Brazoria Drainage District 4
Hazard Mitigation Plan

2019
Update of the Approved 2012 HMP

Adopted by the Board of Commissioners
January 7, 2020

APPENDICES

SECTION 1 – INTRODUCTION AND ADOPTION

THIS PLAN IS AN UPDATE

In 2012 the Brazoria Drainage District No. 4 (BDD4) completed its original Hazard Mitigation Plan (HMP). The Plan was approved by the Federal Emergency Management Agency (FEMA) in 2012 and adopted by the BDD4 Board of Commissioners on October 2, 2012. The Disaster Mitigation Act of 2000 (DMA, Section 201.6 (c)(4)(i)) requires a plan maintenance process, which includes reviewing and updating the Plan every five years. The intent of the current, updated Plan, while incorporating much of the first plan is to:

- Include any newly identified hazards or remove hazards that are no longer deemed a hazard
- Update the hazard/risk data
- Update development data
- Review, update or revise as necessary the goals and actions from the last Plan
- Update the demographic information based on current information
- Provide the planning process
- Review and update plans or reports for inclusion in this update of the Plan

This Plan is a single jurisdiction Plan representing the Brazoria Drainage District No. 4 (BDD4), Texas. An important step in the lengthy process of improving resistance to hazards is the development of a hazard mitigation plan. The BDD4 Hazard Mitigation Plan Update was prepared in accordance with the guidelines provided by FEMA and the Texas Division of Emergency Management (TDEM). The original HMP was prepared in 2012 for several purposes. It set the stage for long-term disaster resistance through identification of actions that will, over time, reduce the exposure of people and property to hazards. Completion of the original Plan, and adoption by the Board of Commissioners, was a significant step toward identifying potential hazards that threaten the BDD4 planning area, assessing risk, and implementing mitigation actions that will reduce property damages, injuries, and loss of life from hazards. Approval of the original Plan and the subsequent update, once reviewed and approved by TDEM and FEMA, also establish eligibility for certain mitigation grant funds. This HMP update continues BDD4's efforts to build a safe and resilient community and to be eligible for FEMA mitigation grants.

SUMMARY

There are five sections of this Plan all with the focus on the last five years 2012-2018 – the Introduction and Community Profile, the Planning Process, the Hazard Profiling and Risk Assessment, the Mitigation Strategy and the Plan Maintenance section. Each section provides updates in the last five years to the natural hazards that threaten the planning area, the people and property exposed to those hazards, the planning process, how hazards are recognized in the District's normal processes and functions, and priority mitigation action items. As in past years, when taking into account, the magnitude of past events, the number of people and properties affected, and the severity of damage, flood hazards clearly are the most significant natural hazard to threaten the planning area. Since the last Plan update, BDD4 has undertaken many activities to mitigate flooding where it has jurisdictional authority, however, it also faced some of its greatest challenges in these last five years, specifically 2017 from Hurricane Harvey.

Notable changes to this plan from the last iteration are as follows:

- The goals have been streamlined from the earlier version.
- The sections have been reduced from ten to five – however, the content from the five sections removed from the last plan have been merged into this Plan's five sections.
- Recognizing the importance of external stakeholder and public review and understanding of the hazard mitigation plan, BDD4 did more outreach to solicit these two important group's views and expertise.

ADOPTION BY BOARD OF COMMISSIONERS

The Mitigation Planning Committee (MPC) for BDD4 advised the Board of Commissioners of its intent to update the hazard mitigation plan but will refrain from presenting the updated plan for adoption until after it has been submitted for review and approval by the Texas Division of Emergency Management (TDEM) and the Federal Emergency Management Agency (FEMA). Once BDD4 receives notice from FEMA that this Plan is Approved Pending Adoption (APA), which indicates there are no more changes required by FEMA to the Plan the Board of Commissioners will formally adopt the Plan and will include the formal resolution.

Brazoria Drainage District No. 4 (BDD4)

WHEREAS, Section 322 of the Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5165) requires local governments to develop a hazardous mitigation plan as a condition for receiving certain types of non-emergency disaster assistance, including funding for mitigation projects; and,

WHEREAS, the Code of Federal Regulations (CFR) at Title 44, Chapter 1, part 201, requires the District to prepare and adopt a local mitigation plan every five years; and,

WHEREAS, a steering committee comprised of members of BDD4's departments as well as the District's leadership was convened in order to assess the risks of hazards facing the area, and to make recommendations on actions to be taken to mitigate these hazards; and,

WHEREAS, the plan incorporates the comments, ideas and concerns of the community and of the public in general, which this plan is designed to protect, ascertained through a series of public meetings, publication of the draft plan, press releases, and other outreach activities; and

NOW THEREFORE, BE IT RESOLVED by the Board of Commissioners of the Brazoria Drainage District No. 4 that the 2019 BDD4 2019 Hazard Mitigation Plan is hereby approved and adopted by the Board of Commissioners of the Brazoria Drainage Drainage District No. 4 and resolves to execute the actions in the plan.

This Resolution shall take effect immediately without reconsideration.

A copy of the plan is attached to this resolution.

ADOPTED by the Board of Commissioners of the Brazoria Drainage District No. 4 on

this 7th day of January 2020.

APPROVED

Jeffrey H. Brennan, Chairman

ATTEST

John Genaro, Superintendent

JURISIDICTIONAL AREA PROFILE

Planning Area

Brazoria Drainage District No.4 encompasses an 83.4 square mile area of northern Brazoria County which includes the Cities of Pearland and Brookside Village. Figure 1 depicts BDD4 within the State of Texas and Figure 2 and Figure 3 depicts the planning area's footprint. BDD4's boundaries from west to east are Fort Bend County to Galveston County and from Clear Creek (Harris County) to a point just north of Alvin, Texas and Manvel, Texas. Major drainage arteries include: Clear Creek, Hickory Slough, Mary's Creek, Cowart Creek, Chigger Creek and portions of Mustang Bayou. Principal subdivisions located in the district include: Country Place, Silver Lake, Southwyck, Crystal Lake, West Oaks, Springfield, Sunset Meadows, Sunset Lakes, Meadow View, Pine Hollow, West Wood, Dixie Woods, and Oak Brook Estates.

BDD4 is responsible for detaining, controlling, preserving and distributing storm and flood waters within its jurisdiction. BDD4 works with local, county, state and federal agencies to maintain existing flood control systems and construct additions and modifications to the systems. Incorporated cities located in the planning area, including the City of Pearland and Brookside Village, are responsible for drainage and storm water within their jurisdiction, but work closely with BDD4 to ensure no negative impacts occur either upstream or downstream with any improvements or construction. Within the City of Pearland, BDD4 is responsible for major drainage ditches, sloughs and creeks. While the City of Pearland has its own Hazard Mitigation Plan, BDD4 is a member of the Stakeholder Group in that plan and the City of the Pearland is a Stakeholder in this plan.

Figure 1 – BDD4 Location within the State of Texas

Figure 2 Brazoria Drainage District No. 4 (Source: BDD4 Homepage)

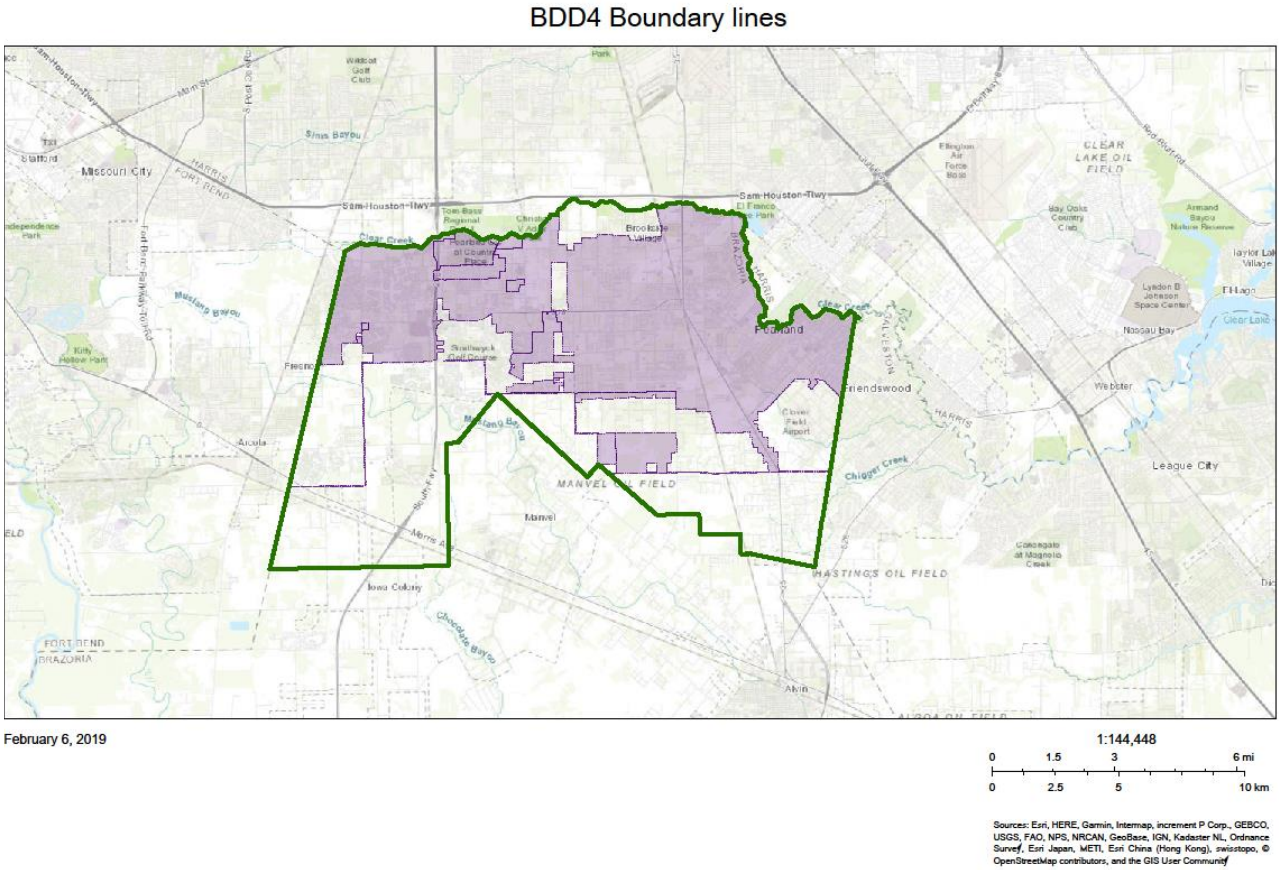
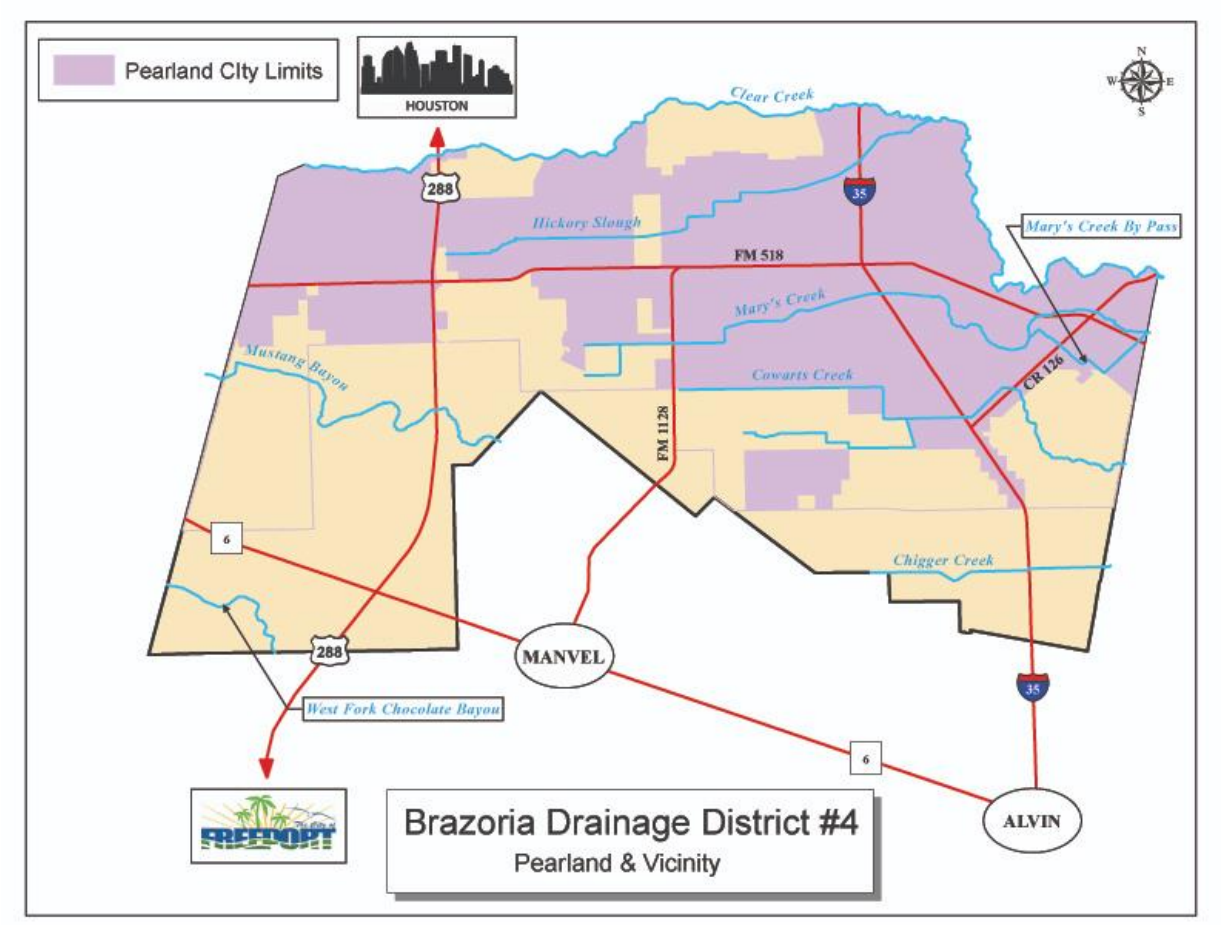


Figure 3 Brazoria Drainage District No. 4 (Source: BDD4 Homepage)



Climate

The climate of the region is humid subtropical, with hot summers and mild winters. The area is typically sunny and mild with an average annual temperature of 68.9 degrees. The climate during the summer is moderated by prevailing cool southeasterly winds from the Gulf of Mexico. Summers are long with high daytime and moderate nighttime temperatures. Normally, the winters are short and mild. The average minimum January temperature is in the low 40's. During December, January, and February, the winds are generally northerly, but during the balance of the year southerly winds predominate.

Generally, the heaviest precipitation occurs during thunderstorms in the spring, summer, and fall, and often is associated with tropical systems and hurricanes moving through the region. Rainfall averages about 48.19 inches per year and, although generally evenly distributed, the heaviest occurs in late spring or early fall.

Population and Growth

The entire State of Texas has grown by nearly a quarter between 2000 to 2013, while the Houston metropolitan area grew by nearly one-third, adding more than 1.3 million new residents (4.7 million in 2000 U.S. Census Bureau estimate to roughly 6.2 million as of the 2012 estimate). BDD4, which includes, Pearland and Brookside Village, grew markedly faster. Pearland's

population grew from 37,640 to an estimated 101,900 residents (170 percent) between 2000 and 2013. The 2017 U.S. Census Bureau Population Estimate estimated the population had increased to 119,940. Pearland continues to be the fastest growing city in Brazoria County.

Brookside Village has also grown since 2010 but not nearly at the same pace as Pearland. Brookside Village is a small town with only 2.1 square miles so there is only so much build out capacity. The US Census, American Fact Finder, Community Facts, has the estimated 2017 population at 1,588 residents, increased from 1,523 in 2010. Unincorporated Brazoria County (of which BDD4 estimates it covers approximately 15%) added approximately 49,291 new residents since 2010. Table 1 provides the BDD4 planning area population estimates.

Table 1 US Census BDD4 Population Estimates 2010 and 2017

	2010	2017	Difference	BDD4 15%	Total Pop for BDD4 2017
U. Brazoria County	313,166	362,457	49,291	54,369	54,369
Pearland	91,252	119,940	26,688		119,940
Brookside Village	1,523	1,588	65		1,588
Total					**175,897**

The US Census American Community Survey 5-year estimates from the 2016 Population shows a significant growth increase from 2010 for housing units. The overall trend is clear, the jurisdictional area's population and housing have increased and will continue to increase. The recent and continued population increase will consequently increase demand for housing.

Table 2 US Census Housing Characteristics, BDD4 Planning Area

US Census Population estimates HOUSING UNITS	**Pearland**	**Brookside Village**	**Unincorporated Brazoria County (15%)**	**Total**
Housing units, July 1, 2016, (V2016)	37,353	608	19,042	57,003
Housing units, April 1, 2010	30,793	575	17,750	49,298

Clearly this growth has increased the amount of people and property at risk from natural hazards. The Cities and the County strictly enforce their respective floodplain ordinances, with a one-foot freeboard requirement above base flood elevation for Pearland and Brookside Village and two foot above the base flood elevation for the County, and requires all new construction to be designed and constructed to withstand 110 mile per hour wind loads, which significantly reduces the potential vulnerability of new development to hazards that have had the highest historical impact on property.

Place of Work
While addressing potential hazards, it is important to note that much of the workforce in the area is mobile, working in the Houston/Galveston metropolitan areas. The 2016 Census Estimate indicates that most County residents work outside of the County (69.9%). Therefore, there are approximately 29.1% of residents that both live and work in Brazoria County.

BDD4 Hazard Mitigation Plan Goal
The MPC reviewed the current plan's overall mitigation goal. The last goal, "To seek solutions to existing problems" was removed as the team considered it vague and the remaining bullets encapsulate that concept. For this plan update, the mitigation goal is as follows:

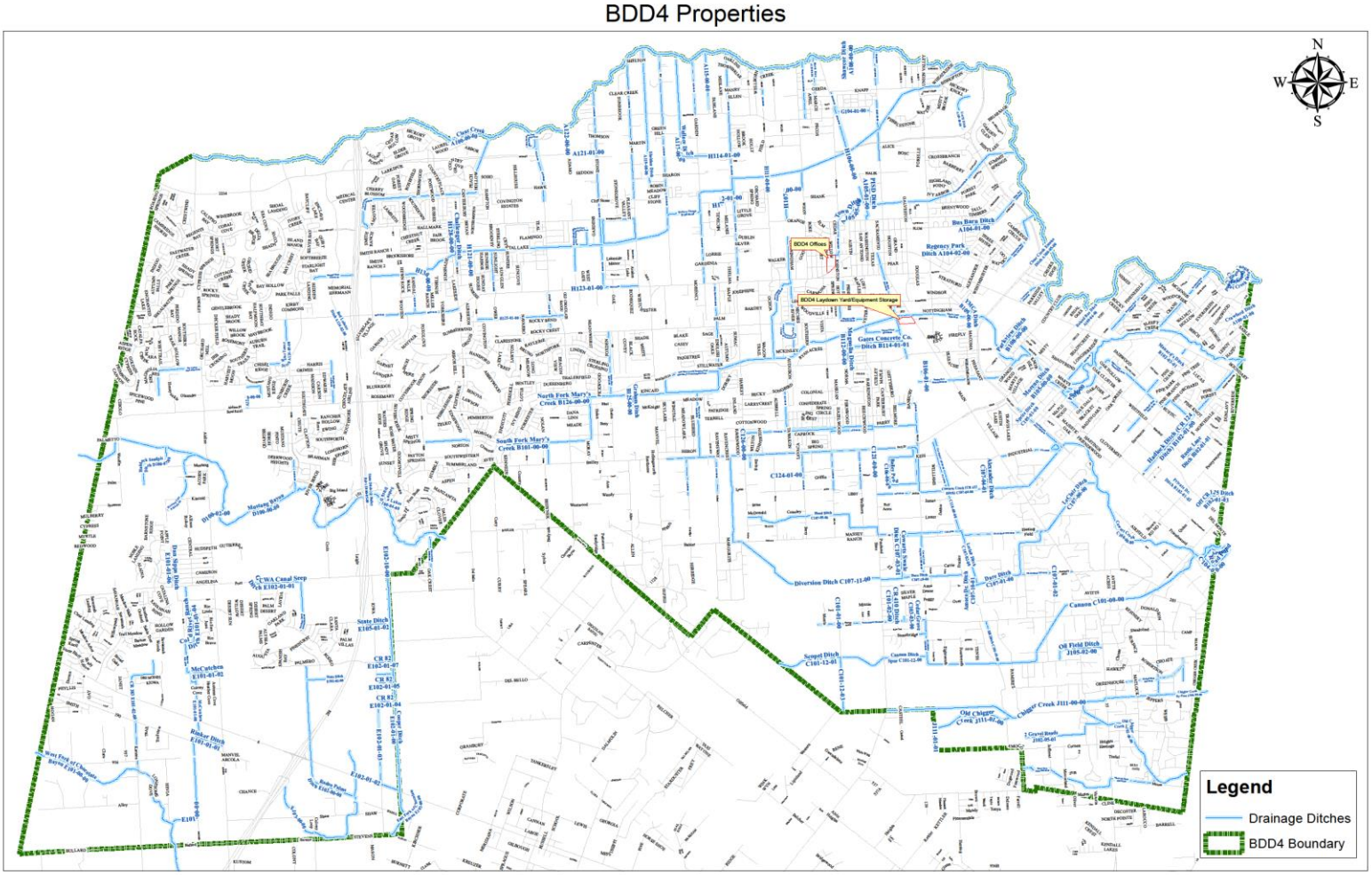
- To protect public health, safety, and welfare;
- To reduce losses due to hazards by identifying hazards, minimizing exposure of citizens and property to hazards, and increasing public awareness and involvement; and
- To facilitate the development review and approval process to accommodate growth in a practical way that recognizes existing stormwater and floodplain problems while avoiding creating new problems or worsening existing problems.

Community Facilities
The MPC reviewed the list of critical facilities and community facilities that are located in the planning area. BDD4 owns and operates six buildings. Within its planning area, the City of Pearland has 18 buildings, 39 facilities and 29 school buildings. These buildings are used for various purposes including government administration, providing essential and emergency services, recreation, educational, and cultural and performing arts. Brookside Village has a fire station, police department and a municipal court/city hall building. Unincorporated Brazoria County has 1 fire station in the jurisdictional area.

In addition, there are a number of critical facilities that are not owned by the Cities, County or BDD4. Examples include, U.S. Post Offices, Hospitals, Schools, and State roads and other State flood mitigation projects.

It is important to note that while these facilities are located in the planning area, BDD4, as a drainage district, only has the authority for drainage issues, so while it is important to understand where critical and community facilities are located in the planning area for drainage plans and mitigation actions, the Cities, County, State and private entities have responsibility for all other aspects of these facilities except for the buildings and equipment owned by BDD4. Figure 4 provides a map of the BDD4 building locations.

FIGURE 4 MAP OF BDD4 FACILITIES



SECTION 2 – THE PLANNING PROCESS

The Purpose of the Plan Update

The Federal Disaster Mitigation Act of 2000 (Public Law 106-390), referred to as the 2000 Stafford Act (DMA 2000), was approved by Congress on October 10, 2000. The Act intended to assist communities in reducing their risk from natural hazards by identifying resources, information and strategies for risk reduction and; through careful planning and collaboration among public agencies, stakeholders and the public; prepare and regularly update mitigation plans. To implement the DMA 2000 planning requirements, FEMA prepared an Interim Final Rule, published in the Federal Register on February 26, 2002 which established planning and federal funding criteria for states and local communities. The Act required both state and local governments to develop hazard mitigation plans as a condition for federal grant assistance. These plans must be updated, reviewed and approved every five years.

The Mitigation Planning Process

BDD4 followed a well-established planning process to update its Hazard Mitigation Plan (HMP) from the original plan. BDD4 maintains a copy of the original plan which can be reviewed upon request.

The mitigation planning process for the 2019 HMP Update was facilitated by a mitigation planning consultant. The Plan Update process followed the FEMA Local Hazard Mitigation Plan regulations set forth in 44 Code of Federal Regulations (CFR) Part 201.6 and is FEMA's official source for defining the requirements for original and updated local hazard mitigation plans. In addition, the FEMA Local Mitigation Planning Handbook (March 2013) was used as a practical guide to ensure all requirements were satisfied for this update. The planning process at a high level is outlined as follow:

- Organize resources and plan process
- Assess risks
- Develop mitigation goals, mitigation actions and status of previous actions
- Implement the plan and monitor progress

Organize Resources and Plan Process

The Mitigation Planning Committee (MPC) was reconvened and met six times during the drafting and public meetings. The MPC leads the review and draft of the update. Minutes were prepared for each meeting to document the process and keep the plan on task. Those minutes can be found at the end of the plan in Appendix A. The meeting dates are summarized below.

The Plan data collection and drafting took place in multiple steps:

MPC and Consultant	Collect and analyze data, information, studies and maps
MPC	Discussion, modifications and approval of drafts
Consultant	Prepare drafts from information collected
Consultant	Outline the technical requirements
Consultant and MPC	Review of complete first draft
Consultant	Modifications based on review, stakeholder feedback

MPC	Presentation to public, compile feedback
Consultant	Add input to final draft
MPC	Prepare and submit final draft

The first meeting took place on September 20, 2018. The purpose of the meeting was to begin the planning process, finalize the MPC membership, to make certain decisions about contents of the plan, and to assign specific tasks to BDD4 staff and consultants. Most of the tasks were related to updating information and maps as well as identifying which areas (of each section) required updates. Each section of the current plan was then reviewed and analyzed to determine which areas required update. This included areas of the plan such as the hazards profiled (and hazard data), the risk assessment, goals, maps, status from action items from the last plan and new action items. During the first meeting, the team identified members who are no longer working in their respective positions and additional members who needed to be included on the MPC. Table 3 lists the MPC for this plan update.

Table 3 Mitigation Planning Committee for the BDD4 HMP Update

MPC Member	Organization/Title
Andrea Broughton	BDD4/District Engineer
Kimberly Woodall	BDD4/Director of Administrative Services
Adrian Gengo	BDD4/Plans Coordinator
Jeff Ward	JSWA/Mitigation Plan Consultant
Kristen Thatcher	JSWA/Mitigation Plan Consultant
Dan Ward	JSWA/Mitigation Plan Consultant

Early in the planning update process, the MPC undertook a detailed review of every section of the existing plan. The MPC identified all the subject areas where specific updates were required. For example, census figures, the numbers and locations of BDD4 buildings and facilities, impacts of recent hazard events (including Hurricane Harvey), as some examples. The second purpose of the review was to ensure that the updated Plan is fully compliant and responsive to all of the FEMA requirements. The review indicated that while changes and updates were needed throughout the document, most of the modifications were relatively limited as hazards did not change significantly and did not require a significant initial public component such as focus groups or surveys.

The second MPC meeting was held on November 8, 2018. The purpose of the meeting was to review the status of various tasks, finalize the goals, begin the discussion of the status of the mitigation actions from the current plan and to review drafts of completed sections.

As part of the Plan Update, certain elements of the original Plan have been retained, and irrelevant or outdated information has been edited or removed. Focus of the plan update included incorporating new hazard information, re-evaluating the jurisdictional area risk assessment, and developing and prioritizing potential mitigation actions and projects. The stakeholder list was finalized as the stakeholders group is comprised of interested groups, neighboring communities, businesses, academia and other organizations and individuals with an interest in this plan update. The Stakeholders, by letter of invitation (an example is attached in

Appendix B), are asked to attend and participate in the public meeting and to review the draft plan. The Stakeholder group is identified in Table 4.

Table 4 Stakeholders for BDD4 Plan Update

Stakeholder Member	Title	Organization	Method of Invite
Vance Riley	EMS Director	Pearland Emergency Medical Services (EMS)	Letter
J.L.Spires	Police Chief	Pearland Police Department	Letter
Chris Orlea	Director	Pearland Parks and Recreation	Letter
Cynthia Pearson	Director	Pearland Finance Department	Letter
Clarence Witter	Public Works Director	Pearland Public Works	
Robert Upton	Director of Capital Projects and Engineering	Pearland Capital Projects and Engineering	Letter
Michael Masters	GIS Manager	Pearland GIS	Letter
John McDonald	Director of Community Development	Pearland Planning Department	Letter
Clay Pearson	City Manager	City of Pearland	Letter
Trent Epperson	Assistant City Manager	City of Pearland	Letter
Jon Branson	Pearland Deputy City Manager	City of Pearland	Letter
Matt Buchanan	President	Pearland Economic Development Corporation	Letter
Myron Jones	Project Coordinator, Precinct 1	Harris County Flood Control District	Letter
Michelle Milliard, PE	Area Engineer	Texas DOT – Brazoria County Area Office	Letter
Grady Maples, P.E.	Area Engineer	Texas DOT – Fort Bend County Area Office	Letter
Matt Cline	Assistant Director of Maintenance	Pearland Independent School District	Letter
Brian Mansfield	Emergency Management Coordinator	City of Friendswood	Letter
Kyle J. Jung	Emergency Management Coordinator	City of Manvel	Letter
Craig Bailey	Mayor	Brookside Village	Letter
Carol Artz-Bucek	President	Pearland Chamber of Commerce	Letter
Mark Flathouse	Emergency Management Coordinator	Fort Bend County	Letter
Steve Rosa	Emergency Management Coordinator	Brazoria County	Letter

Mark Sloan	Emergency Management Coordinator	Harris County	Letter

During the third meeting on December 18, 2018, the MPC focused on finalizing the goal and began review of risks to begin discussion on new actions. During the fourth and fifth meetings, January 10, 2019 and February 21, 2019, the MPC updated current actions, discussed hazards and discussed the prioritization process for the new actions.

