recovery.
- Residential structures destroyed by a tornado may not be rebuilt for years, reducing the tax base for the community.
- Large or intense tornadoes may result in a dramatic population fluctuation, as people are unable to return to their homes or jobs and must seek shelter and/or work outside of the affected area.
- Businesses that are uninsured or underinsured may have difficulty reopening, which results in a net loss of jobs for the community and a potential increase in the unemployment rate.
- Recreation activities may be unavailable and tourism can be unappealing for years following a large tornado, devastating directly related local businesses.

The economic and financial impacts of a tornado event on the community will depend on the scale of the event, what is damaged, costs of repair or replacement, lost business days in impacted areas, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning done by government, businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of a tornado event.

A summary assessment of tornado hazard vulnerability and impacts to the community lifelines is presented in Table 16.

Table 16: Tornado Vulnerability and Consequence Summary by Lifeline

Tornado	Vulnerability	Consequence
Safety and Security	Moderate Vulnerability	Moderate Impact to Lifeline/Services
Food, Water, Sheltering	Moderate Vulnerability	Moderate Impact to Lifeline/Services
Communications	Moderate Vulnerability	Moderate Impact to Lifeline/Services
Transportation	Moderate Vulnerability	Moderate Impact to Lifeline/Services
Health and Medical	Moderate Vulnerability	Moderate Impact to Lifeline/Services
Hazardous Material (Mgmt)	Moderate Vulnerability	Moderate Impact to Lifeline/Services
Energy (Power and Fuel)	High Vulnerability	Significant Impact to Lifeline/Services

g. Expansive Soils

Expansive soils are soils and soft rocks with a relatively high percentage of clay minerals that are subject to changes in volume as they swell and shrink with changing moisture conditions. Drought conditions can cause soils to contract in response to a loss of soil moisture.

Expansive soils contain minerals such as smectite clays that are capable of absorbing water. When these clays absorb water, they increase in volume and expand. Expansions in soil of 10 percent or more are not uncommon in the City of Houston planning area. The change in soil volume and resulting expansion can exert enough force on a building or other structure to cause damage.

Expansive soils will also lose volume and shrink when they dry. A reduction in soil volume can affect the support to buildings or other structures and result in damage. Fissures in the soil can also develop and facilitate the deep penetration of water when moist conditions or runoff occurs. This produces a cycle of shrinkage and swelling that places repetitive stress on structures.

The amount and depth of potential swelling that can occur in a clay material are, to some extent, functions of the cyclical moisture content in the soil. In drier climates where the moisture content in the soil near the ground surface is low because of evaporation, there is a greater potential for extensive swelling than in the same soil in wetter climates where the variations of moisture content are not as severe. Volume changes in highly expansive soils range between 7 and 10 percent, however under abnormal conditions, they can reach as high as 25 percent.

Homeowners and public agencies that assume they cannot afford preventative measures such as more costly foundations and floor systems, often incur the largest percentage of damage and costly repairs from expanding soil. No figures are available for the total damage to homes in the planning area from expansive clays. For the City of Houston planning area the most extensive damage from expansive soils can occur to bridges, highways, streets, and parking lots. The greatest damage occurs when structures are constructed when clays are dry (such as during a drought) and then subsequent soaking rains swell the clay.

The impact of expansive soils experienced in the City of Houston planning area has resulted in no injuries and fatalities, supporting a limited severity of impact meaning injuries and/or illnesses are treatable with first aid, shutdown of facilities and services for 24 hours or less, and less than 10 percent of property is destroyed or with major damage.

A summary assessment of expansive soils hazard vulnerability and impacts to the community lifelines is presented in Table 17.

Table 17: Expansive Soils Vulnerability and Consequence Summary by Lifeline

Expansive Soils	Vulnerability	Consequence
Safety and Security	Low Vulnerability	Low Impact to Lifeline/Services
Food, Water, Sheltering	Moderate Vulnerability	Low Impact to Lifeline/Services
Communications	Low Vulnerability	Low Impact to Lifeline/Services
Transportation	Moderate Vulnerability	Low Impact to Lifeline/Services
Health and Medical	Moderate Vulnerability	Low Impact to Lifeline/Services
Hazardous Material (Mgmt)	Low Vulnerability	Low Impact to Lifeline/Services
Energy (Power and Fuel)	Low Vulnerability	Low Impact to Lifeline/Services

h. Hail

Hailstorm events are a potentially damaging outgrowth of severe thunderstorms. During the developmental stages of a hailstorm, ice crystals form within a low-pressure front due to the rapid rising of warm air into the upper atmosphere, and the subsequent cooling of the air mass. Frozen droplets gradually accumulate into ice crystals until they fall as frozen masses of round or irregularly shaped ice typically greater than 0.75 inches in diameter. The size of hailstones is a direct result of the size and severity of the storm. High velocity updraft winds are required to keep hail in suspension in thunderclouds. The strength of the updraft is a by-product of heating on the Earth's surface. Higher temperature gradients above Earth's surface result in increased suspension time and hailstone size.
The National Weather Service (NWS) classifies a storm as "severe" if there is hail 3/4 of an inch in diameter (approximately the size of a penny) or greater, based on radar intensity or as seen by observers. The intensity category of a hailstorm depends on hail size and the potential damage it could cause, as depicted in the National Centers for Environmental Information (NCEI) Intensity Scale in Table 18.

Table 18: Hail Intensity and Magnitude5

Size Code	Intensity Category	Size (Diameter Inches)	Descriptive Term	Typical Damage
H0	Hard Hail	Up to 0.33	Pea	No damage
H1	Potentially Damaging	0.33 – 0.60	Marble	Slight damage to plants and crops
H2	Potentially Damaging	0.60 – 0.80	Dime	Significant damage to plants and crops
H3	Severe	0.80 – 1.20	Nickel	Severe damage to plants and crops
H4	Severe	1.2 – 1.6	Quarter	Widespread glass and auto damage
H5	Destructive	1.6 – 2.0	Half Dollar	Widespread destruction of glass, roofs, and risk of injuries
H6	Destructive	2.0 – 2.4	Ping Pong Ball	Aircraft bodywork dented and brick walls pitted
H7	Very Destructive	2.4 – 3.0	Golf Ball	Severe roof damage and risk of serious injuries
H8	Very Destructive	3.0 – 3.5	Hen Egg	Severe damage to all structures
H9	Super Hailstorms	3.5 – 4.0	Tennis Ball	Extensive structural damage, could cause fatal injuries
H10	Super Hailstorms	4.0 +	Baseball	Extensive structural damage, could cause fatal injuries

Source: *City of Houston Hazard Mitigation Plan Update 2018*

The intensity scale in Table 18 ranges from H0 to H10, with increments of intensity or damage potential in relation to hail size (distribution and maximum), texture, fall speed, speed of storm translation, and strength of the accompanying wind. Based on available data regarding the previous occurrences for the area, the City of Houston planning area may experience hailstorms ranging from an H0 to an H8 in the future.

Hail events have the potential to pose a significant risk to people and can create dangerous situations. Impacts to the planning area can include:

- Hail may create hazardous road conditions during and immediately following an event, delaying first responders from providing for or preserving public health and safety.
- Individuals and first responders who are exposed to the storm may be struck by hail, falling branches, or downed trees resulting in injuries or possible fatalities.
- Residential structures can be damaged by falling trees, which can result in physical harm to occupants.
- Large hail events will likely cause extensive roof damage to residential structures along with siding damage and broken windows, creating a spike in insurance claims and a rise in premiums.
- Automobile damage may be extensive depending on the size of the hail and length of the storm.
- Hail events can result in power outages over widespread areas, increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.

[5] NCEI Intensity Scale, based on the TORRO Hailstorm Intensity Scale.

- Extended power outages can result in an increase in structure fires and/or carbon monoxide poisoning, as individuals attempt to cook or heat their home with alternate, unsafe cooking or heating devices, such as grills.
- First responders are exposed to downed power lines, damaged structures, hazardous spills, and debris that often accompany hail events, elevating the risk of injury to first responders and potentially diminishing emergency response capabilities.
- Downed power lines and large debris, such as downed trees, can result in the inability of emergency response vehicles to access areas of the community.
- Hazardous road conditions may prevent critical staff from reporting for duty, limiting response capabilities.
- Economic disruption negatively impacts the programs and services provided by the community due to short- and long-term loss in revenue.
- Some businesses not directly damaged by the hail event may be negatively impacted while roads are cleared and utilities are being restored, further slowing economic recovery.
- Businesses that are more reliant on utility infrastructure than others may suffer greater damages without a backup power source.
- Hazardous road conditions will likely lead to increases in automobile accidents, further straining emergency response capabilities.
- Depending on the severity and scale of damage caused by large hail events, damage to power transmission and distribution infrastructure can require days or weeks to repair.
- A significant hail event could significantly damage agricultural crops, resulting in extensive economic losses for the community and surrounding area.
- Hail events may injure or kill livestock and wildlife.
- A large hail event could impact the accessibility of recreational areas and parks due to extended power outages or debris clogged access roads.

The economic and financial impacts of hail will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning conducted by the community, local businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of any hail event.

A summary assessment of hail hazard vulnerability and impacts to the community lifelines is presented in Table 19.

Table 19: Hail Vulnerability and Consequence Summary by Lifeline

Hail	Vulnerability	Consequence
Safety and Security	Moderate Vulnerability	Low Impact to Lifeline/Services
Food, Water, Sheltering	Moderate Vulnerability	Low Impact to Lifeline/Services
Communications	Moderate Vulnerability	Moderate Impact to Lifeline/Services
Transportation	Low Vulnerability	Low Impact to Lifeline/Services
Health and Medical	Moderate Vulnerability	Low Impact to Lifeline/Services
Hazardous Material (Mgmt)	Moderate Vulnerability	Low Impact to Lifeline/Services
Energy (Power and Fuel)	Moderate Vulnerability	Low Impact to Lifeline/Services

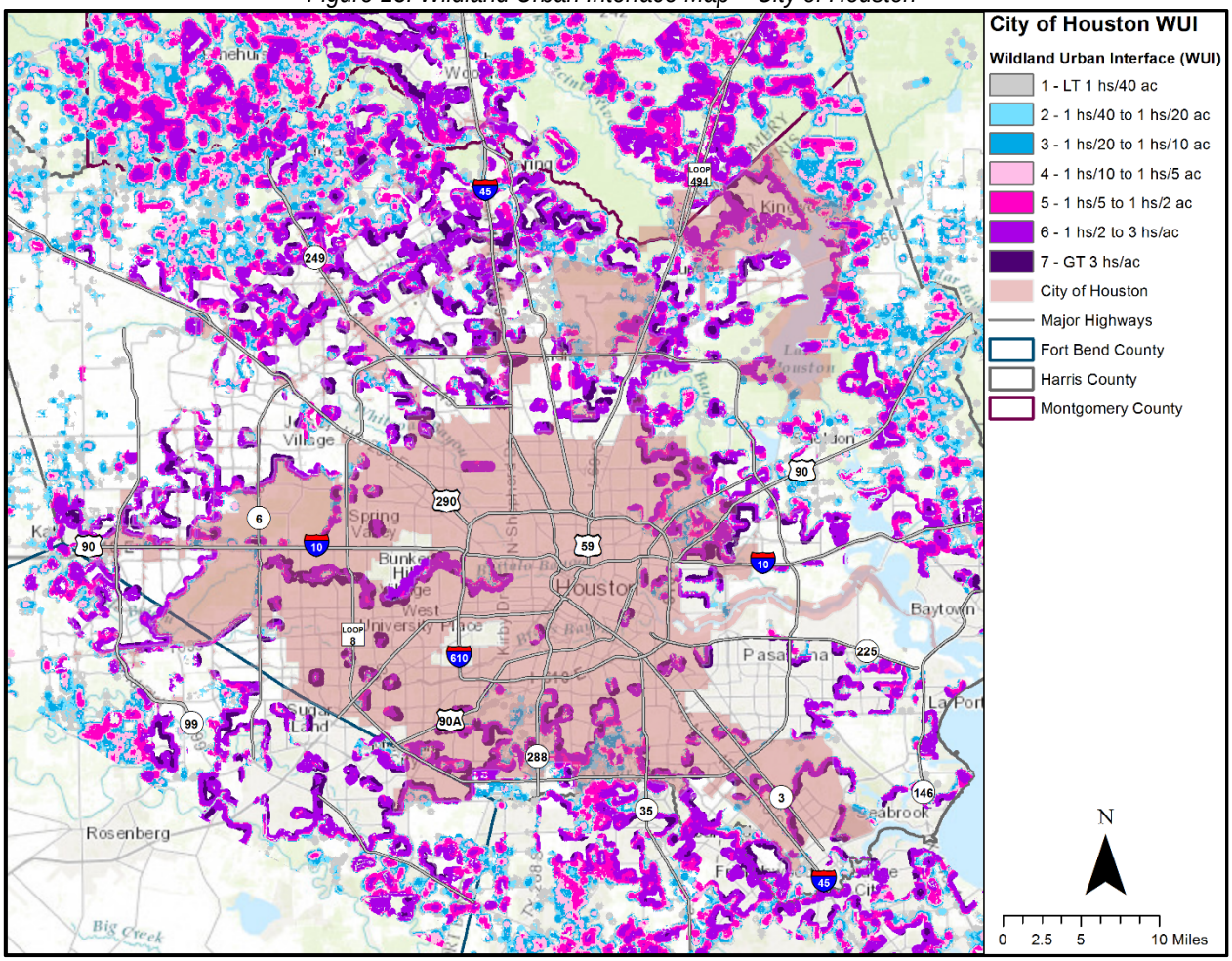
i. Wildfire

A wildfire event can rapidly spread out of control and occurs most often in the summer, when the brush is dry and flames can move unchecked through a highly vegetative area. Wildfires can start as a slow burning fire along the forest floor, killing and damaging trees. The fires often spread more rapidly as they reach the tops of trees, with wind carrying the flames from tree to tree. Usually, dense smoke is the first indication of a wildfire.

A wildfire event often begins unnoticed and spreads quickly, lighting brush, trees, and homes on fire. For example, a wildfire may be started by a campfire that was not doused properly, a tossed cigarette, burning debris, or arson. Texas has seen a significant increase in the number of wildfires in the past 30 years, which included wildland, interface, or intermix fires. Wildland Urban Interface or Intermix (WUI) fires occur in areas where structures and other human improvements meet or intermingle with undeveloped wildland or vegetative fuels. Wildland fires are fueled almost exclusively by natural vegetation while interface or intermix fires are urban/wildland fires in which vegetation and the built-environment provide the fuel.

