Fort Bend County Hazard Mitigation Action Plan 2023

Volume I

September 2023

TETRA TECH

TABLE OF CONTENTS

Volume I

Volume II

Appendices

SECTION 1. INTRODUCTION

1.1 Purpose

Fort Bend County and its participating jurisdictions (the Planning Area) have prepared this multi-hazard mitigation plan to better protect the residents and property throughout the Planning Area from the effects of hazard events. This plan demonstrates the Planning Area's commitment to reducing risk from hazards, increasing resilience overall, and providing a tool to help decision-makers integrate mitigation in their day-to-day processes. This plan was also developed to position the Planning Area for eligibility for pre- and post-disaster Federal Emergency Management Agency (FEMA) grants, including Hazard Mitigation Assistance (HMA) grant programs, which include Hazard Mitigation Grant Program (HMGP), Building Resilient Infrastructure and Communities (BRIC), and Flood Mitigation Assistance (FMA). This plan also aligns with the planning elements of the National Flood Insurance Program's (NFIP) Community Rating System (CRS), which provides for lower flood insurance premiums in CRS communities.

1.2 Background

A Hazard Mitigation Plan (HMP) is a living document that communities use to reduce their vulnerability to hazards. It forms the foundation for a community's long-term strategy to reduce disaster losses and creates a framework for decision-making to reduce damage to lives, property, and the economy from future disasters. Examples of mitigation projects include home acquisitions or elevations to remove structures from high-risk areas, upgrades to critical public facilities, and infrastructure improvements. Ultimately, these actions reduce vulnerability, and communities are able to recover more quickly from disasters. The Planning Area has demonstrated its commitment to reducing disaster losses by initially developing its HMP in 2018 and updating information upon which to base a successful mitigation strategy to reduce the impacts of natural disasters and to increase the resiliency of the Planning Area.

Hazard Mitigation is any sustained action taken to reduce or eliminate the long-term risk and effects that can result from specific hazards.

FEMA defines a **Hazard Mitigation Plan** as the documentation of a state or local government evaluation of natural hazards and the strategies to mitigate such hazards.

In response to the requirements of the Disaster Mitigation Act of 2000 (DMA 2000), which requires local governmental agencies to develop and update their HMP every five years, this plan serves as the 2023 update to the 2018 Fort Bend County HMP. During the course of the planning process, the entire plan was updated with a focus on examining changes in vulnerability due to hazard events, reviewing capabilities and how they implement hazard mitigation, reviewing the mitigation strategy, and identifying new initiatives to increase overall resiliency in the Planning Area.

1.3 Plan Organization

The Fort Bend County HMP 2023 Update is organized as a two-volume plan and aligns with the Texas Division of Emergency Management (TDEM) planning requirements, the 2013 FEMA Local Mitigation Planning Handbook, and the FEMA Local Mitigation Plan Review Tool.

Volume I provides information on the overall planning process and hazard profiling and vulnerability assessments, which serve as a basis for understanding risk and identifying mitigation actions. As such, Volume I is intended for use as a resource for ongoing mitigation analysis.

Volume II provides an annex dedicated to each participating jurisdiction. Each annex summarizes the jurisdiction's legal, regulatory, and fiscal capabilities; identifies vulnerabilities to hazards; documents mitigation plan integration with other planning efforts; records status of past mitigation actions; and presents an individualized mitigation strategy. The annexes are intended to provide a useful resource for each jurisdiction for implementation of mitigation projects and future grant opportunities as well as a place for each jurisdiction to record and maintain their local aspect of the multi-jurisdictional plan.

Volume I of this HMP includes the following sections:

Section 1: Introduction: Overview of the planning process and layout of the plan.

Section 2: Planning Process: Description of the HMP methodology and development process; Steering Committee, Planning Committee, Planning Partnership, and stakeholder involvement efforts; and a description of how this HMP will be incorporated into existing programs.

Section 3: County Profile: Overview of the Planning Area, including: (1) physical setting, (2) land use, (3) land use trends, (4) population and demographics, (5) general building stock, and (6) critical facilities and lifelines.

Section 4: Risk Assessment: Documentation of the hazard identification and hazard risk ranking process, hazard profiles, and findings of the vulnerability assessment (estimates of the impact of hazard events on life, safety, health, general building stock, critical facilities, the economy); description of the status of local data; and planned steps to improve local data to support mitigation planning.

Section 5: Capability Assessment: A summary and description of the existing plans, programs, and regulatory mechanisms at all levels of government (federal, state, county, local) that support hazard mitigation within the Planning Area.

Section 6: Mitigation Strategy: This section provides information regarding the mitigation goals and objectives in response to priority hazards of concern and the process by which Planning Area mitigation strategies have been developed or updated.

Section 7: Plan Maintenance: System established to continue to monitor, evaluate, maintain, and update the HMP.

Volume II of this plan includes the following sections:

Section 8: Planning Partnership: Description of the Planning Partnership, their responsibilities, and Jurisdictional annexes.

Section 9: Annexes: Jurisdiction-specific annexes for Fort Bend County containing their hazards of concern, hazard ranking, capability assessment, mitigation actions, action prioritization specific only to Fort Bend County, progress on prior mitigation activities (as applicable), and a discussion of prior local HMP integration into local planning processes.

Appendices include the following:

Appendix A: Plan Adoption: Resolutions from Fort Bend County and all participating jurisdiction included as each formally adopts the HMP update.

Appendix B: Participation Documentation: Matrix to give a broad overview of who attended meetings and when input was provided to the HMP update and additional worksheets submitted during workshops conducted throughout the planning process.

Appendix C: Meeting Documentation: Agendas, attendance sheets, minutes, and other documentation (as available and applicable) of planning meetings convened during the development of the plan.

Appendix D: Public and Stakeholder Outreach Documentation: Documentation of the public and stakeholder outreach effort, including webpages, informational materials, public and stakeholder meetings and presentations, surveys, and other methods used to receive and incorporate public and stakeholder comment and input to the plan process.

Appendix E: Mitigation Strategy Supplementary Data: Documentation of the broad range of actions identified during the mitigation process; types of mitigation actions; the mitigation catalog developed using jurisdiction input and potential mitigation funding sources.

Appendix F: Plan Maintenance Tools: Examples of plan review tools and templates available to support annual plan review.

Appendix G: Linkage Procedures: Steps non-participating local governments and other local jurisdictions such as Fire Districts, Utility Districts, School Districts, and any other eligible local government as defined in 44 CFR 201.2 within the Planning Area can take to join this plan as a participating jurisdiction and to ultimately achieve approved status.

Appendix H: Critical Facilities: Full list of critical facilities identified for the update of the HMP. Due to the sensitive nature of the information, critical facility details have been redacted.

1.4 2023 HMP Update – What Is Different?

The 2023 HMP update builds on the previous plan and includes the following changes and enhancements:

- Updated data and tools offer more detailed and accurate risk assessment. The risk assessment was prepared to better support future grant applications by providing risk and vulnerability information that would directly support the measurement of "cost-effectiveness" required under FEMA mitigation grant programs.
- The plan identifies implementable actions with enough information to serve as the basis for policy and funding decisions and represent measurable impacts on resiliency and mitigation progress. Strategies provide direction but actions are fundable under grant programs.
- Jurisdictional annexes are included for each participating jurisdiction in Volume II, Section 9.

It should be noted that due to the limitations on participation posed by the pandemic and the strains on time and resources for many local governments and other community organizations from 2020 to present, participation of stakeholders at the municipal level was limited. In accordance with FEMA guiding principles for

inclusive participation at various levels, the planning team will place a high priority on an expanded effort on stakeholder participation with local planning committees in future plan updates.

Table 1-1 indicates the major changes between the two plans as they relate to 44 CFR planning requirements.

Table 1-1. Fort Bend County HMP Changes Crosswalk

44 CFR Requirement	2018 HMP	2023 HMP Plan Update
Requirement §201.6(b): In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: *(1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;* *(2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia, and other private and non-profit interests to be involved in the planning process; and* *(3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.*	The 2018 plan followed an outreach strategy utilizing multiple media developed and approved by the Fort Bend Mitigation Planning Committee (MPC). This strategy involved the following: • The public received invitations to the Risk Assessment meeting. • Use of a public participation survey. • Planning Phase Newsletters were sent to MPC planners outlining the current phase of plan work. • Stakeholders were identified and coordinated with throughout the process. • A variety of existing studies, plans, reports, and technical information were reviewed as part of the planning process.	Building upon the success of the 2018 plan, the 2023 planning effort deployed the same public engagement methodology. The plan included the following enhancements: • Key department personnel formed a Steering Committee for the plan. • Adjacent communities, along with the County, were invited to participate in the planning meetings. • A website was created on Fort Bend County's domain to keep the public informed of the planning process and how to get involved. • Draft plan deliverables were made available on the County and multiple City websites, local libraries, and City Hall's. • All Planning Partnership meetings were open to this public. • Social media was utilized to engage the public. As with the 2018 plan, the 2023 planning process identified key stakeholders and coordinated with them throughout the process. A comprehensive review of relevant plans and programs was performed by the planning team.
§201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.	The 2018 plan included a risk assessment of hazards of concern. The risk assessment included frequency of return, approximate annualized losses, a description of general vulnerability, climate change impacts, secondary hazards, critical facilities and infrastructure, discussion on vulnerabilities, and future development trends.	The 2023 HMP update includes a comprehensive update to the risk assessment. The flood hazard was expanded to include stormwater flooding (or flooding outside of the floodplain). New and updated hazards of concern were included. Jurisdiction-specific risk assessment results are summarized in Section 4 (Risk Assessment) and in each jurisdictional annex (Section 9).