The MPC also prepared a draft schedule:

MPC	Review of complete first draft	March, 2019
MPC	Modifications based on review	March, 2019
MPC	Letter to stakeholders for review	April, 2019
MPC	Presentation to public, compile feedback	April, 2019
MPC	Prepare and submit final draft	May, 2019
TDEM and FEMA	Review and letter of approval	2019
Board of Commissioners	Final adoption after approval	2019

The MPC's March 21, 2019 meeting worked to finalize the draft and to prepare to engage the Stakeholders and the public for input and comments.

Assess Risks - Summary

Section 3 is the hazard assessment section. The risk assessment forms the basis for this hazard mitigation plan by quantifying and rationalizing information about how natural hazards affect Brazoria Drainage District No. 4. The assessment determined several aspects of the risks of natural hazard faced by the jurisdiction:

- The natural hazards that are most likely to affect BDD4's jurisdiction
- How often hazards are expected to impact the BDD4's jurisdiction
- The expected severity of the hazards
- What areas of the District are likely to be affected by hazards
- How BDD4 assets, operations, people and infrastructure may be impacted by hazards
- How private and commercial assets, operations, infrastructure may be impacted by hazards
- The expected future losses if the risk is not mitigated

Through a rating system (explained in detail in Section 3) and based on the BDD4 mission and limited jurisdictional responsibility and protection of its people and assets, the MPC reduced the initial hazard list to four. The rating system utilized a high, medium, or low rating based on the following definitions:

Low	Unlikely to occur in area and/or impact to assets, including BDD4 assets is negligible
Medium	Likely to occur in area, with moderate impact to assets, including BDD4 assets
High	Highly likely to occur in area and impact could cause significant damage to assets, including BDD4 assets and could include fatalities

These are predominant risks to the area: floods, hurricane and tropical storms, severe thunderstorms, and tornadoes. Table 5 compares the 2012 hazards profiled to the 2019 hazards profiled.

Table 5 Risks Assessments

BDD4 2012 Hazards	Proposed 2019 Hazards	Impact	Rank
Flood	Flood poses great risk and is a part of the jurisdictional authority and will be included. However, there are no significant dams in the jurisdictional area or upstream so dam failure will be omitted from the section.	Highly likely to occur in area and impact could cause significant damage to assets, including BDD4 assets and could include fatalities	High
Tornadoes/High Winds	Tornadoes pose a risk to BDD4 facilities and will be included.	Likely to occur in area, with moderate impact to assets, including BDD4 assets	High
Thunderstorm/High winds	Thunderstorms/High windspose a risk to BDD4 facilities and will be included.	Highly likely to occur in area and impact could cause significant damage to assets, including BDD4 assets and could include fatalities	High
Hurricane/Tropical Storms	Hurricanes and Tropical Storms pose a risk to BDD4 and will be profiled and actions provided.	Highly likely to occur in area and impact could cause significant damage to assets, including BDD4 assets and could include fatalities	High
	Proposed 2019 Omission of Hazards		
Coastal Erosion	There is no coastal erosion in planning area and outside of authority of BDD4. OMIT	Unlikely to occur in area and/or impact to assets, including BDD4 assets is negligible	Low

Drought	This hazard does not affect District-owned facilities and BDD4 has no authority to mitigate against this hazard. OMIT	Unlikely to occur in area and/or impact to assets, including BDD4 assets is negligible	Low
Earthquake	Due to the extremely low probability of an earthquake within the planning area, and the fact that there is no record of any historical building damage as a result of seismic activity in the planning area, this hazard does not affect District owned facilities and BDD4 has no authority to mitigate against this hazard. OMIT	Unlikely to occur in area and/or impact to assets, including BDD4 assets is negligible	Low
Extreme Heat	This hazard does not affect District-owned facilities and BDD4 has no authority to mitigate against this hazard. OMIT	Unlikely to occur in area and/or impact to assets, including BDD4 assets is negligible	Low
Hailstorm	BDD4 buildings are built to withstand hail damage. In addition, there is no history of building damage or loss and therefore this hazard does not affect District owned facilities and BDD4 has no authority to mitigate against the hazard. OMIT	Unlikely to occur in area and/or impact to assets, including BDD4 assets is negligible	Low
Land Subsidence	Due to the extremely low probability of a land subsidence within the planning area and the fact that there is no record of any historical occurrences of land subsidence in the planning area, this hazard does not affect District owned facilities and BDD4 has no authority to mitigate against this hazard.	Unlikely to occur in area and/or impact to assets, including BDD4 assets is negligible	Low
Landslides	Due to the extremely low probability of landslides	Unlikely to occur in area and/or	Low

	within the planning area and the fact that there is no record of any historical occurrences of landslides in the planning area, this hazard does not affect District owned facilities and BDD4 has no authority to mitigate against this hazard.	impact to assets, including BDD4 assets is negligible	
Lightning	BDD4 facilities are all built to be protected from lightning and there is no historical record of any building damage or loss of District facilities, therefore, lightning does not affect District owned facilities and BDD4 has no authority to mitigate against this hazard.	Unlikely to occur in area and/or impact to assets, including BDD4 assets is negligible	Low
Winter Storm	While winter storm can cause pipes to freeze, the need for ice and snow to be removed, and downed power lines, the District facilities have been built to insulate the pipes, have backup generators for downed power lines and have the necessary equipment to remove ice and snow. This hazard does not affect District owned facilities and BDD4 has no authority to mitigate against this hazard. OMIT	Unlikely to occur in area and/or impact to assets, including BDD4 assets is negligible	Low
Wildfire	Due to the fact that there is no record of any historical building damage or loss due to wildfire in the Planning area and the fact that BDD4 owned facilities are located outside of any urban-wildland interface (WUI), this hazard does not affect	Unlikely to occur in area and/or impact to assets, including BDD4 assets is negligible	Low

	District owned facilities and BDD4 has no authority to mitigate against this hazard. OMIT		

For each of these hazards with a medium or high ranking, the planning team performed detailed risk assessments. These findings were presented to the MPC, discussed by the group, and approved by the Committee as the basis for later phases of the planning process. The results of the risk assessment were also made available to the public during the public presentations. As noted above, a more detailed description of this process and its results are presented in Section 3.

Develop mitigation goals, mitigation actions and status of previous actions
Section 4 outlines the goals set by the MPC which with the hazard information, helped determine, evaluate and prioritize the new mitigation actions. In addition to new actions, the plan provides an update to the actions described in the currently approved plan.

Implement the Plan and Monitor Progress
BDD4 is responsible for implementing the plan after it is adopted by the Board of Commissioners. The lead District Engineer of BDD4 will evaluate the Plan approximately annually by assembling the Mitigation Planning Committee to review key sections of the document. The group will determine if the Plan continues to correctly characterize BDD4's exposure and vulnerability to natural hazards, and if the goal and actions adequately address BDD4's priorities for addressing natural hazards. The MPC will prepare a summary report annually that will be forwarded to the Board of Commissioners for review and if action is required, recommendation of action to the update the plan. The Engineering Department will maintain a written record of these reports and if any further action was necessary.

Community Participation
Consistent with BDD4's standard practice of informing, engaging and involving citizens, and to fulfill public participation requirements of the mitigation planning programs, the District publicized the initiative, invited residents to review the plan update and solicited public comment.

During this Plan update process the public was involved by requesting their attendance and participation in a public presentation/meeting that was held at the April 2, 2019 Board of Commissioner's meeting. Preliminary drafts of the Plan update were available for public review, and the public was invited to provide input on the document for 30 days. BDD4 published public notices on March 28, 2019 about the draft plan on their website, on Brazoria County's website and on the building entrance before the meeting (See Appendix C, Public Notice Document).

Documentation of the Planning Process
It is important to document the planning process to inform the public and other readers about the overall approach to the plan update and to document who participated and how decisions were reached. To facilitate this documentation:

- Minutes were maintained for the MPC meetings.

- A letter was forwarded to the stakeholders to describe their role in the plan and planning effort and specify the means to provide that input. An example is attached to the plan update in Appendix B.
- The MPC presented the draft plan update and to initiate public review and comment on April 2, 2019. The draft plan update was posted to the District's website and was mailed to interested parties upon request. The public was informed how to provide input during a 30-day comment period;
- There was feedback from the stakeholders but no comments from the public.
- Once comments were received, the MPC review the comments and incorporated them. The finalized draft was submitted it to TDEM for review and FEMA approval.

Local Capabilities Assessment and Integration

Brazoria Drainage District No. 4 was created by Brazoria County Commissioners Court on June 28, 1910 and on May 22, 1929, was made a Conservation and Reclamation District by Special Bill No. 25 of the Texas State Legislature. The District is governed by a three-member elected Board of Commissioners.

In addition to the Board of Commissioners, the District is led by a Superintendent and Assistant Superintendent and has an Engineering Department, Operations Department, Administration Department and Legal Department. It employs 70 full time employees whose primary job is to maintain, reclaim and modify the drainage arteries within the jurisdiction as well as flood control within its boundaries.

The MPC reviewed existing District's capabilities; considering authorities, policies, programs and resources available. The assessment of the mitigation goals, programs and capabilities included a review of the following categories:

- Administrative and technical resources - refers to the community's staff and their tools and skills that can be used for mitigation planning and to implement specific mitigation actions. It also refers to the ability to access and coordinate these resources effectively.
- Financial resources – Financial capabilities - the resources that a jurisdiction has access to or is eligible to use to fund mitigation actions.
- Planning and regulatory –implementation of ordinances, polices, local laws and state statutes, and plans and programs that relate to the management and governance of growth and development to include:
  - Local ordinances, zoning and building codes
  - On-going plans or projects
- Education and outreach –refers to education and outreach programs and methods already in place that could be used to implement mitigation activities and communicate hazard-related information.

With respect to planning for and responding to natural hazard events, the key elements of the District's organization are broken down between the five areas listed above, some departments fall into more than one category in Table 6.

Table 6 Department Capabilities

Departments	Administrative and Technical	Regulatory and Planning	Financial Resources	Education and Outreach	Further information
Departments					
General Management	**X**	**X**	**X**	**X**	Day-to-day management and oversight of the departments
Administration	**X**	**X**	**X**	**X**	Coordinates responsibilities between departments
Operations/ Superintendent	**X**	**X**	**X**		Responsible for the maintenance of existing flood control systems, construction of additions & modifications, & review of proposed additions and modifications
Legal	**X**	**X**	**X**		Prepares & reviews legal documents
Engineering	**X**	**X**	**X**	**X**	Reviews plats and drainage plans to ensure District standards; GIS data management; website development

Administrative and Technical Resources

To facilitate the area's early flood warning capabilities, Brazoria Drainage District 4 (BDD4) maintains several gauges and weather stations throughout the jurisdictional area. The gauges also link to the Harris County Flood Control (HCFCD) network and provide the public with a user-friendly format that is a part of the flood warning system which measures rainfall and monitors water levels in bayous and major streams on a real-time basis to inform the public of dangerous weather conditions. The HCFCD system relies on 154 gauge stations strategically placed the bayous and tributaries. The stations contain sensors that transmit observed data during times of heavy rainfall and during tropical storms and hurricanes. Some gauges also measure wind speed and direction, barometric pressure, air temperature, road temperature and humidity.

The four figures (5,6,7 and 8) below show the location of the gauges and describe the type of data/maps that can be derived to help the public understand rainfall and flood risk in a particular area, a city or even a street. This information can be found at: www.harriscountyfws.org.

Improving and Expanding Administrative and Technical Resources Capabilities

BDD4 will continue to review the gauge system to see if additional gauges are needed in other areas of the Planning area not currently covered. In addition, BDD4 will continue to review the organization's structure to ensure that there is enough staff and resources to continue to support all efforts of flood mitigation.

Figure 5 shows FWS Rain fall for entire HCFCD area in one year

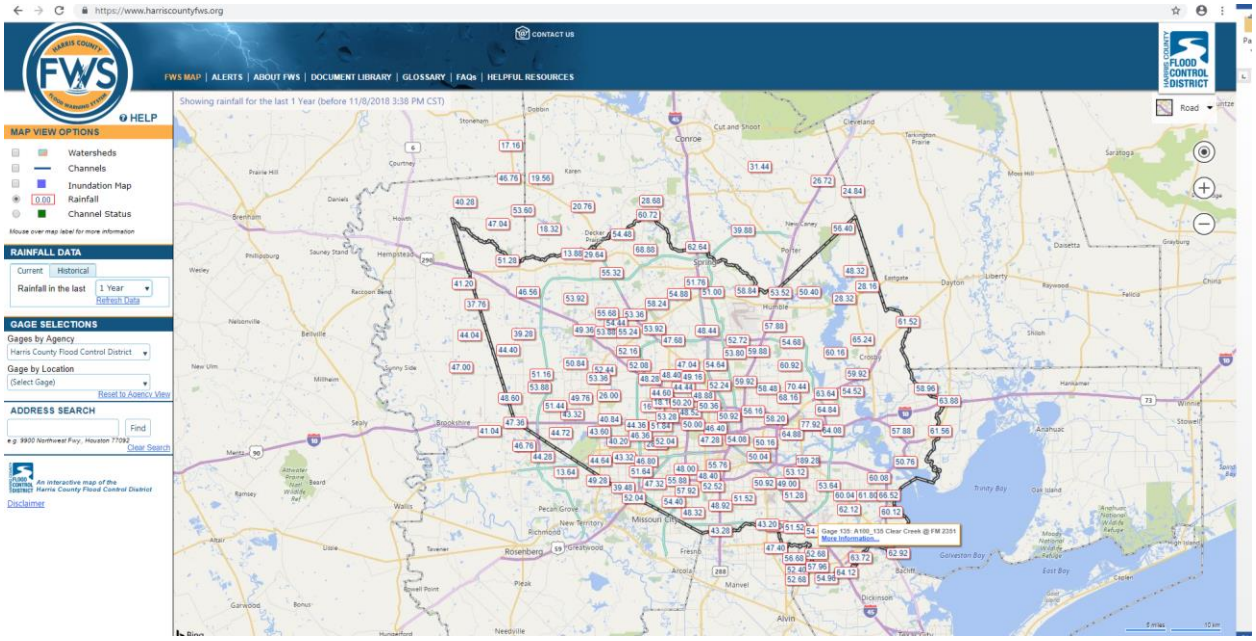


Figure 6 shows rainfall for a specific gauge for one month

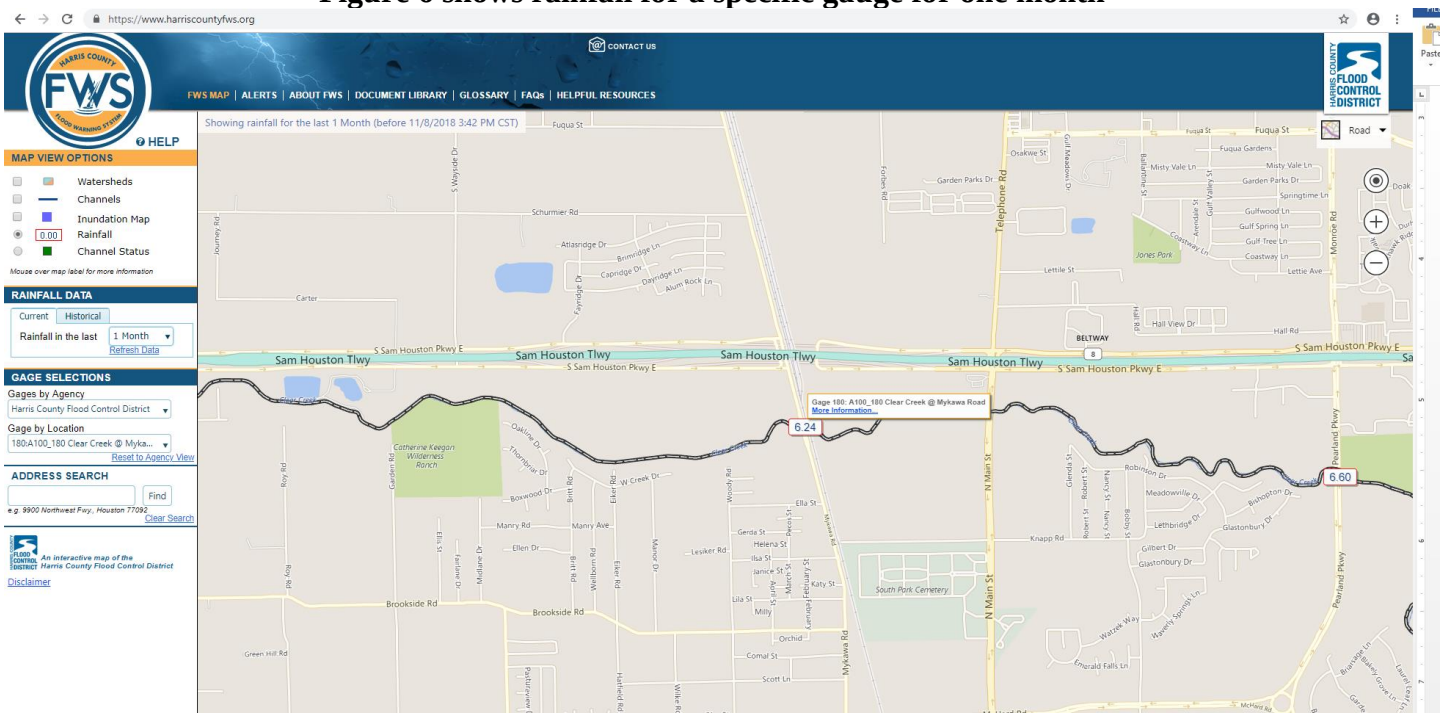


Figure 7 shows rainfall for the BDD4 gauges in a 7 day period

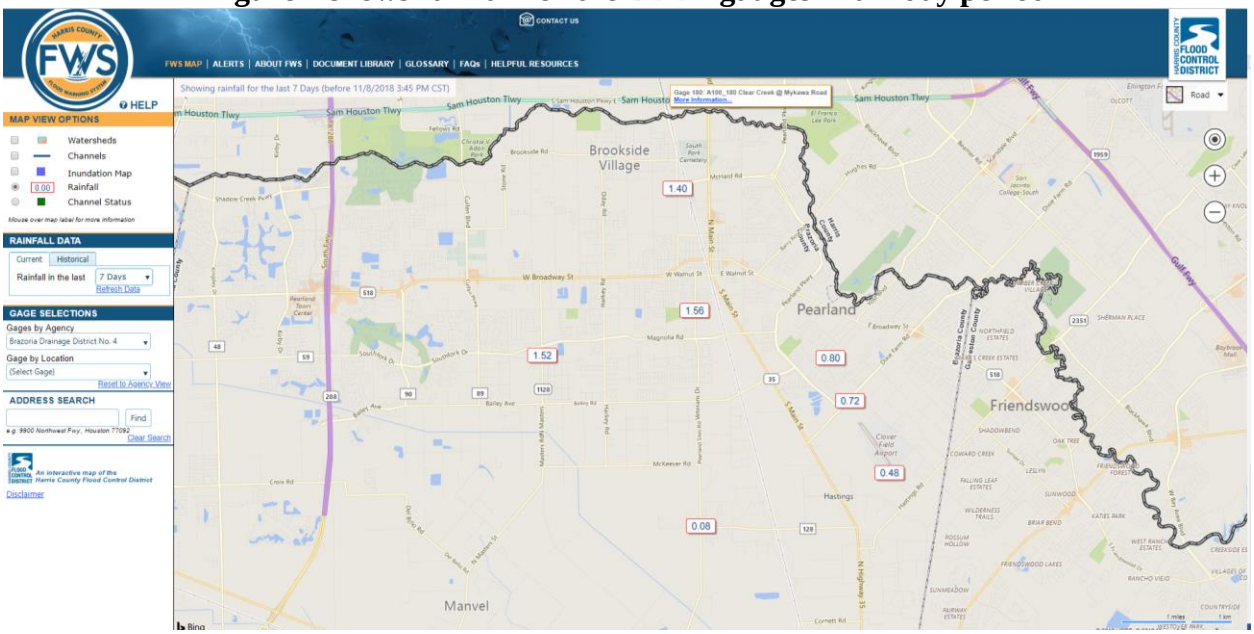
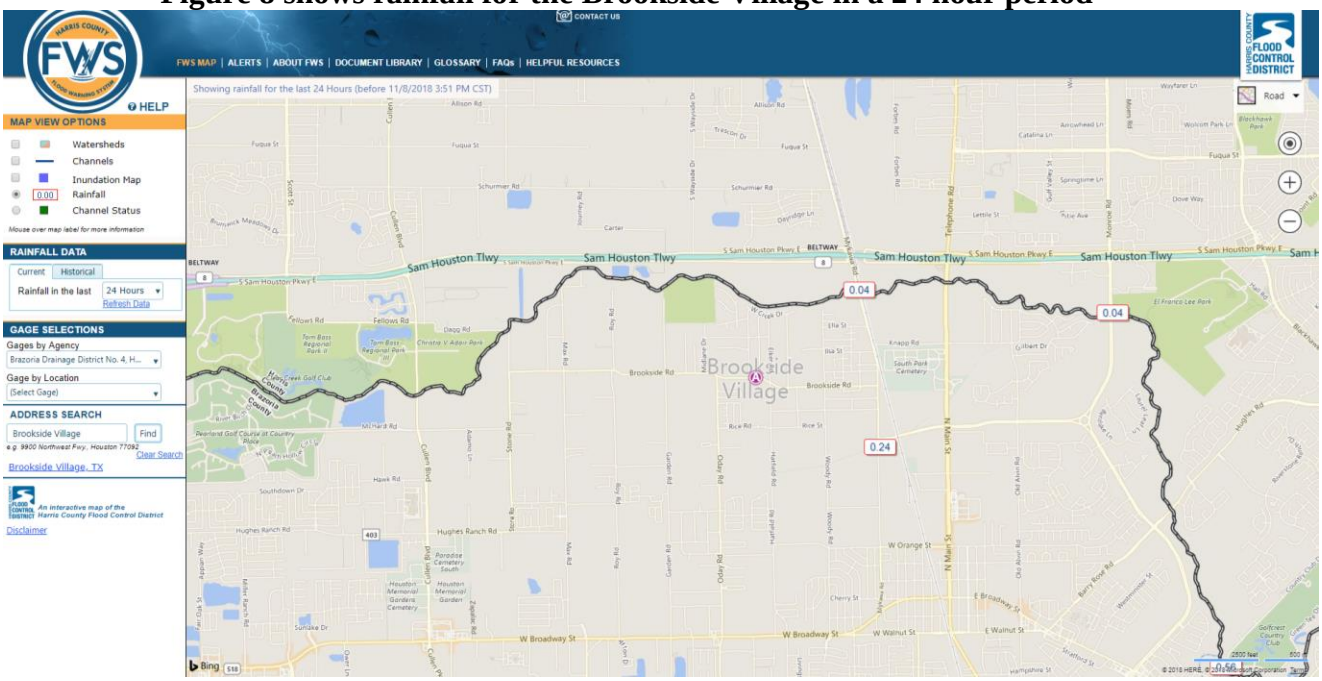


Figure 8 shows rainfall for the Brookside Village in a 24 hour period



Regulatory and Planning

While BDD4 does not have direct oversight of development in the floodplain and with subdivision plans, it is part of the review and approval process with the County and the Cities. As part of that review, BDD4 provides interested parties a clear and consistent review process and documents outlined in the Rules and Regulations Guidelines. These guidelines, as well as all other needed forms and documents can be easily downloaded from the District's website, www.bdd4.org/documents.

- **Rules, Regulations and Guidelines, BDD4.** In 2013, the District prepared rules, regulations and guidelines to provide efficient, consistent and orderly development of drainage facilities within the District's jurisdiction by applying generally accepted engineering criteria, and establish factual and scientific data required for planning and designing future drainage facilities, in order to achieve adequate retention, detention and conveyance from storm and flood waters through the District's jurisdiction.

- **Preliminary and Final Drainage Plan Guidelines**
  The District has prepared preliminary and final drainage plans guidelines to clearly articulate to firms what is required during the planning review.

Improving and Regulatory and Planning Capabilities

Financial Resources
The District has taxing authority for its jurisdictional area to support flood control facilities and services in the jurisdictional area. In addition, the District actively pursues grants through various state and federal agencies for projects and programs, including hazard mitigation.

- **Insured Buildings**
  BDD4 maintains approximately $4.275 Million property insurance coverage on buildings and facilities it owns, to protect the District from damage due to structural fire, wind and lightning (hazards other than flood). BDD4 also carries approximately $1.15 Million in coverage for building contents.

Improving Regulatory and Financial Capabilities
BDD4 will continue to review its rules and guidelines to ensure these rules are supporting mitigation efforts. It will continue to look for funding opportunities with its communities, the County, state and federal agencies and grants to fund mitigation efforts listed in the mitigation action table.

Education and Outreach
BDD4 actively communicates with its residents using a variety of media, each of which have been used to convey information, including content about flood hazards:

- News releases - News releases announcing District events and issues of public interest are sent to local media help publicize information to the public;
- Mailings – Information that could impact the public is also sent by mail to directly reach the constituents; and
- Website - The District's official website provides information, applications, forms, and interactive features such as maps.

National Flood Insurance Program
Participation with the National Flood Insurance Program (NFIP) and the Community Rating System (CRS) are important to the citizens within the jurisdictional area of BDD4. This is evidenced by the Cities of Pearland, Brookside Village and Brazoria County's commitment to regulating development and redevelopment, adoption of provisions that exceed the minimum

requirements, and by their active pursuit of risk mitigation opportunities. Cities and Counties are eligible to apply and maintain status within the NFIP and CRS and in doing so, residents can receive NFIP backed flood insurance and when steps are met, discounted rates through the CRS program.

Pearland satisfied requirements for initial participation in the NFIP and joined the Emergency Program in 1978. Upon issuance and final approval of the Flood Insurance Rate Map (FIRM) in July 1984, the City joined the Regular Program. The effective FIRM for Pearland, which can be found on the City's website, has been revised a number of times to reflect more detailed information and changes to the floodplain, and is now used as a main reference source for the drainage design and setting the finish floor elevation of a structure.

Brookside Village satisfied requirements for initial participation in the NFIP and joined the Emergency Program. Upon issuance and final approval of the Flood Insurance Rate Map in November of 1984, the County joined the Regular Program. The effective Flood Insurance Rate Map for the County has been revised a number of times to reflect more detailed information and changes to the floodplain, and is now used as the minimum flood hazard area within which development must conform to floodplain management regulations.

Brazoria County satisfied requirements for initial participation in the NFIP and joined the Emergency Program. Upon issuance and final approval of the Flood Insurance Rate Map in June of 1983, the City joined the Regular Program. The effective Flood Insurance Rate Map for the County has been revised a number of times to reflect more detailed information and changes to the floodplain, and is now used as the minimum flood hazard area within which development must conform to floodplain management regulations.

Community Rating System Participation.
The Federal Emergency Management Agency's (FEMA) National Flood Insurance Program's (NFIP) Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed NFIP requirements. These requirements and mitigation actions can work to improve a community's CRS rating. Since BDD4 is considered a conservation and reclamation District and not a community, it is not eligible to participate in the CRS, a voluntary program for NFIP participating communities. However, jurisdictions within BDD4 can participate. The goals of the CRS are to reduce flood losses, to facilitate accurate insurance rating, and to promote the awareness of flood insurance. The CRS rewards communities that undertake activities beyond the requirements of the NFIP. The CRS is a point system program that reduces flood insurance premiums for the citizens of participating communities. All communities start with a Class 10 rating and activities are offered to earn credit points that reduce their classification. The lower a community's Class rating, the greater the premium discounts offered by the NFIP. Any future CRS activities such as flood damage reduction or flood preparedness as a result of this should be considered by these jurisdictions if they determine to participate in the CRS program. Pearland is rated a 6 as of 2018 and Brookside Village and Brazoria County, while in the NFIP is not in CRS, so their rates are automatically a 10.

Continued NFIP Compliance
BDD4 is a conservation and reclamation district and a political subdivision of the State of Texas. Considering BDD4 is a separate entity and does not directly participate in the NFIP, specific actions will be determined by representatives and officials with the incorporated areas and Brazoria County within the District. With this in mind, BDD4 did not identify and prioritize NFIP actions as part of the planning process. BDD4 will continue to work closely with the City of Pearland, Brookside Village and Brazoria County to identify and recommend actions that will ensure continued compliance with the NFIP.

Master Drainage Plan
The City of Pearland and Brazoria Drainage District No. 4 retained an engineering firm to prepare a Master Drainage Plan update (MDP) for a combined area study of nearly 97 square miles. Phase I of the master drainage plan was completed in the first quarter of 2017. Phase I was primarily focused on data collection and evaluation, field investigation, and preparation of digital inventory and updates to GIS data, including recommendations for the Phase II effort.

Phase II of the MDP is now completed as of May 2019. Phase II is intended to establish the baseline condition modeling and mapping for the major bayous and tributaries and identify the capacity of smaller ditches within concurrent jurisdiction of the City of Pearland and BDD4. Phase II consists of coordination with the City of Pearland and BDD4 staff and key stakeholders from other department to refine short-term and long-term vision for primary system drainage improvement. In addition, Phase II also consists of public meetings to inform the public about the MDP effort, identify citizen concerns, and provide public information regarding current drainage conditions and potential improvement alternatives.