A wildfire event can be a potentially damaging consequence of drought. Wildfires can vary greatly in terms of size, location, intensity, and duration. While wildfires are not confined to any specific geographic location, they are most likely to occur in open grasslands. The threat to people and property from a wildfire event is greater in the fringe areas where developed areas meet open grass lands, such as the WUI (Figure 13). It is estimated that 14.3 percent of the total population in the City of Houston live within the WUI. However, the entire City of Houston planning area is at risk for wildfires.

Figure 13: Wildland Urban Interface Map – City of Houston

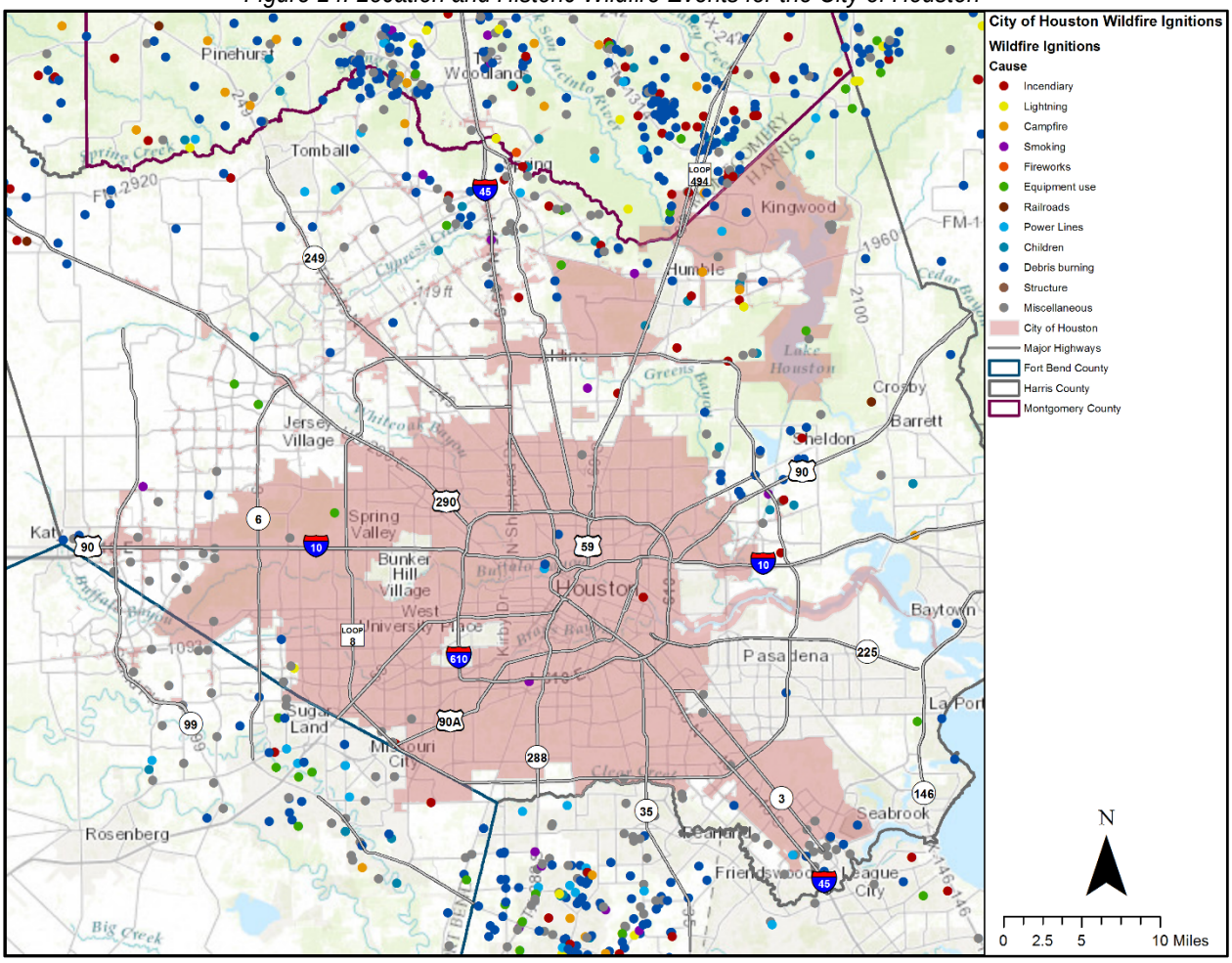


Source: *City of Houston Hazard Mitigation Plan Update 2018*

The Texas Forest Service reported 43 wildfire events between 2005 and 2015. The National Centers for Environmental Information (NCEI) did not include any wildfire events from 1996 through August 1, 2017. The Texas Forest Service (TFS) and volunteer fire departments started fully reporting events in 2005. Due to a lack of recorded

data for wildfire events prior to 2005 and after 2015, frequency calculations are based on an eleven-year period, using only data from recorded years. The map below shows approximate locations of wildfires, which can be grass or brushfires of any size (Figure 14).

Figure 14: Location and Historic Wildfire Events for the City of Houston



Source: *City of Houston Hazard Mitigation Plan Update 2018*

A wildfire event poses a potentially significant risk to public health and safety, particularly if the wildfire is initially unnoticed and spreads quickly. The impacts associated with a wildfire are not limited to the direct damages. Potential impacts for the planning area include:

- Persons in the area at the time of the fire are at risk for injury or death from burns and/or smoke inhalation.
- First responders are at greater risk of physical injury since they are in close proximity to the hazard while extinguishing flames, protecting property or evacuating residents in the area.
- First responders can experience heart disease, respiratory problems, and other long term related illnesses from prolonged exposure to smoke, chemicals, and heat.
- Emergency services may be disrupted during a wildfire if facilities are impacted, and roadways are inaccessible or personnel are unable to report for duty.
- Critical city and/or county departments may not be able to function and provide necessary services depending on the location of the fire and the structures or personnel impacted.
- Non-critical businesses may be directly damaged, suffer loss of utility services, or be otherwise inaccessible, delaying normal operations and slowing the recovery process.

- Displaced residents may not be able to immediately return to work, further slowing economic recovery.
- Roadways in or near the WUI could be damaged or closed due to smoke and limited visibility.
- Older homes are generally exempt from modern building code requirements, which may require fire suppression equipment in the structure.
- Some high-density neighborhoods feature small lots with structures close together, increasing the potential for fire to spread rapidly.
- Air pollution from smoke may exacerbate respiratory problems of vulnerable residents.
- Charred ground after a wildfire cannot easily absorb rainwater, increasing the risk of flooding and potential mudflows.
- Wildfires can cause erosion, degrading stream water quality.
- Wildlife may be displaced or destroyed.
- Historical or cultural resources may be damaged or destroyed.
- Tourism can be significantly disrupted, further delaying economic recovery for the area.
- Economic disruption negatively impacts the programs and services provided by the community due to short and long- term loss in revenue.
- Fire suppression costs can be substantial, exhausting the financial resources of the community.
- Residential structures lost in a wildfire may not be rebuilt for years, reducing the tax base for the community.
- Direct impacts to municipal water supply may occur through contamination of ash and debris during the fire, destruction of aboveground delivery lines, and soil erosion or debris deposits into waterways after the fire.
- The City of Houston includes 52,912 acres of total park space. Recreation activities throughout the city's parks may be unavailable and tourism can be unappealing for years following a large wildfire event, devastating directly related local businesses and negatively impacting economic recovery.

The economic and financial impacts of a wildfire event on local government will depend on the scale of the event, what is damaged, costs of repair or replacement, lost business days in impacted areas, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning done by government, businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of a wildfire event.

A summary assessment of wildfire hazard vulnerability and impacts to the community lifelines is presented in Table 20.

Table 20: Wildfire Vulnerability and Consequence Summary by Lifeline

Wildfire	Vulnerability	Consequence
Safety and Security	Low Vulnerability	Moderate Impact to Lifeline/Services
Food, Water, Sheltering	Moderate Vulnerability	Moderate Impact to Lifeline/Services
Communications	Low Vulnerability	Significant Impact to Lifeline/Services
Transportation	Low Vulnerability	Significant Impact to Lifeline/Services
Health and Medical	Low Vulnerability	Moderate Impact to Lifeline/Services
Hazardous Material (Mgmt)	Low Vulnerability	Moderate Impact to Lifeline/Services
Energy (Power and Fuel)	Moderate Vulnerability	Moderate Impact to Lifeline/Services

j. Drought

Drought is a period of substantially lower rainfall than the average in a region, causing a serious hydrologic imbalance. Drought is the consequence of anticipated natural precipitation not being met over an extended period, usually a season or more in length. Droughts can become very prolonged and persist from one year to the next. Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall.

Droughts can be classified as meteorological, hydrologic, agricultural, and socioeconomic. Table 21 presents definitions for these different types of drought.

Table 21: Drought Classification Definitions[6]

Meteorological Drought	The degree of dryness, as measured as departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales.
Hydrologic Drought	The effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.
Agricultural Drought	Soil moisture deficiencies relative to water demands of plant life, usually crops.
Socioeconomic Drought	The effect of demands for water exceeds the supply as a result of a weather-related supply shortfall.

Droughts occur regularly throughout Texas and the City of Houston and are a normal condition. However, they can vary greatly in their intensity and duration. There is no distinct geographic boundary to drought; therefore, it can occur throughout the City of Houston planning area equally.

Based on available records of historic events, there have been 18 extended time periods of drought (ranging in length from approximately 30 days to over 420 days) within a 21-year reporting period. The probability of future events is 0.86 per year, or an event probable in the next year. This frequency supports a highly likely probability of future events.

Drought impacts large areas and crosses jurisdictional boundaries. All existing and future buildings, facilities, and populations are exposed to this hazard and could potentially be impacted. However, drought impacts are mostly experienced in water shortages and crop/livestock losses on agricultural lands, and typically have no impact on buildings.

Houston's Drinking Water Operations (DWO) is responsible for operating and maintaining three water purification plants and 56 ground water plants. Houston's water system serves approximately 2.2 million citizens each day and spans over 600 square miles serving four counties, therefore, making it one of the most complex water systems in the nation. Local lakes and rivers supply the City of Houston surface water resources. Eighty-seven percent of the planning areas water supply flows from the Trinity River into Lake Livingston, and from the San Jacinto River into Lake Conroe and Lake Houston. Deep underground wells drilled into the Evangeline and Chicot aquifers currently provide the other 13 percent of the City's water supply. While the planning area relies on multiple water resources, high demand can deplete these resources during extreme drought conditions. As resources are depleted, potable water is in short supply and overall water quality can suffer, elevating health concerns for all residents but especially vulnerable populations – typically children, the elderly, and the ill. In addition, potable water is used for drinking, sanitation, patient care, sterilization, equipment, heating and cooling systems, and many other essential functions in medical facilities.

Drought has the potential to impact people in the City of Houston planning area. While it is rare that drought, in and of itself, leads to a direct risk to the health and safety of people in the U.S., severe water shortages could result in inadequate supply for human needs. Drought also is frequently associated with a variety of impacts, including:

[6] Source: Multi-Hazard Identification and Risk Assessment: A Cornerstone of the National Mitigation Strategy, Federal Emergency Management Agency (FEMA).

- The number of health-related low-flow issues (e.g., diminished sewage flows, increased pollution concentrations, reduced firefighting capacity, cross-connection contamination) will increase as the drought intensifies.
- Public safety issues from forest/range wildfires will increase as water availability and/or pressure decreases.
- Respiratory ailments may increase as the air quality decreases.
- There may be an increase in disease due to wildlife concentrations (e.g., rabies, Rocky Mountain spotted fever, Lyme disease).
- Jurisdictions and residents may disagree over water use/water rights, creating conflict.
- Political conflicts may increase between municipalities, counties, states, and regions.
- Water management conflicts may arise between competing interests.
- Increased law enforcement activities may be required to enforce water restrictions.
- Severe water shortages could result in inadequate supply for human needs as well as lower quality of water for consumption.
- Firefighters may have limited water resources to aid in firefighting and suppression activities, increasing risk to lives and property.
- During drought, there is an increased risk for wildfires and dust storms.
- The community may need increased operational costs to enforce water restriction or rationing.
- Prolonged drought can lead to increases in illness and disease related to drought.
- Utility providers can see decreases in revenue as water supplies diminish.
- Utilities providers may cut back energy generation and service to their customers to prioritize critical service needs.
- Hydroelectric power generation facilities and infrastructure would have significantly diminished generation capability. Dams simply cannot produce as much electricity from low water levels as they can from high water levels.
- Fish and wildlife food and habitat will be reduced or degraded over time during a drought and disease will increase, especially for aquatic life.
- Wildlife will move to more sustainable locations, creating higher concentrations of wildlife in smaller areas, increasing vulnerability and further depleting limited natural resources.
- Severe and prolonged drought can result in the reduction of a species or cause the extinction of a species altogether.
- Plant life will suffer from long-term drought. Wind and erosion will also pose a threat to plant life as soil quality will decline.
- Dry and dead vegetation will increase the risk of wildfire.
- Recreational activities that rely on water may be curtailed, such as canoeing at the Armand Bayou Nature Center, resulting in fewer tourists and lower revenue.
- Drought poses a significant risk to annual and perennial crop production and overall crop quality, leading to higher food costs.
- Drought related declines in production may lead to an increase in unemployment.
- Drought may limit livestock grazing resulting in decreased livestock weight, potential increased livestock mortality, and increased cost for feed.
- Negatively impacted water suppliers may face increased costs resulting from the transport of water or developing supplemental water resources.
- Long-term drought may negatively impact future economic development.

The overall extent of damages caused by periods of drought is dependent on its extent and duration. The level of preparedness and pre-event planning done by government, businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of a drought event.

A summary assessment of drought hazard vulnerability and impacts to the community lifelines is presented in Table 22.