44 CFR Requirement	2018 HMP	2023 HMP Plan Update
§201.6(c)(2)(i): [The risk assessment] shall include a] description of the … location and extent of all-natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.	The 2018 plan presented a risk assessment of each hazard of concern. Each section included the following: • General Description • Hazard Location • Previous Occurrences • Hazard Extent and Probability • Impact • Community Drought Vulnerability Summaries	A similar, but adjusted format, using new and updated data, was used for the 2023 HMP update. Each section of the risk assessment includes the following: • Hazard profile, including hazard description and types, maps of extent and location, previous occurrences, and probability of future events • Climate change impacts on future probability • Vulnerability assessment, including impact on life safety and health, general building stock, critical facilities, and the economy as well as future changes that could impact vulnerability • Changes in vulnerability since the 2018 plan
§201.6(c)(2)(ii): [The risk assessment] shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i). This description shall include an overall summary of each hazard and its impact on the community.	Vulnerability was assessed for all hazards of concern. Each hazard of concern included a qualitative summary of assets exposed to the hazard.	A robust, quantitative vulnerability assessment was conducted for the 2023 HMP update, using new and updated asset and hazard data. Volume 1, Section 4.3 summarizes the Planning Area's vulnerability for each hazard of concern. The jurisdictional annexes (Section 9) include a summary table of impacts on both planning partners.
§201.6(c)(2)(ii): [The risk assessment] must also address National Flood Insurance Program-insured structures that have been repetitively damaged by floods.	A summary of NFIP-insured properties identified as repetitive loss and severe repetitive loss locations were included in each jurisdictional annex.	A summary of NFIP-insured properties identified as repetitive loss and severe repetitive loss locations was included in the plan and each jurisdictional annex.
Requirement §201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure and critical facilities located in the identified hazard area.	An inventory of the numbers and types of buildings exposed was generated for each hazard of concern.	Quantitative and qualitative analyses were conducted using the updated hazard and inventory data as presented in Section 4 (Risk Assessment). In addition, critical facilities considered lifelines in accordance with FEMA's definition were identified.
Requirement §201.6(c)(2)(ii)(B): [The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) and a description of the methodology used to prepare the estimate.	Loss estimates were generated for all hazards of concern by using readily available information.	Quantitative and qualitative analyses were conducted using the updated hazard and inventory data as presented in Section 4 (Risk Assessment). Estimated potential losses are reported in both Volume 1 Section 4.3 and Volume II Section 9 for each jurisdiction.
Requirement §201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land	Future trends in development were not discussed in each jurisdictional annex.	A spatial analysis using identified growth areas, and potential new development identified by jurisdictions was conducted

44 CFR Requirement	2018 HMP	2023 HMP Plan Update
uses and development trends within the community so that mitigation options can be considered in future land use decisions.		to determine if located in hazard areas. These results were reported to all participants and summarized in their annexes to discuss mitigation measures. In Volume I, Section 4.3, projected changes in population and development are discussed in each hazard section and how these projected changes may lead to increased vulnerability, or plans/regulations/ordinances in place to implement mitigation to protect the development.
§201.6(c)(3):[The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.]	The 2018 plan contained goals, objectives, and actions. The identified actions covered multiple hazards and goals.	The Planning Partnership reviewed and updated the goals and created objectives. A mitigation strategy workshop with associated tools and guidance on problem statement development was deployed to inform the identification of mitigation actions. Actions that were completed or no longer considered to be feasible were removed. The balance of the actions was carried over to the 2023 HMP update, and in some cases, new actions were added to the action plan.
Requirement §201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.	The Planning Partnership identified goals targeted specifically for this HMP. The planning component supported the actions identified in the plan.	The Planning Partnership reviewed and updated the goals and created objectives. New objectives were identified to align with updated Planning Area priorities.
Requirement §201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.	For each identified hazard, mitigation strategies were developed and prioritized using mitigation action worksheets. The mitigation actions were displayed in a table, in each jurisdictional annex.	For the 2023 update, a mitigation catalog was developed to provide a comprehensive range of specific mitigation actions to be considered. A table with the analysis of mitigation actions by type and hazard was used in jurisdictional annexes to the plan. Mitigation action worksheets with an alternative project evaluation were prepared for FEMA-eligible projects.
Requirement: §201.6(c)(3)(ii): [The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program, and continued compliance with the program's requirements, as appropriate.	Many jurisdictions included mitigations action to promote NFIP flood insurance.	For the 2023 update, each jurisdictional annex includes a description on how each jurisdiction participates and implements the NFIP.
Requirement: §201.6(c)(3)(iii): [The mitigation strategy shall describe] how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and	Each of the actions in this were prioritized based on FEMA's STAPLEE criteria, which includes consideration of the social, technical, administrative,	A revised methodology based on the STAPLEE criteria and using new and updated data was used for the 2023 HMP update. The 14 criteria were used to

44 CFR Requirement	2018 HMP	2023 HMP Plan Update
administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.	political, legal, economic, and environmental factors necessary for the implementation of each action.	evaluate each potential mitigation action. The evaluation included a qualitative benefits and cost review. The results of the evaluation were used to identify the actions to include in the plan and assist with the prioritization.
Requirement §201.6(c)(4)(i): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.	The 2018 plan details a plan maintenance strategy, giving a suggested schedule on when to review, revise, and maintain the plan.	The 2023 HMP update details a plan maintenance strategy similar to that of the initial plan. However, the 2023 plan maintenance strategy includes the use of the BATool[SM] which will enable municipal and county representatives to directly access mitigation initiatives to easily update the status of each project, document successes or obstacles to implementation, add or delete projects to maintain mitigation project implementation.
Requirement §201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.	The 2018 plan details recommendations for incorporating the plan into other planning mechanisms.	The 2023 HMP update details recommendations for incorporating the plan into other planning mechanisms such as the following: • Comprehensive/Master Plan • Emergency Response Plan/ Emergency Operations Plan • Capital Improvement Programs • Municipal Code
Requirement §201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.	The 2018 plan details a strategy for continuing public involvement.	The 2018 plan maintenance strategy was carried over to the 2023 HMP update.
Requirement §201.6(c)(5): [The local hazard mitigation plan shall include] documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commissioner, Tribal Council).	Fort Bend County and all the planning partners have adopted the plan.	The 2023 HMP update achieves DMA compliance for Fort Bend County. Resolutions for each partner adopting the plan can be found in Appendix A of this volume.

SECTION 2. RISK ASSESSMENT

2.1 Introduction

This section includes a description of the planning process used to conduct the 2023 Fort Bend County Hazard Mitigation Plan (HMP) update, including how it was prepared, who was involved in the process, and how the public was involved. To ensure that the plan meets the requirements of the Disaster Mitigation Act of 2000 (DMA 2000) and that the planning process would have the broad and effective support of the participating jurisdictions, regional and local stakeholders, and the public, an approach to the planning process and plan documentation was developed to achieve the following:

- The HMP is multi-jurisdictional and considers natural and human-caused hazards facing the County, thereby satisfying the natural hazards mitigation planning requirements specified in the DMA 2000.
- Fort Bend County is the plan participant.
- The HMP was developed following the process outlined by the DMA 2000, Federal Emergency Management Agency (FEMA) regulations, and prevailing FEMA and Texas Division of Emergency Management (TDEM) guidance. Following this process ensures all the requirements are met and support HMP review.

The 2023 Fort Bend HMP update was developed using the best available information obtained from a wide variety of sources. Throughout the HMP update process, a concerted effort was made to gather information from local and regional agencies and staff as well as stakeholders, federal and state agencies, and Fort Bend County residents. The HMP Planning Partnership solicited information from local agencies and individuals with specific knowledge of certain hazards and past historical events. The HMP Planning Partnership also considered planning and zoning codes, ordinances, and other recent planning decisions. The hazard mitigation strategies identified in this HMP have been developed through an extensive planning process involving regional, Fort Bend County, and local agencies, stakeholders, and residents.

This section describes the mitigation planning process, including (1) Organization of the Planning Process; (2) Stakeholder Outreach and Involvement; (3) Public Participation; (4) Incorporation of Existing Data, Plans, and Technical Information; (5) Integration with Existing Planning Mechanisms and Programs; and (6) Continued Public Involvement.

2.2 Organization of the Planning Process

Many parties supported the preparation of this HMP update: County officials, municipal officials, the Planning Partnership, stakeholders, and the planning consultant. This planning process does not represent the start of hazard risk management in Fort Bend County; rather, it is part of an ongoing process that various State of Texas, Fort Bend County, and local agencies and individuals have continued to embrace. A summary of the past and ongoing mitigation efforts is provided in Section 6 (Mitigation Strategy), as well as in Volume II Section 9 (Jurisdictional Annexes), to give a historical perspective of the County and local activities implemented to reduce vulnerability to hazards.

This section of the HMP identifies how the planning process was organized with the many planning partners involved and outlines the major activities that were conducted in the development of this HMP update.

2.2.1 Organization of the Planning Partnership

A contract planning consultant (Tetra Tech, Inc., referred to herein as Tetra Tech) was selected to guide Fort Bend County through the HMP update process. A contract between Tetra Tech and Fort Bend County was executed in September 2022. Specifically, Tetra Tech, the contract consultant, was tasked with the following:

- Assistance with the organization of the Core Planning Partnership and Planning Partnership
- Assistance with the development and implementation of a public and stakeholder outreach program.
- Data collection
- Facilitation and attendance at meetings (Core Planning Partnership, Planning Partnership, stakeholder, public, and others)
- Review and update of the hazards of concern, hazard profiling, and risk assessment
- Assistance with the review and update of mitigation planning goals and objectives
- Assistance with the review of past mitigation strategies progress
- Assistance with the screening of mitigation actions and the identification of appropriate actions
- Assistance with the prioritization of mitigation actions
- Authoring of the draft and final plan documents

To facilitate plan development, Fort Bend County developed a Planning Partnership to provide guidance and direction to the HMP update effort and to ensure the resulting document will be embraced both politically and by the constituency within Fort Bend County (Table 2-1). Specifically, the Planning Partnership was charged with the following:

- Attending and participating in Planning Partnership meetings
- Representing their jurisdiction throughout the planning process and ensuring participation expectations are met by their jurisdiction
- Supporting and promoting the public involvement process
- Assisting with the development and completion of certain planning elements, including:
    - Reviewing and updating the hazards of concern
    - Developing a public and stakeholder outreach program
    - Assuring that the data and information used in the plan update process are the best available
    - Reviewing and updating the hazard mitigation goals
    - Reporting on progress of mitigation actions identified in prior or existing HMPs, as applicable
    - Identifying and screening of appropriate mitigation strategies and activities
- Reviewing and commenting on plan documents prior to submission to TDEM and FEMA
- Adopting, implementing, and maintaining the plan update

Table 2-1. Fort Bend County Hazard Mitigation Planning Partnership

Name	Title	Organization	Steering Committee Member	Planning Partnership Member
Greg Babst	County Emergency Management Coordinator	Fort Bend County HS&EM	Yes	Yes
Andrea James	Planning Coordinator	Fort Bend County HS&EM	Yes	Yes