Changes in Development
Per the Brazoria County Appraisal District as of 2018, there are 46,563 total residential housing units and 9,992 commercial and public buildings located within the Planning Area. Comparing it to the 2012 numbers, there is an increase in total building in a six year period of approximately 37%, as shown in the table below.

Type	2012	2018	Change since 2012	% Increase
Residential Buildings	35,654	46,563	10,909	31%
Commerical Buildings	5,709	9,992	4,283	75%
Total	41,363	56,555	15,192	37%

The Cities and County are responsible for the building code and development ordinances, and these communities have instituted ordinances to ensure homes and commercial buildings are built to withstand 110 mile per hour wind loads at three seconds gusts and requires any building in the floodplain to be at least 1 foot above the Base flood elevation with an elevation certificate establishing the height. While there has been a steady increase of development, the jurisdictions' recognize the importance to institute measures to limit damage and exposure of citizens and structures to floods and high wind hazards implementation of these codes and ordinances. While BDD4 does not have direct oversight of development in the floodplain and with subdivision plans, it is part of the review and approval process with the County and the Cities. As part of that review, BDD4 provides interested parties a clear and consistent review process

and documents outlined in the Rules and Regulations Guidelines. These guidelines, as well as all other needed forms and documents can be easily downloaded from the District's website, www.bdd4.org/documents.

While there has been an increase in development, sound policies and implementation by the communities have not caused an increase in hazard vulnerability to these new buildings.

Improving Education and Outreach Capabilities

BDD4 will utilize its website and the websites of the communities within its planning area and the County to provide updated information regarding work being done in support of mitigation, efforts individual can do to help with mitigation and raise awareness of the tools available to the public to help understand weather events and the potential impact to the area.

Section 3. Hazard Identification and Risk Assessment

Introduction

Risk assessments are conducted to determine the potential impacts of specified hazards on human safety, the economy, and both the developed and natural environments of the community. Risk, as viewed from a hazard mitigation perspective, is the potential for loss of life, personal injury, property damage, loss or other impacts created by the interaction of natural hazards with local citizens and community assets and include natural processes, such as floods. FEMA has provided a diagram (Figure 9) that helps best illustrate the concept of risk as the overlap between hazards and community assets – the smaller the overlap, the lower the risk. This plan update focuses on how risk has changed since the current plan was completed. Each hazard includes a description of the location, extent, previous occurrence and probability of future events as well as events that occurred since the 2012 plan. Hazards are then evaluated on the basis of potential impact on the planning's areas and within its authority.

Changes from the Last Plan

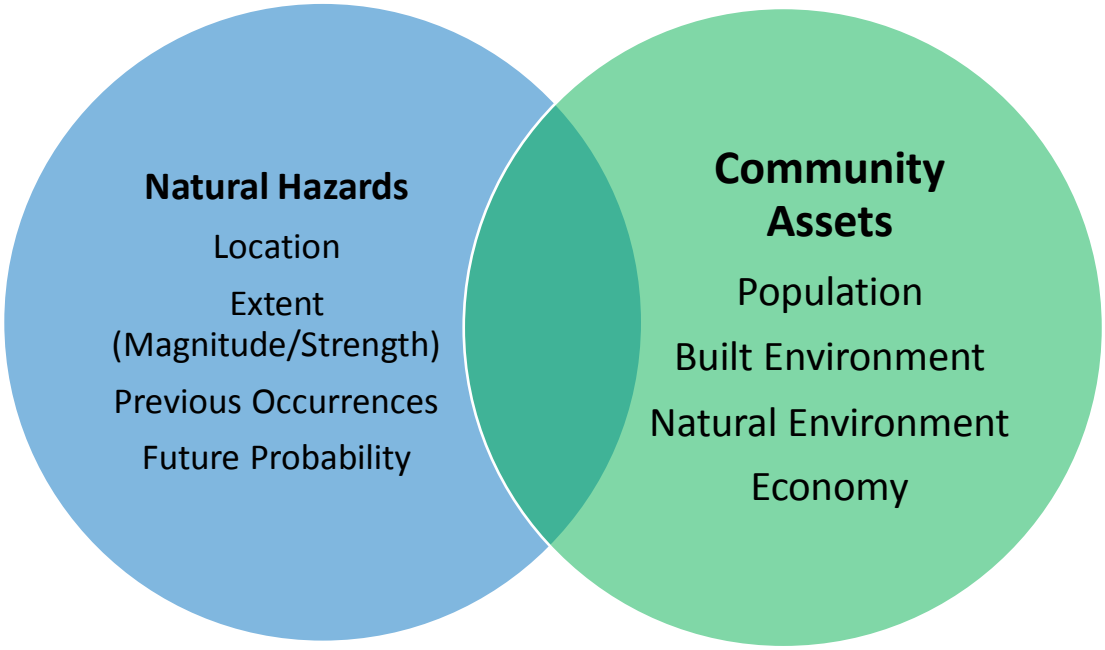
The MPC, for the original Plan in 2012, reviewed, profiled and considered all potential hazards that may affect the jurisdictional area. However, an important factor discussed in that plan, is that while there are hazards that can impact the planning area, the responsibility of mitigation of many of these hazard is under the Cities or County. As part of the update process, the MPC reviewed the hazards, and if BDD4 does not have the authority to mitigate, omitted the hazard from further assessment and provided the explanation that while the hazard can occur in the jurisdictional area, BDD4 does not have the authority to mitigate. Table 7 depicts the hazards profiled in the original plan and the hazards to be profiled and assessed in this plan. Table 9 provides the rationale for omission.

In addition, changes from the original Plan were incorporated, including updated maps and tables displaying the event history from the National Center for Environmental Information (NCEI) for various hazards, as well as many other less significant modifications.

Table 7 - 2012 Hazards and 2019 Hazards

2012 Hazards	2019 Hazards for Plan Update
Flood	**Flood**
Tornadoes	**Tornadoes**
Thunderstorms – High Wind	**Thunderstorms – High Wind**
Hurricanes and Tropical Storms	**Hurricanes and Tropical Storms**
Not in Original Plan	**Hailstorm - Omitted**
Earthquakes	**Omitted**
Landslides	**Omitted**
Winter Storm	**Omitted**
Wildfire	**Omitted**
Dam Failure	**Omitted**
Drought	**Omitted**
Extreme Heat	**Omitted**
Not in original plan	**Lightning - Omitted**

Figure 9 FEMA Concept of Risk Diagram



Overview of Risks

Table 8 identifies the total number and estimated value of buildings/infrastructure within the BDD4 planning area. The table indicates there are 46,563 residential buildings and 9,992 commercial and public buildings/infrastructure in the planning area. While buildings are important and tangible to estimate value, human life is more complex. The potential annual losses from deaths and injuries are calculated by using the values in the current FEMA BCA guidance which is $5.8 million for deaths and $90,000 for treat and release injuries. This information and the data in Table 8 is used periodically throughout this plan update to identify the overall exposure within planning area for certain hazards that equally impact the entire planning area such as hurricanes/tropical storms and floods.

Table 8 Buildings/Infrastructure*

TYPE	PEARLAND		BROOKSIDE VILLAGE		UNICORP. BRAZ NOT INCLUDING PEARLAND		TOTAL	TOTAL
	Count	Market Value	Count	Market Value	Count	Market Value	Count	Market Value
RESIDENTIAL	31,280.00	$ 7,655,890,200.00	551.00	$ 67,199,330.00	14,732.00	$ 3,247,603,452.00	46,563.00	$ 10,970,692,982.00
COMMERCIAL	1,327.00	$ 1,541,315,342.00	42.00	$ 6,714,162.00	5,481.00	$ 619,256,238.00	6,850.00	$ 2,167,285,742.00
PUBLIC BLDGS & INFRA.	1,847.00	$ 923,571,062.00	34.00	$ 2,246,540.00	1,261.00	$ 114,455,279.00	3,142.00	$ 1,040,272,881.00

* Data obtained from Brazoria County Central Appraisal District, September 2018.

Damage and losses (including physical damage, indirect and economic losses, and personal injuries and fatalities) that are associated with hazards result when an event affects areas where people and improved property are located. After hazards are identified, estimates of risk exposure for people and property (measure of "at-risk") can be prepared.

When the full range of potential natural hazards are reviewed, it becomes apparent that some events occur frequently and some are relatively rare. Some hazards impact large numbers of people to a limited degree, while others may cause very localized but significant damage. As described in the flood hazard profile, floods have historically caused the most property damage in the BDD4 jurisdictional area.

BDD4 focused on hazards that fall under their jurisdictional responsibility as a government agency established for the purpose of reclamation and drainage of its overflowed lands and other lands requiring drainage in BDD4 and all property situated within its boundaries. Certain hazards, while they occur within the planning area, like lightning and hailstorms, do not fall under the authority of BDD4 but another jurisdiction like the Cities or County. As mentioned earlier, Table 9 provides the rationale used for removing a hazard from profiling consideration.

Table 9 - BDD4 Rationale for Omission of Hazards Considered

Hazard Considered	Reason for Omission
Earthquakes	According to the State Plan, an earthquake occurrence for the planning area is considered exceedingly rare. There is no history of impact to critical structures, systems, populations or other community assets or vital services as a result of earthquakes and none is expected in the future. In addition, the responsibility of mitigation is outside of BDD4's jurisdiction and falls within another jurisdiction like the Cities or County. Due to the extremely low probability of an earthquake within the planning area, and the fact that there is no record of any historical building damage as a result of seismic activity in the planning area, this hazard does not affect District owned facilities and BDD4 has no authority to mitigate against this hazard. OMIT
Expansive soils/ land subsidence	Due to the extremely low probability of a land subsidence within the planning area and the fact that there is no record of any historical occurrences of land subsidence in the planning area, this hazard does not affect District owned facilities and BDD4 has no authority to mitigate against this hazard.
Landslide	Given that there is no recorded landslides in planning area and the USGS indicates there is less than 1.5% chance the area will be involved in a landslide, and there is less than 1% chance of a future occurrence making future occurrence very rare. In addition, the responsibility of mitigation is outside of BDD4's jurisdiction and falls within another jurisdiction like the Cities or County.
Dam Failure	The Planning area does not have any dams located within its limits. Most of the planning area is located in Brazoria County. The U.S. Army Corp of Engineers (USACE) maintains a National Inventory of Dams (NID), and reports that there are 56 dams in Brazoria County of which 6 are classified as a high hazard, 14 are classified as a significant hazard and 36 are classified as a low hazard. All the dams in Brazoria County are south of the Planning

	area. Since the Planning area does not have any dams and is not immediately downstream from any significant dams, the impact is negligible.
Winter Storm	Due to the fact that there is no record of any historical building damage as a result of winter storms in the planning area, the estimated annual dollar value damage to existing or future buildings due to winter storms is negligible, BDD4 determined that no mitigation measures are needed beyond readiness for highway safety which falls to the Cities, County and State. While winter storm can cause pipes to freeze, the need for ice and snow to be removed, and downed power lines, the District facilities have been built to insulate the pipes, have backup generators for downed power lines and have the necessary equipment to remove ice and snow. This hazard does not affect District owned facilities and BDD4 has no authority to mitigate against this hazard. OMIT
Coastal Erosion	The area does not have coastal erosion, and if it did, it is outside of BDD4's authority to mitigate this action, so it was omitted.
Drought	This hazard does not affect District-owned facilities and BDD4 has no authority to mitigate against this hazard. OMIT
Extreme Heat	This hazard does not affect District-owned facilities and BDD4 has no authority to mitigate against this hazard.
Hailstorm	BDD4 buildings are built to withstand hail damage. In addition, there is no history of building damage or loss and therefore this hazard does not affect District owned facilities and BDD4 has no authority to mitigate against the hazard
Landslides	Due to the extremely low probability of landslides within the planning area and the fact that there is no record of any historical occurrences of landslides in the planning area, this hazard does not affect District owned facilities and BDD4 has no authority to mitigate against this hazard.
Lightning	BDD4 facilities are all built to be protected from lightning and there is no historical record of any building damage or loss of District facilities, therefore, lightning does not affect District owned facilities and BDD4 has no authority to mitigate against this hazard.
Wildfire	Due to the fact that there is no record of any historical building damage or loss due to wildfire in the Planning area and the fact that BDD4 owned facilities are located outside of any urban-wildland interface (WUI), this hazard does not affect District owned facilities and BDD4 has no authority to mitigate against this hazard. OMIT

Through the profile process, for the hazards that affect the hazard area, the NCEI database indicates that, as of the fourth quarter of 2018, over time these hazard events caused a combined total of approximately $5.7 billion in property damage in Brazoria County. The database also indicates that there have been 70 personal injuries and 6 fatalities as a result of these events (see Table 10). Using the FEMA BCA guidance, the estimated loss for those fatalities is approximately $34,800 million; not including personal injury and lost time costs, which would increase costs.

Table 10 - Brazoria County Injuries, Deaths and Damaged from Natural Hazards Source: NOAA/NCEI 1950-2018)

Injuries from 1950-2012	65
Injuries from 2013-2018	5
Total Injuries	70
Death from 1950-2012	4
Injuries from 2013-2018	2
Total Deaths	6
Property Damages from 1950-2012	$1.769 B
Property Damages from 2013-2018	$4.007 B
Total Property Damages	$5.776 B

Numerous federal agencies maintain a variety of records regarding losses associated with natural hazards. Unfortunately, no single source is considered to offer a definitive accounting of all losses. FEMA maintains records on federal expenditures associated with declared major disasters. The U.S. Army Corps of Engineers and the Natural Resources Conservation Service collect data on losses during the course of some of their ongoing projects and studies. As mentioned earlier in this Section, NOAA's National Center for Environmental Information database is another source where data statistics such as injuries, deaths, and damage estimates are maintained for a variety of natural hazards. The data is maintained at the county level, with more recent entries listing the specific location within the county. Although not always specific to the Planning area, this county-wide hazard data from the NCEI is often the best available resource for documenting historical events.

Table 11 provides brief descriptions of particularly significant natural hazard events occurring in the County's recent history. The original plan had the table until 2009 so this iteration includes all events post 2010.

Data on Presidential Disaster Declarations characterize some natural disasters that have affected the area. In 1965, the federal government began to maintain records of events determined to be significant enough to warrant declaration of a major disaster by the President of the United States. Presidential Disaster Declarations (DRs) are made at the county level and are not specific to any one city. It should be noted that not all disaster declarations for Brazoria County affected the BDD4 planning area. However, as of 2018, 15 such disasters had been declared in Brazoria County and are identified as part of the summary in Table 11 below including 4since the last plan update.

Table 11 - Natural Hazard Events and Declared Major Disasters in Brazoria County (Sources: FEMA, NCEI database)

Date & Disaster (DR)	Nature of Event
July 11, 1973 DR-398	**Severe Storm and Flooding.** Clear Creek, Chigger Creek, Cowards Creek, and Mary's Creek flooded due to protracted rains. The storms responsible for the rains also triggered tornadoes within the area. The flooding event inundated roads.
July 28, 1979 DR-595	**Storms and Flash Floods.** Tropical Storm Claudette formed in the Central Atlantic the morning of July 15, 1979. It never reached hurricane intensity as it wandered across the northern Caribbean, and the Gulf of Mexico 10 days, making landfall near Port Arthur the evening of the 24th. The storm veered left and stalled over Alvin, TX the evening/early morning hours of the 25th/26th. This was a weak tropical storm, and went through the "Core Rain" phase during that period. An observer 3.2 miles northwest of Alvin reported 8.0" rainfall in one 4-hour period. Alvin recorded the maximum 24-hour rainfall on record for the United States of 43 inches.
September 25, 1979 DR-603	**Severe Storm and Flooding.** Torrential rains caused Clear Creek to overflow its banks. Many streets and homes within the planning area were flooded.
August 19, 1983 DR-689	**Hurricane Alicia.** Category 3 hurricane which caused $3.0 billion damage/costs and 21 deaths statewide.
April 12,1991 DR-900	**Severe Storms, Tornadoes, and Flooding**. Limited damages to the district planning area.
December 26, 1991 DR-930	**Severe Thunderstorms.** "Christmas Flood". This was not a historic event in terms of large rainfall totals. But in terms of total rain volume that fell from the sky in one event, this certainly was one of the largest in Texas recorded history, if not the largest. Thousands of previously unsuspecting home owners were flooded as Oyster Creek became several miles wide in Brazoria County where five hundred homes suffered serious flood damage.
February 25, 1993	**Tornado**. The public reported a tornado near the grade school at Southdown and Highway 288. This tornado was 100 yards wide and caused about $5,000 in damages.
April 25, 1993	**Hail**. A SkyWarn spotter reported golf ball-size hail on the east side of Pearland. The hail was 1.75" in diameter and caused $5,000 in damages.
October 18, 1994 DR-1041	**Severe Thunderstorms and Flooding.** Disastrous flooding passed down Cypress and Spring Creeks, the W and E Fork San Jacinto Rivers, producing a record elevation in Lake Houston by nearly 3 feet. Three hundred forty thousand cfs passed over the emergency spillway down the San Jacinto River below Lake Houston. The Houston Chronicle listed 15,775 homes damaged - 3,069 destroyed - 22 flood related deaths along these streams. Some homes flooded to the roofs of two story homes.
July 21, 1995	**Heat Wave.** Heat Advisories were issued covering all of Southeast Texas for an eight day period. Overnight lows hovered around 80 degrees, while afternoon highs were near 100 each day. The afternoon heat indices ranged from 105-115 degrees. Approximately 200 people reported signs of heat stress or exhaustion. There were also two deaths reported due to the excessive heat.

Date & Disaster (DR)	Nature of Event
April – May 1996	**Drought.** Continuation of drought conditions from April. May, normally one of the wettest months, had very little rainfall across Southeast Texas. Many stations actually received less than 0.10 of an inch of rain during May. The effects on agricultural products continued to worsen with many spring crops being lost due to lack of rainfall. Property damage for Southeast Texas this month were $10 million, agricultural losses $50 million.
September 23, 1998 DR-1245	**Severe Storm and Flooding - Tropical Storm Francis. –** Tropical Storm Frances, and a localized thunderstorm that followed later in the same month, resulted in widespread flooding.
May 20, 2000	**Thunderstorm.** Severe wind damage at Clover Field. Two airplane hangars, 8 trailers, 1 helicopter, and an unknown number of small airplanes overturned or destroyed. Large awning and billboard down at FM 518 and SH 35. Large trees and power lines down in the Pearland area. There was over $1 M in property damage.
June 9, 2001 DR-1379	**Severe Storm and Flooding - Tropical Storm.** Tropical Storm Allison produced flooding throughout Southeast Texas, Louisiana, and across the eastern United States. Rainfall rates in the Houston area exceeded both the 100 and 500-year rainfall rates resulting in over 50,000 homes flooded. Damages were estimated at $5 Billion and prompted a Presidential disaster declaration for 30 counties in Texas. The City of Pearland experienced devastating flooding from this storm.
April 8, 2002	**Flash Floods**. Heavy rains caused street flooding in the neighborhood of Corrigan. Many roads in this neighborhood were impassable. There was $5,000 in property damage.
September 26, 2002 DR-1434	**Tropical Storm Fay.** Limited damage in the District planning area.
September 24, 2005 DR-1606	**Hurricane Rita.** Minimal damage and no flooding reported in Pearland or Brookside from the event. Four neighborhoods experienced isolated and intermittent power outages.
September 13, 2008 DR-1791	**Hurricane Ike.** The County experienced a direct strike from Hurricane Ike an extremely large Category 2 storm with maximum sustained winds near 90 miles per hour and gusts exceeding 100 miles per hour. Ike caused severe damage to the City of Pearland facilities, damaged approximately two thousand homes and businesses, and created citywide power outages.
April 18, 2009	**Thunderstorm.** Severe thunderstorms in the planning area dumped six to seven inches of rain in four hours. The heavy rains caused localized flooding along area creeks. Several subdivisions in Pearland had street flooding with water threatening homes. The South side of the Planning Area from Fite South and along Magnolia and Bailey the ditches were overflowing and there was extensive field flooding.
	EVENTS SINCE 2012 PLAN

Date & Disaster (DR)	Nature of Event
August 16, 2013	**Thunderstorm/Wind**. A severe thunderstorm developed during the late afternoon through early evening hours and produced wind damage as it moved southward from The Woodlands area to the Angleton area. A severe thunderstorm downed hundreds of trees, numerous power poles, and a lot of fences in the Pearland area between Highway 35 and Highway 288. Winds were estimated to be gusting up to 60 mph as the storm moved southward across the area.
April 16, 2015	**Hail/Thunderstorm**. A passing southwestern shortwave disturbance into a very moist and unstable southeastern Texas environment initialized numerous severe thunderstorms. Dime sized hail reported in the planning area.
April 17, 2015	**Thunderstorm/Wind**. Morning thunderstorms from a weak upper level disturbance produced lightning strikes that damaged several structures. A lightning strike caused an attic fire at a two-story residential home in Pearland.
April 17, 2015	**Flash Flood.** An approaching broad upper low east of the Four Corners region placed eastern Texas in a favorable upper air pattern conducive to sustaining either a mesoscale storm complex or an organized linear storm system. Daytime heating, within a highly moist environment and a passing shortwave disturbance, allowed a south-central Texas originating derecho to pass through within the southwest flow and cause severe weather damage across the Houston, Texas area. Heavy rain caused localized street flooding within the planning area.
May 4, 2015 DR-4223	**Texas Severe Storms, Tornadoes, Straight Line Winds and Flooding.** An upper disturbance initiated a large thunderstorm complex that traveled across southeastern Texas. This line produced damaging severe thunderstorm gusts and an EF-1 tornado along its eastward progression across the Houston area. Thunderstorm winds downed trees, damaged traffic lights and caused roof damage to the local library.
August 20, 2015	**Flash Flood.** Early morning showers and thunderstorms developed and moved very little for several hours resulting in flash flooding across parts of Galveston and Brazoria counties. Rainfall totals of 5 to 7 inches per hour were common, and isolated totals did reach 10 inches in the Bayou Vista area. There was street flooding in and around the Planning area.
October 22, 2015 DR-4245	**Texas Severe Storms, Tornadoes, Straight Line Winds and Flooding.** The remnants of Hurricane Patricia merged with a developing frontal low to produce an intense surface low off the Texas Gulf Coast. As this low moved up the upper Texas coast it produced moderate to heavy rainfall that broad flooding to some areas, an isolated tornado and waterspout, and minor coastal flooding due to elevated storm tides. The tornado damaged the metal roof of a large business south of Beltway 8 west of Cullen Blvd. The damage path extended north of Beltway 8 into the Brunswick Place subdivision.
May 13, 2016	**Thunderstorm/Hail**. Isolated severe thunderstorms produced hail, with some up to ping pong ball size. Pea to dime size hail was reported near the intersection of Walnut Street and Highway 35 in Pearland.

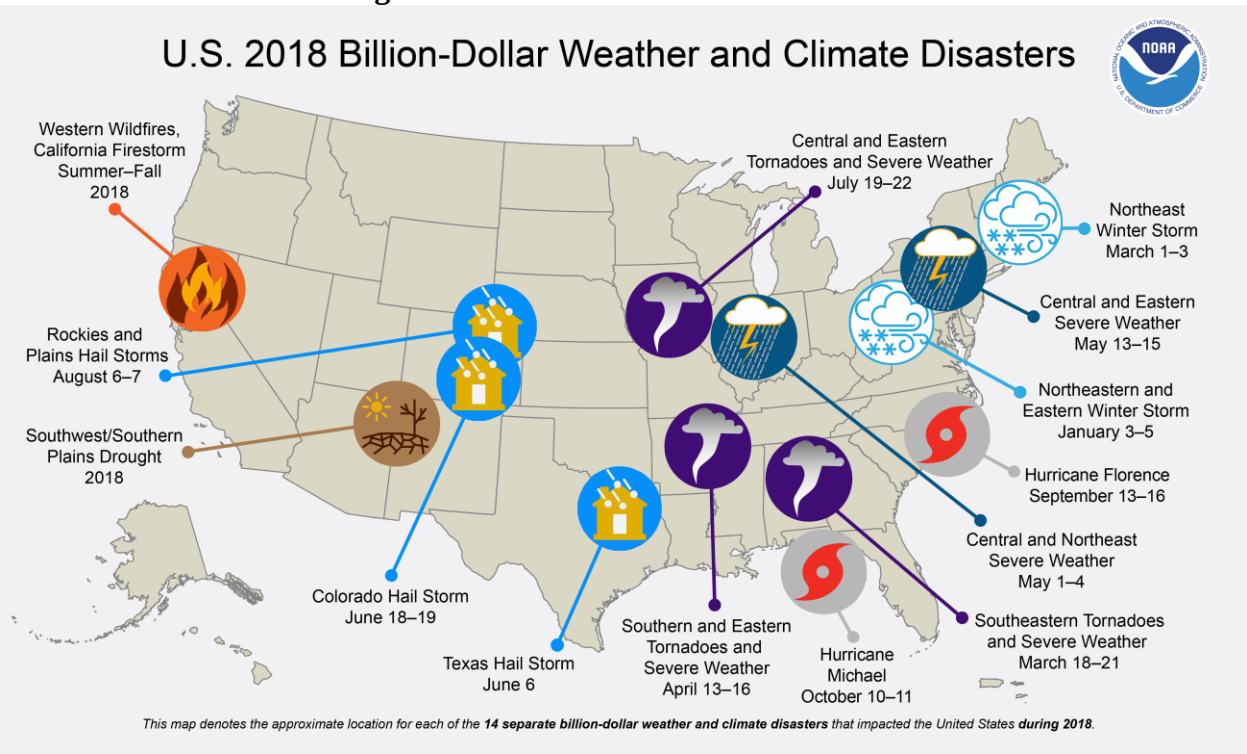
Date & Disaster (DR)	Nature of Event
May 22, 2016 DR-4272	**Texas Severe Storms and Flooding.** A fast, eastward moving storm system tracked across the area during the day. One county reported some wind damage, and there was one flood report on Galveston Island. Severe thunderstorm winds downed trees and damaged power lines near the intersection of County Road 3467 and County Road 654B.
March 29, 2017	**Flash Flood**. A line of thunderstorms moved across southeast Texas during the morning and afternoon hours and produced several tornadoes, hail, wind damage and some flooding. Street flooding was reported across the Pearland area.
August 23, 2017 DR-4332	**Hurricane/Tropical Strom Harvey**. Harvey made landfall as a category 4 hurricane near Rockport, Texas during the evening of August 25th. The storm then weakened to a tropical storm and slowed, looping back and tracking over SE Texas then back over the Gulf of Mexico making a second landfall along the Louisiana coast during the early morning hours of August 30th. During that 5-day period in which Harvey loitered over Southeast Texas the storm produced catastrophic flooding with a large area experiencing 30 to 60 inches of rain, 23 tornadoes, tropical storm force winds and a moderate storm surge near Matagorda Bay. In some of the heavier bands rain fell at a rate of over 5 inches per hour. This record rainfall produced catastrophic flooding. Intense rain over an extended period produces flash flooding and sheet flow, which inundated tens of thousands of homes, businesses, and roads in the metropolitan Houston area. Main stem rivers and adjoining tributaries, creeks and bayous reached capacity and overflowed their banks and this also contributed to the massive flooding across southeastern Texas. Flash flood waters, from sheet flooding and flooding bayous/creeks inundated thousands of homes and businesses in Pearland. Roads and highways in and around Pearland and south into Manvel, or east of Highway 288 along Highway 6, were flooded and impassable for extended periods. Record flooding of the Brazos River, San Bernard River and Oyster Creek caused the flooding of hundreds to thousands of nearby homes, vehicles and businesses. Numerous roads and homes were inundated with flood waters.
May 26, 2018	**Thunderstorm/Wind. –** Early to mid-evening severe thunderstorms produced damaging winds causing damage including a metal roof torn from a two-story building.
October 31,2018	**Thunderstorm/Wind/tornado. –** Strong damage winds gusts and one tornado in association with the passage of a squall line of thunderstorms. Trees down, and roofs were damaged.

Losses Due to Major Disasters

The United States has experienced 241 weather and or climate-related disasters since 1980. Although no definitive record exists of all public and private losses due to disasters in the planning area, there are estimates of the total public and private costs of natural hazards throughout the U.S. where overall damages/costs reached or exceeded $1 billion (including CPI adjustment to 2018). The total cost of these 241 disasters exceeds $1.6 trillion (NCEI), with 2017

being the most disastrous year on record. For 2018, the NCEI reports that there were 14 weather-related disasters including 1 drought event, 8 severe storm events, 2 tropical cyclone events, and 1 wildfire event and 2 winter storm events. Overall for 2018, these events resulted in 247 fatalities and total costs of $91 billion with significant economic effects on the areas impacted. The illustration (Figure 10) below depicts the timing and location of these disasters.

Figure 10 - 2018 Disasters and Locations



In most declared major disasters, the federal government reimburses at least 75% of the eligible costs of cleanup and recovery and possibly more depending on the severity of the disaster. The remaining percentage is covered by the state and affected local jurisdictions.

FEMA estimates of its expenditures for flood disasters in the State of Texas for the period from 1991 through 2009, is more than $8 billion. This period includes Tropical Storm Allison and Hurricanes Rita, Ike and Gustav. Since 2010, there have been ten flooding related disasters declared for Texas. If Hurricane Harvey with estimated damages by the General Land Office (GLO) of approximately $125B in damage costs were included, estimates are approximately $135B. These costs, include those associated with:

- Public assistance for debris removal, emergency services, roads and bridges, flood control facilities, public buildings and equipment, public utilities, and parks and recreational facilities in several disasters.
- Assistance paid out for individual and family grants, emergency food and shelter, and other assistance to individuals.