Table 22: Flood Vulnerability and Consequence Summary by Lifeline

Drought	Vulnerability	Consequence
Safety and Security	High Vulnerability	Low Impact to Lifeline/Services
Food, Water, Sheltering	High Vulnerability	Low Impact to Lifeline/Services
Communications	Low Vulnerability	Low Impact to Lifeline/Services
Transportation	Low Vulnerability	Low Impact to Lifeline/Services
Health and Medical	Moderate Vulnerability	Low Impact to Lifeline/Services
Hazardous Material (Mgmt)	Low Vulnerability	Low Impact to Lifeline/Services
Energy (Power and Fuel)	High Vulnerability	Low Impact to Lifeline/Services

k. Dam-Related Hazards

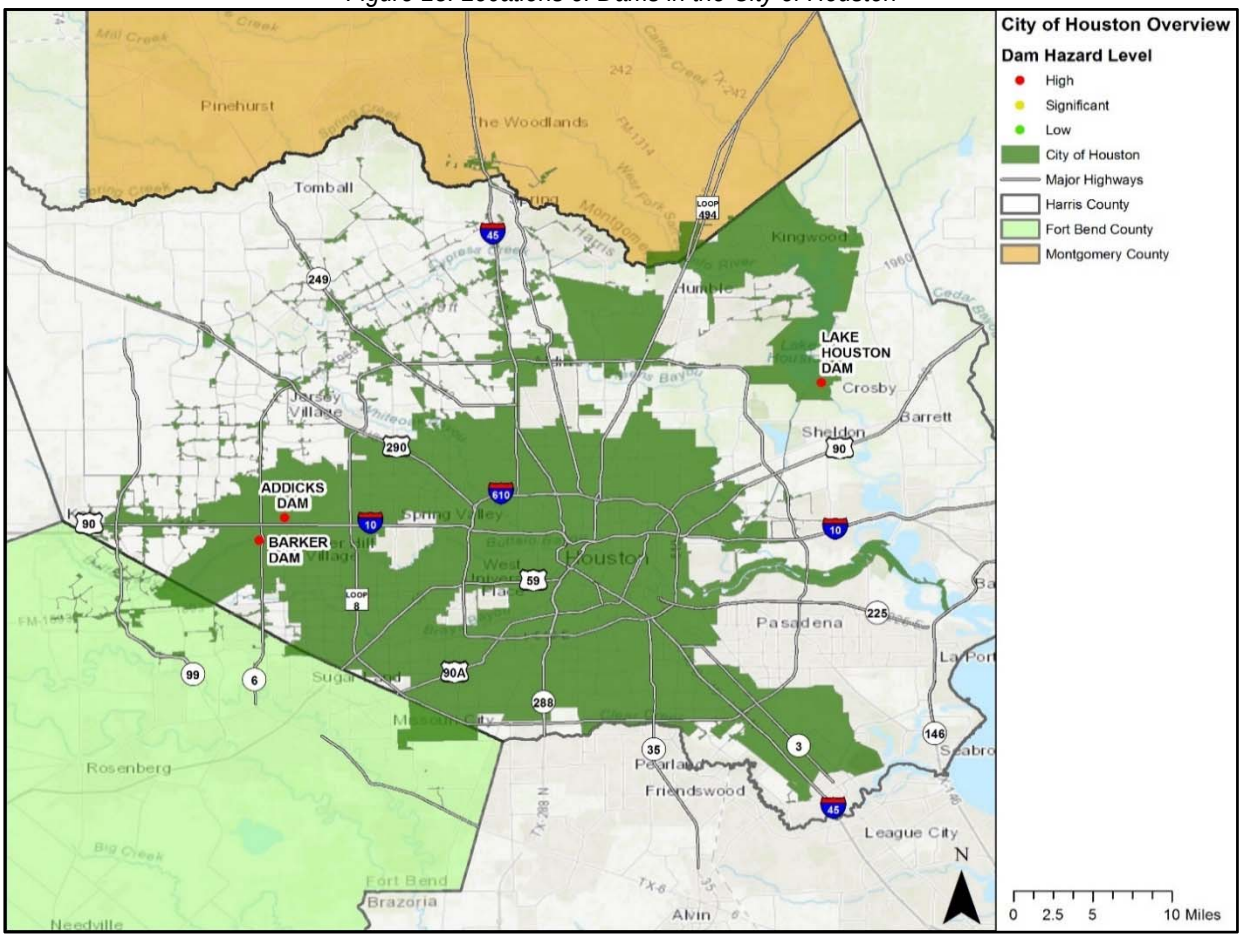
While dam failures are possible, dams are typically designed for extreme conditions. Since there are no historical records of dam failures in the City of Houston, no probability of occurrence can be calculated for the area. While the probability is low, the consequences of a dam failure would be significant.

Table 23: Dam Hazards in the City of Houston

Jurisdiction	Dam Name	Height (Ft.)	Storage (Acre Ft.)	Condition	Profiled
Houston	Barker Dam	42	209,000	Unsatisfactory	Yes
Houston	Addicks Dam	52	200,800	Unsatisfactory	Yes
Magnolia Gardens (Owned by City of Houston)	Lake Houston Dam	66	281,800	Satisfactory	Yes

Source: City of Houston Office of Emergency Management

Figure 15: Locations of Dams in the City of Houston



Source: *City of Houston Hazard Mitigation Plan Update 2018*

In the aftermath of Hurricane Harvey the decision was made to allow a controlled release of both the Addicks and Barker Dams. According to HCFCD both dams are owned and operated by the U.S. Army Corps of Engineers and the combined rate of controlled release was 4,000 cfs. Water was released in a controlled manner into concrete-armored spillways, which is preferable to overtopping the dams. Neighborhoods downstream experienced additional flooding as a result from this controlled release, and neighborhoods upstream experienced flooding from the reservoir itself. Upstream neighborhoods experienced flooding because of the overflow in the reservoirs that was backing up behind the dams. Downstream, the water from the dams was released into Buffalo Bayou, which was already experiencing flooding prior to the release[7].

The *Texas Tribune* states that the Army Corps of Engineers believed that failure of these dams would have resulted in damages exceeding $60 billion in damages, impacting nearly 1 million residents. While homes and business were flooded due to the release, the damage sustained was less than what an overtopped dam would have ultimately done to the community of Houston. Evacuations were considered voluntary and were not mandated during the controlled release. Approximately 53 neighborhoods are located within the Addicks Watershed and 40 within Barker Dam Reservoir area[8].

[7] Source: Harris County Flood Control District https://www.hcfcd.org/hurricane-harvey/flooding-impacts-in-connection-with-the-reservoirs/
[8] Source: Texas Tribune: https://www.texastribune.org/2017/08/29/q-why-houstons-reservoirs-arent-going-fail/

Any individual dam has a very specific area that will be impacted by a catastrophic failure. Dams identified with potential risk can directly threaten the lives of individuals living or working in the inundation zone below the dam. The impact from any catastrophic failure would be similar to that of a flash flood. Potential impacts for the planning area include:

- Lives could be lost.
- There could be injuries from impacts with debris carried by the flood.
- Swift-water rescue of individuals trapped by the water puts the immediate responders at risk for their own lives.
- Individuals involved in the cleanup may be at risk from the debris and contaminants.
- Continuity of operations for any jurisdiction outside the direct impact area could be very limited.
- Roads and bridges could be destroyed.
- Homes and businesses could be damaged or destroyed.
- Emergency services may be temporarily unavailable.
- Disruption of operations and the delivery of services in the impacted area.
- A large dam with a high head of water could effectively scour the terrain below it for miles, taking out all buildings, and other infrastructure.
- Scouring force could erode soil and any buried pipelines.
- Scouring action of a large dam will destroy all vegetation in its path.
- Wildlife and wildlife habitat caught in the flow will likely be destroyed.
- Fish habitat will likely be destroyed.
- Topsoil will erode, slowing the return of natural vegetation.
- The destructive high velocity water flow may include substantial debris and hazardous materials, significantly increasing the risks to life and property in its path.
- Debris and hazardous material deposited downstream may cause further pollution of areas far greater than the inundation zone.
- Destroyed businesses and homes may not be rebuilt, reducing the tax base and impacting long term economic recovery.
- Historical or cultural resources may be damaged or destroyed.
- Recreational activities and tourism may be temporarily unavailable or unappealing, slowing economic recovery.
- The Downtown business district could be devastated, and the Houston Ship Channel could be severely damaged, causing a catastrophic economic loss for the region.

The economic and financial impacts of dam failure on the area will depend entirely on the location of the dam, scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning done by the government, community, local businesses, and residents will also contribute to the overall economic and financial conditions in the aftermath of any dam failure event.

A summary assessment of dam failure hazard vulnerability and impacts to the community lifelines is presented in Table 24.

Table 24: Dam Failure Vulnerability and Consequence Summary by Lifeline

Dam Failure	Vulnerability	Consequence
Safety and Security	Moderate Vulnerability	Significant Impact to Lifeline/Services
Food, Water, Sheltering	Moderate Vulnerability	Significant Impact to Lifeline/Services
Communications	Moderate Vulnerability	Significant Impact to Lifeline/Services
Transportation	Moderate Vulnerability	Significant Impact to Lifeline/Services
Health and Medical	Moderate Vulnerability	Significant Impact to Lifeline/Services
Hazardous Material (Mgmt)	Moderate Vulnerability	Significant Impact to Lifeline/Services
Energy (Power and Fuel)	Moderate Vulnerability	Significant Impact to Lifeline/Services

I. Winter Storms

A winter storm event is identified as a storm with primarily snow, ice, or freezing rain.[9] Winter storms are associated with the combined effects of winter precipitation and strong winds creating a dangerous wind chill, or perceived air temperature. This type of storm can cause significant problems for area residents due to snow, ice hazards, and cold temperatures. Wind chill is a function of temperature and wind. Low wind chill is a product of high winds and freezing temperatures.

The greatest risk from a winter storm hazard is to public health and safety. Potential impacts for the planning area may include:

- Vulnerable populations, particularly the elderly and infants, can face serious or life-threatening health problems from exposure to extreme cold including hypothermia and frostbite. Houston residents are located far south in Texas and therefore may be even more vulnerable than the general population of the United States based on not having proper outwear and warm weather accessories needed to be in the cold.
- Loss of electric power or other heat sources can result in increased potential for fire injuries or hazardous gas inhalation because residents burn candles for light and use fires or generators to stay warm.
- Response personnel, including utility workers, public works personnel, debris removal staff, tow truck operators, and other first responders are vulnerable to injury or illness resulting from exposure to extreme cold temperatures.
- Response personnel would be required to travel in potentially hazardous conditions, elevating the life safety risk due to accidents, and potential contact with downed power lines.
- Operations or service delivery may experience impacts from electricity blackouts due to winter storms.
- Power outages are possible throughout the planning area due to downed trees and power lines and/or rolling blackouts.
- Critical facilities without emergency backup power may not be operational during power outages.
- Emergency response and service operations may be impacted by limitations on access and mobility if roadways are closed, unsafe, or obstructed.
- Hazardous road conditions will likely lead to increases in automobile accidents, further straining emergency response capabilities.
- Depending on the severity and scale of damage caused by ice and snow events, damage to power transmission and distribution infrastructure can require days or weeks to repair.
- A winter storm event could lead to tree, shrub, and plant damage or death.
- Severe cold and ice could significantly damage agricultural crops.
- Schools may be forced to shut early due to treacherous driving conditions.

[9] Source: http://www.nssl.noaa.gov/education/svrwx101/winter/

- Exposed water pipes may be damaged by severe or late season winter storms at both residential and commercial structures, causing significant damages.
- Cities located in the north have a higher frequency and therefore have more resources allocated yearly to fight and mitigate the impacts of winter storms. The resources here, while abundant, may not be primarily focused on mitigating this risk and therefore do not have the resources prepared and staged like cities in the northern United States.

The economic and financial impacts of winter weather on the community will depend on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning done by government, businesses, and citizens will also contribute to the overall economic and financial conditions in the aftermath of a winter storm event.

A summary assessment of winter storm hazard vulnerability and impacts to the community lifelines is presented in Table 25.

Table 25: Winter Storm Vulnerability and Consequence Summary by Lifeline

Winter Storm	Vulnerability	Consequence
Safety and Security	Moderate Vulnerability	Moderate Impact to Lifeline/Services
Food, Water, Sheltering	Moderate Vulnerability	Significant Impact to Lifeline/Services
Communications	Moderate Vulnerability	Moderate Impact to Lifeline/Services
Transportation	High Vulnerability	Significant Impact to Lifeline/Services
Health and Medical	Moderate Vulnerability	Moderate Impact to Lifeline/Services
Hazardous Material (Mgmt)	Moderate Vulnerability	Moderate Impact to Lifeline/Services
Energy (Power and Fuel)	High Vulnerability	Significant Impact to Lifeline/Services

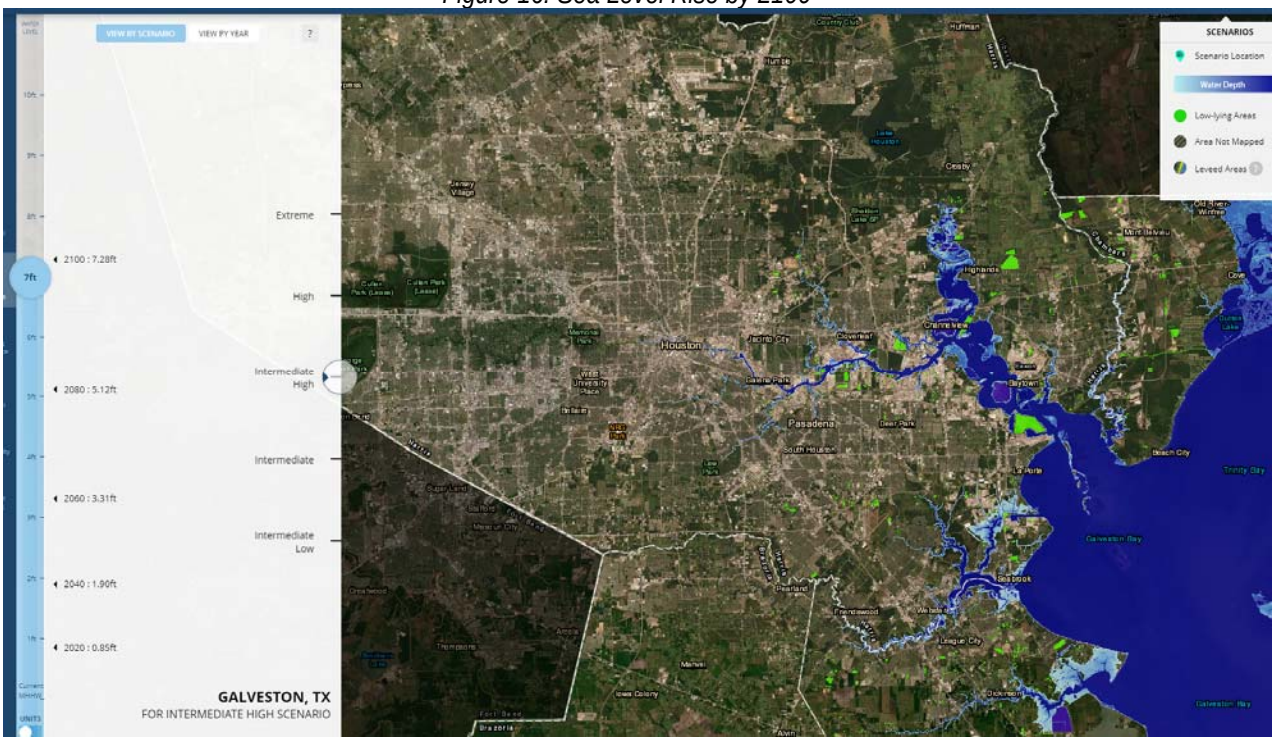
m. Sea Level Rise

According to NOAA, the sea level around Galveston, Texas has risen by 18 inches since 1950. The speed of rise has accelerated over the last ten years and is now rising by nearly 1 inch every year.[1] Scientists have determined these figures by measuring the sea level every 6 minutes using equipment like satellites, floating buoys off the coast, and tidal gauges to accurately measure the local sea level as it accelerates and changes.[3]

By 2050, the Galveston Pleasure Pier can expect to see up to 22 inches of additional rise. The NOAA sea level rise viewer, a web-mapping tool designed to view potential impacts from coastal flooding or sea level rise, provides a range of local scenarios. One of these scenarios is an intermediate-high scenario for Galveston that shows increased water levels in the San Jacinto River and Buffalo Bayou watersheds, as well as severe impacts in the far southeastern reaches of Houston. Figure 15 presents the sea level rise scenario in the Houston-Galveston region for 2100.