Name	Title	Organization	Steering Committee Member	Planning Partnership Member
Mark Vogler	Chief Drainage Engineer	Fort Bend County Engineering	Yes	Yes
Charles Brockett	Planning Coordinator	Fort Bend County HS&EM	Yes	Yes
Angela Wierzbick	Grant Manager	Fort Bend County	Yes	Yes
Scott Wieghat	Director	Fort Bend County Road and Bridge	Yes	Yes
Craig Kalkomey	District Engineer	Fort Bend County Special Districts	Yes	Yes
Mary Staff	Deputy Chief/Budget/Personnel/ PIO	Fort Bend County	No	Yes
Douglas Barnes	Assistant Chief Fire Marshal	Fort Bend County Fire Marshal	No	Yes
Shayna Van Slyke	Administrative Manager	Fort Bend County HS&EM	No	Yes
Jeffery Janecek	Assistant Engineer	Fort Bend County Drainage District	No	Yes
Rodney Grimmer	Deputy Chief/Planning/OPS	Fort Bend County HS&EM	Yes	Yes
Vladimir Hidrovo	Deputy Chief/Recovery/Mitigation	Fort Bend County HS&EM	No	Yes
Rick Staigle	Assistant County Engineer	Fort Bend County Engineering	Yes	Yes
Amanda Bronsell	Precinct 1 Staff Director	Fort Bend County	Yes	Yes
Ishokee Craven	Administrator	Fort Bend County Sheriff's Office	Yes	Yes
Michael Wagner	Special Projects Coordinator	Fort Bend County	Yes	Yes
Andy Meyers	Precinct 3	Fort Bend County Commissioners Court	Yes	Yes
Grady Prestage	Precinct 2	Fort Bend County Commissioners Court	Yes	Yes
Ken DeMerchant	Precinct 4	Fort Bend County Commissioners Court	Yes	Yes
Vincent Morales	Precinct 1	Fort Bend County Commissioners Court	Yes	Yes
Carol Berrego	Director	Fort Bend County Community Development	Yes	Yes
Shaneka Smith	Chief of Staff	Fort Bend County Judge	Yes	Yes
Stacy Slawinski	County Engineer	Fort Bend County Engineering	Yes	Yes
Christina Honzell	Regional Planner	Fort Bend County HS&EM	Yes	Yes
Frank Garza	Regional Planner	Fort Bend County HS&EM	Yes	Yes
Shenae Theriot-Mericle	Houston UASI	UASI Grants Manager	No	Yes
Russell Piper	Inframark	Manager	No	Yes
Jeff Perry	Levee Management Services	Operator	No	Yes
Hector Acevedo	Quail Valley UD	Utility Operator	No	Yes
Tyler Werlin	Operations Consultant	LID Solutions	No	Yes
Tiffany Malzahn	Environmental and Compliance Manager	Brazos River Authority	No	Yes
Donnie Naylor	EMC	Brazos River Authority	No	Yes
Annette Guajardo	City Administrator	Arcola (C)	No	Yes
Fred Burton	Mayor	Arcola (C)	Yes	Yes
Misty Tiemann	City Secretary	Beasley (C)	No	Yes
Kenneth Reid	Mayor	Beasley (C)	Yes	Yes
Lance Bertolino	Mayor	Fairchilds (V)	Yes	Yes
Felix Vargas	Sergeant	Fulshear (C)	No	Yes
Kenny Seymour	Chief of Police	Fulshear (C)	No	Yes
Aaron Groff	Mayor	Fulshear (C)	Yes	Yes
Milena Rucker	Senior Administrative Assistant	Katy (C)	No	Yes

Name	Title	Organization	Steering Committee Member	Planning Partnership Member
Lindsay Kerr	Executive Assistant	Katy (C)	No	Yes
Byron Hebert	City Administrator	Katy (C)	No	Yes
William "Dusty" Thiele	Mayor	Katy (C)	Yes	Yes
Christina Flores	City Secretary	Kendleton (C)	No	Yes
Darryl Humphrey Sr.	Mayor	Kendleton (C)	Yes	Yes
Gary Stewart	Chief of Police	Meadows Place (C)	No	Yes
Jack Ashton	Assistant Chief of Police	Meadows Place (C)	No	Yes
Rod Hainey	Public Works Director	Meadows Place (C)	No	Yes
Charles Jessup	Mayor	Meadows Place (C)	Yes	Yes
David Jordan	City Manager	Missouri City (C)	No	Yes
Trameka Jewett	EMC	Missouri City (C)	No	Yes
Sashi Kumar	Public Works Director	Missouri City (C)	No	Yes
Robin Elackatt	Mayor	Missouri City (C)	Yes	Yes
Michael Dickerson	Chief of Police	Needville (C)	No	Yes
Sandra Dorr	Mayor	Needville (C)	Yes	Yes
Rodney Pavlock	Mayor	Orchard (C)	Yes	Yes
Tom Reid	Mayor	Pearland (C)	Yes	Yes
Jordan Blegan	Fire Chief	Pleak (V)	No	Yes
Larry Bittner	Mayor	Pleak (V)	Yes	Yes
Robert Oliver	EMC	Richmond (C)	No	Yes
Jim Whitehead	Parks Superintendent	Richmond (C)	No	Yes
Rebecca Haas	Mayor	Richmond (C)	Yes	Yes
Darrell Himly	Fire Chief	Rosenberg (C)	No	Yes
Rigo Calzoncin	Director of Public Services	Rosenberg (C)	No	Yes
Kevin Raines	Mayor	Rosenberg (C)	Yes	Yes
Erica Molina	Secretary/EMC	Simonton (C)	No	Yes
Cecil Willis Jr.	Mayor	Stafford (C)	Yes	Yes
Larry Di Camillo	Fire Chief	Stafford (C)	No	Yes
Gabriel Lavine	EMC	Sugar Land (C)	No	Yes
Joe R. Zimmerman	Mayor	Sugar Land (C)	Yes	Yes
Gina Treadgold	Alderman	Thompsons (T)	No	Yes
Freddie Newsome	Mayor	Thompsons (C)	Yes	Yes
Keelan Spaulding	Fire Department	Thompsons (C)	No	Yes
David Heslep	EM Coordinator	Weston Lakes (C)	No	Yes

Appendix B (Participation Matrix) identifies those individuals who represented the planning partners during this planning effort and indicates how they contributed to the planning process.

2.2.2 Planning Activities

Members of the Planning Partnership, as well as key stakeholders, convened and/or communicated regularly to share information and participate in workshops to identify hazards, assess risks, review existing inventories of and identify new critical facilities, assist in updating and developing new mitigation goals and strategies, and provide continuity through the process to ensure that natural hazards vulnerability information and appropriate mitigation strategies were incorporated. All members of the Planning Partnership had the opportunity to review the draft plan, support interaction with other stakeholders, and assist with public involvement efforts.

A summary of Planning Partnership meetings held and key milestones met during the development of the HMP update is included in Table 2-2, which also identifies which DMA 2000 requirements the activities satisfy.

Documentation of meetings (e.g., agendas, sign-in sheets, meeting notes) are in Appendix C (Meeting Documentation) which identifies only the formal meetings held during plan development and does not reflect all planning activities conducted by individuals and groups throughout the planning process. In addition to these meetings, there was a great deal of communication between Fort Bend County, committee members and the contract consultant via individual local meetings, email, and phone.

Table 2-2. Summary of Mitigation Planning Activities and Efforts

Date	DMA 2000 Requirement	Description of Activity	Participants
September 26, 2022	2	Pre-Kick Off Meeting with Fort Bend County: Plan timing and administration, data needs and sharing, hazards of concern, dates, and next steps.	Fort Bend HS&EM, Tetra Tech
November 09, 2022	2	Steering Committee Meeting #1: Introduce Steering Committee to the HMP update process, discuss mitigation planning, project organization, roles and responsibilities, data collection, hazards of concern, and schedule of the plan.	City of Beasley, Fort Bend HS&EM, Fort Bend County Utility Authority, City of Fulshear, City of Kendleton, City of Meadows Place PD, City of Meadows Place Public Works, Missouri City OEM, City of Richmond, City of Rosenberg, City of Simonton, City of Sugar Land, Tetra Tech
November 19, 2022	2, 4a	Planning Partnership Meeting #1: Introduce Planning Partnership to the HMP update process, discuss mitigation planning, project organization, roles and responsibilities, data collection, hazards of concern, and schedule of plan.	City of Beasley, Fort Bend HS&EM, Fort Bend County Utility Authority, City of Fulshear, City of Kendleton, City of Meadows Place PD, City of Meadows Place Public Works, Missouri City OEM, City of Richmond, City of Rosenberg, City of Simonton, City of Sugar Land, Brazos River Authority, LID Solutions, City of Arcola, Houston UASI, Inframark, Levee Management Services, Village of Pleak, Quail Valley UD, Tetra Tech
February 9, 2023	2, 3a, 3b,	Steering Committee Meeting #2: Welcome and Introductions, In-Kind Tracking, Project Schedule and Status Review, Hazards of Concern Review and Finalization, Confirmation of Goals and Objectives, Public and Stakeholder Outreach, Next Steps	Fort Bend HS&EM, Fort Bend County Utility Authority, Tetra Tech, Fort Bend Engineering, Fort Bend Roads and Bridges, Fort Bend Community Development
March 29, 2023	2, 3a, 3b, 3c, 3d, 3e, 4a, 4b	Risk Assessment and Mitigation Strategy Meeting: In-Kind Tracking, Project Overview and Status, Public and Stakeholder Outreach Strategy Reminder, Risk Assessment Preliminary Results, Identifying Mitigation Strategies.	Fort Bend HS&EM, Fort Bend Road & Bridge, Fort Bend LID 2 & 14, Beasley, Simonton, Sugar Land, Richmond, Weston Lakes, Tetra Tech
June 20, 2023	2	Draft Plan Review Presentation: Overview of entire plan and sections; confirmed plan maintenance schedule.	Fort Bend HS&EM, Fort Bend Road & Bridge, Fort Bend LID 2 & 14, Fort Bend County Precinct 3, Richmond, Meadows Place, Missouri City, Sugar Land, Rosenburg, Beasley, Fulshear, Simonton, Tetra Tech
July 10, 2023	1b, 2	Draft HMP posted to public project website; all plan participants were notified and asked to assist with the public outreach including social media. Neighboring	Public and Stakeholders

Date	DMA 2000 Requirement	Description of Activity	Participants
		communities and stakeholders were notified of the posting as well.	
TBD	2	HMP submitted to TDEM and FEMA Region VI.	TDEM, FEMA Region VI
Upon plan approval by FEMA	1a	Plan adoption by resolution by the governing bodies of all participating jurisdictions.	All Plan Participants

Note: All activities/efforts were conducted during the National Emergency response to the COVID-19 pandemic.
TBD = to be determined.
Each number in column 2 identifies specific DMA 2000 requirements, as follows:
1a – Prerequisite – Adoption by the Local Governing Body
1b – Public Participation
2 – Planning Process – Documentation of the Planning Process
3a – Risk Assessment – Identifying Hazards
3b – Risk Assessment – Profiling Hazard Events
3c – Risk Assessment – Assessing Vulnerability: Identifying Assets
3d – Risk Assessment – Assessing Vulnerability: Estimating Potential Losses
3e – Risk Assessment – Assessing Vulnerability: Analyzing Development Trends
4a – Mitigation Strategy – Local Hazard Mitigation Goals
4b – Mitigation Strategy – Identification and Analysis of Mitigation Measures
4c – Mitigation Strategy – Implementation of Mitigation Measures
5a – Plan Maintenance Procedures – Monitoring, Evaluating, and Updating the Plan
5b – Plan Maintenance Procedures – Implementation through Existing Programs
5c – Plan Maintenance Procedures – Continued Public Involvement

2.3 Stakeholder Outreach and Involvement

Stakeholders are the individuals, agencies, and jurisdictions that have a vested interest in the recommendations of the HMP, including all planning partners. Diligent efforts were made to ensure broad regional, Fort Bend County, and local representation in this planning process. To that end, a comprehensive list of stakeholders was developed with the support of the Planning Partnership. Stakeholder outreach was performed early on and continually throughout the planning process. This HMP update includes information and input provided by these stakeholders where appropriate, as identified in the references.