- Funds set aside to support hazard mitigation grants.
- BDD4 received Public Assistance (PA) funds after several of the events above, however BDD4 did not request any PA after Hurricane Harvey.
- In addition to PA funds, BDD4 has received a flood mitigation assistance grant to complete the engineering design, construction and drainage improvements along Mykawa Road in Pearland.

The MPC reviewed the State Hazard Mitigation Plan, the National Oceanic and Atmospheric Administration's National Centers for Environmental Information (NOAA, NCEI), FEMA's Disaster Declarations, the US Army Corp of Engineers National Inventory of Dams, the Harris County Flood Control District's flood warning system website database and Texas A&M Forest Service, Texas Wildfire Risk Assessment (TxWRAP). These reports were used in this plan update as follows:

- State Hazard Mitigation Plan: Plan's goals, actions and hazards were reviewed to gather data for this plan for mitigation strategy, goals, actions and hazard data.

- National Oceanic and Atmospheric Administration's National Centers for Environmental Information (NOAA, NCEI): Information used to gather hazard data.

- FEMA Disaster Declarations: Information was used for historical information and for hazard data.

- USACE National Inventory of Dams: Review of the database to determine locations, size and other relevant information to determine if hazard should be profiled or omitted.

- Harris County Flood Control District's Flood Warning System Database: Database was queried to provide historical and real time hazard data.

- Harris County Hazard Mitigation Plan Update: Plan's goals, actions and hazards were reviewed to gather data for this plan.

- Brazoria County Hazard Mitigation Plan Update: Plan's goals, actions and hazards were reviewed to gather data for this plan.

- Texas A&M Forest Service Texas Wildfire Assessment: Report was reviewed to gather hazard data to determine if the hazard should be profiled or omitted.

The next part of this section focuses on hazard identification, the potential impact of these hazards and the community's vulnerability from each hazard. The hazards include: Floods, Hurricanes and Tropical Storms, Thunderstorms with severe high winds and Tornadoes.

FLOOD
UPDATE FROM LAST PLAN

- Events since 2012 were updated and described.
- Removed the description of the types since the impacts are the same.
- In addition, this section was formatted to explicitly address: Location, Previous Occurrence, Future Occurrence (Probability), and Extent. Also explicitly addressed are Impact and vulnerability summary.

Hazard Description Flood

When rainfall runoff collects in rivers, creeks, and streams and exceeds the capacity of channels, floodwaters overflow onto adjacent lands. Floods result from rain events, whether short and intense or prolonged and less intense. In recent years, most flooding in the planning area has been associated with storms that originate as hurricanes and tropical storms that subsequently move inland.

Floods have been and continue to be the most frequent, destructive, and costly natural hazard facing the State of Texas. Ninety percent of the State's damage reported for major disasters is associated with floods. Records indicate that the streams draining the planning area have flooded throughout the area's history. Most recently, since 1990 the planning area has been impacted by six significant flood events including: 1994, 1998, 2001, 2005, 2008 and 2017.

Location - Flood

The location of the 1% (100-year) and 0.2% (500-year) annual chance event floodplains for the planning area are shown in Figures 12, 13, 14, 15 and 16, the planning areas maps. These are the locations within the planning area that are at greatest risk of flooding.

NFIP Policies in Force. Flood insurance policies and claims information can be used to identify buildings in mapped floodplains (where lenders require insurance) and where flooding has occurred (where owners are sufficiently concerned that they purchase flood insurance even if not required). Data provided by FEMA illustrate in comparison from the last plan that policies are increasing. It could be from the increase in population or an increase in awareness of being located where floods occur. Table 12 compares the reported policies in force from the 2012 plan and the most recent reported data from FEMA as of October, 2018. As reported in the FEMA NFIP Statistics, Policy Statistics for Texas as of October 1, 2018, Brazoria County has 18,646 policies in force.

Recognizing that the planning area only encompasses a fraction of the total Brazoria County, for reporting purposes, the MPC used 15% as the total of Brazoria County unincorporated for the planning area portion for this plan. Therefore, Unincorporated Brazoria County (15%), there are 2,796 policies in force. There are 8,326 NFIP policies in force for Pearland and 309 for Brookside Village. The total insuring structures and contents are at a value of $3,505,865,875.00 as illustrating in Table 12.

Table 12 – 2012 to 2019 Policies-In-Force – BDD4 Planning Area

Planning Area	Policies-in-Force from 2012 Plan	15% For Unicorporated Brazoria County 2012	Total for 2012 Plan		Policies-in-Force 2018	15% For Unicorp-orated Brazoria County 2018	Total for 2019 Plan	Diff-erence
Unin-corporated Brazoria County	15,500.00	2,325.00	2,325.00		18,646.00	2,797.00	2,797.00	472.00
Brookside Village	240.00		240.00		309.00		309.00	69.00
Pearland	7,893.00		7,893.00		8,326.00		8,326.00	433.00
TOTAL			**10,458.00**				**11,432.00**	**974.00**

Figure 11 – Map of Repetitive Loss Sites within BDD4 Planning Area

Figure 12 - City of Pearland Effective FIRM (source: City of Pearland)

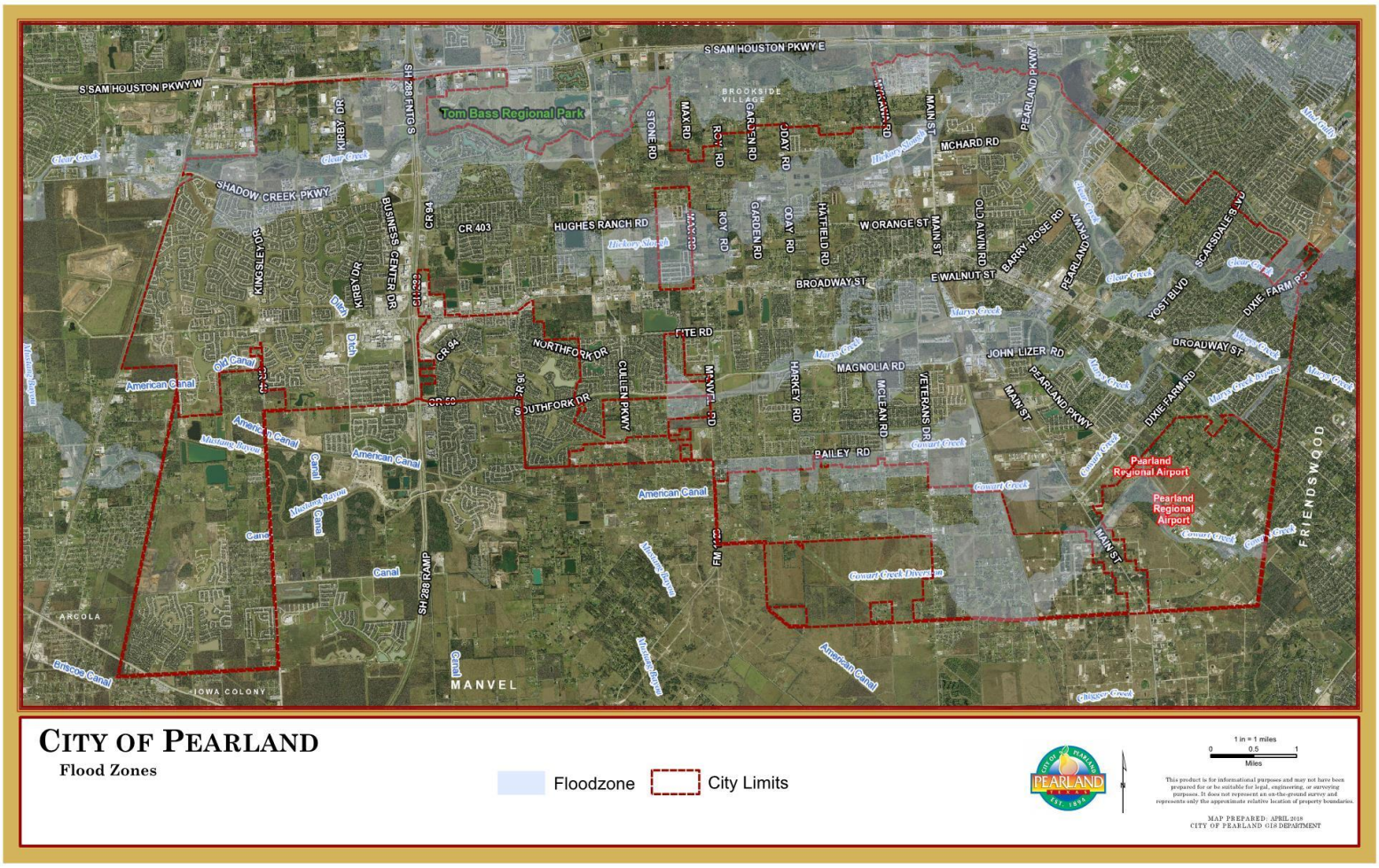


Figure 13 City of Pearland Effective FIRM (source: City of Pearland)

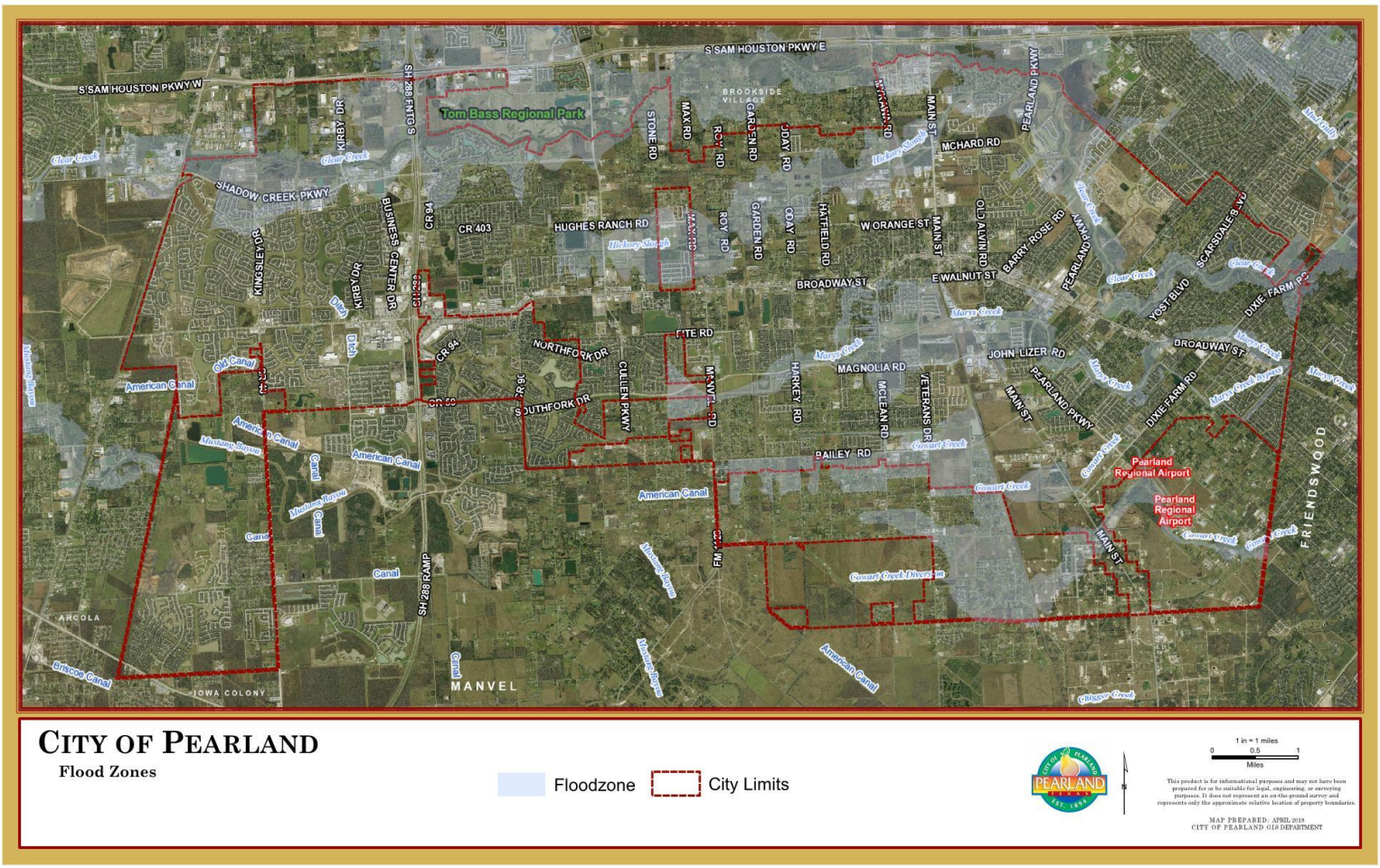


Figure 14 Brookside Village FIRM (source: FEMA Map Service Center)

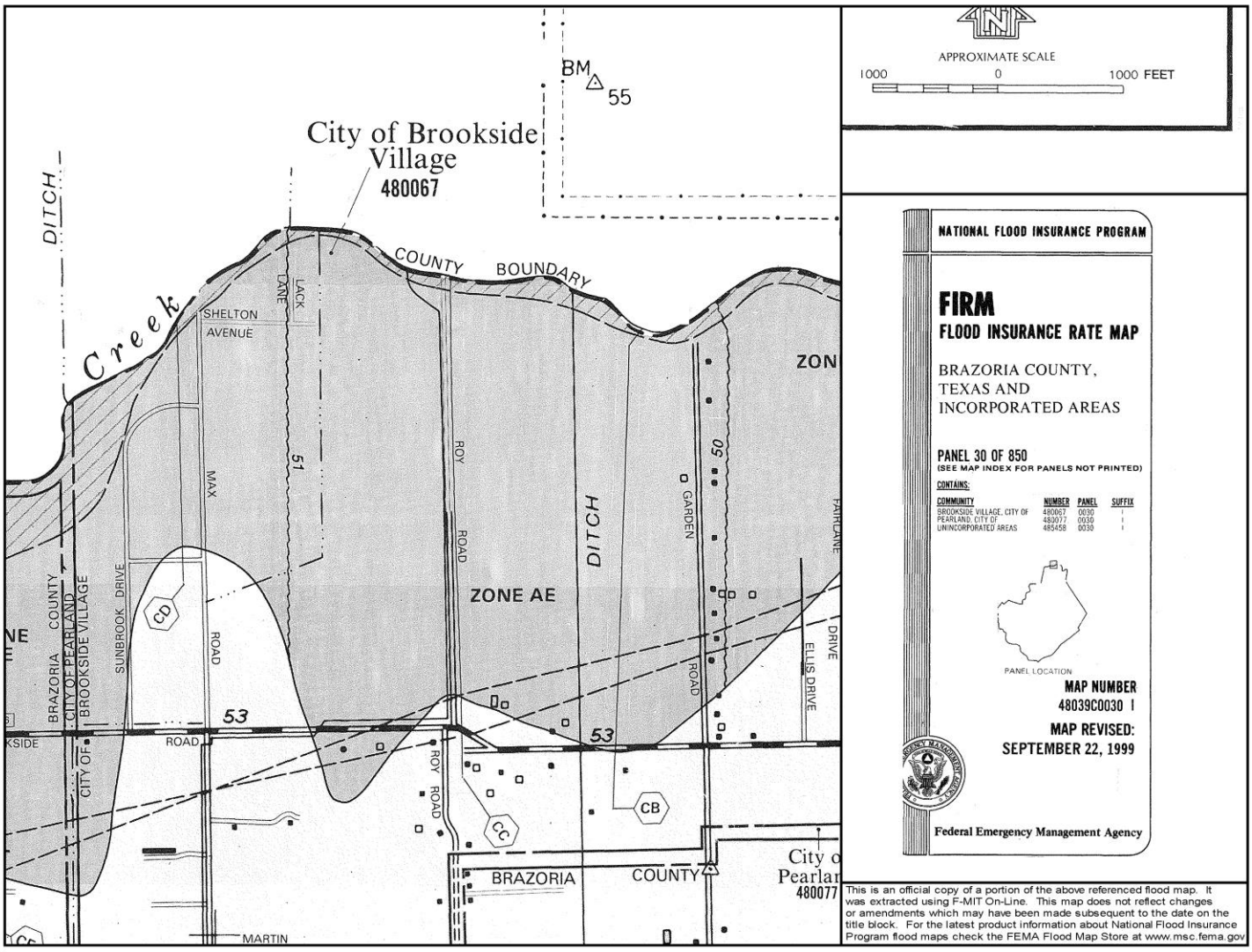


Figure 15 - Brazoria County Unincorporated that is within BDD4 Planning Area (Source: FEMA Map Service Center, area is the SouthEast side of planning area)

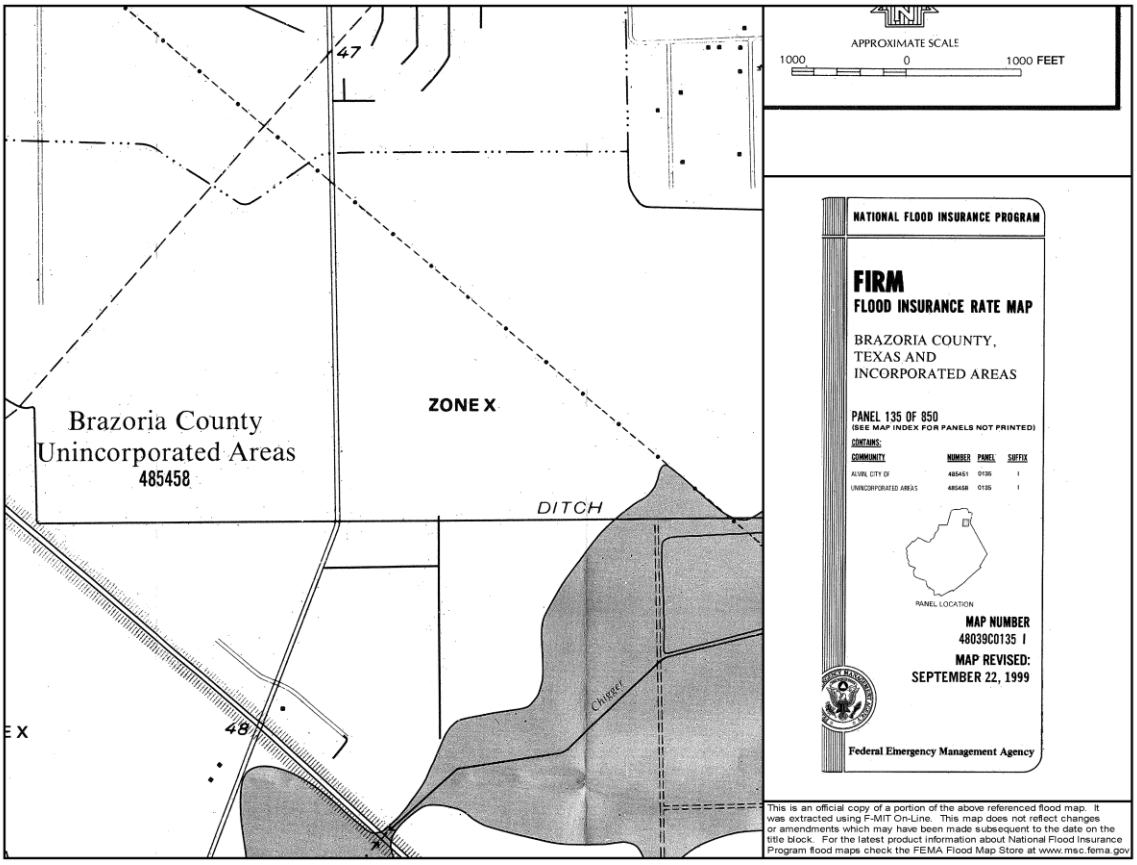
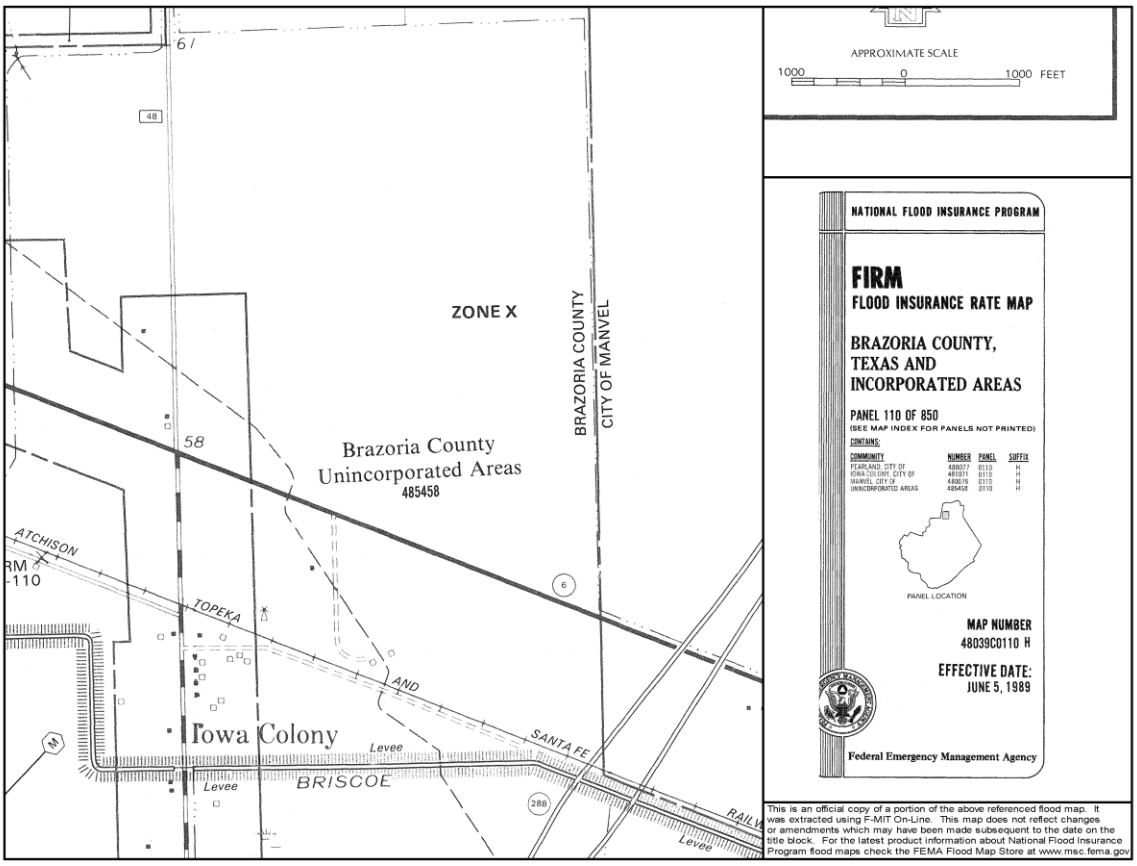


Figure 16 - Brazoria County Unincorporated that is within BDD4 Planning Area (source: FEMA Map Service Center, Area is the Southwest side of planning area)



Previous Occurrences

The NCEI Storm Events Database only lists flood events from 1997 to present. The listed flood events show location and/or a description of damages within the planning area. The NCEI indicates that between 1997 and 2018 there were 20 flood events that impacted the planning area. There is no indication as to why there are no events listed prior to 1997, but it is assumed that flooding followed similar patterns in the past. For these events, the NCEI database reported no deaths or injuries and a total of $3,220,681,000.00 in damages. It is important to note, however, that there were a number of flood-related fatalities in the surrounding communities so there is a potential risk of loss of life, which as calculated by FEMA BCA guidance amounts to approximately $5.8 million each. Table 13 summarizes the 20 events that have occurred in the planning area, including six that occurred since the last version of this Plan.

Table 13 Flood Events in the BDD4 Planning Area 1997 – 2018 (Source: NOAA/NCEI)

COUNTY	LOCATION	DATE	DTH	INJ	DAMAGE	EVENT DESCRIPTION
BRAZORIA CO.	COUNTYWIDE	1/27/1997	0	0	$ 5,000.00	Street Flooding
BRAZORIA CO.	COUNTYWIDE	4/25/1997	0	0	$ 10,000.00	Street Flooding
BRAZORIA CO.	PEARLAND	1/6/1998	0	0	$ 2,000.00	Street Flooding
BRAZORIA CO.	BRAZORIA	10/18/1998	0	0	$ 3,000.00	Street Flooding
BRAZORIA CO.	COUNTYWIDE	6/9/2001	0	0	$ 220,000,000.00	TS Alison casused widespread flooding
BRAZORIA CO.	PEARLAND	4/8/2002	0	0	$ 5,000.00	Street Flooding
BRAZORIA CO.	PEARLAND	5/17/2002	0	0	$ 1,000.00	Street Flooding
BRAZORIA CO.	COUNTYWIDE	9/10/2002	0	0	$ 30,000.00	Countywide flooding
BRAZORIA CO.	PEARLAND	10/24/2002	0	0	$ 75,000.00	Water within two ft. of entering home
BRAZORIA CO.	COUNTYWIDE	11/5/2002	0	0	$ 35,000.00	Street Flooding
BRAZORIA CO.	PEARLAND	11/17/2003	0	0	$ 5,000.00	Flooding across Northern part of County
BRAZORIA CO.	BRAZORIA	10/16/2006	0	0	$ 500,000.00	Approximately 115 homes flooded in several locations around the county including Pearland.
BRAZORIA CO.	COUNTYWIDE	9/12/2008	0	0	$ 1,000,000,000.00	Ike damaged approximately 2000 homes and businesses and crated county-wide power outages
BRAZORIA CO.	PEARLAND	4/24/2009	0	0	$ 1,000.00	Street Flooding
BRAZORIA CO.	BRAZORIA	1/22/2015	0	0	$ 1,000.00	Street Flooding
BRAZORIA CO.	PEARLAND	4/17/2015	0	0	$ 8,000.00	Street Flooding
BRAZORIA CO.	PEARLAND	8/20/2015	0	0	$ -	Street Flooding
BRAZORIA CO.	PEARLAND	3/29/2017	0	0	$ -	Street Flooding
BRAZORIA CO.	PEARLAND	8/26/2017	0	0	$ 2,000,000,000.00	Harvey damaged approximately 2500 homes and businesses and government buildings
BRAZORIA CO.	BRAZORIA	8/28/2017	0	0	$ -	
		TOTAL	**0**	**0**	**$ 3,220,681,000.00**	

Future Probability

The BDD4 planning area has experienced 20 flood events between 1997 and 2018. 20 events reported over 21 years suggests a flood occurs approximately every year on average, though frequently, most are limited to street flooding and costs confined to debris removal.

Flood Extent

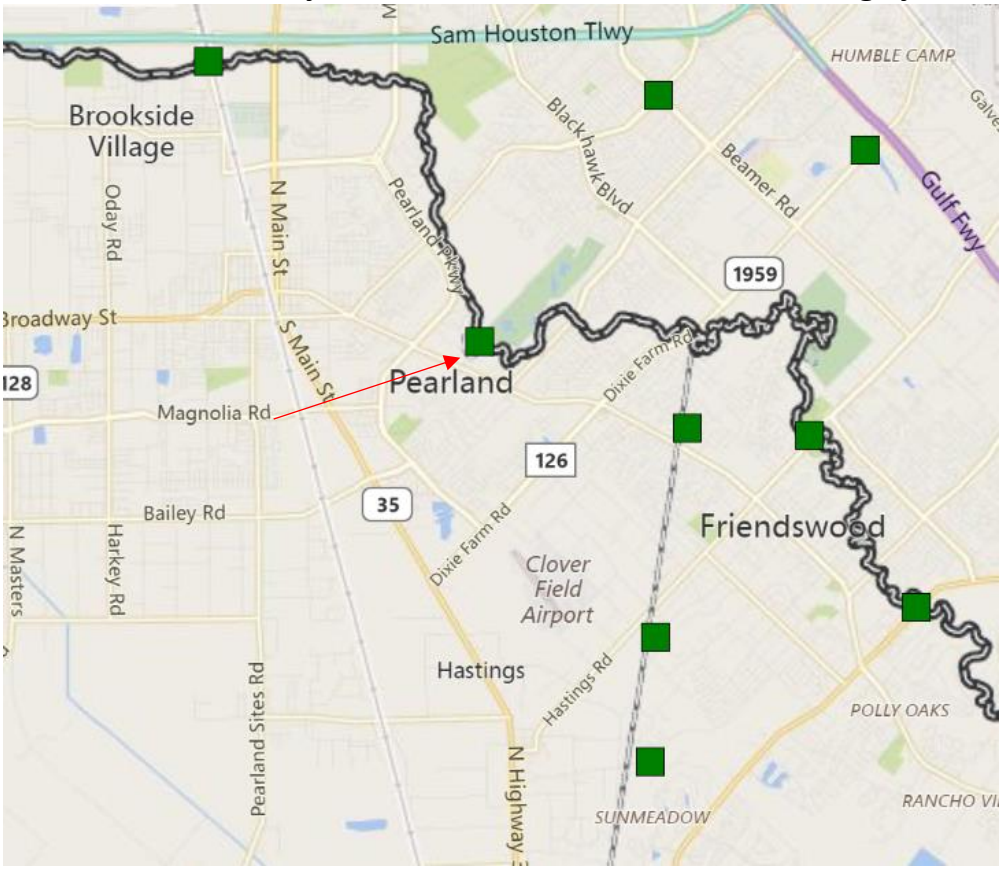
Flood severity is measured in various ways, including frequency, depth, velocity, duration and contamination, among others. For BDD4, characterizing the severity of the flood hazard depends on what part of the planning area is being considered, but generally speaking the issues relate to how often floods occur. Floods are and continue to be the most frequent, destructive, and costly natural hazard facing the District.