The City of Houston considers sea level rise in climate action planning as well as mitigation planning, though it often appears in conjunction with hurricane and flood hazard mitigation due to the inland nature of most of the City.

Figure 16: Sea Level Rise by 2100



Source: NOAA, Office for Coastal Management DIGITALCOST, "Sea Level Rise Viewer:" https://coast.noaa.gov/digitalcoast/tools/slr.html

A summary assessment of hazard vulnerability and impacts to the community lifelines related to sea level rise is presented in Table 26.

Table 26: Sea Level Rise Vulnerability and Consequence Summary by Lifeline

Sea Level Rise	Vulnerability	Consequence
Safety and Security	Low Vulnerability	Significant Impact to Lifeline/Services
Food, Water, Sheltering	Low Vulnerability	Significant Impact to Lifeline/Services
Communications	Low Vulnerability	Low Impact to Lifeline/Services
Transportation	Low Vulnerability	Moderate Impact to Lifeline/Services
Health and Medical	Low Vulnerability	Significant Impact to Lifeline/Services
Hazardous Material (Mgmt)	Low Vulnerability	Significant Impact to Lifeline/Services
Energy (Power and Fuel)	Low Vulnerability	Significant Impact to Lifeline/Services

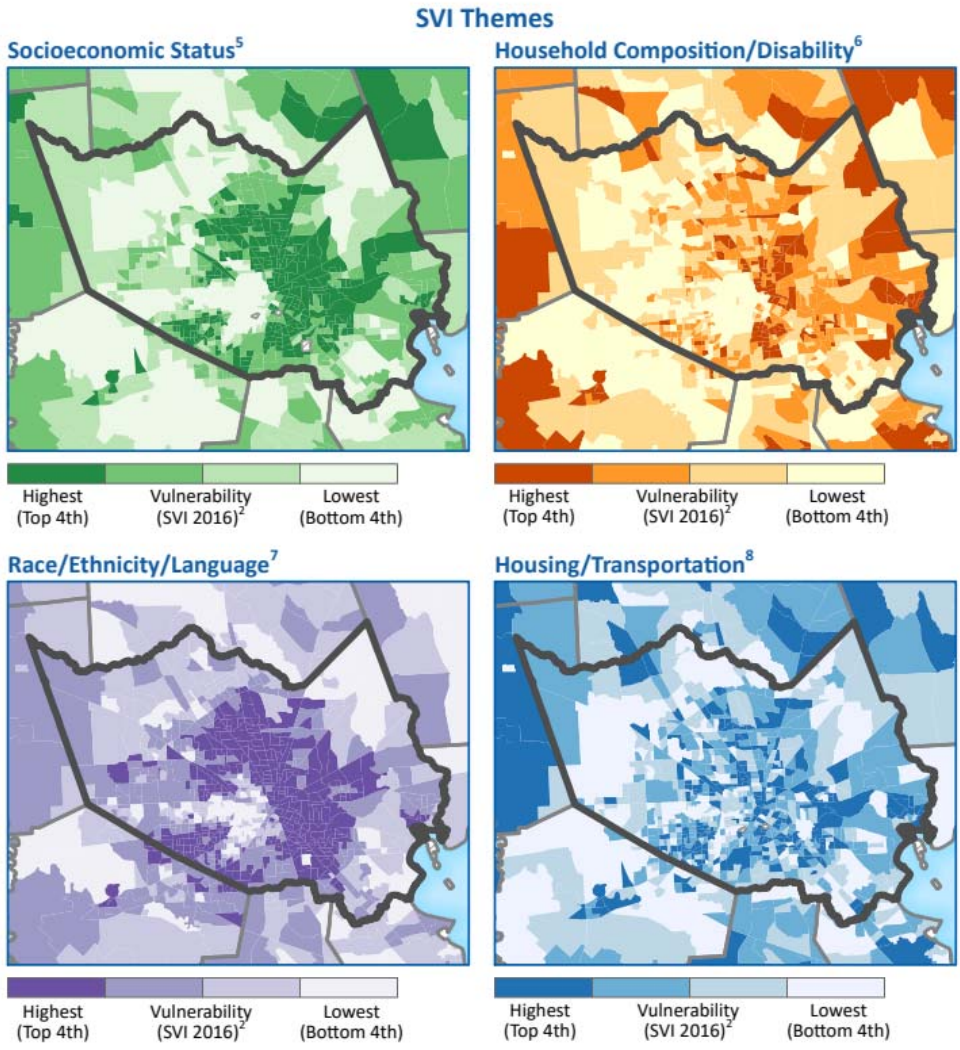
4. Vulnerability Assessment

There are areas within Houston in which disparities exist in relation to housing, open space, amenities, sustainable land use patterns, cultural preservation, and access to social programs and resources. Through the identification and mapping of the areas with highest vulnerabilities, the City can work with various communities to strategically mitigate the highest risks and target additional benefits. To develop the appropriate mitigation strategies that will provide the maximum benefit to the most vulnerable areas and address the high ranked risks and hazards, social vulnerability must also be considered as part of the mitigation needs assessment. How the proposed mitigation actions help

address areas with the highest social vulnerability across different themes will need to be considered in project prioritization and program formulation.

According to the Centers for Disease Control and Prevention (CDC), "social vulnerability refers to the resilience of communities when confronted by external stresses on human health, stresses such as natural or human-caused disasters, or disease outbreaks. Reducing social vulnerability can decrease both human suffering and economic loss." The CDC's Social Vulnerability Index uses 15 U.S. census variables at the tract level to help local officials identify communities that may need support in preparing for hazards; or recovering from disaster.[10]" Social Vulnerability Index themes include socioeconomic status, household composition, language, and transportation/housing status. Figure 17 shows the Social Vulnerability Index themes for the City of Houston planning area, and Figure 18 presents the overall social vulnerability for the planning area.

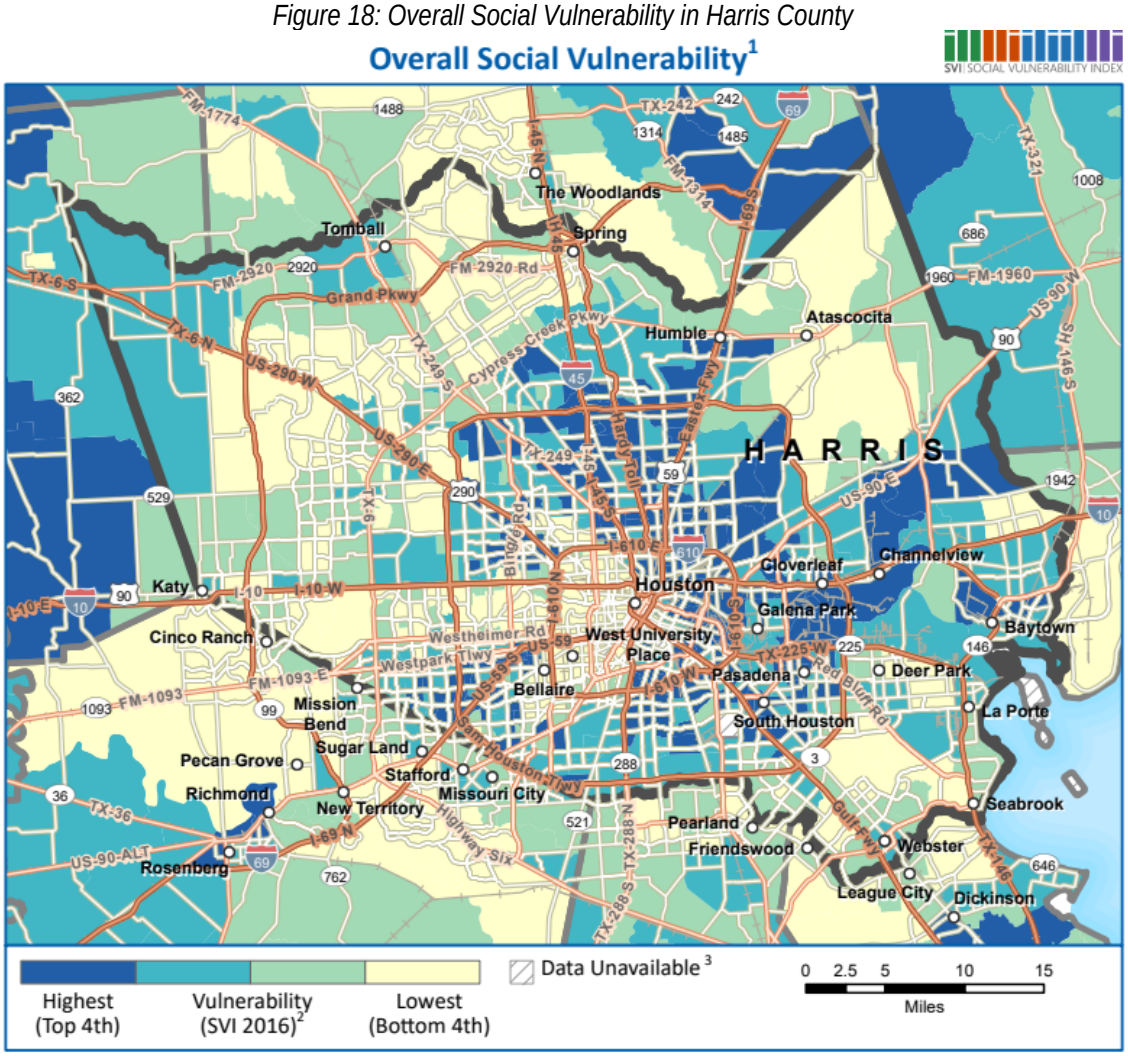
Figure 17: Social Vulnerability Themes in Harris County



Source: Agency for Toxic Substances and Disease Registry, "CDC's Social Vulnerability Index 2016 Harris County, Texas:" https://svi.cdc.gov/prepared-county-maps.html

[10] https://svi.cdc.gov/

Figure 18: Overall Social Vulnerability in Harris County



Source: Agency for Toxic Substances and Disease Registry, "CDC's Social Vulnerability Index 2016 Harris County, Texas:" https://svi.cdc.gov/prepared-county-maps.html

C. Use of Funds

1. Connection to Identified Risk

The most significant consideration in developing CDBG-MIT activities and the allocation of funds is the mitigation needs assessment. This assessment is based on the *City of Houston Hazard Mitigation Action Plan* and other data related to risk and recovery. Mitigation activities are also funded in context with threats to Community Lifelines. The mitigation needs assessment was completed to identify long-term risks and investment priorities for CDBG-MIT funding. The assessment may be amended as additional information become available or existing information is updated.

In review of the mitigation needs assessment, threats to Community Lifelines, and public feedback, funding is allocated for infrastructure programs to lessen the risk of flooding in buildings, with the ultimate goal of removing people and property from harm's way. In addition, decreasing flooding will also improve mobility so services that enable the continuous operation of critical business and government functions and that are critical to the protection of human health and safety would remain available and accessible. There is a need to improve the City's infrastructure, particularly its drainage systems, to reduce flooding.

2. Allocations

The City of Houston allocates CDBG-MIT resources to fund a Local Flood Mitigation Program and Administrative activities. Per requirements, at least 50 percent of CDBG-MIT funds will be spent to benefit low- and moderate-income (LMI) communities. The entire CDBG-MIT allocation will be used in HUD-identified most impacted and distressed (MID) area, as the City of Houston is entirely within a HUD-identified MID area. The following table provides a breakdown of the proposed budget of the CDBG-MIT funds.

Table 27: CDBG-MIT Budget Allocation with MID and LMI

Program	Total	% of Total	MID Amount	LMI Amount
Flood Mitigation Program	$58,789,800.00	95%	$58,789,800.00	$29,394,900.00
Administration	$3,094,200.00	5%	$3,094,200.00	N/A
Total	$61,884,000.00	100%	$61,884,000.00	$29,394,900.00

Source: City of Houston Housing and Community Development Department

3. Low- and Moderate-Income Priority

Although impacts from flooding and extreme weather events vary from one neighborhood to the next, the relative disaster-related losses experienced in LMI communities and communities of color is disproportionately high. The City of Houston is committed to driving an equitable recovery and serving all residents, particularly the most vulnerable in LMI areas, which will be prioritized for CDBG-MIT activities. The requirement for CDBG-MIT funds is to expend at least 50 percent of CDBG-MIT on activities benefiting LMI persons, and the City expects to exceed this requirement.

The City of Houston will prioritize infrastructure projects funded with CDBG-MIT that address flooding in LMI neighborhoods. Decreasing flood risk in neighborhoods, especially LMI neighborhoods, will positively affect Houstonians, of all protected classes, and increase the ability of individuals and households to more quickly recover from future flood events. Decreasing flood risk will also reduce disruptions at a larger-scale, allowing Houstonians to return to normalcy more quickly while reducing the negative social and economic consequences of flooding. Minimizing flooding in neighborhoods through flood mitigation projects will also protect housing and make neighborhoods safer and more desirable places to live.

The City works in many ways to assist low- and moderate-income communities. One example is the City's Complete Communities Program, which is an interdepartmental initiative led by the Mayor's Office of Complete Communities.

The Complete Communities program identified ten historically disinvested neighborhoods with a high concentration of low- and moderate-income households to create neighborhood-scale, community driven action plans. Five of these plans are complete, and five are underway. These City Council adopted neighborhood plans will also help to identify community-driven mitigation priorities. Three additional LMI communities were identified for the City's Living with Water Workshop conducted in May 2018 as part of the resilience strategy development. These complementary planning initiatives provide the City with additional opportunities to reach more low- and moderate-income residents.