This subsection discusses the various stakeholders that were invited to participate in the development of this HMP update and how these stakeholders participated and contributed. This summary listing cannot possibly represent the total of stakeholders that were aware of and/or contributed to this HMP update, as outreach efforts were being made, both formally and informally, throughout the process by the many planning partners involved in the effort, and documentation of all such efforts is impossible. Instead, this summary is intended to demonstrate the scope and breadth of the stakeholder outreach efforts made during the plan update process:

- Opened all Planning Partnership meetings to the public and advertised via the County's HMP website (https://www.fortbendcountytxhmp.com/).
- Provided outreach materials to the Planning Partnership to post on their websites and social media platforms and to distribute as printed materials.
- Distributed a stakeholder survey and neighbor survey to provide input regarding vulnerabilities, capabilities, and mitigation projects.
- Posted draft plan on the Fort Bend County HMP website and advertised using social media platforms.
- Email correspondence to regional stakeholders and neighboring communities to review the draft HMP and provide input.

2.3.1 Federal, State, and County Agencies

The following describes the various departments and agencies that were involved during the planning process.

Federal Agencies

Please see Appendix B (Participation Documentation) for further details regarding federal agency participation. All responses to the stakeholder surveys may be found in Appendix D (Outreach).

FEMA Region VI: Provided updated planning guidance and conducted plan review.

Information regarding hazard identification and the risk assessment for this plan update were requested and received or incorporated by reference from the following agencies and organizations:

- National Climatic Data Center (NCDC)
- National Hurricane Center (NHC)
- National Oceanic and Atmospheric Administration (NOAA)
- National Weather Service (NWS)
- Storm Prediction Center (SPC)
- U.S. Army Corps of Engineers (USACE)
- U.S. Census Bureau
- U.S. Department of Agriculture (USDA)
- U.S. Department of Health and Human Services
- U.S. Environmental Protection Agency (USEPA)
- U.S. Geological Survey (USGS)

State Agencies

Please see Appendix B (Participation Documentation) for further details regarding state agency participation. All responses to the surveys may be found in Appendix D (Outreach).

- Texas Division of Emergency Management (TDEM): Administered the planning grant, provided updated planning guidance, and provided review of the draft HMP update.

County Agencies and Departments

Several County agencies and departments were represented on the Planning Partnership and involved in the HMP update planning process. Appendix B (Participation Matrix) provides further details regarding regional and local stakeholder agencies. All responses to the stakeholder surveys are in Appendix D (Outreach). Refer to Section 5 (Capability Assessment) for details on each department and their roles during the HMP update and their overall responsibilities in Fort Bend County.

- Fort Bend County Homeland Security & Emergency Management – Led the planning process on behalf of Fort Bend County, served on the Steering Committee, provided input throughout the planning process, and completed the stakeholder survey.
- Fort Bend County Drainage District – Served on the Steering Committee, provided input throughout the planning process, and completed the stakeholder survey.
- Fort Bend County Parks Department – Completed the stakeholder survey.

2.3.2 Regional and Local Stakeholders

All Planning Partnership meetings were announced on the Fort Bend HMP project website and posted on social media to invite residents and stakeholders. In addition, Planning Partnership representatives emailed regional and local stakeholders requesting their participation in stakeholder sector-specific surveys to provide input on vulnerable assets, capabilities, and current/potential future mitigation projects and invited them to provide input on the draft HMP. Refer to Appendix C (Participation Documentation) for further details regarding regional and local stakeholder agency attendance at meetings and Appendix D for additional details on the public and stakeholder outreach, including responses received to the surveys.

Academia

Schools, universities, and other academic institutions were invited to attend planning process meetings and asked to complete the stakeholder survey. The following academic stakeholders were invited to participate in the planning process:

- Brazos ISD
- Fort Bend CISD
- Houston Community College
- Houston IISD
- Katy Independent School District
- Lamar Consolidated Independent School District
- Needville ISD
- Stafford Municipal School District
- Texas State Technical College
- University of Houston at Sugar Land

Business, Commercial, and Nonprofit Interests

Business and commercial industries in Fort Bend County were invited to take the stakeholder survey and provide input to the planning process. The following businesses, commercial, and nonprofit stakeholders were invited to participate in the planning process:

- American Red Cross Texas Gulf Coast Region
- Arcola/Fresno Club
- Calpine
- East Fort Bend Human Needs Ministry
- Fort Bend Chamber of Commerce
- Fort Bend County EDC
- Fort Bend Herald
- Fort Bend Hope
- Fort Bend Women's Center
- Needville American Legion
- Pinnacle Senior Center Staff
- Rosenberg Housing Authority
- Second Mile

Emergency Services

Local emergency service providers (police, fire, and emergency medical services [EMS]) were invited to take the stakeholder survey and provide input to the planning process, including the following:

- All municipal police, fire, and EMS providers
- Fort Bend County EMS

Healthcare

Healthcare facilities and providers located in Fort Bend County were invited to take the stakeholder survey and provide input to the planning process. The following healthcare stakeholders were invited to take the stakeholder survey and provide input to the planning process:

- Houston Methodist Sugar Land Hospital
- Memorial Hermann Sugar Land Hospital
- OakBend Medical Center

Transportation

County and local highway and public works departments were notified of the stakeholder survey and invited to provide input on the draft HMP. The following transportation stakeholders were invited to take the stakeholder survey and provide input to the planning process:

- Houston Southwest Airport
- Fort Bend County Public Transportation

Utilities

Utility providers in Fort Bend County were invited to take the stakeholder survey and provide input to the planning process, including the following:

- Brazoria County Municipal Utility District No. 22
- Brazoria-Fort Bend Counties Municipal Utility District No. 1
- Brazos River Authority
- Brazos River Authority
- Cinco MUD #7
- Cinco MUD #9
- First Colony LID
- First Colony LID 2
- Fort Bend County LID 10
- Fort Bend County LID 11
- Fort Bend County LID 15
- Fort Bend County LID 17
- Fort Bend County LID 19
- Fort Bend County LID 2
- Fort Bend County LID 6
- Fort Bend County LID 7
- Fort Bend County LID 20

- Fort Bend County MUD # 46
- Fort Bend County MUD #115
- Fort Bend County MUD #128
- Fort Bend County MUD #146
- Fort Bend County MUD #162 – completed the stakeholder survey
- Fort Bend County MUD #195
- Fort Bend County MUD #198
- Fort Bend County MUD #200 – completed the stakeholder survey
- Fort Bend County MUD #207
- Fort Bend County MUD #218
- Fort Bend County MUD #22
- Fort Bend County MUD #42
- Fort Bend-Waller Counties Municipal Utility District No. 3
- Fulshear Water
- Grand Lakes Municipal Utility District No. 1
- Harris-Fort Bend Counties Municipal Utility District No. 1
- Levee Management Services
- Needville Water
- North Mission Glen Municipal Utility District
- Pecan Grove MUD
- Quail Valley Utility District
- Renn Road Municipal Utility District – completed the stakeholder survey
- Si Environmental, LLC – completed the stakeholder survey
- Williams Ranch Municipal Utility District No. 1
- Willow Fork Drainage District

County and Adjacent Municipalities

Fort Bend County has made efforts to keep the counties and surrounding municipalities apprised of the project, invited to take the stakeholder survey, and allowed the opportunity to provide input to this planning process, including the following:

- Houston-Galveston Area Council – completed the stakeholder survey
- Brazos ISD – completed the stakeholder survey
- Harris County Office of Homeland Security and Emergency Management - completed the stakeholder survey
- Waller County Office of Emergency Management – completed the stakeholder survey
- Austin County
- Brazoria County
- Wharton County

2.3.3 Stakeholder Survey Summary

The following provides a summary of the results and feedback received by stakeholders who completed the survey. Feedback was reviewed by the Planning Partnership and integrated where appropriate in the plan.

Stakeholder Survey

The stakeholder survey was designed to help identify general needs for hazard mitigation and resiliency within Fort Bend County from their perspective and identify specific projects that may be included in the mitigation plan. It was distributed to identified stakeholders, including the various County and municipal departments and agencies in the County. As of April 3, 2023, nine stakeholders completed the survey, representing the following sectors: academic/research, emergency services, health and human services public works, and utilities.

Roughly 56% of respondents stated the buildings/facilities/structures they have worked in and/or are responsible for have not been impacted by a hazard. The 33% that experienced damage stated that the structure damage was primarily due to heavy rains and flooding from Hurricane Harvey and Tax Day floods. When asked what areas are most vulnerable to hazards in Fort Bend County, answers included low-lying areas located in floodplains, wastewater/drainage infrastructure, academic institutions, and County utilities and structures.

The respondents stated that they have the following plans in place: Emergency Operations Plan (56%), Continuity of Government Plan (11%), and Continuity of Operations Plan (33%). Approximately 22% selected that they were unsure if there are any plans in place. Two respondents included Emergency Preparedness Plan (EPP) and Drought Contingency Plan in their responses.

Neighbor Survey

The neighbor survey was sent to the surrounding municipalities and counties of Fort Bend County due to their proximity to and because effects of hazard events that impact the County would be similar to that of their neighbors. As of March 28, 2023, two responses have been received from the five neighboring counties (Austin County, Brazoria County, Harris County, Waller County, and Wharton County) identified in the survey: Harris County OEM and Waller County OEM.

Only one response stated that Fort Bend County was involved in their community's comprehensive emergency operations planning (50%) and that they were also involved with the County's comprehensive emergency operation planning (50%). One response highlighted that their community had an Interlocal Agreement for Mutual Aid Assistance with the County. Both neighboring municipalities stated that they were not involved, or were unsure of involvement, in Fort Bend County's Continuity of Operations planning.

Only one response stated that they shared risk and vulnerability assessment mapping with the County (50%) as well as having access to a contact for the County's emergency operation center (50%). The main hazards of concern highlighted for both the neighboring municipalities and the County were flooding, especially of the Brazos River floodplain area; severe storm events, such as tornadoes and hurricanes; and hazardous material spills along major transportation routes, such as Interstate Highway 10.

2.4 Public Participation – Public Involvement

To facilitate better coordination and communication between the Planning Partnership and citizens and to involve the public in the planning process, it was determined that meeting dates/locations will be made available to the public via the Fort Bend HMP website (https://www.fortbendcountytxhmp.com/) and social media, and the draft HMP available on the Fort Bend HMP website. The participating partners also feel that

community input on the HMP will increase the likelihood of hazard mitigation becoming one of the standard considerations in the evolution and growth of the County.