Flash floods almost always result from rains associated with hurricanes and tropical storms. The planning area also experiences the second greatest frequency of thunderstorms in the United States and is conducive to frequent, heavy rainfall – which typically results in an annual rainfall of over 50 inches. The flooding problems in the planning area are considered severe in some areas. The flat terrain, clay soils and impervious surfaces found in this area contribute to the flood problem. In the planning area, there are 11,432 active flood insurance policies, many of which sit within the floodplain. Flooding can occur during any month of the year; however, the greatest likelihood of the occurrence is mid-summer to early winter. Mid-summer flooding (July, August, and September) is most likely to result from tropical storm and hurricane development. Flooding in the fall to early winter (October, November and December) usually results from stationary weak cold fronts. BDD4 can expect up to 40" of flooding in the future.

BDD4 has been actively pursuing projects to reduce the severity of flooding in the area and a review of the status of current actions explains the projects underway or under review. In addition to projects, to assist the planning area's early flood warning capabilities, BDD4 maintains and operates nine stream gauges. These gauges link to the Harris County Flood Control network and provide the public with a user-friendly format that is a part of the flood warning system which measures rainfall and monitors water levels in bayous and major streams on a real-time basis to inform the public of dangerous weather conditions. The system relies on 154-gauge stations strategically placed throughout Harris and Brazoria County bayous and their tributaries. The stations contain sensors that transmit valuable data during times of heavy rainfall and during tropical storms and hurricanes. Some gauges also measure wind speed and direction, barometric pressure, air temperature, road temperature and humidity.

BDD4 owns nine weather stations, which feed information to its communities' weather stations and can be viewed through the community sites. The nine rain gauges are located on Clear Creek, Mary's Creek, Cowart Creek, Chigger Creek, Beamer Ditch and Turkey Creek are maintained by the Harris County Flood Warning System. The rain gauges are shown in Figure 17 below.

Figure 17 Rain Gauges
Source: Harris County Flood Control District – Flood Warning System



These gauges show real time data including water level showing how far water is below the bank and expected water elevation for a 10-year, 50-year, 100-year and 500-year event. They also show high water marks during various storms. Tables 14 and 15 below are for the Clear Creek Gauge at Country Club Drive (the gauge indicated by the red arrow). The top of the bank for this part of Clear Creek is 36.00 Feet. Table 14 shows the elevation and frequency and Table 15 shows a specific event and the elevation level.

Table 14 Flood Water Elevation & Frequency for Clear Creek Gauge at Country Club Dr.
Source: Harris County Flood Control District – Flood Warning System

Flood Frequency	Elevation
10% (10-year)	36.40'
2% (50-year)	38.30'
1% (100-year)	39.10'
.2% (500-year)	40.80'

Table 15 Historical Storm Water Elevation for the Clear Creek Gauge at Country Club Dr. Harris County Flood Control District – Flood Warning System

Date	Event	Elevation* (Top of Bank 36.00')
10/16/2006		35.70'
8/16/2008	Erin	32.40'
9/13/2008	Ike	33.90'
4/18/2009		34.10'
8/27/2017	Harvey	40.30

*High water elevations are approximate

As noted by Table 15, Hurricane Harvey pushed flood waters more than four feet over the top of the bank in this area. Many of the other gauges show similar data, with a few gauges showing some of the above storms other than Harvey also exceeding the banks of the creeks.

Impact

Table 16 describes the inventory counts for buildings in the BDD4 planning area.

Table 16 Structures within the BDD4 Planning Area

TYPE	Pearland	Brookside Village	Unincorporated Brazoria County (15%)	TOTAL
Residential	31,280.00	551.00	14,732.00	46,563.00
Commercial	1,327.00	42.00	5,481.00	6,850.00
Public Buildings and Infrastructure	1,847.00	34.00	1,261.00	3,142.00
TOTAL	34,454.00	627.00	21,474.00	56,555.00

Flood insurance policies and claims information can be used to identify buildings in mapped floodplains (where lenders require insurance) and where flooding has occurred (where owners are sufficiently concerned that they purchase flood insurance even if not required). This characterization of flood risk is described below.

Data provided by FEMA indicate that as of October 1, 2018, 11,432 federal flood insurance policies were in-force, insuring structures and contents at a value of $2,286,243,100. These insurance policies are administered by the National Flood Insurance Program (NFIP). There are:

Planning Area	RL	SRL	Total		Insured
Brazoriza County	132.00	24.00	156.00		71.00
Brookside Village	33.00	7.00	40.00		14.00
Pearland	223.00	93.00	316.00		134.00
TOTAL	**388.00**	**124.00**	**512.00**		**219.00**
Totals for Brazoria County are 880 RL and 157 SRL, however, only 15% of the					
Unincorporated Brazoria County is within the planning area so the column reflects that percentage.					

388 Repetitive Loss structures and 124 Severe Repetitive Loss structures in the planning area. Of those properties, 219 are insured and thus, 43% percent are not insured.

NFIP Repetitive Loss Properties

In recent years, FEMA has focused considerable attention on the Repetitive Loss (RL) subset of insured buildings. These properties have received two or more claim payments of at least $1,000 over a ten-year period. FEMA's database identifies 388 properties as RL properties in the planning area (this number includes properties with active flood insurance policies as well as those with inactive policies). Note that the RL properties below do not include those listed as mitigated on FEMA's database. Collectively, they had received claim payments of over $10 million (includes payments for building damage and contents damage).

As of October 1, 2018, repetitive loss statistics for the planning area showed 388 Repetitive Loss properties. Table 17 summarizes the RL Statistics for planning area.

Table 17 - RL Statistics for the BDD4 Planning Area (Source: FEMA, 2018)

	No. of RL	Building Payments	Contents Payments	Total	No. of Claims	Avg. Claim Payment
Brookside	33	$ 2,864,580.53	$ 1,031,010.98	$ 3,895,591.50	87	$ 44,776.91
Pearland	223	$ 15,261,438.28	$ 5,890,051.60	$ 21,151,489.88	644	$ 32,843.93
U BC	132	$ 9,067,148.78	$ 2,722,893.36	$ 11,790,042.14	317	$ 37,192.56
TOTAL	**388**	**$ 27,193,167.59**	**$ 9,643,955.94**	**$ 36,837,123.52**	**1,048.00**	**$ 35,149.93**

Flood Risk to Residential Repetitive Loss Properties

The building, contents, and total claims data has been combined for the areas that encompass the planning area. The table shows that the 388 residential repetitive loss properties received claim payments over $36 million (includes payments for building damage and contents damage).

The planning area has an extensive history of repetitive loss flood claims, so it is possible to perform a relatively simple statistical risk assessment using average annual losses and a present value coefficient calculation to project losses over a planning horizon. Residential flood risk is calculated by a simple methodology that uses the FEMA default present-value coefficients from the benefit-cost analysis software modules. To perform this calculation, the repetitive loss data was reviewed to determine an approximate period over which the claims occurred. This method should not be used for risk assessments for individual properties because of the generalizations that are used, but the method is appropriate for larger numbers of properties and policies that are spread over an entire jurisdictional area. It is presumed that more accurate figures would be

somewhat higher because the underlying statistics are for properties that had flood insurance, were flooded, and had paid claims. There are nearly always some properties in a jurisdiction that are flooded in big events, and do not have flood insurance (or did not make claims) and are thus not represented in the sample.

Most of the flood claims in this query occurred between 1980 and 2018, a period of 38 years. Based on a 100-year horizon and a present value coefficient of 14.27 (the coefficient for 100 years using the mandatory Office of Management and Budget (OMB) discount rate of 7.0 percent), the projected flood risk to these properties is shown at the bottom of Table 18. FEMA guidance defines net present value as "The benefits of a mitigation measure that are counted into the future (for the duration of the project useful life) and then discounted using an OMB-established discount rate."

When the historical losses are reviewed, $36,837,123.52 experienced over a 38-year period, derived annualized losses of $969,397.99. The net present value of annualized losses of $969,397.99 over a hundred year horizon. To do this the MPC uses the 100 year net value coefficient of 14.27. The calculated net present value of a 969,397.99 annual loss over the next 100 years is $13,833,309.28.

The difference between $36,837,123.52 experienced over a 38-year period and a projected $13,833,309.28 over the next 100 years, is that the latter is a net present value calculation. It must be understood that individuals can obtain and cancel flood insurance policies, and the flood hazard depends on many variables, including the weather, so this projection is simply an estimate of potential damages. Therefore, if not mitigated, the net present value of projected flood risk over a 100 year timeframe is $13,833,309.28. While it is an estimate, it offers a useful metric that can be used in assessing the potential cost effectiveness of mitigation actions as shown in Table 18.

Table 18– Projected 100-year Flood Risk in Planning Area to Repetitive Loss Properties (including SRL properties) (Source: FEMA NFIP query October 1, 2018)

Data	Value
Period in years	38
Number of claims	1,048
Total value of claims	$36,837,123.52
Average value of claims per year	$969,397.99
Projected risk, 100-year horizon	**$13,833,309.28**

NFIP SEVERE REPETITIVE LOSS PROPERTIES

In 2004 FEMA began to develop the Severe Repetitive Loss (SRL) Grant Program in an effort to reduce or eliminate flood damages to residential properties that met certain minimum

requirements. FEMA initiated the program early in 2008. The SRL Grant Program has since been included in the FMA Grant Program, with SRL properties being a top priority. An SRL property is defined as a residential property that is covered under an NFIP flood insurance policy and:

- has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or
- for which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

As of October 1, 2018, Severe Repetitive Loss (SRL) statistics for the planning area showed 124 SRL properties (a subset of RL). Table 19 summarizes the SRL Statistics for planning area.

Table 19 - SRL Statistics for the BDD4 Planning Area (Source: FEMA, 2018)

	No. of SRL	Building Payments	Contents Payments	Total	No. of Claims	Avg. Claim Payment
Brookside	7	$ 1,326,168.94	$ 441,635.14	$ 1,767,804.90	48	$ 36,829.27
Pearland	93	$ 16,664,073.82	$ 5,859,966.34	$ 22,524,040.16	512	$ 43,992.27
U BC	24	$ 3,684,639.77	$ 1,203,495.92	$ 4,888,135.68	117	$ 41,778.94
TOTAL	**124**	**$ 21,674,882.53**	**$ 7,505,097.40**	**$ 29,179,980.74**	**677**	**$ 43,101.89**

SRL properties are a subset of the RL list. Reviewing just the SRL data, as of October 1, 2018, Table 20 shows the risk to just residential Severe Repetitive Loss Properties. There have been 677 claims in the 38-year period with a projected 100 year risk of $10,957,850.66.

Table 20 – Projected 100-year Flood Risk in Pearland to Severe Residential Repetitive Loss Areas (Source: FEMA NFIP query October 1, 2018)

Data	Value
Period in years	38
Number of claims	677
Total value of claims	$29,179,980.74
Average value of claims per year	$234,564.15
Projected risk, 100-year horizon	**$10,957,850.66**

Flood Risks – Local Drainage

Many areas and streets experience accumulations of rainfall that are slow to drain, which may cause disruption of normal traffic, soil erosion, and water quality problems. Local drainage

problems contribute to the frequency of flooding, increase ditch maintenance costs, and are perceived to adversely affect the quality of life in some neighborhoods.

Many areas prone to shallow, local drainage flooding are not shown on the Cities' or County's Flood Insurance Rate Maps. One measure of the magnitude of this problem is the number of flood insurance policies in-force on buildings that are outside of the mapped floodplain (nearly 2,000). Localized flooding throughout some subdivisions in the planning area is a persistent problem, common even during the frequent rainstorms experienced in the planning area. It is a concern because access for emergency services (fire, emergency medical) can be impeded. While the depth of water generally is relatively shallow, a number of homes have been flooded repetitively and are identified by FEMA as repetitive loss properties.

Vulnerability

Properties identified as Repetitive or Severe Repetitive Loss properties are considered vulnerabilities due to the fact that they are documented structures that are repeatedly impacted by flooding hazards. This data is especially important due to the fact that this data may, at times, identify structures that suffer from localized flooding outside of the designated Special Flood Hazard Area. As mentioned above, homeowners living in RL or SRL properties are vulnerable as well as critical infrastructure including buildings, facilities, roads and drainage systems.

Hurricane and Tropical Storm
UPDATED FROM LAST PLAN

- Events since 2012, were updated and described.
- In addition, this section was formatted to explicitly address: Location, Previous Occurrence, Future Occurrence (Probability), and Extent. Also explicitly addressed are impact and vulnerability summary.

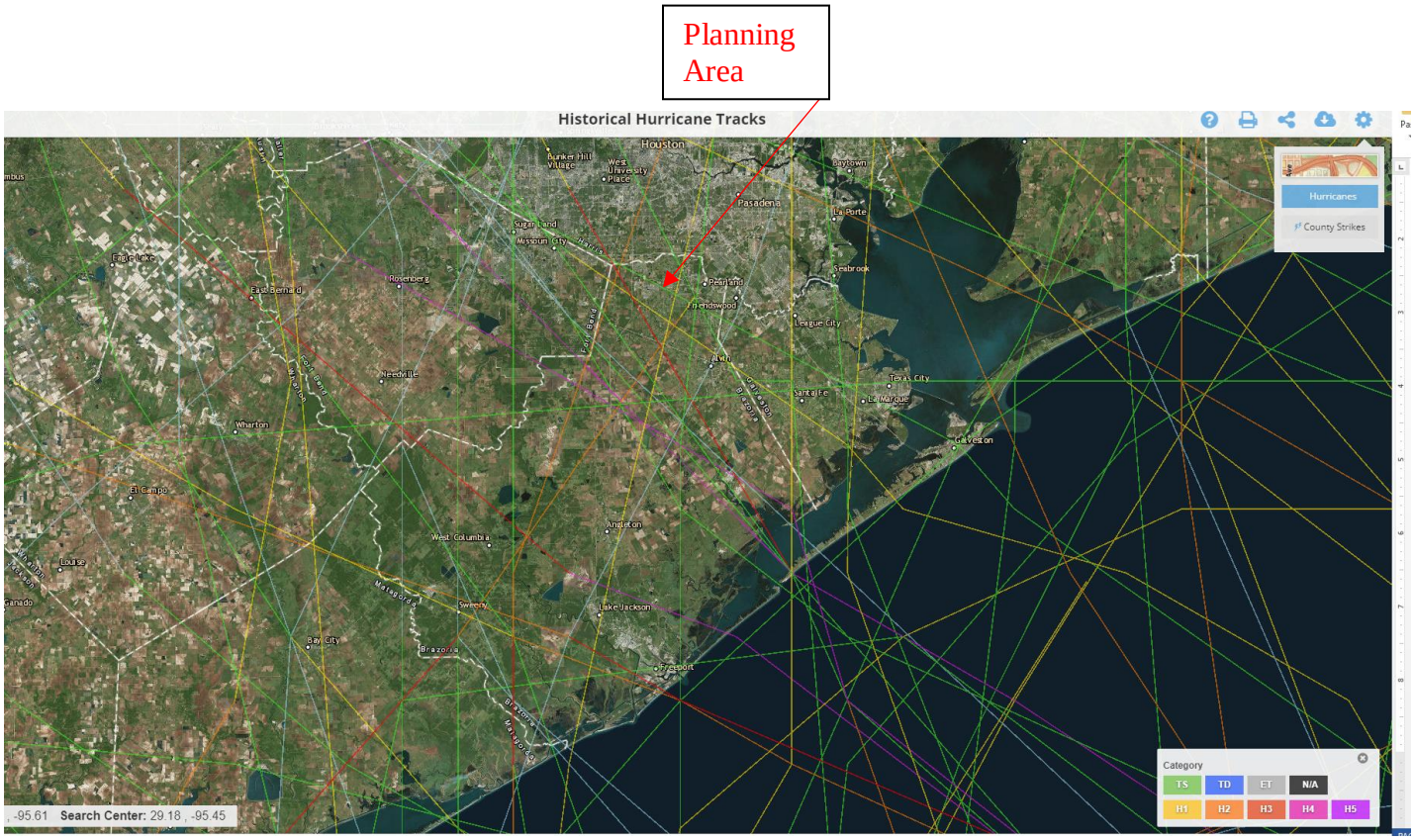
Hazard Description - Hurricane and Tropical Storm

A hurricane begins as a tropical depression with wind speeds below 39 mph. As it intensifies, it may develop into a tropical storm, with further development producing a hurricane. Hurricane winds blow in a large spiral around a relative calm center known as the "eye." The "eye", the storm's core, is an area of low barometric pressure and is generally 20 to 30 miles wide. The storm may extend outward 100 - 400 miles in diameter. As a hurricane approaches, the skies will begin to darken and winds will grow in strength. As a hurricane nears land, it can bring torrential rains, high winds, storm surges, and severe flooding. A single hurricane can persist for more than 2 weeks over open waters and can run a path across the entire length of the Eastern Seaboard. August and September are peak months during the hurricane season that extends from June 1 through November 30.

Location

BDD4, located within close proximity to the Gulf of Mexico, is exposed to risk from hurricanes and tropical storms. Due to the widespread effects of hurricane and tropical storms, the entire planning area is affected equally. Figure 18 shows the planning area, indicated by the red arrow, and the paths of the 26 hurricanes and tropical storms that came within 65 Miles of the area. (Hurricane Harvey was not included in the NOAA's Historical Hurricane Tracks at the time of this Plan update, however it also impacted the planning area).

Figure 18 Historical Hurricane/Tropical Storm Tracks
(Source: NOAA Historical Hurricane Tracks)



Previous Occurrences

The NCEI Storm Events Database is limited to hurricane and tropical storm events from 1998 to 2018 so NOAA's Historical Hurricane Tracks was used, however it only shows data up until 2016. NOAA indicates that between 1842 and 2016 there were 26 hurricanes and 24 tropical storms that impacted Brazoria County. Using both documents provides a full picture of storms since the 1950's hitting close to the planning area (Northern Brazoria County). In addition, the NCEI also shows Harvey, which occurred on August 25, 2017. Therefore, results of the 22 events that impacted the planning area since 1950 are shown in Table 21 below.

Table 21 Hurricanes and Tropical Storms Brazoria County 1950 - 2018
(Sources: NOAA Historical Hurricane Track and NCEI Storm Events Database)

Storm Name	Date	Storm Category (highest recorded point near planning area)
Bertha	08/08/1957 – 08/11/1957	Tropical Storm
Debra	07/22/1959 – 07/27/1959	H1
Cindy	09/16/1963 – 06/20/1963	H1
Abby	08/05/1964 – 08/08/1964	Tropical Storm
Felice	09/12/1970 – 09/17/1970	Tropical Storm
Delia	09/01/1973 – 09/07/1973	Tropical Storm
Elena	08/30/1979 – 09/02/1979	Tropical Storm
Danielle	09/04/1980 – 09/07/1980	Tropical Storm
Alicia	08/15/1983 – 08/21/1983	H3
Unnamed 1987	08/09/1987 – 08/17/1987	Tropical Storm
Allison	06/24/1989 – 07/01/1989	Tropical Storm
Chantal	07/30/1989 – 08/03/1989	H1
Jerry	10/12/1989 – 10/16/1989	H1
Dean	07/28/1995 – 08/02/1995	Tropical Storm
Allison	06/05/2001 – 06/19/2001	Tropical Storm
Claudette	07/14/2003 – 07/16/2003	H1
Grace	08/30/2003 – 09/02/2003	Tropical Storm
Rita	09/23/2005 – 09/24/2005	H3
Humberto	09/12/2007 – 09/14/2007	H1
Edouard	08/03/2008 – 08/06/2008	Tropical Storm
Ike	09/01/2008 – 09/15/2008	H2
Harvey	08/25/2017 – 08/30/2017	Tropical Storm

Significant Historic Events
Unnamed Hurricane of 1900 (09/05/1900 - 09/15/1900, Category 4): The Hurricane of 1900 made landfall near Galveston on September 8, 1900 as a Category 4 hurricane with estimated winds of 145 mph. This was the deadliest and one of the costliest storms in U.S. history. Approximately 8,000 fatalities occurred.

Unnamed Hurricane of 1915 (08/17/1915 – 08/20/1915, Category 4): The Hurricane of 1915 made landfall near Galveston, following a similar path to the unnamed hurricane of 1900. In Houston, there were 80 mph winds and heavy rainfall and nearly $1 Million in damages.
Hurricane Alicia (08/15/1983 - 08/21/1983, Category 3): Hurricane Alicia made landfall approximately 25 miles southwest of Galveston, Texas as a Category 3 hurricane with winds of 115 mph. Throughout the State, Hurricane Alicia caused 21 fatalities, produced 23 tornadoes (in the Houston Galveston area), and over $2 billion in damages.

Tropical Storm Allison (06/06/2001 – 06/09/2001): Tropical Storm Allison made landfall to the West of Galveston Island. Over the next five days, Allison produced record rainfall that led to devastating flooding across Southeast Texas, including Brazoria County. For the planning area,

hundreds of residences were flooded, high winds and wind driven rain caused water intrusion at the Green Tee Number 1 wastewater-lift station.

Hurricane Ike (09/12/2008 – 09/13/2008): Hurricane Ike made landfall as a Category 2 Hurricane with a storm surge of 7 to 10 feet in Brazoria County and caused an estimated $700 Million in damage within Brazoria County. For the planning area, Ike damaged approximately 2,000 homes and businesses and created power outages throughout the planning area. High winds associated with Hurricane Ike damaged roads, buildings, equipment, vehicles and destroyed street lights, signs and fences. In addition, the storm left widespread debris on public roadways.

Tropical Storm Harvey (08/25/2017 – 08/30/2017): Harvey made landfall as a category 4 Hurricane near Rockport, Texas on the evening of August 25th. The storm then weakened and slowed, looping back and tracking over SE Texas. Slow moving Tropical Storm Harvey produced torrential rains and catastrophic flooding in Brazoria County, causing an estimated $2 Billion in damages. Several tornadoes touched down. Major to record flooding occurred along the Brazos and San Bernard Rivers and several other creeks and tributaries including Oyster Creek. Flooding in Planning area is attributed to Clear Creek, Mary's Creek, Cowart Creek and Hickory Slough.

Future Probability
With 22 events reported over 68 years, a hurricane or tropical storm occurs approximately every three and a half years on average. Therefore, there is a 32% chance of a hurricane or tropical storm event affecting the planning area in any given year.

Extent
Tables 22 and 23, below, identify the criteria for each stage of development. The Saffir / Simpson Hurricane Scale is used to classify storms by numbered categories. Hurricanes are classified as Categories 1 through 5 based on central pressure, wind speed, and damage potential. BDD4 can expect to experience a storm ranging from a tropical depression to a category 5 hurricane in the planning area.

Table 22 Classification of Tropical Cyclones

Stage of Development	Criteria
Tropical Depression (development)	**Maximum sustained surface wind speed is < 39 mph**
Tropical Storm	**Maximum sustained wind speed ranges 39 - <74 mph**
Hurricane	**Maximum sustained surface wind speed 74 mph+**
Tropical Depression (dissipation)	**Decaying stages of a cyclone in which maximum sustained surface wind speed has dropped below 39 mph**

Table 23 Saffir/Simpson Hurricane Scale

Storm Category	Central Pressure	Sustained Winds	Potential Damage
1	> 980 mbar	74 - 95 mph	**Minimal**
2	965 – 979 mbar	96 - 110 mph	**Moderate**
3	945 – 964 mbar	111 – 130 mph	**Extensive**
4	920 – 944 mbar	131 – 155 mph	**Extreme**
5	**< 920 mbar**	**> 155 mph**	**Catastrophic**

Hurricane and Tropical Storm Impact

Hurricanes as severe as Category 4 have been experienced in the planning area. The type of impacts that can be expected are hurricane-force winds which drive rain into buildings causing water damage, downed trees, debris-blocked roads, disabled power lines, roof and mobile home damage. Hurricanes and tropical storms also bring heavy rains which have caused nearby creeks to exceed their capacity, inundating the surrounding area. BDD4 can expect to see tropical storms and hurricanes as severe as Category 4 causing extreme and even catastrophic damage in some cases.

Vulnerability

Severe hurricanes and tropical storms have flooded thousands of homes, closed and damaged many roads throughout the Planning area and damaged BDD4 buildings and equipment. In order to mitigate the flood risk, Brazoria County requires 24 inches above the base flood elevation, and the City of Pearland and Brookside Village require 12 inches of freeboard above the standard Base Flood Elevation. Flooded roads and debris accumulation from downed trees and damaged structures can impede emergency responders and hinder their timely response to calls for assistance. Additionally, utility interruption can occur from downed power lines causing an interruption in service to residents and critical infrastructure. This could degrade critical services and reduce or eliminate the ability of critical infrastructure to meet demand for service. The northeastern portion of the planning area has the most Repetitive Loss properties and frequently experiences street flooding.

Severe Thunderstorm High Wind
UPDATED FROM LAST PLAN

- Events since 2012, were updated and described.
- In addition, this section was formatted to explicitly address: Location, Previous Occurrence, Future Occurrence (Probability), and Extent. Also explicitly addressed are impact and vulnerability summary.

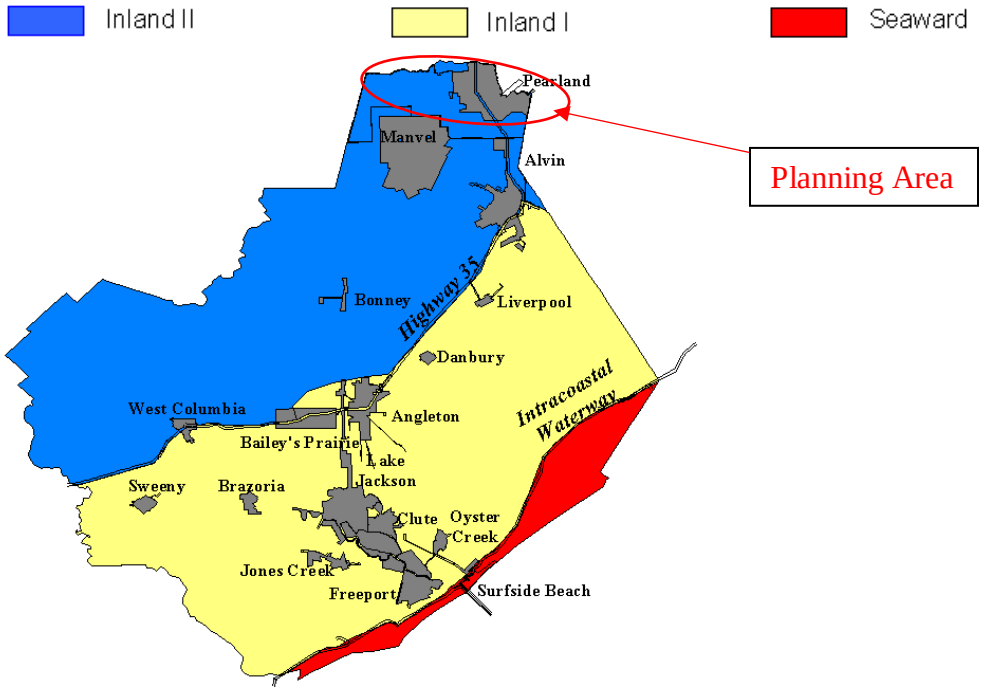
Hazard Description

Thunderstorms are the by-products of atmospheric instability, which promotes vigorous rising of warm air. A typical thunderstorm may cover an area three miles wide. The National Weather Service (NWS) considers a thunderstorm "severe" if it produces tornadoes, hail of 0.75 inches or more in diameter, or winds of 58 miles per hour (50 Knots) or more. Structural wind damage may imply the occurrence of a severe thunderstorm. Thunderstorms/High winds affect the entire planning area.

Location - Severe Thunderstorm High Wind

Figure 19 shows the "3-Second Gust Design Wind Speed" map from the Texas Department of Insurance. This map is used to design buildings to withstand reasonably anticipated winds in order to minimize property damage. The Planning Area falls within the area designated as "Inland II", where buildings need to be built to withstand 3-second gusts of 110 miles per hour. The building codes administered by the County and the Cities in the planning area requires all new construction to be designed and constructed for 110 miles per hour wind loads. The high wind hazard could be experienced anywhere within the planning area and affects the entire planning area.

Figure 19 - 3-Second Gust Design Wind Speed
(Source: http://www.tdi.texas.gov/wind/maps/brazoria.html#map)



INLAND II, 110 mph 3-second gust design wind speed

Previous Occurrences

The NCEI Storm Events Database only categorizes Thunderstorm events prior to 1993 by County, however, it has narratives and location maps describing the impacts of those events. The NCEI indicates that between 1950 and 2018 there were 30 Severe Thunderstorm High Wind events that impacted the planning area. For these events, the NCEI database reported no fatalities or injuries and a total of $415,000 in damages. Table 24 summarizes the 30 events that have occurred in the Planning area with 50 Knots or more recorded, including four that occurred since the last version of this Plan.