4. CDBG-MIT Activities

The following activities were developed to meet the requirements of the CDBG-MIT program, as well as other federal, state, and local requirements and regulations, to fund mitigation activities that protect against loss of life and property as efficiently and expeditiously as possible. The following activities address flooding though infrastructure improvements but do not include direct assistance to household beneficiaries. Households may be eligible for direct assistance though other funding sources including CDBG-DR and other entitlement programs through the City's Housing and Community Development Department (www.houstontx.gov/housing and https://recovery.houstontx.gov).

a. Local Flood Mitigation Program

The Local Flood Mitigation Program is a crucial component of a comprehensive, long-term recovery strategy to improve the City's drainage systems and reduce the risk of potential future flooding in neighborhoods and homes. The purpose of this program is to reduce the number of homes damaged by floodwaters, thereby decreasing direct flooding impacts for Houston families. There will likely be many co-benefits to addressing flooding in homes through infrastructure improvements, which may include improved mobility, aesthetic improvements, recreational benefits, property value increases, and life cycle cost savings. This program will be administered by the City of Houston through the Housing and Community Development Department (HCDD) and Houston Public Works (HPW).

Allocation Amount: $58,789,800.00

Eligible Mitigation Activity

This program is an eligible mitigation activity under the infrastructure criteria, as defined in the CDBG-MIT requirements, and will improve the stormwater drainage system in Houston. This activity will alleviate capacity issues and coordinate with improvements to Harris County Flood Control District's assets to address the flood risks from future severe storms and hurricanes, as identified in the mitigation needs assessment.

Eligible Activities

Activities allowed under CDBG-MIT; HCDA Section 105(a)(1-5), 105(a)(7-9), and 105(a)(11), include but are not limited to:

i. Acquisition or disposition of real property;
ii. Infrastructure improvements (such as water and sewer facilities, streets, provision of generators, removal of debris, bridges, etc.), including flood control and drainage repair and improvements through the construction or rehabilitation of stormwater management system;
iii. Natural or green infrastructure;
iv. Clearance, demolition, rehabilitation of publicly or privately-owned buildings, and code enforcement;
v. Removal of materials and architectural barriers
vi. Public service (such as job training and employment services, healthcare, child care, and crime prevention within the 15 percent cap).
vii. Buyouts or acquisition with or without relocation assistance, downpayment assistance, housing assistance, demolition or other activities designed to relocate families outside of floodplains;

Ineligible Activities

i. Emergency response services;
ii. CDBG–MIT funds may not be used to enlarge a dam or levee beyond the original footprint of the structure that existed prior to the disaster event. However, CDBG–MIT funds can be used for levees and dams if used to:
    a. Register and maintain entries regarding such structures with the USACE National Levee Database or National Inventory of Dams;
    b. Ensure that the structure is admitted in the USACE PL 84–99 Rehabilitation Program (Rehabilitation Assistance for Non-Federal Flood Control Projects);
    c. Ensure the structure is accredited under the FEMA NFIP;
    d. Maintain file documentation demonstrating a risk assessment prior to funding the flood control structure and documentation that the investment includes risk reduction measures.
iii. Funds may not be used to assist a privately-owned utility for any purpose;
iv. Buildings and facilities used for the general conduct of government (e.g., city halls, courthouses, and emergency operation centers);
v. By law, (codified in the HCD Act as a note to 105(a)), the amount of CDBG–MIT funds that may be contributed to a USACE project is $250,000 or less.

National Objectives

National objectives for this program may include LMI, elimination of slum/blight, and/or urgent need.

Geographic Eligibility

Infrastructure projects under this program will be located within the City of Houston and will benefit Houston residents. More information about the location of specific projects will be available once these projects are selected for implementation.

Selection Criteria

Through its Capital Improvements Program (CIP), HPW has a current list of unfunded drainage improvement projects. An analysis will be conducted to select projects that will maximize system capacity and have the greatest benefit on the health, safety, and overall welfare of Houstonians. After the selection of potential projects, City Council will approve the selection to be funded with CDBG-MIT funds.

Projects will be identified by determining level of service and need and prioritized using the criteria below. HPW has defined criteria establishing the level of service goal for each infrastructure category.

Storm drainage level of service standards:

i. Curb and gutter: 2 year hydraulic grade line (HGL) below gutter line
ii. Roadside ditch: 2 year HGL 6” below edge of pavement
iii. 100 year water surface elevation (WSE) below the maximum ponding elevation (MPE)
    a. MPE is established to prevent structural flooding and is the lowest of:
        1. Natural ground at the right-of-way line
        2. Curb and gutter: 6” above top-of-curb at pavement high points
        3. Curb and gutter:18” above top-of-curb at pavement low points
        4. Roadside ditch: 12” above pavement high points
        5. Roadside ditch: 24” above pavement low points
iv. Spread less than 1 lane, or roadway centerline for residential streets, during 2 year storm

Need identification starts with a comprehensive assessment of existing conditions compared to predefined acceptable level of service standards.

Need is driven by a combination of factors that indicate an inability of infrastructure to address storm drainage needs – primarily resulting in structural flooding.

i. Drainage Effectiveness
    a. 2-year pipe adequacy determination
    b. 3-1-1 drainage complaints
    c. Ponding areas
ii. Damages from Structural Flooding
    a. 3-1-1 flooding complaints
    b. FEMA insured losses
iii. Mobility Impacts
    a. Ponding greater than 24 inches
iv. Emergency Response
    a. Responder reports of impeded access into/out of neighborhoods

For CDBG-MIT funding, priority will be given to projects that

i. Benefit primarily LMI communities
ii. Can be completed in a timely manner
iii. Coordinate with other local and/or regional infrastructure efforts to ensure consistency, and promote community-level and/or regional post-disaster recovery and mitigation planning;
iv. Have co-benefits to meet goals set as a part the City's resilient strategy in *Resilient Houston*
v. Include natural infrastructure or other low impact development methods

Maximum Award Amount
No person, household or business will receive direct benefits through this program.

Timeline
The proposed program start date is one month after HUD's approval of this Action Plan. The proposed end date is 12 years from the start date of the program.

b. Administration

The City's administrative costs will not exceed 5 percent of the total CDBG-MIT allocation. These costs are necessary for the general administration of the CDBG-MIT program and may include, but not be limited to the City's staff time, or the time of its subrecipients or contractors, to: administer and manage mitigation activities; perform compliance, monitoring, and reporting of the activities; and utilize funds for other costs specified as eligible administrative expenses in 24.206.

Allocation Amount: $3,094,200.00

Eligible Activities: Administration Costs, as defined at 24 CFR 570.205 and 570.206 and any applicable waivers or alternative requirements.

National Objectives
National objectives are not applicable to administrative funds.

Geographic Eligibility
City of Houston

Maximum Award Amount
No person, household or business will receive direct benefits through this program.

Timeline

The proposed program start date is one month after HUD's approval of this Action Plan. The proposed end date is 12 years from the start date of the program.

D. General Requirements

1. Certification of Controls, Processes, and Procedures

As directed by HUD, the City of Houston certified and submitted the following to HUD by January 2, 2020.

- Proficient financial controls and procurement processes
- Adequate procedures to prevent any duplication of benefits
- Processes to ensure timely expenditure of funds
- Ability to maintain comprehensive websites regarding all disaster recovery activities assisted with CDBG-MIT funds
- Adequate measure to detect and prevent waste, fraud, and abuse of funds

2. Implementation Plan and Capacity Assessment

As directed by HUD, the City submitted to HUD in conjunction with this Action Plan its Implementation Plan which outlines the following:

- Procedures to collect timely information on application status
- A capacity assessment
- Staffing plan
- Procedures ensuring internal interagency coordination
- Procedures to provide technical assistance
- Accountability procedures.

3. Program Income

The City does not intend to implement any programs or activities that generate income as described in 24 CFR 570.489. However, if any CDBG-MIT activities generate income, the City will retain program income to fund additional CDBG-MIT activities or to fund the repair, operation, or maintenance of existing CDBG-MIT projects. The City will comply with all HUD requirements in 24 CFR 570.504, as well as the rules outlined in 84 FR 45838 and subsequent notices, including tracking program income in the DRGR system and using program income before drawing additional grant funds. Specifically, the City will adhere to the program income policies and procedures as stated in the City's financial certifications.

4. Long-Term Planning and Risk Mitigation Considerations

The City has historically experienced flooding, but the impacts of recent flood events have resulted in an extraordinary amount of damage, disruption, and lasting negative consequences long after flood waters subsided. The City has been proactive in undertaking measures that address resilience and sustainability, as well as educating the public to minimize risk for communities and individuals. Over the past few years, the City has taken the lead on implementing more resilience-focused programs that will rebuild, transform, and protect communities. This includes changes to policy and regulations, improving modeling tools and data acquisition, incentivizing nature-based development, strengthening and building new partnerships with other local, state, and federal agencies and private sector for project and planning coordination, and improving communications and engaging all Houstonians. The following efforts detail the long-term planning and risks mitigation considerations that are underway.

The City of Houston adopted their first General Plan in 2015, named Plan Houston, the plan includes a framework of goals around people, places, culture, education, economy, environment, public services, housing, and transportation. Key Plan Houston goals include (6 of 32):

- A safe, secure community
- Equal access to opportunity and prosperity

- Sufficient quality, affordable housing options throughout the community
- Resilient man-made and natural systems that protect citizens and assets from disasters and other risks
- A culture that encourages innovation
- High-quality community facilities that provide for the diverse needs of residents

In 2018, the City began the development of the first Climate Action Plan to mitigate climate risk through greenhouse gas reduction. The Climate Action Plan will focus on buildings, transportation, materials management, and energy transition. Also in 2018, the City began the development of the first Resilience Strategy to provide a comprehensive framework for addressing numerous shocks and stresses including flooding, hurricanes, aging infrastructure, affordable housing, extreme heat, inequity, and population growth. Resilient Houston looks at resilience-building at the individual, neighborhood, bayou, city and regional scales and has been focused on water and climate, equity and inclusion, health and safety, infrastructure and economy and housing and mobility. These efforts are expected to be released in the winter of 2019/2020.

a. Chief Recovery Officer

In 2016, Mayor Sylvester Turner appointed the City's first "flood czar," which evolved to become the City's official Chief Recovery Officer. Since then, the Mayor's Recovery Office has engaged, on the Mayor's behalf, with governmental entities, private and non-profit organizations, interest groups, individuals, and City departments to: 1) ensure a rapid, quality recovery from Hurricane Harvey and other Legacy disasters and 2) position the City to be less vulnerable to the next record-breaking storm. The Chief Recovery Officer helps to identify transformative projects and design strategies for mitigating flood risk and achieving flood resiliency.

b. Resilient Houston

The Chief Resilience Officer leads the city-wide resilience-building efforts to help Houston prepare for, withstand, and recover from "shocks" – catastrophic events like hurricanes, floods, and cyberattacks – and "stresses" – slow moving disasters like aging infrastructure homelessness, and economic inequality, which are increasingly a part of 21st century life.

In May 2018, the first step of the Resilience Strategy was completed. After conducting a resilience assessment, the City produced a Resilience Framework that identified 12 drivers that collectively determine the city's ability to withstand a wide range of shocks and stresses. This framework will be used throughout the development and implementation of Houston's Resilience Strategy to evaluate existing policies, identify areas of strength and weakness, and measure progress.

In August 2018, one year after Hurricane Harvey, Houston was named the 101st member of 100 Resilient Cities – Pioneered by the Rockefeller Foundation, now know as part of the Global Resilient Cities Network. Upon joining a global network of cities, Houston began the development of the Resilient Houston Strategy. The pre-strategy planning included an Agenda Setting Workshop and the Living with Water Workshop in November 2018. In early 2019, Mayor Sylvester Turner appointed a Chief Resilience Officer to develop the Strategy.

The Chief Resilience Officer leads the city-wide resilience-building efforts to help Houston prepare for, withstand, and recover from "shocks" – catastrophic events like hurricanes, floods, and cyberattacks – and "stresses" – slow moving disasters like aging infrastructure homelessness, and economic inequality, which are increasingly a part of 21st century life. Resilient Houston looks at resilience-building at the individual, neighborhood, bayou, city and regional scales and has been focused on water and climate, equity and inclusion, health and safety, infrastructure and economy and housing and mobility. This process also included hosting Houston's "Dutch Dialogue" through a two-part Living With Water workshop in November 2018 and May 2019. These efforts brought various stakeholders, including businesses, non-profits, government agencies, and the public, to discuss the key challenges faced in Houston and identify a vision to create a more resilient city. Flooding was highlighted continuously as a main area of focus.

c. Floodplain Management

After the devastating effects of Hurricane Harvey in 2017, Tax Day flood in 2016, and Memorial Day flood in 2015, the City's floodplain ordinance was updated to make the city more resilient as it rebuilds. The new rules for future construction of homes and buildings in floodplains took effect September 1, 2018, close to the 1-year anniversary of Hurricane Harvey. Now, new construction will have to sit two feet above the 500-year floodplain, which is land predicted to flood during a once-every-500-years storm (17-19 inches of rain in 24 hours). The previous standard was set at one foot above the 100-year floodplain, land that is predicted to flood during a once-every-100-years (13-14 inches of rain in 24 hours). Additional ordinances are under development to update rules on providing rainwater retention areas.

In addition, the City, through various departments, will continue efforts to make the community aware of flood hazards. The Office of Emergency Management will also continue its efforts to promote the use of hazard insurance for Houston residents, through educational campaigns, social media posts, and public presentations.

5. Coordination of Mitigation Projects and Leveraging Resources

The City of Houston aims to maximize the impact of CDBG-MIT funds by identifying and leveraging other federal and non-federal funding sources for activities. Houston Public Works has joint studies underway to coordinate planning and project development with the Harris County Flood Control District. CDBG-MIT projects will leverage city Capital Improvement Program funds, Harris County Flood Control District bond funds and Tax Increment Reinvestment Zones to enhance the benefits of planned projects. Leveraged funds for CDBG-MIT activities will be identified in the DRGR system. The City will utilize existing relationships and strive to create new partnerships with other federal, state, regional and local agencies, private corporations, foundations, nonprofits, and other stakeholders to leverage all viable sources of funding. The Chief Recovery Officer and Chief Resilience Officer will help to coordinate CDBG-MIT programs and activities with other City departments to advance long-term resilience. This coordination will help to generate better outcomes by enhancing the benefits of CDBG-MIT funded activities.

The OEM continues to work closely with FEMA to integrate the latest guidance into the City's hazard mitigation planning. HCDD will also continue to work with FEMA to deliver short–term disaster relief after disasters, as needed. The City also participates in projects led by the U.S. Army Corps of Engineers including projects related to the reservoirs, impacts of sedimentation in the ship channel, and regional watershed assessments.