The Planning Partnership has made the following efforts toward public participation in the development and review of the HMP:

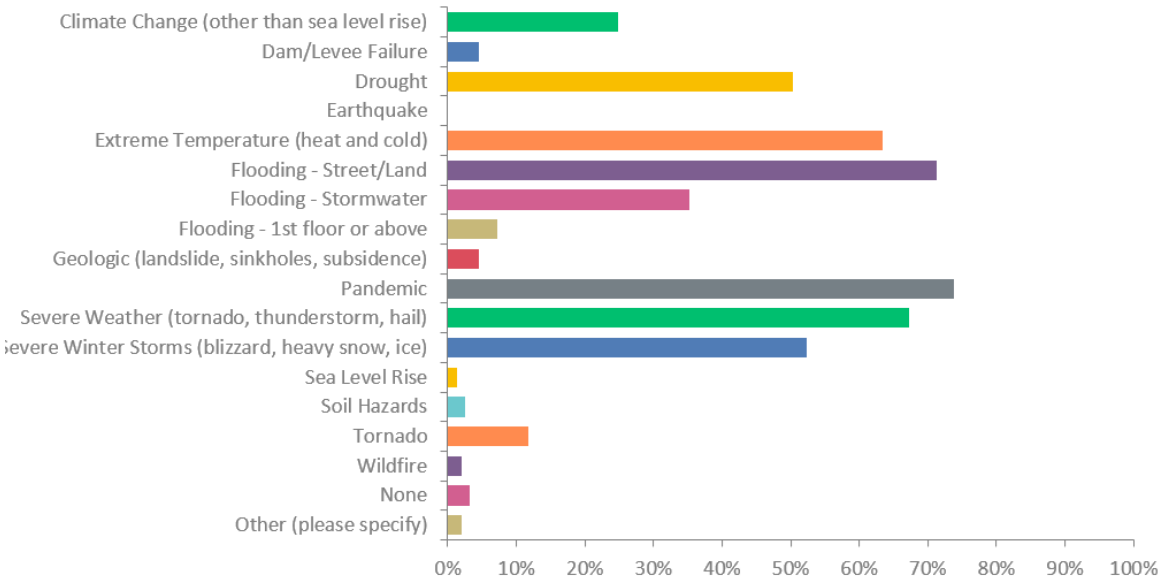
- A dedicated website was created for this project (https://www.fortbendcountytxhmp.com/). The website went live in February 2023 and was continuously updated throughout the planning process. The public website contains a project overview, meeting announcements, draft documents for review and comment, and a link to the public and stakeholder surveys.
- All hazard mitigation Planning Partnership meetings that were open to the public were advertised on the Fort Bend HMP website and various social media accounts. Additional examples of municipal outreach are presented in Appendix D.
- An online natural hazards preparedness public survey was developed to gauge household preparedness that may impact the County and to assess the level of knowledge of tools and techniques to assist in reducing risk and loss of those hazards. The questionnaire asked quantifiable questions about citizen perception of risk, knowledge of mitigation, and support of community programs. The questionnaire also asked several demographic questions to help analyze trends. The questionnaire was available on the public website from November 2022 to May 2023, and further advertised on additional Planning Partnership websites and on printed materials. Reponses were collected and provided back to plan participants for consideration in the mitigation action development (153 responses in total). Appendix D summarizes public input received through the website, the online survey, and other sources.
    - Results from the natural hazards preparedness survey were used to inform the action plans of the planning partners. To address the most requested types of projects that residents wanted local and County agencies to be doing, many planning partners included actions to improve and strengthen infrastructure, improve the damage resistance of utilities, buy out flood-prone properties, improve protective structures, and provide greater control over development in high hazard areas.
- All plan participants were encouraged to post links to the project webpage and citizen survey. In addition, all participants were requested to advertise the availability of the project website, citizen survey and stakeholder surveys via local homepage links, and other available public announcement methods (e.g., Facebook, Twitter, email blasts). Refer to Appendix D, which highlights these local efforts.
- Residents within Fort Bend County were provided opportunity to comment on the draft HMP before submittal to FEMA. The HMP was posted on the HMP public website on July 10, 2023 for review. All Planning Partnership participants were requested to assist with advertising the plan via their websites and social media. Public comments received through July 24, 2023 were distributed to Planning Partnership for their consideration.
- Additional examples of public outreach efforts, and results of surveys distributed, are presented in Appendix D (Public and Stakeholder Outreach Documentation).

2.4.1 Public Survey Responses

Demographically, survey respondents were from the City of Richmond, City of Rosenberg, City of Meadows Place, City of Missouri City, City of Simontown, City of Sugar Land, among others. The respondents ages ranged

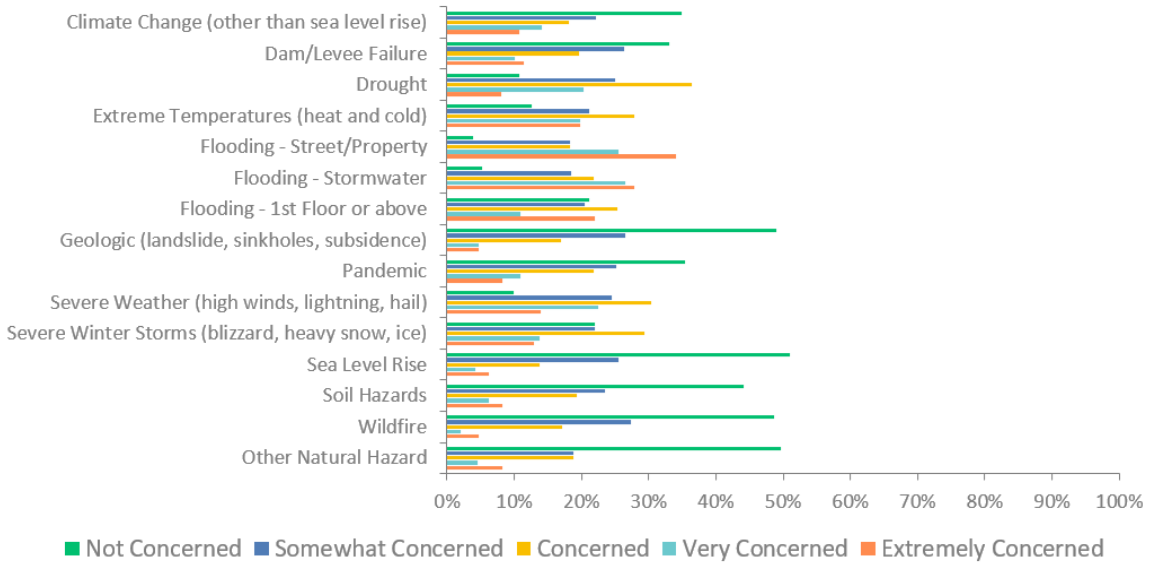
from 18 to over 61 years. The highest percentage being over 61 years of age (35%). The majority of respondents owned their single-family homes and have lived there for over 20 years (44%). In the past five years, the majority of respondents experienced the following hazards within Fort Bend County: pandemic (74%), street/land flooding (71%), severe weather (67%), extreme temperatures (63%), severe winter storms (52%), and drought (50%). Figure 2-1 lists the hazard events that respondents have experienced within Fort Bend County in the last five years. Earthquake received zero responses. Residents were asked about the ways in which they receive their information concerning a natural disaster, such as the hazard events listed in Figure 2-1. The majority of respondents rely on TV news (75%) and social media (71%) to receive information concerning these natural disasters. Over half of the respondents (67%) receive information through the internet and through the Mass Notification System (58%).

Figure 2-1. Hazards experienced in the last 5 years by respondents



Survey respondents were asked how concerned they were about 17 different hazards, on a scale of "not concerned" to "extremely concerned". Respondents were most concerned (reporting "concerned", "very concerned", or "extremely concerned") about street/property/stormwater flooding, extreme temperatures (hot/cold), drought, severe weather, and severe winter storms. Figure 2-2 illustrates the remaining hazards with their associated level of concern. Sea level rise had the highest percentage of respondents not concerned (51%).

Figure 2-2. Level of concern for hazards in Fort Bend County



About 72% of respondents' properties are not located in the floodplain, with 28% within a floodplain. Of the respondents in the floodplain, 10% do not have flood insurance, 34% do have flood insurance, and 57% were unsure. Of the residents whose properties are located outside of the floodplain, 28% do not have flood insurance, 42% have flood insurance, and 30% were unsure. Residents were then asked what types of planning projects are the most important to them within their community in terms of reducing damage and disruption of disasters in Fort Bend County. The scale to evaluate the responses are "not very important" to "very important." Results for "very important" are listed below:

- (76%) Protecting private property
- (89%) Protecting critical facilities and community lifelines
- (69%) Preventing development in hazard areas(e.g., restrict building in the floodplain)
- (70%) Enhance the functions of natural features (e.g., streams, wetlands)
- (40%) Protecting historical and cultural landmarks
- (85%) Protecting and reducing damage to utilities
- (75%) Strengthening emergency services (e.g., police, fire, EMS)
- (72%) Disclosing natural hazard risks during real estate transactions
- (66%) Promoting cooperation among public agencies, residents, nonprofit organizations, and local businesses

2.5 Incorporation of Existing Plans, Studies, Reports, and Technical Information

The Fort Bend County HMP strives to use the best available technical information, plans, studies, and reports throughout the plan process to support hazard profiling; risk and vulnerability assessment; review and evaluation of mitigation capabilities; and the identification, development, and prioritization of County and local mitigation strategies.

The asset and inventory data used for the risk and vulnerability assessments is presented in Fort Bend County Profile (Section 3). Details of the source of this data, along with technical information on how the data was used to develop the risk and vulnerability assessment, is presented in the Risk Assessment, specifically in Section 4.1 Methodology and Tools, as well as throughout the hazard profiles in Section 4.3 (Hazard Profiles). Further, the source of technical data and information used may be found within the References section.

Plans, reports, and other technical information were identified and provided directly by the Planning Partnership and numerous stakeholders involved in the planning effort as well as through independent research by the planning consultant. The Planning Partnership was tasked with updating the inventory of their planning and regulatory capabilities in Section 9 (Annexes) and providing relevant planning and regulatory documents, as applicable. Relevant documents, including plans, reports, and ordinances were reviewed to identify the following:

- Existing local and regional capabilities
- Needs and opportunities to develop or enhance capabilities, which may be identified within the mitigation strategies
- Mitigation-related goals or objectives considered in the review and update of the overall Goals and Objectives in Section 6 (Mitigation Strategy)
- Proposed, in-progress, or potential mitigation projects, actions, and initiatives to be incorporated into the updated County and local mitigation strategies

The following local regulations, codes, ordinances, and plans were reviewed during this process to develop mitigation planning goals, objectives, and strategies that are consistent across local and regional planning and regulatory mechanisms to accomplish complementary and mutually supportive strategies:

- Master/Comprehensive Plans
- Building Codes
- Zoning and Subdivision Ordinances
- National Flood Insurance Program (NFIP) Flood Damage Prevention Ordinances
- Site Plan Requirements
- Stormwater Management Plans
- Emergency Management and Response Plans
- Land Use and Open Space Plans
- Capital Plans
- State of Texas Hazard Mitigation Plan (2018)
- Fort Bend County Hazard Mitigation Plan Update (2018)

2.6 Integration With Existing Planning Mechanisms and Programs

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies become an integral part of public activities and decision-making. Within Fort Bend County there are many existing plans and programs that support hazard risk management, and thus, it is critical that this HMP integrate and coordinate with and complement those mechanisms.