Table 24 Severe Thunderstorm High Wind Events over 50 Knots for BDD4 Planning Area 1950 - 2018
(Source: NOAA/NCEI)

COUNTY	LOCATION	DATE	TYPE	MAGNITUDE (KNOTS)	DEATHS	INJURIES	PROPERTY DAMAGE
BRAZORIA CO.	COUNTYWIDE	3/26/1974	Thunderstorm Wind	55	0	0	$ -
BRAZORIA CO.	COUNTYWIDE	5/30/1975	Thunderstorm Wind	73	0	0	$ -
BRAZORIA CO.	COUNTYWIDE	5/30/1975	Thunderstorm Wind	73	0	0	$ -
BRAZORIA CO.	COUNTYWIDE	9/13/1977	Thunderstorm Wind	52	0	0	$ -
BRAZORIA CO.	COUNTYWIDE	5/2/1978	Thunderstorm Wind	63	0	0	$ -
BRAZORIA CO.	COUNTYWIDE	1/17/1980	Thunderstorm Wind	70	0	0	$ -
BRAZORIA CO.	COUNTYWIDE	6/11/1981	Thunderstorm Wind	54	0	0	$ -
BRAZORIA CO.	COUNTYWIDE	5/13/1982	Thunderstorm Wind	52	0	0	$ -
BRAZORIA CO.	COUNTYWIDE	9/18/1983	Thunderstorm Wind	55	0	0	$ -
BRAZORIA CO.	COUNTYWIDE	9/19/1983	Thunderstorm Wind	55	0	0	$ -
BRAZORIA CO.	COUNTYWIDE	12/31/1984	Thunderstorm Wind	52	0	0	$ -
BRAZORIA CO.	COUNTYWIDE	5/5/1987	Thunderstorm Wind	50	0	0	$ -
BRAZORIA CO.	COUNTYWIDE	11/16/1987	Thunderstorm Wind	51	0	2	$ -
BRAZORIA CO.	COUNTYWIDE	3/29/1990	Thunderstorm Wind	53	0	0	$ -
BRAZORIA CO.	COUNTYWIDE	1/14/1991	Thunderstorm Wind	75	0	0	$ -
BRAZORIA CO.	COUNTYWIDE	6/30/1992	Thunderstorm Wind	54	0	0	$ -
BRAZORIA CO.	PEARLAND	6/17/1997	Thunderstorm Wind	58	0	0	$ -
BRAZORIA CO.	PEARLAND	10/4/2004	Thunderstorm Wind	52	0	0	$ -
BRAZORIA CO.	COUNTYWIDE	5/8/2005	Thunderstorm Wind	52	0	0	$ 87,000.00
BRAZORIA CO.	PEARLAND	5/29/2005	Thunderstorm Wind	58	0	0	$ 23,000.00
BRAZORIA CO.	BRAZORIA	2/16/2008	Thunderstorm Wind	52	0	0	$ 8,000.00
BRAZORIA CO.	PEARLAND	6/21/2008	Thunderstorm Wind	52	0	0	$ -
BRAZORIA CO.	PEARLAND	8/12/2009	Thunderstorm Wind	50	0	0	$ 1,000.00
BRAZORIA CO.	BRAZORIA	6/8/2010	Thunderstorm Wind	52	0	0	$ 80,000.00
BRAZORIA CO.	BRAZORIA	2/1/2011	Thunderstorm Wind	56	0	0	$ 5,000.00
BRAZORIA CO.	PEARLAND	1/25/2012	Thunderstorm Wind	61	0	0	$ 35,000.00
BRAZORIA CO.	PEARLAND	8/16/2013	Thunderstorm Wind	61	0	0	$ 100,000.00
BRAZORIA CO.	BRAZORIA	4/17/2015	Thunderstorm Wind	60	0	0	$ 75,000.00
BRAZORIA CO.	BRAZORIA	5/19/2016	Thunderstorm Wind	52	0	0	$ -
BRAZORIA CO.	BRAZORIA	3/29/2018	Thunderstorm Wind	51	0	0	$ 1,000.00
			TOTAL				$ 415,000.00

There were ten events in which damage occurred, five of which occurred since the last plan. The January 25, 2012 event caused downed power lines and poles, tree and fence damage and twenty homes and five businesses had some siding and roof damage. The August 16, 2013 event caused downed trees, numerous power poles and lines, and fences to be damaged. The April 17, 2015

event caused downed trees which destroyed a two-story house and a pavilion. The May 19, 2016 event damaged power lines and caused downed trees and the March 29, 2018 event caused carport and fence damage.

Future Probability

The BDD4 planning area has experienced 30 severe thunderstorm and high wind events between 1950 and 2018, causing an estimated $415,000 in property damage. Calculations involving 30 events reported over 68 years, suggest a severe thunderstorm and high wind event occurs approximately every four and a half years on average. Consequently, there is a 44% chance of a severe thunderstorm and high wind event in any given year.

Extent

The most widely accepted descriptive wind scale is the Beaufort Wind Scale shown in Table 25. The table below described the force of the storm and the wind speed, classification and appearance that is associated with each wind force. The planning area can expect to experience wind events ranging from light winds to hurricane force winds.

Table 25 Beaufort Wind Scale
(Source: NOAA)

Force	Wind (Knots)	WMO Classification	On the Water	On Land
0	Less than 1	Calm	Sea surface smooth and mirror-like	Calm, smoke rises vertically
1	1-3	Light Air	Scaly ripples, no foam crests	Smoke drift indicates wind direction, still wind vanes
2	4-6	Light Breeze	Small wavelets, crests glassy, no breaking	Wind felt on face, leaves rustle, vanes begin to move
3	7-10	Gentle Breeze	Large wavelets, crests begin to break, scattered whitecaps	Leaves and small twigs constantly moving, light flags extended
4	11-16	Moderate Breeze	Small waves 1-4 ft. becoming longer, numerous whitecaps	Dust, leaves, and loose paper lifted, small tree branches move
5	17-21	Fresh Breeze	Moderate waves 4-8 ft. taking longer form, many whitecaps, some spray	Small trees in leaf begin to sway
6	22-27	Strong Breeze	Larger waves 8-13 ft., whitecaps common, more spray	Larger tree branches moving, whistling in wires
7	28-33	Near Gale	Sea heaps up, waves 13-19 ft., white foam streaks off breakers	Whole trees moving, resistance felt walking against wind

8	34-40	Gale	Moderately high (18-25 ft.) waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks	Twigs breaking off trees, generally impedes progress
9	41-47	Strong Gale	High waves (23-32 ft.), sea begins to roll, dense streaks of foam, spray may reduce visibility	Slight structural damage occurs, slate blows off roofs
10	48-55	Storm	Very high waves (29-41 ft.) with overhanging crests, sea white with densely blown foam, heavy rolling, lowered visibility	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	56-63	Violent Storm	Exceptionally high (37-52 ft.) waves, foam patches cover sea, visibility more reduced	
12	64+	Hurricane	Air filled with foam, waves over 45 ft., sea completely white with driving spray, visibility greatly reduced	

Impact

For the BDD4 planning area, most wind damage has been limited to downed trees, debris-blocked roads damaged fences, and disabled power lines with the occasional roof and mobile home damage. It has experienced severe thunderstorms and high winds up to 75 Knots. The type of impacts that can be expected are associated with the magnitudes from the Beaufort Wind Scale, which indicate storms as severe as a "Hurricane force wind" extent, involving trees being broken or uprooted along with considerable structural damage.

Vulnerability

According to the NCEI, there have been 30 severe thunderstorm and high wind events within the Planning Area and taking into effect the jurisdictional authority of BDD4, vulnerability could be: debris accumulation from downed trees and damaged structures that are associated with a high wind event can impact roads and impede emergency responders, hindering their ability to respond to calls for assistance. Additionally, utility interruption can occur from downed power lines causing an interruption in service to residents and critical infrastructure. This can degrade critical services and impede or eliminate the ability of critical facilities to satisfy demand for service.

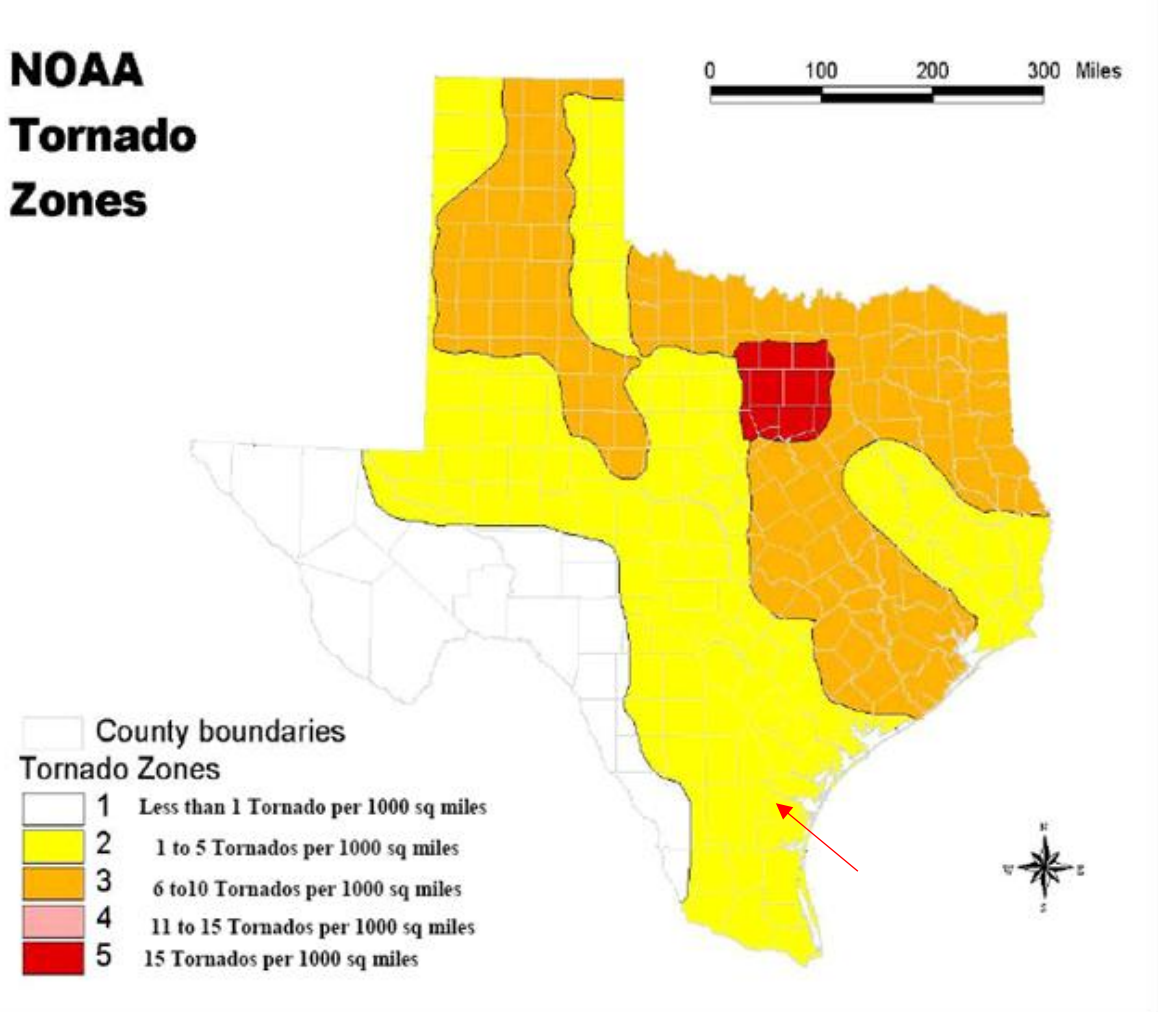
Tornadoes
UPDATE FROM LAST PLAN

- Events since 2012, were updated and described.
- In addition, this section was formatted to explicitly address: Location, Previous Occurrence, Future Occurrence (Probability), and Extent. Also explicitly addressed are impact and vulnerability summary.

Hazard Description
The National Weather Service defines a tornado as a violently rotating column of air in contact with the ground and extending from the base of a thunderstorm. Tornadoes can form any time of the year; but the season of greatest activity extends from March to August.

Location - Tornadoes
Figure 20 illustrates the frequency of tornado strikes in Texas per 1,000 square miles, the arrow denotes the approximate location of the Planning Area, which falls within the zone for 1-5 tornadoes in a 1,000 square mile per the NOAA Prediction Center Map. With an average of 153 tornadoes touching down each year, Texas is considered the U.S. "tornado capital." While tornadoes can occur in any month in Texas and at all hours of the day or night, they occur with greatest frequency during the late spring and early summer months, during late afternoon and early evening hours. There is some potential for the full range of tornadoes (from EF-0 to EF5) to impact most areas of Texas, including Brazoria County, although events at the lesser end of the scale are much more likely. Northern Texas is most vulnerable, but the planning area experiences considerable activity. The tornado hazard affects the entire planning area approximately equally. All structures in the planning area are vulnerable to the effects of tornadoes (particularly tornadoes at the more intense end of the Enhanced Fujita scale). However, highly-engineered commercial (and other non-residential) structures are typically less vulnerable to the effects of tornadoes than are residential structures, with some exceptions.

Figure 20 - Tornado Activity in Texas
(Source: NOAA – Storm Prediction Center)



Previous Occurrences

The NCEI Storm Events Database indicates that between 1950 and 2018, Brazoria County experienced 54 tornados, 2 F3, 2F2, 21 F1 and 29 F0 scale. Table 26 summarizes the tornadoes that have occurred in Brazoria County, including two tornadoes that occurred since the last version of this Plan.

Table 26 Tornadoes within the Planning Area 1950 - 2018
(Source: NOAA/NCEI)

COUNTY	LOCATION	DATE	TYPE	F - SCALE	DEA-THS	INJ	PROPERTY DAMAGE
BRAZORIA	COUNTYWIDE	2/8/1956	Tornado	F0	0	0	$ -
BRAZORIA	COUNTYWIDE	3/17/1957	Tornado		0	0	$ -
BRAZORIA	COUNTYWIDE	3/17/1957	Tornado	F1	0	0	$ 250,000.00
BRAZORIA	COUNTYWIDE	7/10/1958	Tornado	F0	0	0	$ 30.00
BRAZORIA	COUNTYWIDE	8/13/1959	Tornado	F0	0	0	$ 30.00
BRAZORIA	COUNTYWIDE	6/28/1963	Tornado	F1	0	0	$ -

BRAZORIA	COUNTYWIDE	4/18/1966	Tornado	F3	0	0	$ -
BRAZORIA	COUNTYWIDE	9/20/1967	Tornado		0	0	$ 2,500.00
BRAZORIA	COUNTYWIDE	9/21/1967	Tornado		0	0	$ -
BRAZORIA	COUNTYWIDE	8/8/1968	Tornado	F0	0	0	$ -
BRAZORIA	COUNTYWIDE	9/15/1968	Tornado	F0	0	0	$ -
BRAZORIA	COUNTYWIDE	8/11/1970	Tornado	F1	0	0	$ 2,500.00
BRAZORIA	COUNTYWIDE	5/12/1972	Tornado	F1	0	1	$ -
BRAZORIA	COUNTYWIDE	5/12/1972	Tornado	F1	0	6	$ 250,000.00
BRAZORIA	COUNTYWIDE	5/12/1972	Tornado	F1	0	0	$ 2,500.00
BRAZORIA	COUNTYWIDE	6/5/1973	Tornado	F1	0	0	$ -
BRAZORIA.	COUNTYWIDE	6/20/1973	Tornado	F1	0	0	$ 25,000.00
BRAZORIA	COUNTYWIDE	9/13/1974	Tornado	F0	0	0	$ 30.00
BRAZORIA	COUNTYWIDE	6/27/1975	Tornado	F0	0	0	$ -
BRAZORIA	COUNTYWIDE	3/8/1976	Tornado	F1	0	0	$ 250,000.00
BRAZORIA	COUNTYWIDE	3/8/1976	Tornado	F3	0	18	$ 2,500,000.00
BRAZORIA	COUNTYWIDE	9/26/1976	Tornado	F1	0	0	$ -
BRAZORIA	COUNTYWIDE	9/18/1979	Tornado	F1	0	0	$ 25,000.00
BRAZORIA	COUNTYWIDE	9/6/1980	Tornado	F0	0	0	$ -
BRAZORIA	COUNTYWIDE	5/3/1981	Tornado	F2	0	10	$ 250,000.00
BRAZORIA	COUNTYWIDE	6/3/1981	Tornado	F0	0	0	$ 2,500.00
BRAZORIA	COUNTYWIDE	8/31/1981	Tornado	F1	0	0	$ 250,000.00
BRAZORIA.	COUNTYWIDE	8/31/1981	Tornado	F1	0	0	$ 25,000.00
BRAZORIA	COUNTYWIDE	5/6/1982	Tornado	F1	0	0	$ 25,000.00
BRAZORIA	COUNTYWIDE	5/13/1982	Tornado	F1	0	0	$ 250,000.00
BRAZORIA	COUNTYWIDE	1/31/1983	Tornado	F1	0	0	$ 250,000.00
BRAZORIA	COUNTYWIDE	2/9/1983	Tornado	F2	0	0	$ 25,000.00
BRAZORIA	COUNTYWIDE	3/16/1983	Tornado	F0	0	0	$ 25,000.00
BRAZORIA	COUNTYWIDE	3/26/1983	Tornado	F0	0	0	$ 2,500.00
BRAZORIA	COUNTYWIDE	3/26/1983	Tornado	F1	0	7	$ 250,000.00
BRAZORIA.	COUNTYWIDE	7/15/1983	Tornado	F1	0	2	$ 250,000.00
BRAZORIA	COUNTYWIDE	8/18/1983	Tornado	F0	0	0	$ 30.00
BRAZORIA	COUNTYWIDE	8/18/1983	Tornado	F0	0	0	$ 30.00
BRAZORIA	COUNTYWIDE	8/18/1983	Tornado	F0	0	0	$ 30.00
BRAZORIA.	COUNTYWIDE	1/29/1989	Tornado	F0	0	0	$ 25,000.00
BRAZORIA	COUNTYWIDE	1/29/1989	Tornado	F0	0	0	$ 25,000.00
BRAZORIA	COUNTYWIDE	1/18/1991	Tornado	F0	0	0	$ 250,000.00
BRAZORIA	COUNTYWIDE	5/4/1991	Tornado	F0	0	0	$ 25,000.00
BRAZORIA	COUNTYWIDE	2/22/1992	Tornado	F0	0	0	$ 2,500.00
BRAZORIA.	COUNTYWIDE	2/22/1992	Tornado	F1	0	0	$ 25,000.00

BRAZORIA	COUNTYWIDE	11/21/1992	Tornado	F1	0	0	$ 250,000.00
BRAZORIA	PEARLAND	2/25/1993	Tornado	F0	0	0	$ 5,000.00
BRAZORIA	COUNTYWIDE	11/16/1993	Tornado	F0	0	0	$ 500.00
BRAZORIA	BRAZORIA	8/30/2001	Tornado	F0	0	0	$ 5,000.00
BRAZORIA.	BRAZORIA	12/12/2001	Tornado	F0	0	0	$ 200,000.00
BRAZORIA	BRAZORIA	12/12/2001	Tornado	F1	0	0	$ 200,000.00
BRAZORIA.	BRAZORIA	11/17/2003	Tornado	F0	0	1	$ 75,000.00
BRAZORIA	PEARLAND	1/25/2012	Tornado	EF0	0	0	$ 15,000.00
BRAZORIA	PEARLAND	10/24/2015	Tornado	EF0	0	0	$ 20,000.00
			54				$ 6,035,680.00

The two tornados since the last plan occurred in Pearland which is in the planning area. The January 25, 2012 tornado touched down near the intersection of Highway 35 and Plum Street in Pearland. A gas station had its awning destroyed and a business to the south of Plum Street had its roof peeled back, causing an estimated $15,000 in property damage. The most recent reported event occurred on October 24, 2015. This tornado damaged the metal roof of a large business south of Beltway 8 west of Cullen Blvd. The damage path extended north of Beltway 8, into the Brunswick Place subdivision.

Future Probability

The planning area has experienced 54 tornadoes between 1950 and 2018, causing an estimated $6,035,680 in property damage County-wide. Calculations based on 54 events, reported over 68 years, suggest Brazoria county-wide experiences a tornado event approximately every 1.25 years, on average. Therefore, there is a 79.4% chance of a tornado event in any given year.

Extent

Tornado damage severity is measured by the Enhanced Fujita Tornado Scale (EF-Scale). The Enhanced Fujita Scale assigns numerical values based on wind speed and categorizes tornadoes from zero to five representing increasing degrees of damage. Tornadoes are related to larger vortex formations, and therefore often form in convective cells such as thunderstorms or in the right forward quadrant of a hurricane or tropical storm, far from the hurricane eye. Table 27 describes the categories for the Enhanced Fujita Tornado Scale. The planning area can expect to experience a tornado ranging from EF0 to EF5 in the planning area.

Table 27 - The Enhanced Fujita (EF) Scale

Enhanced Fujita (EF) Scale		
Enhanced Fujita Category	**Wind Speed (mph)**	**Potential Damage**
EF0	65-85	**Light damage.** Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	**Moderate damage.** Roofs severely stripped; mobile homes overturned

		or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage.** Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage**. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	**Devastating damage**. Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Incredible damage**. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd.); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Impact

In the BDD4 planning area, most wind damage has been limited to downed trees, blocked roads, and disabled power lines with the occasional roof damage. Historically, the area has experienced tornadoes limited to EF0-EF1 strength. However, tornadoes up to EF3 have been experienced nearby in the County. The type of impacts that can be expected are associated with those magnitudes from EF0-EF3 described Table 27 above.

Vulnerability

According to the NCEI, there have been 54 tornadoes within the planning area, 2 F3, 2F2, 21 F1 and 29 F0 scale. Mobile and manufactured homes are the most susceptible to tornado damage as they can be easily displaced or overturned in high winds. The debris accumulation from downed trees and damaged structures that are associated with high wind events can impact roads and

impede emergency responders, hindering their ability to respond to calls for assistance. Additionally, utility interruption can occur from downed power lines causing an interruption in service to residents and critical infrastructure. This can degrade critical services and impede or eliminate the ability of critical facilities to satisfy demand for service.

Community Assets
Paramount to analyzing risk is to understand what is at risk. Assets can be described in the following four categories: People, Economy, Built Environment and Natural Environment. Although all assets may be affected by hazards, some assets are more vulnerable because of their physical characteristics or socioeconomic importance to help identify potential vulnerabilities in the Pearland planning area.

People: The health, safety, security and general well-being of the citizens within the planning area are of paramount importance to the District. The District always considers the impact to its citizens on every project.

Economy: A thriving economy is also fundamental to the well-being of the planning area its residents so considering factors like major employers, primary economic sectors, commercial centers; the loss or degradation of which would impact the community and the interdependence between business and government which is critical to the community's expeditious recovery from disasters. The District always considers the impact to businesses and government on every project.

Natural Environment: The District identified critical areas that provide protective benefit or reduce the magnitude of an event and areas that need protection in the event of disaster.

Built Environment: Per the Brazoria County Appraisal District as of 2018, there are 46,563 total residential housing units and 9,992 commercial and public buildings located within the Planning Area as shown in Table 28.

Table 28 – Residential, Commercial and Public Buildings in BDD4 Planning Area (Source: Brazoria County Central Appraisal District)

TYPE	Pearland	Brookside Village		Unincorp Brazoria Cty	TOTAL
Residential	31,280.00	551.00		14,732.00	46,563.00
Commerical	1,327.00	42.00		5,481.00	6,850.00
Public Bldgs and Infrastructure	1,847.00	34.00		1,261.00	3,142.00
TOTAL	34,454.00	627.00		21,474.00	56,555.00

The following community assets are considered critical facilities by BDD4.

BDD4-Owned Buildings – BDD4 owns six buildings, an administrative and several equipment and material buildings as well as construction equipment and trucks.

While there are critical facilities located in the planning area, they are owned and operated by the jurisdictions. BDD4 works with these communities to help with drainage issues that could impact these facilities.

Government Owned Buildings in Pearland, Brookside Village and Unincorporated Brazoria County located in BDD4's planning area - The City of Pearland owns or leases 18

buildings and 39 facilities. Brookside Village owns three buildings – an administrative building, a police headquarters and a firehouse. In the portion of Brazoria County Unincorporated, there is 1 firehouse.

Public Schools. The Pearland Independent School District owns the City's 27 public schools and buildings. (Figure H-32). There are 4 are High Schools (grade 9-12), 4 are Junior High Schools (grade 7-8), 4 are Middle Schools (grades 5-6) and 11 are Elementary Schools (grades PK-4) and six support facilities (Transportation, Maintenance, Agricultural, West Side Transportation, Education Support and Administration Buildings). While not part of the Pearland ISD, Alvin ISD (9) and Pasadena ISD (1) also have schools in the City. Brookside Village has one elementary school, and there are no schools in an unincorporated Brazoria County that falls within the BDD4 planning area.

Hospital and Nursing Homes. There are 3 hospitals and 12 nursing homes located in the planning area.

Wastewater Treatment Plants. There are five wastewater treatment facilities and associated sewage collection systems and treats 100 percent of wastewater collected that Pearland owns and operates that are located in the planning area.

BDD4 Assets. As mentioned above, BDD4 owns six buildings - one administrative building, three equipment and two material buildings as well as construction equipment housed in the equipment building when not in use and trucks. The table below lists the asset, the impact hazard can have on the asset and the ranking.

BDD4 Assets	Impacts Hazards can have on BDD4 Assets	Ranking
Administrative Building Equipment Buildings A/B/C Material Buildings 1/2	Flood waters due to hurricanes/tropical storms or severe rain events can damage the infrastructure of the building and the contents and could cause injury or death High winds carrying debris or just the velocity of wind from thunderstorms/high winds and tornadoes can damage the infrastructure of the building and the content and could cause injury or death.	HIGH -Highly likely to occur in area and impact could cause significant damage to assets, including BDD4 assets and could include fatalities
BDD4 Trucks	Flood waters can wash away a truck in a flooded area. If not inside a garage, debris from high winds/tornadoes could damage or destroy a truck	HIGH -Highly likely to occur in area and impact could cause significant damage to assets, including BDD4 assets and could include fatalities

Analyze Risk

Once establishment of the hazard areas, extent, impact and probability are complete and community assets identified, analysis can be conducted to identify where community specific vulnerabilities and problem areas exist. Throughout this process, BDD4 updated its critical infrastructure list to better assess what, exactly, is at risk. Using this information and the most recent experience of Hurricane Harvey, the MPC ranked the hazards and developed actions to mitigate those hazards.

Hazard rankings were based on the impact to assets and hazard analysis. Hazards were ranked using a high, medium, or low ranking, defined as follows:

Low	Unlikely to occur in area and impact to assets, including BDD4 assets is negligible
Medium	Likely to occur in area, with moderate impact to assets, including BDD4 assets
High	Highly likely to occur in area and impact could cause significant damage to assets, including BDD4 assets and could include fatalities

Summarize Vulnerability

Once establishment of the hazard areas, extent, impact and probability are completed and community assets identified, analysis can be conducted to identify where community specific vulnerabilities and problem areas existed. Using this information and the most recent experience of Hurricane Harvey, the MPC ranked the hazards and developed actions to help mitigate those hazards. The ranking list is in Table 29.

Table 29 Hazard Ranking

Hazard	Rank (HIGH MEDIUM LOW)
Flood	High
Hurricane/Tropical Storms	High
Thunderstorms/High Wind	High
Tornadoes	High

After the hazards are identified, analyzed and ranked, a strategy to mitigate impacts from these hazards occurred and can be found in section 4.

Section 4. Mitigation Strategy

Update from Last Plan

- Added a section on Mitigation strategy
- Slightly revised goal statement
- Separated the status of the 2012 existing actions into completed or removed tables.
- Provided a status for ongoing actions and provided a goal summary of completed actions.
- Removed the linking goals to action table
- Reformatted the Mitigation Action Table

Mitigation Strategy

The District works with other local, county and regional organizations toward mitigation actions that meet the BDD4's objective of migrating risks due to natural hazards, without creating new problems.

This plan emphasizes mitigation goals and actions focusing on activities that occur prior to a natural hazard that reduce damage when disasters strikes. While developing new mitigation actions, the MPC carefully considered preventative activities (e.g. planning and zoning and hazard mapping), property protection (e.g. acquisitions, critical facility improvements), natural resource protection (floodplain protection), structural projects (storm sewer, roads and buildings), emergency services (warning systems, training) and public information and awareness (outreach, education and training).

The first step of the mitigation strategy involved review of the current plan's mitigation goal, to assess whether it remains reflective of the District's mitigation strategy.

Mitigation Goal

BDD4 slightly revised its goal statement by removing from the original plan the general statement to seek solutions to existing programs as it seemed redundant to the third bullet. The goal of this plan update is stated below:

BDD4's Mitigation Goal Statement
The mitigation goal of BDD4 is:

- To protect public health, safety, and welfare
- To reduce losses due to hazards by identifying hazards, minimizing exposure of citizens and property to hazards, and increasing public awareness and involvement
- To facilitate the development review and approval process to accommodate growth that recognizes existing storm water and floodplain problems to avoid creating new problems or worsening existing problems

Status of Actions from the Current Mitigation Plan

The 2012 plan distinguished actions by classifying them as high and medium priorities as there were no low priorities. Status was provided for the remaining actions. Table 30 provides the status of high and medium actions and Table 31 provides the one action that will be removed.

Table 30 – Status of Actions from 2012 Plan

Action from 2012 Plan	Status and Goal Achievement Summary
2012 ACTION: Mary's Creek Bypass Channel Reclamation **RANKING: HIGH** The goal of this project is conservation and reclamation of the channel. The channel and berms along the bypass are experiencing erosion which is impacting the integrity of the channel. This project will reduce the erosion and allow the channel to function as built. Because of the erosion, pipeline relocation will be a necessary part of the plan. The detention for this project is included in the BDD4's East Mary Creek Detention Facility located at the headwaters of the Mary's Creek Bypass. Therefore, there will be no negative impact on the channel.	**2019 STATUS: IN PROGRESS** There are five phases to this project, two of which have been completed and paid with BDD4 Operating Budget (FM 518 to Rustic Elementary School, and second phase Pearland Parkway to Liberty Drive).
2012 ACTION: Cowarts Creek Diversion Project **RANKING: HIGH** The goal of this project will alleviate flooding in the neighborhoods north of Cowarts Creek. The project will consist of installing a series of Reinforced Concrete Boxes to intercept flow within the Cowarts Creek Watershed and outfall the flow upstream of the original outfall location on the main channel. This diversion would prevent sheet flow from entering the subdivision. The detention for this project is proposed at a site upstream on Cowarts Creek. Therefore, there will be no negative impact on the creek.	**2019 STATUS: COMPLETED** **Goal Achievement Summary:** This project helped alleviate flooding during Hurricane Harvey.