The City will continue to strengthen the relationships with Harris County Flood Control District and other cities and counties to identify and implement stormwater management solutions that maximize flood reduction benefits to entire watersheds. At the largest scale, Houston is a patchwork of jurisdictional bodies, which means that collaboration is key to effectively manage development within Houston's bayous. Additional City/County partnerships will be explored with specific attention to flood reduction projects that provide multiple benefits. This will enable the creation of a collaboration framework that highlights the goals of living safely with water at a regional scale.

6. Plans to Minimize Displacement

Activities funded through the CDBG-MIT allocation will be designed to eliminate or minimize the occurrence of displacement of persons and/or entities. However, if any proposed projects cause the displacement, the City will ensure that the assistance and protections are afforded to persons or entities under the Uniform Relocation Assistance and Real Property Acquisition Policies Act (URA) of 1970, and Section 104(d) of the Housing and Community Development Act of 1974, and by implementing the regulations under 24 CFR Part 570.496(a), subject to any waivers or alternative requirements provided by HUD. Also, in the event any displacement occurs, the City will make reasonable accommodations for displaced persons with disabilities in accordance with guidance outlined in Chapter 3 of HUD's Relocation Handbook (https://www.hud.gov/program_offices/administration/hudclips/handbooks/cpd/13780).

Given its priority to engage in voluntary acquisition and optional relocation activities to avoid repeated flood damage and improve floodplain management, the City accepts the HUD waiver of the Section 104(d) requirements, which assures uniform and equitable treatment by setting the URA and its implementation regulations, as the sole standard for relocation assistance under the Notice published at 84 FR 45838. Efforts to conduct voluntary buyouts for destroyed and extensively damaged buildings in a floodplain may not be subject to all provisions of the URA requirements.

7. Natural Infrastructure

The City of Houston has created an incentives program to encourage the spread of green stormwater infrastructure (GSI) in the city. The incentives mark the first step toward developing a robust green infrastructure program complemented by municipal projects in partnership with private development.

The recommended incentives are the result of a study, commissioned by the City's Chief Recovery Officer and funded by Houston Endowment, to identify and recommend incentives encouraging the use of green infrastructure in private land development in the city.

The incentives are:

- Integrated GSI Development Rules: The City will adopt rules that harmonize parking, landscaping, open space, drainage design, detention design and stormwater quality design requirements.
- Property Tax Abatements: The City will defer or reduce property tax bills for developers who use GSI in their projects.
- Award and Recognition Program: The City will recognize and award developers who use GSI.
- Increased Permitting Process Certainty and Speed: The City will provide a fee-based, more consistent and faster plan review process, with lower fees associated with projects that use GSI.

The City will encourage inclusion of multifunctional design elements, such as natural or green infrastructure or other low impact development techniques, in construction of stormwater drainage infrastructure, as much as is feasible. By incorporating resilient design principles, these projects can not only provide storm protection but can also serve as an asset to the community for recreation and transportation options and improved health benefits and quality of life. These will need to be evaluated on a project-by-project basis for functionality and overall benefit for flood risk reduction. The following infrastructure strategies are examples that may be incorporated to reduce runoff, retain water, improve water quality, and increase multi-functional uses through a CDBG-MIT activity:

- Retaining or planting native vegetation
- Removing existing impervious surface or utilizing pervious pavement or other porous materials
- Installing bioswales or other retention areas
- Collecting and utilizing rainwater in other ways, like underground storage or to use for nonpotable practices

8. Construction Standards

CDBG-MIT funds will address flood risk through infrastructure improvements, reducing the number of homes damaged and families impacted by potential future flooding. Because flooding not only has financial impacts for Houstonians, it also impacts the health and wellness of residents and neighborhoods. By protecting homes from flooding, there is a potential for an increase in property values and development, which will benefit the community.

The City of Houston will emphasize high quality, durability, energy efficiency, and sustainability of construction in its CDBG-MIT activities. HPW maintains quality construction standards for infrastructure projects through reviewing plans and monitoring construction work. The City of Houston is an Envision Supported Agency, which is an international network of government entities that are using Envision and have an Envision Sustainability Professional on staff. Envision sets the standard for sustainable infrastructure and gives recognition to projects that make significant contributions to sustainability.

Green building standards and elevation requirements do not apply to Houston's CDBG-MIT activities because the activities will not rehabilitate, replace, construct, or elevate residential housing.

9. Operation and Maintenance Plan

CDBG-MIT regulations allow for flexibility in the use of program income to address on-going operations and maintenance of mitigation projects. If program income is received, the City may use income for eligible uses including repair, operation, and maintenance of publicly owned projects financed with CDBG-MIT funds. If no program income is received, the City of Houston plans to use local sources to fund the long-term operation and maintenance the projects constructed with CDBG-MIT.

The Houston Public Works Storm Water Maintenance Branch (SWMB) directs the daily operations of Houston's critical Storm Drainage System Infrastructure. SWMB is dedicated to providing the best possible maintenance to the storm drainage system infrastructure, delivering results in a timely and cost effective manner for the City's residents. Residents are encouraged to call 311 to report problems with storm drains and storm water quality.
The SMWB's core services are divided into four primary areas as follows:

The Storm Sewer Maintenance Section (Closed System) handles the operation and maintenance of the City's storm sewer system, including tasks such as inspecting and cleaning manholes, inlets, and storm sewer lines.
To ensure that routine daily activities can be carried out, this section operates and maintains the following assets over a 650 square mile region:

- Approximately 3,800 Miles of Storm Sewer Lines and Related Infrastructure (Manholes, Inlets)
- 6,305 Outfalls
- 28 Roadway Underpasses with Storm Ponding Level Warning Devices (Some with Pump Stations)

This Section is also responsible for entering large-diameter storm sewers to remove debris and objects that can block the storm sewer. These tasks are performed by "Confined Space Entry" teams that ensure safe maintenance in these conditions. The Section also conducts inspections of new and rehabilitated storm water systems.
By design, storm sewers are self-cleaning; however, these sewers are designed only for storm water and empty directly into major ditches and bayous. In order to limit environmental concerns and maintenance needs, citizens should never dispose of grass clippings, motor oil, or any other items/debris in the storm sewer.

The Ditch Maintenance Section (Open System) handles the Operation and Maintenance of the City's ditches (roadside and major/off-road) and detention systems, which includes tasks such as de-silting and re-grading ditches, as well as flushing culverts under driveways and streets. To ensure routine daily activities can be carried out, this section operates and maintains the following assets over a 650 square mile region:

- Approximately 2,400 Miles of Roadside Ditches (Both Sides of Street)
- 74 Miles of Off-Road/Major Drainage Ditches
- 10 Storm Water Detention Basins

10. Cost Verification

Cost verification controls assure that construction costs are reasonable and consistent with market costs at the time and place of construction. Construction activities are based on sealed designs and an engineering estimate of probable costs. Houston Public Works staff undertake the following activities:

- Manage preliminary and final engineering design, construction management, and inspection contracts.
- Manage construction awards.
- Construction management, administration and inspection services of projects.
- Construction phase appropriations.
- Project acceptance and close out actions.

11. Mitigation Planning

In Resilient Houston, the City proposes updates to existing planning activities, including to the City's building codes, and also proposes new planning initiatives to address natural hazards, risk, and resilience. The Strategy addresses the need to modernize Houston's infrastructure by integrating green infrastructure, modernizing building codes and standards, modernizing integrated resource recovery management, and implementing the Houston Complete Streets and Transportation Plan.

Although CDBG-MIT funds will not fund planning activities for building code updates or hazard mitigation planning, other sources of funding will be used to implement planning efforts identified in Resilient Houston or by other City departments. Funding sources include local City funds, including existing CDBG-DR funds, and potential State mitigation funds. For instance, the Houston Planning Department will utilize local funds in 2020 to begin the process of updating Chapter 42 of the City's Code of Ordinances, which guides building and development in the City. It is also anticipated that CDBG-DR funds will be used to support an update to the Houston Hazard Mitigation Plan.

E. Public Feedback

The City is committed to incorporating residents' and stakeholders' comments into this Action Plan. In this document, the City has created a Citizen Participation Plan for CDBG-MIT, which includes citizen participation requirements for the lifetime of the grant.

1. Public Engagement

a. Local Action Plan for Hurricane Harvey

In preparation of *the Local Action Plan for Hurricane Harvey*, later incorporated into the *State of Texas Action Plan for Disaster Recovery Hurricane Harvey – Round 1*, as amended, the HCDD engaged more than 800 Houstonians through public meetings, 746 through an online survey, and more than 3,000 people through a tele-townhall co-hosted with AARP. To achieve this ambitious six-week engagement, HCDD partnered with a number of neighborhood, nonprofit, and community development organizations to seek guidance and support in their engagement strategies and outreach.

The following are a few highlights from feedback received from these community meetings:

- Some people have been able to rebuild, but others are stuck in unsafe homes
- Housing and drainage are deeply connected
- In areas that didn't flood, longtime residents want protection from displacement
- In areas that flooded severely, a rise in vacant homes is threatening the fabric of communities

In addition, in anticipation of CDBG-MIT, the online survey included questions about mitigation funding priorities. The online survey was open from May 14, 2018 to June 24, 2018 and there were 746 respondents.

The three top activities respondents selected to reduce the risks of flooding in the future include: 1) drainage improvements to prevent flooding during heavy rains, 2) large scale flood retention/detention improvements to hold water runoff (ponds and basins), and 3) other changes to infrastructure through building or improvement dams, levees, seawalls, retaining walls. Other prevention activities given by respondents included: 1) development restrictions, 2) improvements to Buffalo Bayou, and 3) buyouts.

Over 80 percent of respondents thought it was very important that: 1) the community take regulatory action to influence the way land is developed and buildings are built and that 2) actions should be taken to lessen the impact of flooding through structural projects.

The top three themes that respondents thought that the City of Houston can do in their neighborhood to reduce or eliminate the risk of damage from future natural disasters include: 1) improve water drainage, storage, and management, 2) maintain and improve bayous, and 3) build a third reservoir.

b. Resilient Houston

Beginning in 2018 through the end of 2019, the Chief Resilience Officer coordinated engagement with the public and City departments to inform the resilience strategy. The development of the strategy included a representative interdisciplinary working group of more than 100 people focused on five areas of resilience: Achieving Equity and Inclusion, Building Forward, Improving Health and Safety, Integrating Housing and Mobility, and Living With and Without Water. Via these workgroups, key input was obtained for specific areas to prioritize. A parallel effort tied to Living with Water allowed the City to explore specific flood mitigation and resilience strategies through three different Houston neighborhoods. The toolkit and strategies identified through extensive stakeholder engagement are transferable and has been taken into consideration in the development of this plan and will be referenced as specific projects are identified and selected.

c. Public Hearings for CDBG-MIT

The requirements for CDBG-MIT grantees mandate a minimum number of public hearings. For Houston, the minimum number is two, one during the development of the Action Plan and one after the publication of the Action Plan for public comment. Public hearings were held:

- In different locations to ensure geographic balance and accessibility
- In facilities that are physically accessible to persons with disabilities
- In compliance with civil rights requirements

Recordings of the hearings were posted on the HCDD Facebook page and the City's mitigation webpage.

Table 28: Mitigation Public Hearing Schedule

Public Hearing	Date	Location
First Public Hearing: Pre-Action Plan Publication	Tuesday, November 19, 2019	Burrus Elementary School 701 East 33rd Street, 77022
Second Public Hearing: Public Comment Period	TBD	TBD

Source: City of Houston Housing and Community Development Department

The first public hearing included a variety of ways through which residents could engage with the City of Houston staff. The meeting began and ended with an open house format with City staff posted at tables around the room. Each table included comment cards and materials, maps, or other information about various City housing programs or information about the Office of Emergency Management (OEM) or HPW. At each of the tables, residents could ask questions and interact with programmatic experts. After a short presentation about CDBG-MIT requirements and goals, staff led discussion groups to gather information about residents' priorities for addressing risk in Houston using CDBG-MIT funds. Lastly, residents were given the opportunity to voice their opinions and personal testimony regarding the CDBG-MIT funding. The City considered and incorporated the public comments into this Action Plan.

d. Publication of Draft Action Plan

Before the City of Houston adopts the Action Plan for CDBG-MIT, the City published the Action Plan on the City's mitigation website: https://houstontx.gov/housing/mitigation.html. The City notified affected residents of the public hearings and the Draft Action Plan publication through electronic mailings, public notices, newsletters, contacts with neighborhood organizations, and/or through social media. The City prominently posted information about the draft plan on HCDD's website, and the topic of mitigation is also navigable from this website.

The City will ensure that all residents have equal access to information about the Action Plan's programs, including persons with disabilities and limited English proficiency. The City will provide translations of the Action Plan into other languages or formats upon request.

The public comment period for the original publication of the Draft Action Plan was 45 days, from Friday, December 13, 2019 to Monday, January 27, 2020. The City of Houston accepted public comments regarding the Draft Action Plan. A summary of the comment received and the City's response to each is located included the Appendix of this document and will be submitted to HUD.

2. Summary of Input

Flooding in Houston over the past five years has impacted many Houstonians and their families financially, physically, and emotionally. Many of the same feedback received as a part of the Local Action Plan for Hurricane Harvey was reiterated in the more recent public engagement forums. Residents do not want to have their homes flooded again and are frustrated when assistance seems slow to arrive. Community input received during the public

hearings asked for a coordinated effort between the City and other agencies, such as the Harris County Flood Control District, to maintain, enlarge, and improve stormwater infrastructure to decrease the risk of residential structure flooding in the future. Residents also voiced their support of improving building and land development codes to address future flood risks. The majority of Houstonians providing input for the development of this Action Plan want to continue to live in their communities or even their current flood-damaged home but want their community improved so that flood risk is substantially decreased.

F. Citizen Participation Plan for Houston's CDBG-MIT (CPP-MIT)

1. Introduction

The purpose of the Citizen Participation Plan for Houston's Community Development Block Grant Mitigation (CDBG-MIT) is to establish a means by which residents of the City of Houston (City), public agencies, and other interested parties can actively participate in the implementation and assessment of documents related to CDBG-MIT activities. The City developed the CPP-MIT to meet the requirements of the CDBG-MIT funds and reflects the alternative requirements as specified by *84 FR 45838 and any subsequent notices*.

The CPP – MIT is a separate, distinct and tailored plan based upon and consistent with the City's *Citizen Participation Plan*, which describes public participation related to the consolidated planning process and entitlement grants. The City encourages citizen participation that emphasizes the involvement of low- and moderate-income residents, minority populations, persons with limited English proficiency, and persons with disabilities.