Section 5 (Capability Assessment) provides a summary and description of the existing plans, programs, and regulatory mechanisms at all levels of government (federal, state, county, and local) that support hazard mitigation within Fort Bend County. Within each annex in Section 9, the counties, cities, and entities identified

how they integrate hazard risk management into their existing planning, regulatory, and operational/administrative framework (integration capabilities) and how they intend to promote this integration (integration actions). In addition, as noted above, a summary of the plan reviews indicating relevant goals and mitigation actions is provided in Appendix E. This information provided input to identify integration of mitigation concepts into the operations of the County.

A further summary of these continued efforts to develop and promote a comprehensive and holistic approach to hazard risk management and mitigation is presented in Section 7 (Plan Maintenance).

2.7 Continued Public Involvement

Fort Bend County is committed to the continued involvement of the public in the hazard mitigation process. This HMP update will be made available for review on the HMP public website. Each jurisdiction's elected official shall be responsible for receiving, tracking, and filing public comments regarding this HMP update. Further details regarding continued public involvement are provided in Section 7 (Plan Maintenance).

A notice regarding annual updates of the plan and the location of plan copies will be publicized annually after the annual plan evaluation meeting (refer to Section 7 – Plan Maintenance) and posted on the public website at https://www.fortbendcountytxhmp.com/.

The public will have an opportunity to comment on the HMP update as a part of the annual mitigation planning evaluation process and the next five-year mitigation plan update. The HMP Coordinator (currently Greg Babst, Fort Bend County Deputy Emergency Management Coordinator) is responsible for coordinating the plan evaluation portion of the meeting, soliciting feedback, collecting, and reviewing the comments, and ensuring their incorporation in the 5-year plan update as appropriate; however, members of the Planning Partnership will assist the HMP Coordinator. Additional meetings may also be held as deemed necessary. The purpose of these meetings would be to provide the public an opportunity to express concerns, opinions, and ideas about the HMP.

After completion of this HMP update, implementation and ongoing maintenance will continue to be a function of the Planning Partnership. The Planning Partnership will review the plan and accept public comment as part of an annual review and as part of five-year mitigation plan updates.

A notice regarding annual updates of the plan will be publicized annually after the HMP Committee's annual evaluation and posted on the public website.

Greg Babst has been identified as the ongoing HMP Coordinator (see Section 7) and is responsible for receiving, tracking, and filing public comments regarding this HMP update. Contact information is:

Mailing Address:	Fort Bend County Homeland Security and Emergency Management 307 Fort St., Richmond, TX 77469
Contact Name:	Greg Babst
Email Address:	Gregory.Babst@fortbendcountytx.gov
Phone Number:	(281) 238-3428

SECTION 3. COUNTY PROFILE

3.1 General Information

Fort Bend County (the County) holds a prominent place in Texas history. Karankawa Indians once roamed the plains and inhabited the river bottoms. In the early 1820s, the Anglo-American colonization of Texas under grants from the Spanish government was initiated. In 1837, the Congress of the Republic of Texas incorporated Richmond and 18 other towns. Later in the same year, the County of Fort Bend was created from portions of Austin, Harris, and Brazoria Counties. The early sugar cane plantations and farms supplied the Imperial Sugar industrial complex, and its company town evolved into the current City of Sugar Land. When the railroad from Galveston through Richmond was built in the 1850s, the County became a ready provider of agricultural products and raw materials to coastal markets and beyond. Additional railroads further opened the County to new settlers, many from central Europe. Discovery of oil and gas at Blueridge in the early 1920s, followed by discoveries at Orchard and Thompsons, then later at Katy, signaled the beginning of Fort Bend's petroleum industry. Production continues today in several areas of the County. Beginning in the early 1970s with Houston's expansion, Fort Bend County saw new growth in the form of increased residential development (Fort Bend County n.d.).

3.2 Major Past Hazard Events

Presidential disaster declarations are issued for hazard events that cause more damage than state and local governments can handle without assistance from the federal government. No specific dollar loss threshold has been established for these declarations. A presidential disaster declaration operationalizes federal recovery programs to assist disaster victims, businesses, and public entities. Programs can be matched by state programs. Review of presidential disaster declarations helps establish the probability of reoccurrence for each hazard and identify targets for risk reduction. Table 3-1 shows FEMA disaster declarations that have included Fort Bend County between January 2010 and February 2023.

Table 3-1. History of Hazard Events in Fort Bend County, Texas

Disaster Number	Declaration Date	Incident Type	Incident Dates
DR-4223-TX	May 29, 2015	Severe Storm	May 4, 2015-June 22, 2015
DR-4269-TX	April 25, 2016	Flood	April 17, 2016-April 30, 2016
DR-4272-TX	June 11, 2016	Flood	May 22, 2016-June 24, 2016
DR-4332-TX	August 25, 2017	Hurricane	August 23, 2017-September 15, 2017
EM-3458-TX	March 13, 2020	Biological	January 20, 2020-Current
DR-4485-TX	March 25, 2020	Biological	January 20, 2020-Current
EM-3530-TX	July 26, 2020	Hurricane	July 25, 2020-July 27, 2020
EM-3540-TX	August 24, 2020	Hurricane	August 23, 2020-August 27, 2020
EM-3554-TX	February 14, 2021	Severe Ice Storm	February 11, 2021-February 21, 2021
DR-4586-TX	February 19, 2021	Severe Ice Storm	February 11, 2021-February 21, 2021

Review of these events helps identify targets for risk reduction and ways to increase a community's capability to avoid large-scale events in the future. Still, many natural hazard events do not trigger federal disaster declaration protocol but have significant impacts on communities. These events are important to consider in

establishing recurrence intervals for hazards of concern. More detailed event tables can be found in the individual hazard profile sections.

3.3 Physical Setting

This section presents the physical setting of the County, including land use/land cover, location, climate, hydrography and hydrology, topography, and geology.

3.3.1 Location

Fort Bend County is located in the Houston metropolitan area of southeast Texas. It encompasses a total of 875.0 square miles (562,560 acres). The terrain varies from level to gently rolling hills, with elevations from 46 to 127 feet above sea level and an average elevation of 85 feet. US 59 traverses the center of the County from northeast to southwest, while US 90A crosses from east to west. State Highways (SH) 6, 36, and 99 provide important north-south routes. Neighboring counties are Austin, Brazoria, Harris, Waller, and Wharton (Fort Bend County 2023).

3.3.2 Topography and Geography

The soils in Fort Bend County are primarily in the Gulf Coast Prairie; a small portion of the northwestern edge of the County is located in the Flood Plains. Soils in the Gulf Coast Prairie are a mix of well-developed, clayey soils with high shrink-swell properties and loamy surface textures with loamy, clayey subsoil horizons. The area is characterized by low local relief and dissection by rivers that flow to the Gulf of Mexico. The Flood Plains have soil that is characterized by clayey textures and high shrink-swell properties. These soils formed in alluvium on flood plains, the nearly level plains that border a stream and that are subject to inundation under river flood-stage conditions (USDA, NRCS 2008).

3.3.3 Hydrography and Hydrology

Fort Bend County has approximately 11 square miles of surface water in rivers, creeks, and small lakes. The County is drained by the Brazos and San Bernard Rivers as well as Oyster Creek. The Brazos River formed a broad alluvial valley, up to 10 miles wide in places. The resulting fertile soils have been a major contributing factor to the agricultural industry in the County (Fort Bend County 2023).

The three permanently floatable waterways in Fort Bend County are the Brazos River, the San Bernard River south of Farm to Market Road 442, and Oyster Creek south of State Highway 6. The San Bernard River, south of Interstate Highway 10, is a seasonally floatable waterway, shared on the west with adjacent counties (Fort Bend County 2023).

Fort Bend County's major drainage basin is the Brazos River, with approximately 89 miles of the river running through the County, with smaller portions of the County located in the Brazos-Colorado Coastal Basin and the San Jacinto-Brazos Coastal Basin. The Brazos Basin is the second largest river basin by area within Texas; it flows from the confluence of its Salt and Double Mountain forks in Stonewall County to the Gulf of Mexico (Texas Water Develoment Board 2023).

3.3.4 Climate

The growing season is 296 days, with an average annual rainfall of 45.3 inches. The average first freeze date in the fall is December 7, and the average last freeze date is February 14. Temperatures range from a mean

minimum in January of 41° to a mean maximum in July of 93°. The Gulf of Mexico is located only 50 miles from Fort Bend County, and its close proximity helps to hold the summer and winter temperatures to moderate levels (Fort Bend County 2023).

3.3.5 Land Use and Land Cover

Land use refers to the way land is developed or left in an undeveloped state. Historical land use patterns show how the community has developed over time. Zoning and related ordinances are used to guide development within the County and largely reflect the existing and desired development patterns. Traditional zoning divides a community into various districts and permits or disallows land uses by zoning district. Much of the County's land area (approximately 63.9 percent) is set aside for agricultural uses, followed by urban (or residential) at 23.8 percent. Table 3-2 identifies the land use percentage and acreage for Fort Bend County; Figure 3-2 illustrates the land use and land cover for the County.

Table 3-2. Land Use in Fort Bend County, Texas

Land Use Category*	2013 Data		2016 Data		2019 Data	
	Acreage	Percent of County	Acreage	Percent of County	Acreage	Percent of County
Agriculture	330,554	58.3%	321,820	56.8%	315,120	55.6%
Barren Land	1,680	0.3%	1,430	0.3%	1,402	0.2%
Forest	22,697	4.0%	22,614	4.0%	22,229	3.9%
Rangeland	12,054	2.1%	11,968	2.1%	11,519	2.0%
Urban Area	135,125	23.8%	145,510	25.7%	153,847	27.1%
Water	9,362	1.7%	9,652	1.7%	9,614	1.7%
Wetlands	55,362	9.8%	53,841	9.5%	53,103	9.4%
Fort Bend County Total	**566,834**	**100.0%**	**566,834**	**100.0%**	**566,834**	**100.0%**

Source: Multi-Resolution Land Characteristics (MRLC) Consortium 2013, 2016

**Agriculture – areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops; or areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation*

**Barren Land – areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, and other accumulations of earthen material.*

**Forest – areas dominated by trees, typically greater than 15 feet tall, and greater than 20 percent total vegetation cover*

**Rangeland – areas dominated by shrubs, less than 15 feet tall with shrub canopy, includes shrubs, young trees in an early successional stage or trees stunted from environmental conditions; or areas dominated by herbaceous vegetation, generally greater than 80 percent of total vegetation*

**Urban Area – areas with a mixture of constructed materials and vegetation consisting of residential homes, parks, golf courses, and vegetation planted in developed settings*