Action from 2012 Plan	Status and Goal Achievement Summary
2012 ACTION: Cowarts Creek Flood Control Project **RANKING: HIGH** The goal of this project will be to alleviate flooding in the upstream areas of Cowarts Creek. The project will consist of Channel Reclamation, Bridge Replacement, and Detention. A proposed 80 acre Detention site on Cowarts Creek is located upstream of State Highway 35 near the Santa Fe Railway. Several Bridges including a Railroad Trestle will be replaced. This project will greatly reduce the flooding of homes and other structures in the watershed The impact to the Cowarts Creek Watershed will be zero.	**2019 STATUS: COMPLETED** **Goal Achievement Summary:** This project helped alleviate flooding during Hurricane Harvey.
2012 ACTION: Culvert replacement and installation **RANKING: HIGH** The goal of this project will be to alleviate potential flooding in areas such Roy and Max Roads. This area experiences flooding due to inadequate culvert sizes in the outfall ditches The project will consist of replacing the inadequate sized culverts with culverts sized by BDD4's District Engineer. These outfall ditches are in residential areas that experience flooding. Therefore, there will be no negative impact on the channel.	**2019 STATUS: COMPLETED** **Goal Achievement Summary:** This project helped alleviate flooding during Hurricane Harvey.
Mykawa Road Culvert Installation **RANKING: HIGH** The goal of this project will be to alleviate flooding in the Willow Crest subdivision and street flooding along Mykawa Road. This project will consist of installing reinforced box culverts in the Mykawa Road Drainage Ditch from Orange St to Cherry St. and reworking the Willow Crest Subdivision storm sewer outfalls The Detention for this project will be in the David L Smith Detention Facility. Therefore, there will be no negative impact to the area.	**2019 STATUS: ONGOING** BDD4 received an FMA grant from FEMA administered through the TWDB for the project. The project is in the final engineering design phase with plans to bid for construction in July 2019 and for the project to be completed by 2021.

Action from 2012 Plan	Status and Goal Achievement Summary
2012 ACTION: Master drainage Plan **RANKING: HIGH** Develop and adopt a master drainage plan in order for BDD4 to exercise the authority granted to drainage districts under Chapter 49.211 of the Texas Water Code. Chapter 49.211 requires districts to adopt master drainage plans before adopting rules relating to the review and approval of proposed development drainage plans.	**2019 STATUS: ONGOING** The Master Drainage Plan is in the final stages of the draft and should be finalized in 2019.
2012 ACTION: PROCESS FOR HAZARD EVENTS **RANKING: MEDIUM** Formalize procedures on BDD4s roles and responsibilities before, during, and after a hazard event.	**2019 STATUS: ONGOING** The District is working on documenting procedures to formalize each Department's role during a hazard event. The District plans to have it completed by 2020.
2012 ACTION: PROCESS FOR HAZARD EVENTS **RANKING: MEDIUM** Periodically perform engineering and structural surveys of BDD4 facilities to ensure that they are sufficiently protected from effects of hazards, especially wind.	**2019 STATUS: ONGOING** The District has an annual review of facilities as well as an immediate review of facilities after and event.
2012 ACTION: HARDENING BDD4-OWNED ADMINISTRATIVE BUILDING **RANKING: MEDIUM** Harden BDD4 Administrative Office to make a safe harbor for any person that so chooses to stay in these buildings during an event.	**2019 STATUS: COMPLETED** **Goal Achievement Summary:** During Hurricane Harvey, the building was not damaged and BDD4 essential employees who were stationed there were safe.

Table 31 - 2012 Actions to be removed from 2019 Actions

Action from 2012 Plan	Reason for Removing Action from 2019 Plan Update
2012 ACTION: SEVERE WEATHER ACTION PLAN **RANKING: MEDIUM** Create severe weather action plan, conduct drills, identify and promulgate evacuation and sheltering options.	**2019 STATUS: REMOVING** The MPC determined this is more of a preparedness action than a mitigation action, so it will be removed after this plan iteration.

Identification of New Actions
After a review of the actions in the current plan, the MPC began a process to identify new actions. The MPC utilized a version of FEMA's Mitigation Implementation Action Summary Worksheet to help describe important information about the action. After the actions were summarized, the MPC prioritized (discussed next section), the Actions Summary Worksheets were converted into the Mitigation Action Table 32.

Evaluate and Prioritize
In order to evaluate feasibility and analyze prioritization of actions, all new actions were reviewed by the MPC. The process utilized the Mitigation Action Implementation Tool. The actions were first placed in the types of mitigation actions:

- Local Plans and Regulations – 1 Action
- Education and Awareness – 2 Actions
- Structure and Infrastructure Projects – 5 Actions
- Natural Systems Protection – there were no actions that fit this category.

The MPC was asked to prioritize each identified mitigation actions using the Mitigation Action Evaluation Tool, ranking 1-10 each of the items described below:
Life Safety – How effective will the action be at protecting lives and preventing injuries?
Property Protection – How significant will the action be at eliminating or reducing damage to structures and infrastructures?
Technical – Is the mitigation action technically feasible? Is it a long-term solution?
Political – Is there overall public support for the mitigation action? Is there political will to support it?
Legal – Does the community have the authority to implement the action?
Environmental – What are the potential environmental impaction of the action, will it comply with environmental regulations?
Social – Will the proposed action adversely affect one segment of the population, will the action disrupt neighbors, break up voting districts or cause the relocation of lower income people?
Administration – Does the community have the personnel and administrative capabilities to implement the action and maintain it or will outside help be necessary?
Local Champion – Is there a strong advocate for the action or project among local departments and agencies that will support the action's implementation?
Other Community Objectives – Does the action advance other community objectives?

Each item was given a score of 1-10 with 1 being low for the category and 10 being high for the category. In addition to the evaluation tools above, the cost was taken into consideration when prioritizing actions and given a value with 1 being a high cost and low benefit and 10 being a low cost and high benefit. Where a cost was high, but the benefit to the community was also high, the value would be discussed and the team would come to a consensus on the value. The categories and cost were totaled and then a priority rank was provided:

- Low is defined as 1-19
- Medium is defined as 20-39
- High is defined as 40-60.

The results are depicted in Table 32.

Table 32 Ranking of hazards to Determine Priority Level

Mitigation Action Prioritization (1-10) Ranked with 1 being low priority for that category and 10 being high for the Category Minimum Score: 1 Maximum Score 60 TOTAL SCORE BETWEEN 1-19 ACTION IS LOW PRIORITY TOTAL SCORE BETWEEN 20-39 ACTION IS MEDIUM PRIORITY TOTAL SCORE BETWEEN 40-60 ACTION IS HIGH PRIORITY	Priority	Hazards
Education and Awareness		
Create and implement a new drainage maintenance system	HIGH	Flood Hurricane/Tropical Storm Thunderstorms/High Winds Tornadoes
Create a new, real time gage information impact to be placed on the District's website for residents to be able to understand the gage data provided	HIGH	Flood Hurricane/Tropical Storm
Structure/Infrastructure		
Cowart Creek Watershed Project to alleviate flooding in the area south of Bailey Road	HIGH	Flood Hurricane/Tropical Storm
Acquire land to build a retention pond south of Clear Creek in Twin Woods Creek Neighborhood	HIGH	Flood Hurricane/Tropical Storm
Install asphalt parking and construction lot at second building (HWY 35) where there is currently gravel	LOW	Thunderstorms/High Winds Tornadoes
All new buildings constructed by BDD4 will be built to withstand 110 mph 3 second gust wind speed	HIGH	Hurricane/Tropical Storm Thunderstorms/High Winds Tornadoes
Add new stream gages and weather stations to the gage network	HIGH	Flood Hurricane/Tropical Storm
Hickory Slough (Cullen Boulevard to Garden Road)	HIGH	Flood Hurricane/Tropical Storm

Mitigation Action Prioritization (1-10) Ranked with 1 being low priority for that category and 10 being high for the Category Minimum Score: 1 Maximum Score 60 TOTAL SCORE BETWEEN 1-19 ACTION IS LOW PRIORITY TOTAL SCORE BETWEEN 20-39 ACTION IS MEDIUM PRIORITY TOTAL SCORE BETWEEN 40-60 ACTION IS HIGH PRIORITY	Priority	Hazards
Cowart Creek (Wells Drive to BNSF Railroad)	HIGH	Flood Hurricane/Tropical Storm
West Chocolate Bayou – Cold River Ranch Ditch (Upstream of Hwy 6)	HIGH	Flood Hurricane/Tropical Storm
Cannon Ditch (Pearland Site Road to Amoco Industrial Street)	HIGH	Flood Hurricane/Tropical Storm
Mary's Creek (Confluence with B129-01-00 to McLean Road)	HIGH	Flood Hurricane/Tropical Storm
Mustang Bayou (CR 521 to Airline Road)	HIGH	Flood Hurricane/Tropical Storm
Mustang Bayou (Airline Road to SH 288)	HIGH	Flood Hurricane/Tropical Storm
Hickory Slough (Garden Road to SH 35)	HIGH	Flood Hurricane/Tropical Storm
Enclose the BDD4 Carports	MED	Hurricane/Tropical Storm Thunderstorms/High Winds Tornadoes
West Chocolate Bayou – CR 383 Ditch	MED	Flood Hurricane/Tropical Storm
West Fork Chocolate Bayou	MED	Flood Hurricane/Tropical Storm

Mitigation Action Prioritization (1-10) Ranked with 1 being low priority for that category and 10 being high for the Category Minimum Score: 1 Maximum Score 60 TOTAL SCORE BETWEEN 1-19 ACTION IS LOW PRIORITY TOTAL SCORE BETWEEN 20-39 ACTION IS MEDIUM PRIORITY TOTAL SCORE BETWEEN 40-60 ACTION IS HIGH PRIORITY	Priority	Hazards
Hickory Slough (CR 94 to Cullen Boulevard)	MED	Flood Hurricane/Tropical Storm
Actions/Regulations		
Develop new regulatory guidelines for the design criteria manual	HIGH	Flood Hurricane/Tropical Storm

The Mitigation Action Table for the 2019 Hazard Mitigation Plan Update is list below at Table 33.

Table 33 – 2019 Mitigation Actions

2019 MITIGATION ACTION TABLE * A= Actions reducing risk to existing buildings and infrastructure * B= Actions reducing risk to new development				
MITIGATION ACTION: Cowart Creek Watershed Project				
Hazard	**Description**		**Implementing Agency**	
Flood Tropical Storm/Hurricane	To help alleviate flooding in the area south of Bailey Road that is found on the Cowart Creek, the District would design and construct a watershed Project including watershed protection and flood mitigation measures.		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budget/ Grants	HIGH	Estimated Cost: $13,089,500 While this watershed project is expensive, the benefits would include protection of existing homes and infrastructures and any new builds.	A/B	3-5 Years
MITIGATION ACTION: Retention Pond South of Clear Creek				
Hazard	**Description**		**Implementing Agency**	
Flood Tropical Storm/Hurricane	Acquire land and build a retention pond south of Clear Creek in Twin Woods Creek Neighborhood		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budget/ Grants	HIGH	Estimated Cost: $8,500,000 While this acquisition of land and a retention pond project is expensive, the benefits would include protection of existing homes and infrastructures and any new builds.	A/B	3-5 Years
MITIGATION ACTION: Pave a gravel parking and construction lot at BDD4 Second location				
Hazard	**Description**		**Implementing Agency**	

Tornadoes Thunderstorm/ High Wind Tropical Storm/Hurricane	Install asphalt parking and construction lots at BDD4 building (located on HWY 35) where they are currently gravel.		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budget/ Grants	LOW	Estimated Cost: $385,000 Cost to moving to asphalt would help mitigate damages to the equipment, infrastructure, buildings and neighboring buildings from blown gravel.	A/B	3-10 Years

MITIGATION ACTION: Add new Gauges and Weather Stations				
Hazard	**Description**		**Implementing Agency**	
Flood Tropical Storm/Hurricane	Add new gauges and weather stations to sections of creeks and rivers not currently covered by existing gauges and weather stations.		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budget/ Grants	HIGH	Estimated Cost: $ 75,000-350,000 The cost is dependent on how many gauges and weather stations are being added as well as the software needed to integrate the new equipment to the network.	A/B	1-5 Years

MITIGATION ACTION: New Build Wind speed Requirements				
Hazard	**Description**		**Implementing Agency**	
Tornadoes Thunderstorm/ High Wind Tropical Storm/Hurricane	All new buildings constructed by BDD4 will be built to withstand 110 mph 3 second gust wind speed		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**

Capital Budget/ Grants	HIGH	Estimated Cost: $ Dependent upon what is being built. As winds cause damage in the area, the benefit to build at a wind resistant level would that can protect live and property has a high benefit to the cost.	B	1-5 Years

MITIGATION ACTION: Create and implement a new drainage maintenance system				
Hazard	**Description**		**Implementing Agency**	
Flood Tropical Storm/Hurricane Tornadoes Thunderstorm/ High Wind	Create and implement a new drainage maintenance system that is web-based which will allow the public to inform BDD4 of impeded culverts, drainage ways, and channels by debris resulting from floods, tropical storms, hurricane, tornadoes, thunderstorms and high wind.		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budget/ Grants	HIGH	Estimated Cost: $ 25,000 The cost to create the system, and then have someone manage the system so the work can be completed is low compared to the benefits of removing debris that could cause additional flooding or become flying debris in wind events.	A	3-5 Years

MITIGATION ACTION: Creation a real gauge information website				
Hazard	**Description**		**Implementing Agency**	
Flood Tropical Storm/Hurricane	Create a new, real time gauge information web-based interactive tool to be placed on the District's website for residents to be able to understand the gauge data provided.		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budget/ Grants	HIGH	Estimated Cost: $ 10,000 Very low cost for a high benefit to inform users how to read the data and use the data.	A/B	1-5 Years

MITIGATION ACTION: Develop new regulatory guidelines for design criteria manual				
Hazard	**Description**		**Implementing Agency**	
Flood Tropical Storm/Hurricane	BDD4's current rules, regulations and guidelines were adopted in 2013 and address the preparation of drainage plans in support of development and protection of health and safety for citizens and property. These should be reviewed and updated every five years to ensure it reflects a consistent, efficient and orderly development that is aligned with all current legal and regulatory requirements.		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budget/ Grants	HIGH	Estimated Cost: $50,000 BDD4's current rules, regulations and guidelines were adopted in 2013 and the cost to create new guidelines is not as significant as the benefit to all those that rely on new guidelines.	A/B	2-5 Years

MITIGATION ACTION: Hickory Slough (Cullen Boulevard to Garden Road)				
Hazard	**Description**		**Implementing Agency**	
Flood Tropical Storm/Hurricane	The project includes channel conveyance improvements from Roy Road to Garden Road. The channel conveyance improvements and detention will contain the 100-year inundation and remove inundation from all structures for the 10- and 100-year event.		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budgets/ Grants	HIGH	Estimated Cost: $43.2 MM Remove inundation from all the structures for 100-yr and 10-yr -Contain the 100-year future conditions flows within channel -Estimated reduction of $36.5 M in present value damages	A/B	2-10 Years

MITIGATION ACTION: Cowart Creek (Wells Drive to BNSF Railroad)				
Hazard	**Description**		**Implementing Agency**	
Flood Tropical Storm/Hurricane	The project includes channel conveyance improvements from XS 45221 which is~330 ft south of Bailey Rd and Wells Dr intersection to BNSF railroad. The Alternative 2 (10-year LOS) channel conveyance improvements will provide a significant reduction in the inundated area and remove inundation from all the structures currently estimated to be flooded by the 100-year and 10-year event.		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budgets/ Grants	HIGH	Estimated Cost: $7.3MM - Remove inundation from all the structures for 100-yr and 10-yr - 85+% reduction for 100-year inundation - Estimated reduction of $10 M in present value damages	A/B	2-10 Years

MITIGATION ACTION: West Chocolate Bayou (Cold River Ranch Ditch Upstream of Hwy 6)				
Hazard	**Description**		**Implementing Agency**	
Flood Tropical Storm/Hurricane	The project includes trapezoidal channel conveyance improvements, from Rio Lindo Street to Hwy 6, and stormwater detention. The Alternative 1 (100-year LOS) channel conveyance improvements will provide a significant reduction in the inundated area and remove inundation from all structures currently estimated to be flooded by the 100-year event and the 10-year event.		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budgets/ Grants	HIGH	Estimated Cost: $21MM - Remove inundation from up to 104 structures (10-yr) and 128 structures (100-yr) -Contain the 100-year future conditions flows within channel and Estimated reduction of $12.6 M in present value damages	A/B	2-10 Years

MITIGATION ACTION: Mary's Creek (Confluence with B129 01-00 to McLean Road)		
Hazard	**Description**	**Implementing Agency**

Flood Tropical Storm/Hurricane	The project includes trapezoidal channel conveyance improvements, from confluence with B129-01-00 to McLean Road, and stormwater detention. The Alternative 2 (25-year LOS) channel conveyance improvements will provide a significant reduction in the inundated area and remove inundation from 249 of 251 structures currently estimated to be flooded by the 100-year event and 2 structures for the 10-year event.		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budgets/ Grants	HIGH	Estimated Cost: $31.4MM - Remove inundation from up to 2 structures (10-yr) and 249 structures (100-yr) -Significant reduction for 100-yr inundation and Estimated reduction of $18 M in present value damages	A/B	2-10 Years
MITIGATION ACTION: Cannon Ditch (Pearland Site Road to Amoco Industrial Street)				
Hazard	**Description**		**Implementing Agency**	
Flood Tropical Storm/Hurricane	The project includes trapezoidal channel conveyance improvements from the confluence of Cannon Ditch and C101-12-03 to the railroad crossing near Amoco Industrial Street. The channel conveyance improvements and detention will contain the 100-year inundation and remove inundation from all structures for the 10- and 100-year event.		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budgets/ Grants	HIGH	Estimated Cost: $46.5MM - Remove inundation from up to 272 structures (10-yr) and 353 structures (100-yr) -Contain the 100-year future conditions flows within channel and Estimated reduction of $2 M in present value damages and facilities improvements to Trevino Ditch (C101-00-00)	A/B	2-10 Years
MITIGATION ACTION: Mustang Bayou (CR 521 to Airline Road)				
Hazard	**Description**		**Implementing Agency**	

Flood Tropical Storm/Hurricane	The project includes trapezoidal channel conveyance improvements, from Almeda Road downstream to Airline Road, and stormwater detention. The Alternative 2 (25-year LOS) channel conveyance improvements will provide a significant reduction in the inundated area and remove inundation from 278 of 393 structures currently estimated to be flooded by the 100-year event and 144 structures for the 10-year event. Due to restriction of land availability, improvements are limited along Mustang Bayou.		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budgets/ Grants	HIGH	Estimated Cost: $121MM - Remove inundation from up to 144 structures (10-yr) and 278 structures (100-yr) -55% reduction for 100-yr inundation and Estimated reduction of $4.5 M in present value damages	A/B	2-10 Years
MITIGATION ACTION: Mustang Bayou (Airline Road to SH 288)				
Hazard	**Description**		**Implementing Agency**	
Flood Tropical Storm/Hurricane	The project includes trapezoidal channel conveyance improvements, from Airline Road downstream to SH 288, and stormwater detention. The Alternative 2 (25-year LOS) channel conveyance improvements will provide a significant reduction in the inundated area and remove inundation from 79 of 96 structures currently estimated to be flooded by the 100-year event and 54 structures for the 10-year event		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budgets/ Grants	HIGH	Estimated Cost: $102MM - Remove inundation from up to 54 structures (10-yr) and 79 structures (100-yr) -55% reduction for 100 yr inundation and Estimated reduction of $19 M in present value damages	A/B	2-10 Years
MITIGATION ACTION: West Chocolate Bayou – CR 383 Ditch				
Hazard	**Description**		**Implementing Agency**	

Flood Tropical Storm/Hurricane	The project includes trapezoidal channel conveyance improvements, from upstream end near confluence with E101-02-00 to confluence with West Fork of Chocolate Bayou, and stormwater detention. The Alternative 2 (5-year LOS) channel conveyance improvements will provide a significant reduction in the inundated area and remove inundation from 93 of 94 structures currently estimated to be flooded by the 100-year event and 91 structures for the 10-year event		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budgets/ Grants	MED	Estimated Cost: $252MM - Remove inundation from up to 91 structures (10-yr) and 93 structures (100-yr) -Significant reduction for 100-year inundation flows within channel and Estimated reduction of $955 K in present value damages	A/B	2-10 Years
MITIGATION ACTION: Hickory Slough (Garden Road to SH 35)				
Hazard	**Description**		**Implementing Agency**	
Flood Tropical Storm/Hurricane	The project includes channel conveyance improvements from Garden Road to SH 35. The channel conveyance improvements and associated mitigation will provide a significant reduction in the inundated area and remove inundation from 68 of 79 structures currently estimated to be flooded by the 100-year event and 22 structures for the 10-year event.		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budgets/ Grants	MED	Estimated Cost: $52.3MM - Remove inundation from up to 22 structures (10-yr) and 68 structures (100-yr) -Significant reduction for 100-year inundation and Estimated reduction of $550K in present value damages	A/B	2-10 Years
MITIGATION ACTION: West Fork Chocolate Bayou				
Hazard	**Description**		**Implementing Agency**	

Flood Tropical Storm/Hurricane	The project includes trapezoidal channel conveyance improvements, from upstream end near confluence with E101-02-00 to confluence with West Fork of Chocolate Bayou, and stormwater detention. The Alternative 2 (5-year LOS) channel conveyance improvements will provide a significant reduction in the inundated area and remove inundation from 40 of 46 structures currently estimated to be flooded by the 100-year event and 38 structures for the 10-year event		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budgets/ Grants	MED	Estimated Cost: $103.5MM - Remove inundation from up to 38 structures (10-yr) and 40 structures (100-yr) -Significant reduction for 100-year inundation and Estimated reduction of $1.4 M in present value damages	A/B	2-10 Years

MITIGATION ACTION: Hickory Slough (CR 94 to Cullen Boulevard)				
Hazard	**Description**		**Implementing Agency**	
Flood Tropical Storm/Hurricane	The project includes trapezoidal channel conveyance improvements, from upstream end near CR 94 (Smith Ranch Road) to confluence with H126-00-00, and stormwater detention. The Alternative 1 (100-year LOS) channel conveyance improvements will provide a significant reduction in the inundated area and remove inundation from all structures currently estimated to be flooded by the 100-year event and the 10-year event		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budgets/ Grants	MED	Estimated Cost: $56.7MM - Remove inundation from up to 12 structures (10-yr) and 147 structures (100-yr) -Contain the 100-year future conditions flows within channel and Estimated reduction of $5.1 M in present value damages	A/B	2-10 Years

MITIGATION ACTION: Enclose the BDD4 Carports				
Hazard	**Description**		**Implementing Agency**	
Tornadoes Thunderstorm/ High Wind Tropical Storm/Hurricane	The BDD4 trucks are stored under carports. The project includes enclosing the BDD4 carports on all four sides and installing additional tie downs.		BDD4	
Cost Funding	**Priority**	**Cost Estimate and Cost/Benefit Considerations**	**Risk Focus (A/B)***	**Time Frame**
Capital Budgets/ Grants	MED	Estimated Cost: $150,000-$300,000 - Further protect the trucks from debris because completely enclosed - Hardening of the carports to four walls and more tie downs will help the carports to survive tornadoes/high winds	A/B	2-10 Years

Section 5. Plan Maintenance Process

Introduction

The plan maintenance section of this document details the formal process that will ensure that BDD4 hazard mitigation plan remains a responsive and relevant document. The maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan every five years. It also describes how the District will integrate public participation throughout the plan and implementation process and explain how it plans to incorporate the mitigation strategies outlined in this plan into existing planning mechanisms.

Update from Last Plan

The District will name a member of its team as the Hazard Mitigation coordinator. This position will lead the annual monitoring and evaluation of the plan.

Monitoring, Evaluating and Updating the Plan

The maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan every five years.

The minimum task of the annual hazard mitigation planning team meeting will be the evaluation of the progress of the plan and incorporating the actions into other plans. This review will include:

- Summary of any hazard events that occurred during the prior year and their impact on the planning area
- Review of successful mitigation action identified in the plan
- Review actions that were not completed to understand if there are impediments impacting the action (e.g. financial, technical, etc.)
- Re-evaluate the action plan to determine if the timeline for identified projects remains accurate (e.g. if funding becomes available, a long-term activity could become a near-term project)
- Recommendation for new mitigation actions and projects.
- Changes in potential for funding.
- Collection of maps and data to help with data needs for next iteration of plan.
- Impact of any other planning programs within the planning area that involve hazard mitigation.

In addition to the scheduled reports, the Hazard Mitigation Coordinator will convene meetings after damaging natural hazard events to review the effects of such events. Based on those effects, adjustments to the mitigation goals and actions may be made or additional event-specific actions identified. Such revisions shall be documented.

Circumstances or conditions under which BDD4 will initiate Plan reviews and updates outside of the annual review:

- On the recommendation of the Hazard Mitigation Coordinator or on its own initiative, the Board of Commissioners may initiate a Plan review at any time.

- At approximately the one-year anniversary of the updated plan's adoption, and every year thereafter (Annual Progress Reports), the team will meet for review.
- After natural hazard events that appear to significantly change the apparent risk to District assets, operations and/or citizens.
- When activities of the planning area, or the State significantly alter the potential effects of natural hazards on District assets, operations and/or citizens. Examples include completed mitigation projects that reduce risk, or actions or circumstances that increase risk.
- When new mitigation opportunities or sources of funding are identified.

In addition to the circumstances listed above, revisions that warrant changing the text of this Plan update or incorporating new information may be prompted by a number of circumstances, including identification of specific, new mitigation projects, completion of several mitigation actions, or requirements for qualifying for specific funding. Minor revisions may be handled by addenda. Lastly the entire plan will be monitored, evaluated and updated including but not limited to the planning process, the mitigation actions, the risk assessments and the capabilities assessments.

Major comprehensive review of and revisions to this Hazard Mitigation Plan Update will be considered on a five-year cycle. The 2019 Plan will enter its next review cycle and updating sometime in 2023, with adoption of that update in 2024. The MPC will be reconvened to conduct the comprehensive evaluation and revision.

Integration into Existing Plans, Procedures and Programs

There are two integration processes:

- Incorporation of other plans into this plan
- Incorporation of this plan into other plans

As this plan was reviewed and updated, in addition to the County, State, and National reports and databases outlined in section 3 of this plan, the MPC used the following local plans, budgets or reports to provide key information for the update. These reports are described in Table 34.

Table 34 – Reports, Plans and Processes Reviewed in Support of 2019 BDD4 Hazard Mitigation Plan

NAME	DESCRIPTION
Pearland and BDD4 Master Drainage Plan	Reviewed to help identify drainage problem areas in support of mitigation actions
2015 Pearland Comprehensive Plan	Reviewed the plan to understand current and future land use.
City of Pearland Capital Improvements Program (CIP) 2018-2022	Reviewed the CIP to understand priority capital projects for the City as the possibility of expanding or teaming on capital improvement projects that maximize mitigation effects (for example, by modifying a drainage project to address repetitive flood loss properties).

Brazoria County Capital Improvements Program (CIP) 2018-2022	Reviewed the CIP to understand priority capital projects for the City as the possibility of expanding or teaming on capital improvement projects that maximize mitigation effects by modifying a drainage project to address repetitive flood loss properties.
Brookside Village Annual Budget	Reviewed the budget to understand priority capital projects for the City as the possibility of expanding or teaming on capital improvement projects that maximize mitigation effects (for example, by modifying a drainage project to address repetitive flood loss properties).
City of Pearland's Engineering Design Criteria Manual Update	Reviewed for ordinances and regulations required.

The second process is how the District will work with other governing bodies to have this plan reviewed and information from it potentially used in other plans, reports or processes. FEMA's Final Rule that governs mitigation planning, requires a process for the Hazard Mitigation Plan to be incorporated into other planning mechanisms. As part of the annual review of the plan, the MPC will reach out to the communities in the planning area as well as neighboring Cities, Brazoria County and neighboring Harris and Fort Bend County to understand what plans are under review. It will ask to be included in notices about the plan updates and revisions to see if there are any areas where this plan can be incorporated. For instance, when the City and Countyplans such as the 1) Comprehensive plan, 2)NPDES-MS4, 3) Community Rating System, and 4) EDCM are reviewed on their respective 5 year or 2 year review cycle, BDD4 will ask to provide input from this plan to those plans.

Additionally, when communities are reviewing their existing storm water and floodplain ordinances, BDD4 will be asked to provide information from this HMP to assist in incorporating recommended changes. The process for these reviews starts the year before the respective plan needs to be re-permitted so BDD4 will ask for notification.

Continued Public Involvement

Upon adoption of the Plan update, the public will be periodically updated through an Annual Progress Report during the Board of Commissioner's meeting under the plan monitoring strategy described above.