2. Availability and Accessibility of Records

During the term of the CDBG-MIT grant, the City will provide citizens and other interested parties with reasonable and timely access to information and records relating to the action plan and to the grantee's use of grant funds. This Action Plan and associated amendments and performance reports will be made available on HCDD's website, and upon request from the HCDD. In addition, these documents are available in a form accessible to persons with disabilities and those with limited English proficiency, upon request.

a. Citizen Advisory Group

The City of Houston will form one citizen advisory committee that will meet at least twice annually to provide increased transparency in the implementation of the CDBG-MIT funds, to solicit and respond to public comment and input regarding Houston's mitigation activities, and to serve as an on-going public forum to continuously inform Houston's CDBG-MIT projects and programs.

b. Public Website

HCDD maintains a public website which provides information for how CDBG-MIT funds are used, managed, and administered. It will include links to all CDBG-MIT Action Plans and amendments, performance reports, CDBG-MIT citizen participation requirements, and activity/program information for activities described in the CDBG-MIT Action Plan. It will also include details of all contracts and ongoing procurement policies.

The following items will be available on the Mitigation website (https://houstontx.gov/housing/mitigation.html):

- Action Plan and amendments
- Quarterly Performance Reports (QPRs)
- Procurement policies and procedures
- All executed contracts that will use CDBG-MIT funds
- The status of services or goods currently being procured

3. Amendments

Occasionally, it may be necessary for the City to update the Action Plan. Amendments to the Action Plan are divided into two categories: Substantial Amendments and Nonsubstantial Amendments. As amendments occur, both types of amendments are numbered sequentially and posted on the City's CDBG-MIT website https://houstontx.gov/housing/mitigation.html.

Copies of amendments are available upon request to: hcdd@houstontx.gov or 832.394.6200.

The most current version of entire action plan will be accessible for viewing as a single document. Each amendment will have highlighted changes, and the beginning of amendments will include:

- Section identifying exactly what content is added, deleted, or changed
- Revised budget allocation table that reflects all funds and illustrates where funds are coming from and moving to, as amended and applicable
- Description of how amendment is consistent with the mitigation needs assessment

a. Substantial Amendment

The following criteria are used to determine what constitutes a Substantial Amendment to its approved Action Plan:

- The addition of a CDBG-MIT Covered Project
- A change in program benefit or eligibility criteria
- The addition or deletion of an activity
- A new allocation or reallocation of more than 25 percent of an activity in the Program Budget

Substantial Amendments are subject to a citizen participation process and require formal action by the City Council and submission to HUD. The City announces Substantial Amendments to the public through a public notice published in one or more newspapers of general circulation, for a period of 30 days, in order to provide opportunity for public review and comment regarding proposed Substantial Amendments. Notices will be available in English and may also be available in Spanish and other languages, as feasible. The City will consider all written and/or oral comments or views concerning proposed Substantial Amendments that are received during the comment period. A summary of these comments and views, including comments or views not accepted, and the reason why, along with HCDD's response to each, shall be submitted with each Substantial Amendment.

b. Nonsubstantial Amendment

The City is not required to undertake public comment for an Action Plan amendment that is not considered a Substantial Amendment. The City will notify HUD of a Nonsubstantial Amendment at least 5 business days before the amendment becomes effective.

4. Application Status and Transparency

As applicable, the City of Houston will provide multiple methods of communication to provide applicants with timely information to determine the status of their application for assistance, including by phone, by mail, and in person. When competitively awarding CDBG-MIT funds, the City of Houston will publish on the website the eligibility requirements for the funding, all criteria to be used in the selection of application for funding-including the relative importance of each criterion, and the time frame for consideration of applications. HCDD will maintain documentation to demonstrate that each funded and unfunded application was reviewed and acted upon in accordance with the published eligibility requirements and funding criteria. Currently, no person, household or business will receive direct benefits through the Local Flood Mitigation Program.

5. Citizen Complaints

Written complaints from the public related to this Action Plan (or its amendments), QPRs, or the City's activities or programs funded with CDBG-MIT, will receive careful consideration and will be answered in writing, or other effective method of communication, within 15 business days, where practicable.

Written complaints should be sent to

Attn: Planning and Grants Management
City of Houston Housing and Community Development Department
2100 Travis Street, Suite 900
Houston, TX 77002

Email: HCDDComplaintsAppeals@houstontx.gov
Phone: 832.394.6200

Complaints regarding fraud, waste, or abuse of government funds will be forwarded to the City of Houston Office of Inspector General or the Department of Housing and Urban Development Office of Inspector General (Phone: 1-800-347-3735 or Email: hotline@hudoig.gov).

G. Certifications

In accordance with the applicable statutes and regulations governing the CDBG-MIT funds, including 84 FR 45869, the City of Houston (the Grantee) certifies as follows:

a. The Grantee certifies that it has in effect and is following a residential anti-displacement and relocation assistance plan in connection with any activity assisted with funding under the CDBG program.
b. The Grantee certifies its compliance with restrictions on lobbying required by 24 CFR part 87, together with disclosure forms, if required by part 87.
c. The Grantee certifies that the Action Plan is authorized under State and local law (as applicable) and that the grantee, and any entity or entities designated by the Grantee, possess(es) the legal authority to carry out the program for which it is seeking funding, in accordance with applicable HUD regulations and this Notice. The grantee certifies that activities to be administered with funds under this Notice are consistent with its Action Plan.
d. The Grantee certifies that it will comply with the acquisition and relocation requirements of the URA, as amended, and implementing regulations at 49 CFR part 24, except where waivers or alternative requirements are provided for in this Notice.
e. The Grantee certifies that it will comply with section 3 of the Housing and Urban Development Act of 1968 (12 U.S.C. 1701u), and implementing regulations at 24 CFR part 135.
f. The Grantee certifies that it is following a detailed citizen participation plan that satisfies the requirements of 24 CFR 91.105 or 91.115, as applicable (except as provided for in notices providing waivers and alternative requirements for this grant). Also, each local government receiving assistance from a State grantee must follow a detailed citizen participation plan that satisfies the requirements of 24 CFR 570.486 (except as provided for in notices providing waivers and alternative requirements for this grant).
g. The Grantee certifies that it has consulted with affected local governments in counties designated in covered major disaster declarations in the non-entitlement, entitlement, and tribal areas of the State in determining the uses of funds, including method of distribution of funding, or activities carried out directly by the State.
h. The Grantee certifies that it is complying with each of the following criteria:
    (1) Funds will be used solely for necessary expenses related to disaster relief, long-term mitigation, restoration of infrastructure and housing, and economic revitalization in the most impacted and distressed areas for which the President declared a major disaster in 2017 pursuant to the Robert T. Stafford Disaster Relief and emergency Assistance Act of 1974 (42 U.S.C. 5121 et seq.).
    (2) With respect to activities expected to be assisted with CDBG-DR funds, the Action Plan has been developed so as to give the maximum feasible priority to activities that will benefit low- and moderate-income families.
    (3) The aggregate use of CDBG-DR funds shall principally benefit low- and moderate-income families in a manner that ensures that at least 70 percent of the grant amount is expended for activities that benefit such persons.
    (4) The grantee will not attempt to recover any capital costs of public improvements assisted with CDBG-DR grant funds, by assessing any amount against properties owned and occupied by persons of low- and moderate-income, including any fee charged or assessment made as a condition of obtaining access to such public improvements, unless: (a) disaster mitigation grant funds are used to pay the proportion of such fee or assessment that relates to the capital costs of such public improvements that are financed from revenue sources other than under this title; or (b) for purposes of assessing any amount against properties owned and occupied by persons of moderate income, the grantee certifies to the Secretary that it lacks sufficient CDBG funds (in any form) to comply with the requirements of clause (a).
i. The Grantee certifies that it grant will conduct and carry out the grant in conformity with title VI of the Civil Rights Act of 1964 (42 U.S.C. 2000d) and the Fair Housing Act (42 U.S.C. 3601–3619) and implementing regulations, and that it will affirmatively further fair housing.

j. The Grantee certifies that it has adopted and is enforcing the following policies. In addition, States receiving a direct award must certify that they will require UGLGs that receive grant funds to certify that they have adopted and are enforcing:
   (1) A policy prohibiting the use of excessive force by law enforcement agencies within its jurisdiction against any individuals engaged in nonviolent civil rights demonstrations; and
   (2) A policy of enforcing applicable State and local laws against physically barring entrance to or exit from a facility or location that is the subject of such nonviolent civil rights demonstrations within its jurisdiction.

k. The Grantee certifies that it (and any subrecipient or administering entity) currently has or will develop and maintain the capacity to carry out disaster mitigation activities in a timely manner and that the grantee has reviewed the requirements of this notice. The grantee certifies to the accuracy of its Public Law 115-56 Financial Management and Grant Compliance certification checklist, or other recent certification submission, if approved by HUD, and related supporting documentation referenced at A.1.a under Section VI and its Implementation Plan and Capacity Assessment and related submission to HUD referenced at A.1.b under Section VI.

l. The Grantee certifies that it considered the following resources in the preparation of its action plan, as appropriate: FEMA Local Mitigation Planning Handbook: https:// www.fema.gov/media-library-data/ 20130726-1910-25045-9160/fema_local_ mitigation_handbook.pdf; DHS Office of Infrastructure Protection: https:// www.dhs.gov/sites/default/files/ publications/ip-fact-sheet-508.pdf; National Association of Counties, Improving Lifelines (2014): https:// www.naco.org/sites/default/files/ documents/NACo_ResilientCounties_ Lifelines_Nov2014.pdf; the National Interagency Coordination Center (NICC) for coordinating the mobilization of resources for wildland fire: https:// www.nifc.gov/nicc/); the U.S. Forest Service's resources around wildland fire (https://www.fs.fed.us/managing-land/ fire); and HUD's CPD Mapping tool: https://egis.hud.gov/cpdmaps/.

m. The Grantee will not use grant funds for any activity in an area identified as flood prone for land use or hazard mitigation planning purposes by the State, local, or tribal government or delineated as a special flood hazard area (or 100-year floodplain) in FEMA's most recent flood advisory maps, unless it also ensures that the action is designed or modified to minimize harm to or within the floodplain, in accordance with Executive Order 11988 and 24 CFR part 55. The relevant data source for this provision is the State, local and tribal government land use regulations and hazard mitigation plan and the latest issued FEMA data or guidance, which includes advisory data (such as Advisory Base Flood Elevations) or preliminary and final Flood Insurance Rate Maps.

n. The Grantee certifies that its activities concerning lead-based paint will comply with the requirements of 24 CFR part 35, subparts A, B, J, K, and R.

o. The Grantee certifies that it will comply with environmental requirements at 24 CFR Part 58.

p. The Grantee certifies that it will comply with applicable laws.

Appendix 1: Projection of Expenditures and Outcomes

Appendix 1: Projected Expenditures and Outcomes

Program/Activity	Program Allocation	2020			
		Q1	Q2	Q3	Q4
Local Flood Mitigation Program	$58,789,800	-	$0	$0	$50,000
Administration	$3,094,200	-	$0	$50,000	$50,000
Grand Total	$61,884,000	-	$0	$50,000	$100,000
Funds Remaining		-	$61,884,000	$61,834,000	$61,734,000

Program/Activity	Program Allocation	2021			
		Q1	Q2	Q3	Q4
Local Flood Mitigation Program	$58,789,800	$50,000	$50,000	$500,000	$500,000
Administration	$3,094,200	$65,000	$65,000	$65,000	$65,000
Grand Total	$61,884,000	$115,000	$115,000	$565,000	$565,000
Funds Remaining		$61,619,000	$61,504,000	$60,939,000	$60,374,000

Program/Activity	Program Allocation	2022			
		Q1	Q2	Q3	Q4
Local Flood Mitigation Program	$58,789,800	$1,000,000	$1,000,000	$1,000,000	$1,000,000
Administration	$3,094,200	$65,000	$65,000	$65,000	$65,000
Grand Total	$61,884,000	$1,065,000	$1,065,000	$1,065,000	$1,065,000
Funds Remaining		$59,309,000	$58,244,000	$57,179,000	$56,114,000

Program/Activity	Program Allocation	2023			
		Q1	Q2	Q3	Q4
Local Flood Mitigation Program	$58,789,800	$2,000,000	$2,000,000	$2,000,000	$2,000,000
Administration	$3,094,200	$70,000	$70,000	$70,000	$70,000
Grand Total	$61,884,000	$2,070,000	$2,070,000	$2,070,000	$2,070,000
Funds Remaining		$54,044,000	$51,974,000	$49,904,000	$47,834,000

Program/Activity	Program Allocation	2024			
		Q1	Q2	Q3	Q4
Local Flood Mitigation Program	$58,789,800	$2,500,000	$2,500,000	$2,500,000	$2,500,000
Administration	$3,094,200	$70,000	$70,000	$70,000	$70,000
Grand Total	$61,884,000	$2,570,000	$2,570,000	$2,570,000	$2,570,000
Funds Remaining		$45,264,000	$42,694,000	$40,124,000	$37,554,000

Program/Activity	Program Allocation	2025			
		Q1	Q2	Q3	Q4
Local Flood Mitigation Program	$58,789,800	$2,500,000	$2,500,000	$2,500,000	$2,500,000
Administration	$3,094,200	$70,000	$70,000	$70,000	$70,000
Grand Total	$61,884,000	$2,570,000	$2,570,000	$2,570,000	$2,570,000
Funds Remaining		$34,984,000	$32,414,000	$29,844,000	$27,274,000

Program/Activity	Program Allocation	2026			
		Q1	Q2	Q3	Q4
Local Flood Mitigation Program	$58,789,800	$2,000,000	$2,000,000	$2,000,000	$2,000,000
Administration	$3,094,200	$70,000	$70,000	$70,000	$70,000
Grand Total	$61,884,000	$2,070,000	$2,070,000	$2,070,000	$2,070,000
Funds Remaining		$25,204,000	$23,134,000	$21,064,000	$18,994,000

Program/Activity	Program Allocation	2027			
		Q1	Q2	Q3	Q4
Local Flood Mitigation Program	$58,789,800	$1,500,000	$1,500,000	$1,500,000	$1,500,000
Administration	$3,094,200	$65,000	$65,000	$65,000	$65,000
Grand Total	$61,884,000	$1,565,000	$1,565,000	$1,565,000	$1,565,000
Funds Remaining		$17,429,000	$15,864,000	$14,299,000	$12,734,000