**Water – areas of open water, generally with less than 25 percent cover of vegetation*

**Wetland - areas where forest or shrubland vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water*

Figure 3-1. Fort Bend County

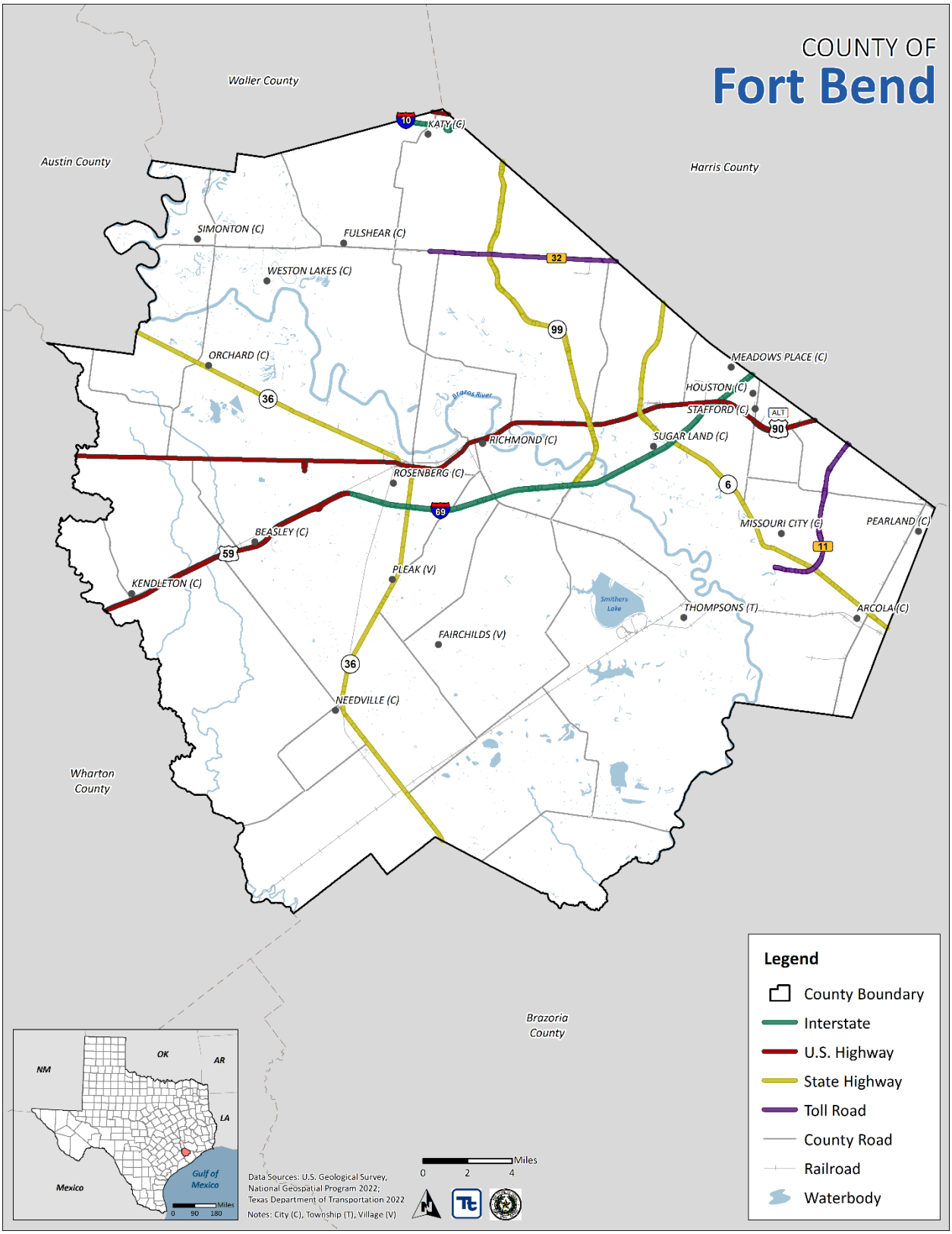
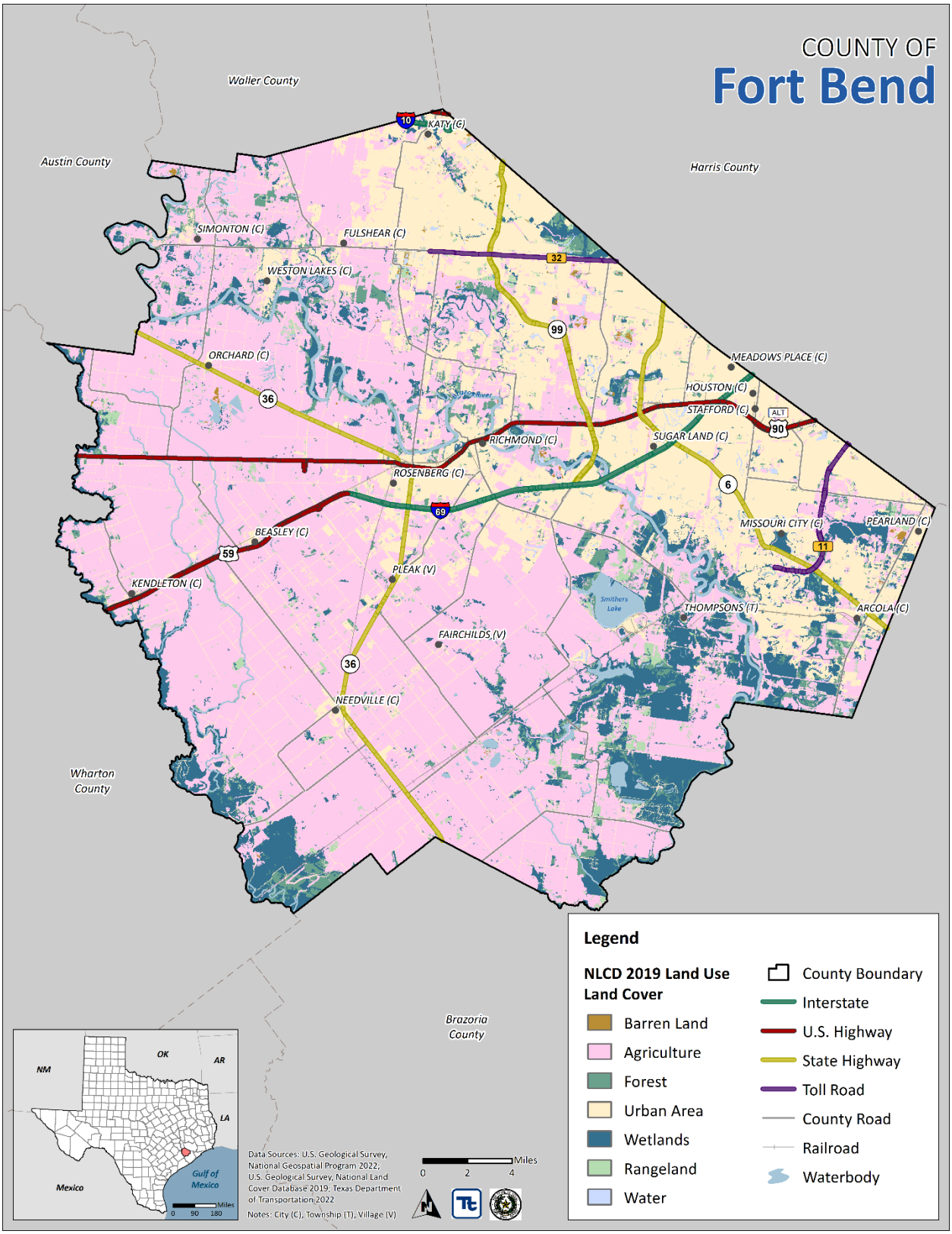


Figure 3-2. Land Use and Land Cover – Fort Bend County



3.4 Population and Demographics

Various Census Bureau products were used as sources for the population trends section. The Decennial Census is the official population count taken every 10 years. American Community Survey 5-Year Estimates are used to show annual population changes, but it is not an official population count. 5-Year Estimates are used because they are the most accurate form of American Community Survey with the largest sample size, which allows for greater accuracy at smaller geographic areas. The American Community Survey 5-Year Estimate products were used to establish annual changes in population. The numbers provided are not official Census counts, but are official estimates provided to communities so that they may have a greater understanding in population changes within their jurisdictions.

An understanding of the planning area population characteristics provides a foundation for deciphering the impacts of natural hazards in the County. As noted in Section 4.2 (Methodology) of this plan, modeling of the impacts of natural hazards on the population was performed using FEMA's Hazards U.S. Multi-Hazard (Hazus-MH) in which the available population information includes the 2010 Census, which indicates a County population of 585,375. However, more current data, according to U.S. Census Bureau, 2021 American Community Survey 5-Year Estimate, estimates a County population of approximately 806,497, which is an increase in population since 2010. Table 3-3 shows the 2021 American Community Survey 5-year population estimates for Fort Bend County and its jurisdictions. The information presented in this table is the best available population data available during the HMP update.

For the purposes of this plan, the default population data available in Hazus-MH v5.1 are used for Hazus estimated results (representing 2010 data) to support the analysis for displaced households and number of persons seeking shelter. Population exposure results are based on the 2021 5-year ACS Population Estimates.

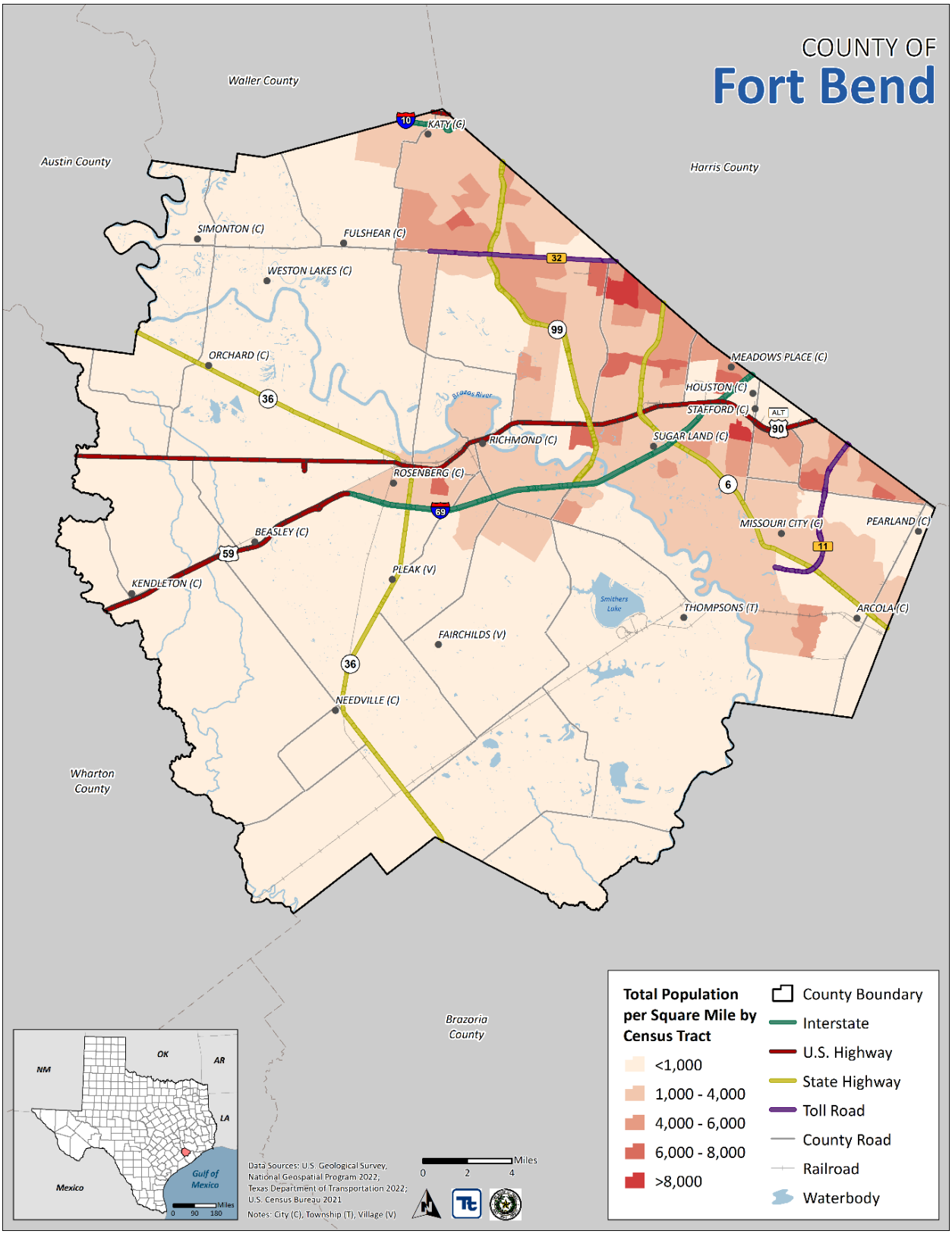
Table 3-3. Recent Population by Jurisdiction in Fort Bend County