BDD4 will involve the public in the plan maintenance process and during the major comprehensive review to the Plan in the same ways used during the original plan development. The public will be notified when the revision process is started and provided the opportunity to review and comment on changes to the plan and priority action items. It is expected that a combination of informational public meetings, surveys and questionnaires, draft documents posted on the website, and public Commissioners meetings will be undertaken.

Annual Processes Review

Monitoring and evaluating the processes of the plan (i.e. plan integration, continued public involved, or the plan maintenance process) will be done in the annual meeting that is also used to review the information in the plan. The review will include:

- Review of the current processes (plan integration, continued public involvement and plan maintenance process)
- Evaluation on what worked with each process and any need for improvement
- Determination if the process needs to be revised or revamped for the next year and in preparation for the next plan update.
- If the process is being revised or revamped, a process diagram will be provided with detail of the new process and the date when the revised process will be initiated.

Appendix Update from last plan:

- Removed appendix of general description of hazards, they are in the profile of the hazard
- Removed Acronym page
- Removed key terms page

APPENDIX A – Minutes from the MPC Meetings

BDD4
Hazard Mitigation Plan Update Minutes
September 20, 2018

These minutes document the Mitigation Planning Committee (MPC) meeting on the BDD4 hazard mitigation plan update. The team held the meeting on Thursday, September 20, 2018 beginning at 2:30 pm. These minutes were prepared by Kristen Thatcher and Jeff Ward. Attendees were:

Andrea Broughton	(AB)	BDD4
Kim Woodall	(KW)	BDD4
Kristen Thatcher	(KT)	JSWA

AGENDA

1) **Review of Stakeholders**
2) **Discussion of hazards that impact BDD4 and BDD4 has jurisdictional authority to mitigate**
3) **Request to TWDB for RL/SRL database information**
4) **Discussion to update Action status listed from last plan**
5) **Next steps and establish date/time for next call**

MINUTES

Review of Stakeholders

The following table is from the current approved plan. The team reviewed the list and recognized there have been changes and will provide revisions and additions by October 4th.

Stakeholder	Title	Organization
Jeff Sundseth	EMS Director	Pearland Emergency Medical Services (EMS)
Chris Doyle	Police Chief	Pearland Police Department
Michelle Smith	Director	Pearland Parks and Recreation
Claire Bogard	Director	Pearland Finance Department
Danny Cameron	Public Works Director	Pearland Public Works
Michael Masters	GIS Coordinator	Pearland GIS
Lata Krishnarao	Director of Planning	Pearland Planning Department
Bill Eisen	Pearland City Manager	City of Pearland
Mike Hodge	Pearland Assistant City Manager	City of Pearland
Jon Branson	Pearland Assistant City Manager	City of Pearland
Jack Colbath	Director of Fire Services	City of Pearland
Curtis Lampley	Project Coordinator, Precinct 1	Harris County Flood Control District
Larry Heckathron, P.E.	District Engineer	Texas DOT – Brazoria County Area Office
Jim Hunt, P.E.	District Engineer	Texas DOT – Fort Bend County Area Office
Craig Bailey	Mayor	Brookside Village

Jeff Braun	Emergency Management Coordinator	Fort Bend County
Doc Adams	Emergency Management Coordinator	Brazoria County
Mark Sloan	Emergency Management Coordinator	Harris County

Hazards

In the current approved plan, hazards were profiled to determine the impact to the community. Since BDD4's authority is limited and other jurisdictions have responsibly for hazards in the community, the team determined to omit some hazards and provide a rational for each omission. The table below indicates what hazards will be profiled and actions provided and what hazards will be omitted for the 2018 plan. There were no PWs requested by BDD4 for Harvey.

BDD4 2012 Hazards	Proposed 2018 Hazards
Flood	Flood poses great risk and will be included. However, there are no significant dams in the jurisdictional area or upstream so dam failure it will be omitted from the section.
Tornadoes/High Winds	High Winds (including tornado, thunderstorm high wind and hurricane high wind) will be merged and profiled because it does pose a risk to BDD4 infrastructure and actions will be provided.
Thunderstorm/High winds	See above
Hurricane/Tropical Storms	Hurricanes and Tropical Storms pose a risk to BDD4 and will be profiled and actions provided
Drought	Omit – Outside of the authority of BDD4
Earthquake	Omit – Outside of the authority of BDD4
Extreme Heat	Omit – Outside of the authority of BDD4
Winter Storm	Omit – Outside of the authority of BDD4
Wildfire	Omit – Outside of the authority of BDD4

Request to TWDB for RL/SRL database

BDD4 requested the RL/SRL database from TWDB on 9-11-18 and will send a follow up email to check status.

Discussion to update Actions listed from last plan status

The actions from the current plan were provided to the team. The MPC will work on a status for each of the actions by October 4th for the plan update. As the team reviews the current actions, the team will start to focus on new actions for this plan update. The team also discussed some of the processes in place between BDD4 and the County and Cities to coordinate information including the master drainage plan, design meetings and daily calls on status.

Next steps and time/date for next call

Next steps	Owner
Prepare Minutes	KT

Review stakeholders list and provide update by October 4th	MPC
Review actions from current approved plan and provide status update on each action by October 4th	MPC
Follow up with TWDB on RL/SRL list	AB
Draft of hazard section for review at next meeting	KT

The team will reconvene for the next conference call on Thursday, November 1st at 10:30 am. An agenda and call in bridge will be provided the week before the call. The table below outlines the action items from this meeting.

Adjourn: The meeting adjourned at 2:56 pm.

BDD4
Hazard Mitigation Plan Update Minutes
November 8, 2018

These minutes document the Mitigation Planning Committee (MPC) meeting on the BDD4 hazard mitigation plan update. The team held the meeting on Thursday, November 8, 2018 beginning at 9:30 am. These minutes were prepared by Kristen Thatcher and Jeff Ward. Attendees were:

Andrea Broughton	(AB)	BDD4
Kim Woodall	(KW)	BDD4
Kristen Thatcher	(KT)	JSWA

AGENDA

6) **Suggested schedule**
7) **Update of current actions**
8) **Request to TWDB for RL/SRL database information**
9) **Finalize goals**
10) **Review TOC, Section 1 Introduction and Adoption and 2 Planning Process**
11) **Establish date/time for December Call**

MINUTES

Suggested Schedule
The MPC discussed a schedule for completing the draft, review by stakeholders and public and tentative date to submit a draft for review to TDEM.

MPC	Review of complete first draft	January, 2019
MPC	Modifications based on review	January, 2019
MPC	Letter to stakeholders for review	February, 2019
MPC	Presentation to public, compile feedback	February, 2019
MPC	Prepare and submit final draft	March, 2019
TDEM and FEMA	Review and letter of approval	2019
City Council	Final adoption after approval	2019

Update on current actions
The actions from the current plan were provided to the team. KT will work with AG to provide a status for each of the actions by the next meeting. As the team reviews the current actions, the team will start to focus on new actions for this plan update.

Request to TWDB for RL/SRL database
BDD4 requested the RL/SRL database from TWDB on 9-11-18 and will send a follow up email to check status and to narrow the query to Unincorporated Brazoria County, Pearland and Brookside Village.

Finalize goals
The currently approved 2012 plan included the following Goal Statement.

BDD4's Mitigation Goal Statement

The mitigation goals of BDD4 are:

- To protect public health, safety, and welfare
- To reduce losses due to hazards by identifying hazards, minimizing exposure of citizens and property to hazards, and increasing public awareness and involvement
- To facilitate the development review and approval process to accommodate growth in a practical way that recognizes existing stormwater and floodplain problems while avoiding creating new problems or worsening existing problems
- To seek solutions to existing problems

The MPC recommended removing the last bullet and changing the third bullet to read:

- To facilitate the development review and approval process to accommodate growth that recognizes existing stormwater and floodplain problems to avoid creating new problems or worsening existing problems.

Review TOC, Section 1 Introduction and Adoption and 2 Planning Process

KT will send to MPC the TOC, Section 1 and Section 2 for review and comment to be provided before the next call, December 18th.

Next steps and time/date for next call

The team will reconvene for the next conference call on Thursday, December 18th at 9:30 am. An agenda and call in bridge will be provided the week before the call. The table below outlines the action items from this meeting.

Next steps	Owner
Prepare Minutes	KT
Review actions from current approved plan and provide status update on each action by December 18	KT and AG
Follow up with TWDB on RL/SRL list	AB
Review TOC, Section 1 and Section 2 by December 18th	MPC

Adjourn: The meeting adjourned at 10:00 am.

BDD4
Hazard Mitigation Plan Update Minutes
December 18, 2018

These minutes document the Mitigation Planning Committee (MPC) meeting on the BDD4 hazard mitigation plan update. The team held the meeting on Tuesday, December 18, 2018 beginning at 2:30 pm. These minutes were prepared by Kristen Thatcher and Jeff Ward. Attendees were:

Andrea Broughton	(AB)	BDD4
Adrian Gengo	(AG)	BDD4
Kim Woodall	(KW)	BDD4
Kristen Thatcher	(KT)	JSWA

AGENDA

1) **Suggested schedule**
2) **Update of current actions**
3) **Request to TWDB for RL/SRL database information**
4) **Discuss new action items**
5) **Review TOC, Section 1 Introduction and Adoption and 2 Planning Process sent in December**
6) **Establish date/time for January call**

MINUTES

Suggested Schedule

The MPC discussed a schedule for completing the draft, review by stakeholders and public and tentative date to submit a draft for review to TDEM.

MPC	Review of complete first draft	January, 2019
MPC	Modifications based on review	January, 2019
MPC	Letter to stakeholders for review	February, 2019
MPC	Presentation to public, compile feedback	February, 2019
MPC	Prepare and submit final draft	March, 2019
TDEM and FEMA	Review and letter of approval	2019
City Council	Final adoption after approval	2019

Update on current actions

The actions from the current plan were provided to the team. AB and AG to provide a status for each of the actions by the next meeting. As the team reviews the current actions, the team will start to focus on new actions for this plan update.

Request to TWDB for RL/SRL database

BDD4 requested the RL/SRL database from TWDB on 9-11-18 and will send a follow up email to check status and to narrow the query to Unincorporated Brazoria County, Pearland and Brookside Village.

Review TOC, Section 1 Introduction and Adoption and 2 Planning Process

KT sent to MPC the TOC, Section 1 and Section 2 for review and comment to be provided before the next call, January 10th.

Next steps and time/date for next call
The team will reconvene for the next conference call on Thursday, January 10th at 9:30 am. An agenda and call in bridge will be provided the week before the call. The table below outlines the action items from this meeting.

Next steps	Owner
Prepare Minutes	KT
Review actions from current approved plan and provide status update on each action by December 18	AB and AG
Follow up with TWDB on RL/SRL list	AB
Review TOC, Section 1 and Section 2 by January 10th	MPC
Provide draft for Sections 3-5 by January 10th	KT

Adjourn: The meeting adjourned at 3:30 pm.

BDD4
Hazard Mitigation Plan Update Minutes
January 10, 2019

These minutes document the Mitigation Planning Committee (MPC) meeting on the BDD4 hazard mitigation plan update. The team held the meeting on Thursday, January 10, 2019 beginning at 9:30 am. These minutes were prepared by Kristen Thatcher and Jeff Ward. Attendees were:

Andrea Broughton	(AB)	BDD4
Adrian Gengo	(AG)	BDD4
Kim Woodall	(KW)	BDD4
Kristen Thatcher	(KT)	JSWA

AGENDA

1) **Suggested schedule**
2) **Update of current actions**
3) **Received from TWDB for RL/SRL database information**
4) **Federal Government shutdown and access to NOAA databases**
5) **New Actions and prioritization**
6) **Establish date/time for February Call**

MINUTES

Suggested Schedule and update on current actins
AG will have provided comments and new actions on or before 1-31-19. KT will provide section 3 on or before 2-21-19. At that meeting team will prioritize action items.

Request to TWDB for RL/SRL database
TWDB sent the updated RL/SRL database on 1-9-19 and KT will begin section 3. However, certain sections of Section 3 cannot be updated until Federal Government reopens and public access to key weather databases (NOAA) can occur.

New Actions and Prioritization
At the February meeting, the team will prioritize the actions using a ranking system described next. The MPC will be asked to consider the feasibility of identified mitigation actions as high, medium or low and using the Mitigation Action Evaluation Tool (Life Safety, Property Protection, Technical, Political, Legal, Environmental, Social, Administration, Local Champion, and Other Community Objectives) rank the category 1-10 with 1 being a low priority for the category and 10 being a high for the category. Low is defined as 1-19; Medium is defined as 20-39; and High is defined as 40-60.

Mitigation Action Prioritization (1-10) Ranked with 1 being low priority for that category and 10 being high for the Category Minimum Score: 1 Maximum Score 60 TOTAL SCORE BETWEEN 1-19 HAZARD IS LOW PRIORITY TOTAL SCORE BETWEEN 20-39 HAZARD IS MEDIUM PRIORITY TOTAL SCORE BETWEEN 40-60 HAZARD IS HIGH PRIORITY	Priority
Education and Awareness	
Structure/Infrastructure	
Natural Systems Protections	
Actions/Regulations	

Next steps and time/date for next call
The team will reconvene for the next conference call on Thursday, February 21st at 9:30 am. An agenda and call in bridge will be provided the week before the call. The table below outlines the action items from this meeting.

Next steps	Owner
Prepare Minutes	KT
Review actions from current approved plan and provide status update on each action by January 31st	AB and AG
Provide draft for Sections 3 by next month	KT

Adjourn: The meeting adjourned at 10:30 am.

BDD4
Hazard Mitigation Plan Update Minutes
February 21, 2019

These minutes document the Mitigation Planning Committee (MPC) meeting on the BDD4 hazard mitigation plan update. The team held the meeting on Thursday, February 21, 2019 beginning at 9:30 am. These minutes were prepared by Kristen Thatcher and Jeff Ward. Attendees were:

Andrea Broughton	(AB)	BDD4
Adrian Gengo	(AG)	BDD4
Kim Woodall	(KW)	BDD4
Kristen Thatcher	(KT)	JSWA

AGENDA

1) **Suggested schedule**
2) **Update of current actions – need to finalize**
3) **New Actions and prioritization**
4) **Review of hazards discussion with TDEM**
5) **Establish date/time for March Call**

MINUTES

Suggested Schedule and update on current actions
AG will provide status of current actions by March 4th. MPC will meet the same day to finalize the new actions and prioritize them. Section 3 draft on hazards will be provided.

New Actions and Prioritization
A mitigation action is a specific action, project, activity, or process taken to reduce or eliminate long-term risk to people and property from hazards and their impacts. The actions to reduce vulnerability to threats and hazards form the core of the plan and are a key outcome of the planning process. Actions are needed for all profiled hazards: flood, thunderstorm-high wind, tornadoes, and hurricanes and tropical storms.

At the March 4th meeting, the team will finalize its new actions and prioritize the actions using a ranking system described next. The MPC will be asked to consider the feasibility of identified mitigation actions as high, medium or low and using the Mitigation Action Evaluation Tool (Life Safety, Property Protection, Technical, Political, Legal, Environmental, Social, Administration, Local Champion, and Other Community Objectives) rank the category 1-10 with 1 being a low priority for the category and 10 being a high for the category. Low is defined as 1-19; Medium is defined as 20-39; and High is defined as 40-60. The attached worksheets and definitions will be used to help with the actions.

Mitigation Action Prioritization (1-10) Ranked with 1 being low priority for that category and 10 being high for the Category Minimum Score: 1 Maximum Score 60 TOTAL SCORE BETWEEN 1-19 HAZARD IS LOW PRIORITY TOTAL SCORE BETWEEN 20-39 HAZARD IS MEDIUM PRIORITY TOTAL SCORE BETWEEN 40-60 HAZARD IS HIGH PRIORITY	P r i o r i t y
Education and Awareness	
Structure/Infrastructure	
Natural Systems Protections	
Actions/Regulations	

Review of hazards discussion with TDEM

KT had some discussions with TDEM regarding the District's authorities and hazards in the planning area that while they exist and are not negligible, the District does not have authority to mitigate. After TDEM worked with FEMA to better clarify if hazards like hail and lightning should be profiled which requires actions if a drainage district's mission is limited to drainage support. TDEM with concurrence from FEMA concluded that due to the authority of the drainage district, the District could omit these hazards.

Next steps and time/date for next call

In addition to the mitigation action call on March 4th, the team will reconvene for the next conference call on Thursday, March 21st at 10:00 am. An agenda and call in bridge will be provided the week before the call. The table below outlines the action items from this meeting.

Next steps	Owner
Prepare Minutes	KT
Review actions from current approved plan and provide status update on each action by March 4	AB and AG
Provide draft for Sections March 4	KT

Meet to finalize actions for tornadoes, floods, thunderstorms-high winds, hurricanes and tropical storms and to prioritize scheduled for March 4th at 2 pm CST	Team
Provide maps for SFHA area for Brazoria County, Pearland and Brookside Village and maps depicting RL locations	AG

Adjourn: The meeting adjourned at 10:30 am.

APPENDIX B – EXAMPLE STAKEHOLDER LETTER

4813 W. Broadway
0065
Pearland, Texas 77581
(281) 485-1434

Fax (281) 485-

info@*bdd4.org*

Brazoria Drainage District No. 4

A Political Subdivision of the State of Texas

March 28, 2019

Vance Riley
Fire Chief/EMS Director
2703 Veterans Drive
Pearland, Texas 77584

RE: Brazoria Drainage District No. 4 (BDD4), Texas, Local Hazard Mitigation Plan Update

Dear Stakeholder:

As you may be aware, BDD4 is currently in the process of updating its FEMA Local Hazard Mitigation Plan. While the nature of natural hazards confronting the planning area has not changed significantly since the current plan was prepared in 2012, there have been some structural projects and population changes. In addition, the status of planned hazard mitigation efforts have been updated and new mitigation actions have been added.

BDD4 anticipates making the draft hazard mitigation plan update available to the public for review and comment on April 2, 2019. This will occur in conjunction with a presentation to the Board of Commissioners, which describes the draft plan update. The presentation will coincide with the start of a 30-day public comment period during which residents and business interests can review the draft plan update and provide comments to BDD4 before the update is finalized.

Once the comment period is closed, BDD4 staff will review all public and stakeholder comments and take them under consideration as the document is finalized. Once finalized, the draft plan update will then be submitted to TDEM and FEMA for review and approval. When notification of approval is received from FEMA, the draft plan update will be presented to the Board of Commissioners for formal adoption, after which it will remain valid for five years.

Your organization has been identified by BDD4 as one that could be impacted by the mitigation actions and strategy and therefore, the District would like to invite you to be one of its stakeholders. BDD4 respectfully requests your organization review the draft and provide any comments on the draft. The draft has been placed on the District's website at http://bdd4.org where you can download it.

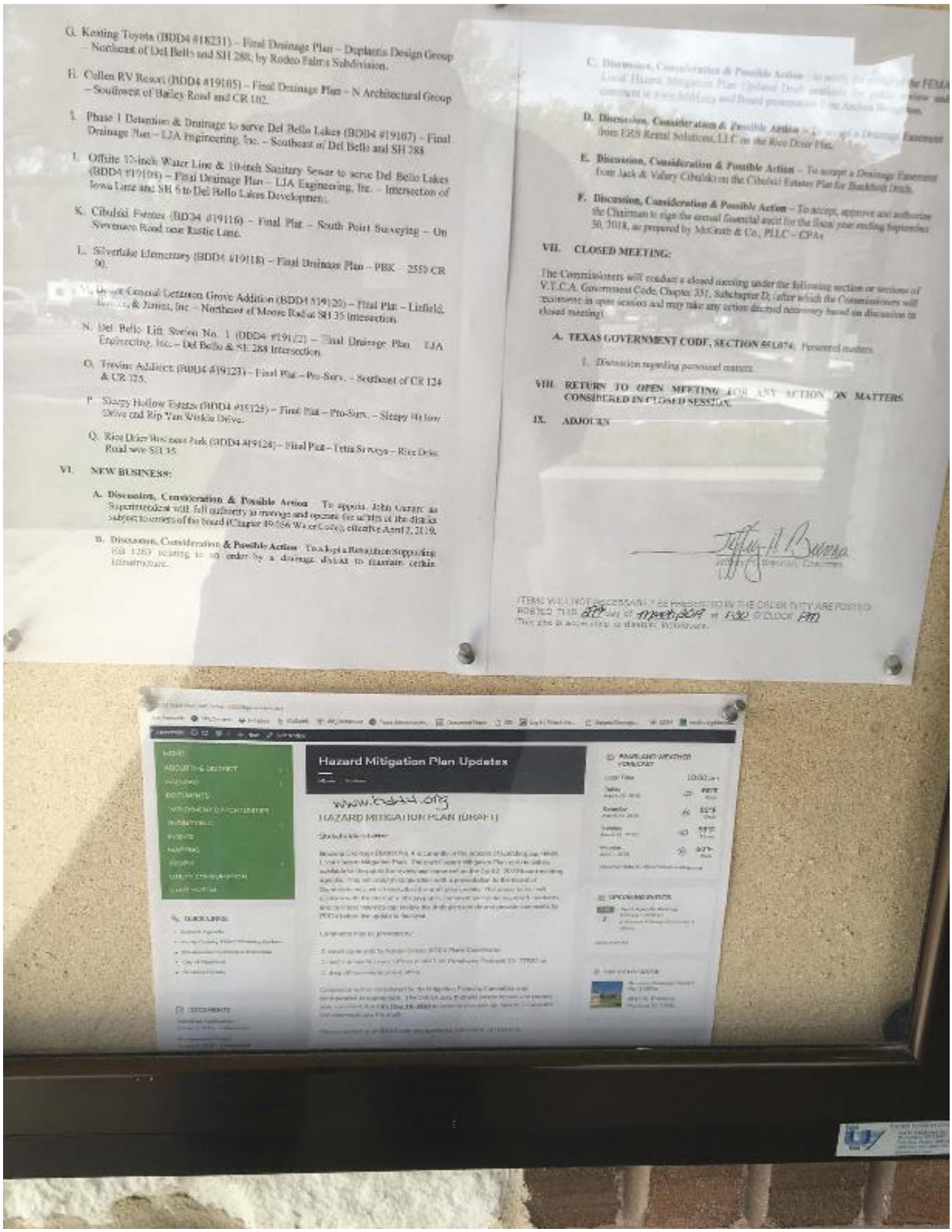
Comments may be provided via email to Adrian Gengo, BDD4 Plans Coordinator at agengo@bdd4.org or you may drop it off or mail your comments to Mr. Gengo's attention at 4813 W. Broadway, Pearland, Texas 77581. Comments will be considered by the Mitigation Planning Committee and incorporated as appropriate. The District asks that you please review and provide your comments back by **May 10, 2019** in order to give enough time to incorporate the comments into the draft.

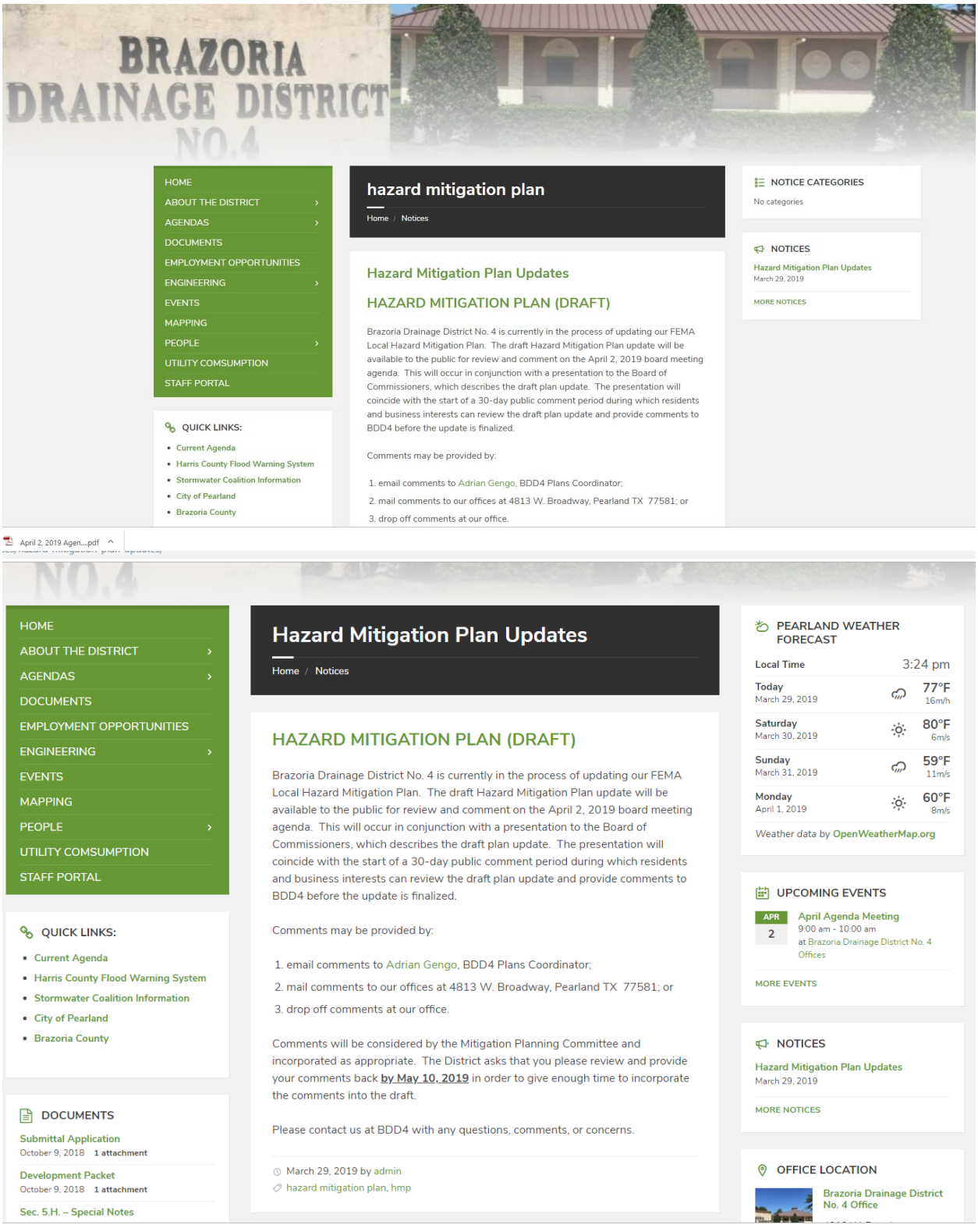
Thank you very much for considering this request. It is important that stakeholders and the public have an opportunity to review and comment.

Sincerely,

John Genaro
Superintendent

APPENDIX C –PUBLIC NOTICE OF PUBLIC MEETING AT BDD4 BUILDING AND ON WEBSITE




BRAZORIA
DRAINAGE DISTRICT
NO.4
HOME
ABOUT THE DISTRICT
AGENDAS
DOCUMENTS
EMPLOYMENT OPPORTUNITIES
ENGINEERING
EVENTS
MAPPING
PEOPLE
UTILITY COMSUMPTION
STAFF PORTAL
QUICK LINKS:
Current Agenda
Harris County Flood Warning System
Stormwater Coalition Information
City of Pearland
Brazoria County
hazard mitigation plan
Home / Notices
Hazard Mitigation Plan Updates
HAZARD MITIGATION PLAN (DRAFT)
Brazoria Drainage District No. 4 is currently in the process of updating our FEMA Local Hazard Mitigation Plan. The draft Hazard Mitigation Plan update will be available to the public for review and comment on the April 2, 2019 board meeting agenda. This will occur in conjunction with a presentation to the Board of Commissioners, which describes the draft plan update. The presentation will coincide with the start of a 30-day public comment period during which residents and business interests can review the draft plan update and provide comments to BDD4 before the update is finalized.
Comments may be provided by:
1. email comments to Adrian Gengo, BDD4 Plans Coordinator;
2. mail comments to our offices at 4813 W. Broadway, Pearland TX 77581; or
3. drop off comments at our office.
NOTICE CATEGORIES
No categories
NOTICES
Hazard Mitigation Plan Updates
March 29, 2019
MORE NOTICES
April 2, 2019 Agen....pdf
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ABOUT THE DISTRICT
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UTILITY COMSUMPTION
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QUICK LINKS:
Current Agenda
Harris County Flood Warning System
Stormwater Coalition Information
City of Pearland
Brazoria County
DOCUMENTS
Submittal Application
October 9, 2018 1 attachment
Development Packet
October 9, 2018 1 attachment
Sec. 5.H. – Special Notes
Hazard Mitigation Plan Updates
Home / Notices
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3. drop off comments at our office.
Comments will be considered by the Mitigation Planning Committee and incorporated as appropriate. The District asks that you please review and provide your comments back by May 10, 2019 in order to give enough time to incorporate the comments into the draft.
Please contact us at BDD4 with any questions, comments, or concerns.
March 29, 2019 by admin
hazard mitigation plan, hmp
PEARLAND WEATHER FORECAST
Local Time 3:24 pm
Today March 29, 2019 77°F 16m/h
Saturday March 30, 2019 80°F 6m/s
Sunday March 31, 2019 59°F 11m/s
Monday April 1, 2019 60°F 8m/s
Weather data by OpenWeatherMap.org
UPCOMING EVENTS
APR 2
April Agenda Meeting
9:00 am - 10:00 am
at Brazoria Drainage District No. 4 Offices
MORE EVENTS
NOTICES
Hazard Mitigation Plan Updates
March 29, 2019
MORE NOTICES
OFFICE LOCATION
Brazoria Drainage District No. 4 Office