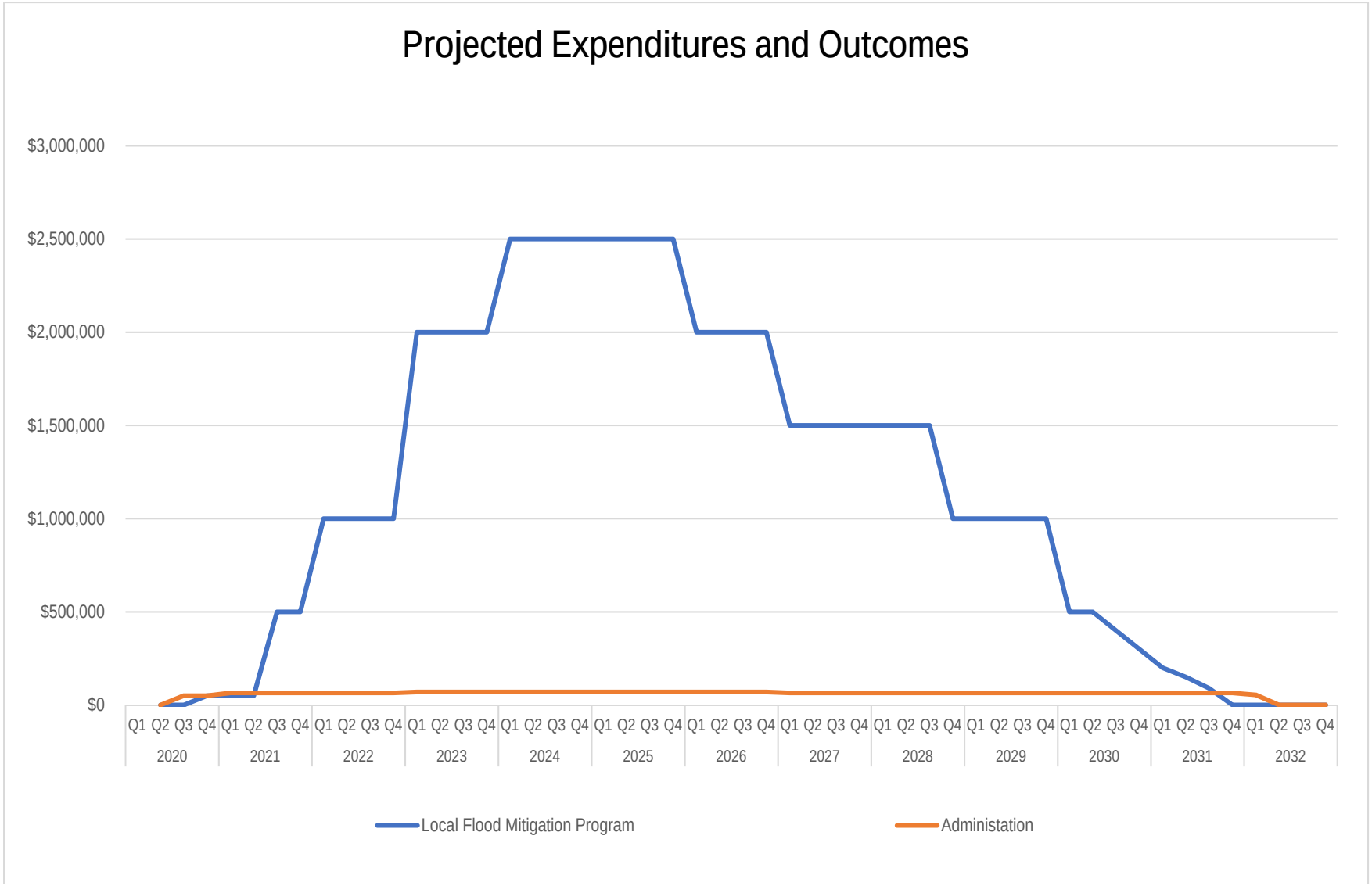
Program/Activity	Program Allocation	2028			
		Q1	Q2	Q3	Q4
Local Flood Mitigation Program	$58,789,800	$1,500,000	$1,500,000	$1,500,000	$1,000,000
Administration	$3,094,200	$65,000	$65,000	$65,000	$65,000
Grand Total	$61,884,000	$1,565,000	$1,565,000	$1,565,000	$1,065,000
Funds Remaining		$11,169,000	$9,604,000	$8,039,000	$6,974,000

Program/Activity	Program Allocation	2029			
		Q1	Q2	Q3	Q4
Local Flood Mitigation Program	$58,789,800	$1,000,000	$1,000,000	$1,000,000	$1,000,000
Administration	$3,094,200	$65,000	$65,000	$65,000	$65,000
Grand Total	$61,884,000	$1,065,000	$1,065,000	$1,065,000	$1,065,000
Funds Remaining		$5,909,000	$4,844,000	$3,779,000	$2,714,000

Program/Activity	Program Allocation	2030			
		Q1	Q2	Q3	Q4
Local Flood Mitigation Program	$58,789,800	$500,000	$500,000	$400,000	$300,000
Administration	$3,094,200	$65,000	$65,000	$65,000	$65,000
Grand Total	$61,884,000	$565,000	$565,000	$465,000	$365,000
Funds Remaining		$2,149,000	$1,584,000	$1,119,000	$754,000

Program/Activity	Program Allocation	2031			
		Q1	Q2	Q3	Q4
Local Flood Mitigation Program	$58,789,800	$200,000	$150,000	$89,800	$0
Administration	$3,094,200	$65,000	$65,000	$65,000	$65,000
Grand Total	$61,884,000	$265,000	$215,000	$154,800	$65,000
Funds Remaining		$489,000	$274,000	$119,200	$54,200

Program/Activity	Program Allocation	2032			
		Q1	Q2	Q3	Q4
Local Flood Mitigation Program	$58,789,800	$0			
Administration	$3,094,200	$54,200			
Grand Total	$61,884,000	$54,200	$0	$0	$0
Funds Remaining		$0	$0	$0	$0


Projected Expenditures and Outcomes
$3,000,000
$2,500,000
$2,000,000
$1,500,000
$1,000,000
$500,000
$0
Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4
2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032
Local Flood Mitigation Program
Administation

Appendix 2: Maps

Appendix 3: SF-424

OMB Number: 4040-0004
Expiration Date: 12/31/2019

Application for Federal Assistance SF-424

* 1. Type of Submission:
- [ ] Preapplication
- [x] Application
- [ ] Changed/Corrected Application

* 2. Type of Application:
- [x] New
- [ ] Continuation
- [ ] Revision

* If Revision, select appropriate letter(s):

* Other (Specify):

* 3. Date Received:

4. Applicant Identifier:

5a. Federal Entity Identifier:

5b. Federal Award Identifier:

State Use Only:

6. Date Received by State:

7. State Application Identifier:

8. APPLICANT INFORMATION:

* a. Legal Name: City of Houston

* b. Employer/Taxpayer Identification Number (EIN/TIN): 746001164

* c. Organizational DUNS: 8324319850000

d. Address:

* Street1: 2100 Travis Street, 9th Floor

Street2:

* City: Houston

County/Parish:

* State: TX: Texas

Province:

* Country: USA: UNITED STATES

* Zip / Postal Code: 77002

e. Organizational Unit:

Department Name: Housing and Community Dev Dept

Division Name:

f. Name and contact information of person to be contacted on matters involving this application:

Prefix:

* First Name: Tom

Middle Name:

* Last Name: McCasland

Suffix:

Title: Director

Organizational Affiliation:

* Telephone Number: 832.394.6282

Fax Number:

* Email: Tom.McCasland@houstontx.gov

Application for Federal Assistance SF-424

*** 9. Type of Applicant 1: Select Applicant Type:**

C: City or Township Government

Type of Applicant 2: Select Applicant Type:

Type of Applicant 3: Select Applicant Type:

* Other (specify):

*** 10. Name of Federal Agency:**

U.S. Department of Housing and Urban Development

11. Catalog of Federal Domestic Assistance Number:

14.218

CFDA Title:

Community Development Block Grants/Entitlement Grants

*** 12. Funding Opportunity Number:**

* Title:

13. Competition Identification Number:

Title:

14. Areas Affected by Project (Cities, Counties, States, etc.):

Add Attachment | Delete Attachment | View Attachment

*** 15. Descriptive Title of Applicant's Project:**

Community Development Block Grant Mitigation (CDBG-MIT)

Attach supporting documents as specified in agency instructions.

Add Attachments | Delete Attachments | View Attachments

Application for Federal Assistance SF-424

16. Congressional Districts Of:

* a. Applicant | * b. Program/Project

Attach an additional list of Program/Project Congressional Districts if needed.

Add Attachment | Delete Attachment | View Attachment

17. Proposed Project:

* a. Start Date: 05/01/2020 | * b. End Date: 04/30/2032

18. Estimated Funding ($):

* a. Federal	61,884,000.00
* b. Applicant	0.00
* c. State	0.00
* d. Local	0.00
* e. Other	0.00
* f. Program Income	0.00
* g. TOTAL	61,884,000.00

*** 19. Is Application Subject to Review By State Under Executive Order 12372 Process?**

☐ a. This application was made available to the State under the Executive Order 12372 Process for review on .

☐ b. Program is subject to E.O. 12372 but has not been selected by the State for review.

☒ c. Program is not covered by E.O. 12372.

*** 20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes," provide explanation in attachment.)**

☐ Yes ☒ No

If "Yes", provide explanation and attach

Add Attachment | Delete Attachment | View Attachment

21. *By signing this application, I certify (1) to the statements contained in the list of certifications and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances** and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 218, Section 1001)**

☒ ** I AGREE

** The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions.

Authorized Representative:

Prefix: | * First Name: Sylvester

Middle Name:

* Last Name: Turner

Suffix:

* Title: Mayor

* Telephone Number: 832.393.1011 | Fax Number:

* Email: sylvester.turner@houstontx.gov

* Signature of Authorized Representative: | * Date Signed:

ASSURANCES - CONSTRUCTION PROGRAMS

OMB Number: 4040-0009
Expiration Date: 02/28/2022

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

NOTE: Certain of these assurances may not be applicable to your project or program. If you have questions, please contact the Awarding Agency. Further, certain Federal assistance awarding agencies may require applicants to certify to additional assurances. If such is the case, you will be notified.

As the duly authorized representative of the applicant:, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance, and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project costs) to ensure proper planning, management and completion of project described in this application.
2. Will give the awarding agency, the Comptroller General of the United States and, if appropriate, the State, the right to examine all records, books, papers, or documents related to the assistance; and will establish a proper accounting system in accordance with generally accepted accounting standards or agency directives.
3. Will not dispose of, modify the use of, or change the terms of the real property title or other interest in the site and facilities without permission and instructions from the awarding agency. Will record the Federal awarding agency directives and will include a covenant in the title of real property acquired in whole or in part with Federal assistance funds to assure non-discrimination during the useful life of the project.
4. Will comply with the requirements of the assistance awarding agency with regard to the drafting, review and approval of construction plans and specifications.
5. Will provide and maintain competent and adequate engineering supervision at the construction site to ensure that the complete work conforms with the approved plans and specifications and will furnish progressive reports and such other information as may be required by the assistance awarding agency or State.
6. Will initiate and complete the work within the applicable time frame after receipt of approval of the awarding agency.
7. Will establish safeguards to prohibit employees from using their positions for a purpose that constitutes or presents the appearance of personal or organizational conflict of interest, or personal gain.
8. Will comply with the Intergovernmental Personnel Act of 1970 (42 U.S.C. §§4728-4763) relating to prescribed standards of merit systems for programs funded under one of the 19 statutes or regulations specified in Appendix A of OPM's Standards for a Merit System of Personnel Administration (5 C.F.R. 900, Subpart F).
9. Will comply with the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. §§4801 et seq.) which prohibits the use of lead-based paint in construction or rehabilitation of residence structures.
10. Will comply with all Federal statutes relating to non-discrimination. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which prohibits discrimination on the basis of race, color or national origin; (b) Title IX of the Education Amendments of 1972, as amended (20 U.S.C. §§1681 1683, and 1685-1686), which prohibits discrimination on the basis of sex; (c) Section 504 of the Rehabilitation Act of 1973, as amended (29) U.S.C. §794), which prohibits discrimination on the basis of handicaps; (d) the Age Discrimination Act of 1975, as amended (42 U.S.C. §§6101-6107), which prohibits discrimination on the basis of age; (e) the Drug Abuse Office and Treatment Act of 1972 (P.L. 92-255), as amended relating to nondiscrimination on the basis of drug abuse; (f) the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970 (P.L. 91-616), as amended, relating to nondiscrimination on the basis of alcohol abuse or alcoholism; (g) §§523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. §§290 dd-3 and 290 ee 3), as amended, relating to confidentiality of alcohol and drug abuse patient records; (h) Title VIII of the Civil Rights Act of 1968 (42 U.S.C. §§3601 et seq.), as amended, relating to nondiscrimination in the sale, rental or financing of housing; (i) any other nondiscrimination provisions in the specific statue(s) under which application for Federal assistance is being made; and (j) the requirements of any other nondiscrimination statue(s) which may apply to the application.

11. Will comply, or has already complied, with the requirements of Titles II and III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal and federally-assisted programs. These requirements apply to all interests in real property acquired for project purposes regardless of Federal participation in purchases.

12. Will comply with the provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

13. Will comply, as applicable, with the provisions of the Davis-Bacon Act (40 U.S.C. §§276a to 276a-7), the Copeland Act (40 U.S.C. §276c and 18 U.S.C. §874), and the Contract Work Hours and Safety Standards Act (40 U.S.C. §§327-333) regarding labor standards for federally-assisted construction subagreements.

14. Will comply with flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93-234) which requires recipients in a special flood hazard area to participate in the program and to purchase flood insurance if the total cost of insurable construction and acquisition is $10,000 or more.

15. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in floodplains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451 et seq.); (f) conformity of Federal actions to State (Clean Air) implementation Plans under Section 176(c) of the Clean Air Act of 1955, as amended (42 U.S.C. §§7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended (P.L. 93-523); and, (h) protection of endangered species under the Endangered Species Act of 1973, as amended (P.L. 93-205).

16. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.

17. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. §470), EO 11593 (identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. §§469a-1 et seq).

18. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act Amendments of 1996 and OMB Circular No. A-133, "Audits of States, Local Governments, and Non-Profit Organizations."

19. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing this program.

20. Will comply with the requirements of Section 106(g) of the Trafficking Victims Protection Act (TVPA) of 2000, as amended (22 U.S.C. 7104) which prohibits grant award recipients or a sub-recipient from (1) Engaging in severe forms of trafficking in persons during the period of time that the award is in effect (2) Procuring a commercial sex act during the period of time that the award is in effect or (3) Using forced labor in the performance of the award or subawards under the award.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL	TITLE
	Mayor
APPLICANT ORGANIZATION	DATE SUBMITTED
City of Houston	

Appendix 4: Public Comments

Information in this appendix will be added in the final Action Plan.

CDBG-MIT
Action Plan

City of Houston
Housing and Community Development Department
2100 Travis Street | 9th floor | Houston, TX 77002 | 832.394.6200
www.houstontx.gov/housing

@HoustonHCDD