Fort Bend Jurisdiction	Population (American Community Survey 2021)	
	Total	Percent of County Total
Arcola (C)	2,593	0.3%
Beasley (C)	957	0.1%
Fairchilds (V)	755	0.1%
Fulshear (C)	17,259	2.1%
Houston (C)*	41,279	5.1%
Katy (C)	21,926	2.7%
Kendleton (C)	341	0.0%
Meadows Place (C)	4,755	0.6%
Missouri City (C)	73,682	9.1%
Needville (C)	3,059	0.4%
Orchard (C)	219	<0.1%
Pearland (C)	122,609	15.2%
Pleak (V)	1,756	0.2%
Richmond (C)	11,768	1.5%
Rosenberg (C)	37,871	4.7%
Simonton (C)	838	0.1%
Stafford (C)	17,170	2.1%
Sugar Land (C)	110,272	13.7%
Thompsons (T)	265	<0.1%
Weston Lakes (C)	3,763	0.5%
Unincorporated Fort Bend County	333,360	41.3%
Fort Bend County (Total)	**806,497**	**100.0%**

Source: U.S. Census 2021, Stats America

**Houston (C): Total City Population multiplied by 0.018 to get the City's population that is within Fort Bend County*

Figure 3-3. Total Population Per Square Mile, Fort Bend County



3.4.1 Population and Demographic Trends

Fort Bend has a growing population of nearly 900,000 people and projects its population to be over 1,000,000 by 2030. Fort Bend is also classified as one of the most diverse counties in the nation, with a 25.5 percent Hispanic population, a 21.6 percent Asian population, 30.3 percent white population, a 21.9 percent African American population, and a.7 percent population classified as "Other." The average age in the County is 35.6 years old, and 73.5 percent of the workforce is classified as "white collar" (Fort Bend Economic Development Council 2022).

According to the U.S. Census Bureau, the 2010 population for Fort Bend County was 590,177 persons, which is a 64.5 percent increase from the 2000 Census population of 358,738. Over the last 50 years, from 1970 to 2020, the County has seen extreme population growth. The largest increase in absolute terms and in percentage was between 1970 and 1980, when the population increased by 150.8 percent.

Table 3-4. Fort Bend County Population Trends, 1970 to 2020

Year	Population	Change in Population	Percent (%) Population Change
2020	828,632	238,455	40.4%
2010	590,177	231,439	64.5%
2000	358,738	130,547	57.2%
1990	228,191	94,988	71.3%
1980	133,203	80,084	150.8%
1970	53,119	-	-

Source: USAFacts 2022

3.4.2 Vulnerable Populations

DMA 2000 requires that HMPs consider socially vulnerable populations. These populations can be more susceptible to hazard events based on several factors, including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. The vulnerable populations in the 2023 Hazard Mitigation Plan (HMP) include (1) the elderly (persons aged 65 and over), (2) those identified as living below the poverty threshold (households with two adults and two children with an annual household income below $25,926 per year), (3) the physically or mentally disabled, and (4) non-English speakers. Identifying concentrations of vulnerable populations can assist communities in targeting preparedness, response, and mitigation actions.

Populations with a higher level of vulnerability can be more seriously affected during an emergency or disaster. Vulnerable populations have unique needs that must be considered by public officials to ensure the safety of demographics with a higher level of risk. Refer to Table 3-5, which summarizes Fort Bend County's 2021 ACS Vulnerable Population Estimates by jurisdiction. Figure 3-4 displays the population densities by census tract for various vulnerable populations in Fort Bend County.

Figure 3-4. Vulnerable Population Densities in Fort Bend County, Texas

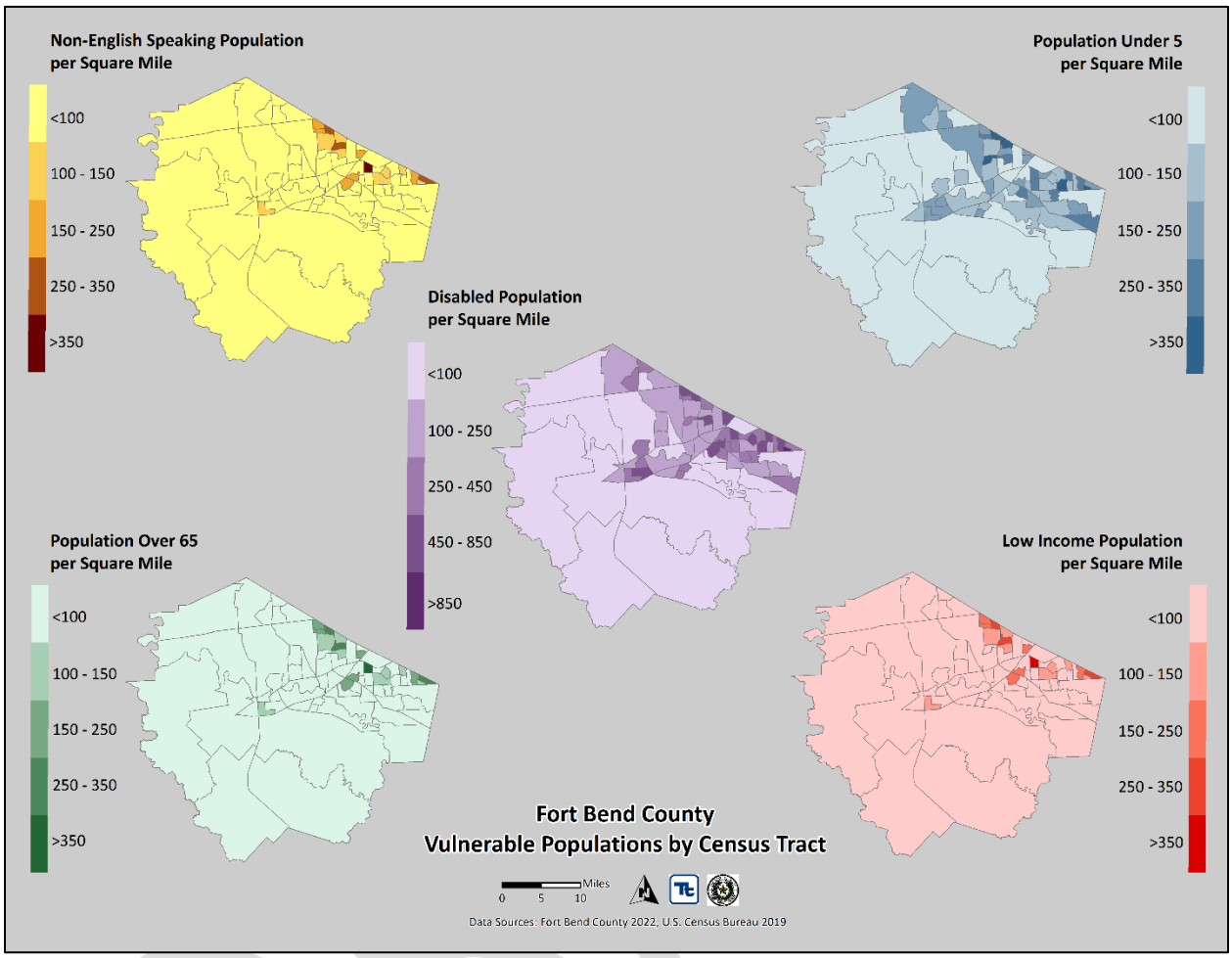


Table 3-5. Fort Bend County Vulnerable Population Statistics

Fort Bend Jurisdiction	Population (ACS 2021)		ACS 2021									
	Total	Percent of County Total	Over 65	Percent of Jurisdiction Total	Under 5	Percent of Jurisdiction Total	Non-English Speaking Households	Percent of Jurisdiction Total	Disability	Percent of Jurisdiction Total	Poverty Level	Percent of Jurisdiction Total
Arcola (C)	2,593	0.3%	143	5.5%	176	6.8%	253	9.8%	168	6.5%	404	15.6%
Beasley (C)	957	0.1%	80	8.4%	67	7.0%	25	2.6%	61	6.4%	180	18.8%
Fairchilds (V)	755	0.1%	164	21.7%	26	3.4%	46	6.1%	139	18.4%	98	13.0%
Fulshear (C)	17,259	2.1%	1,304	7.6%	770	4.5%	547	3.2%	931	5.4%	368	2.1%
Houston (C)	41,279	5.1%	4,599	11.1%	2,966	7.2%	6,668	16.2%	4,066	9.9%	7,927	19.2%
Katy (C)	21,926	2.7%	2,823	12.9%	1,505	6.9%	1,301	5.9%	2,376	10.8%	484	2.2%
Kendleton (C)	341	0.0%	86	25.2%	6	1.8%	0	0.0%	41	12.0%	40	11.7%
Meadows Place (C)	4,755	0.6%	1,066	22.4%	133	2.8%	222	4.7%	733	15.4%	291	6.1%
Missouri City (C)	73,682	9.1%	11,204	15.2%	4,643	6.3%	3,529	4.8%	6,731	9.1%	4,217	5.7%
Needville (C)	3,059	0.4%	478	15.6%	180	5.9%	37	1.2%	415	13.6%	475	15.5%
Orchard (C)	219	<0.1%	68	31.1%	7	3.2%	0	0.0%	13	5.9%	17	7.8%
Pearland (C)	122,609	15.2%	13,405	10.9%	9,926	8.1%	4,307	3.5%	8,426	6.9%	3,473	2.8%
Pleak (V)	1,756	0.2%	217	12.4%	33	1.9%	111	6.3%	80	4.6%	204	11.6%
Richmond (C)	11,768	1.5%	1,575	13.4%	670	5.7%	516	4.4%	1,272	10.8%	2,113	18.0%
Rosenberg (C)	37,871	4.7%	4,352	11.5%	3,238	8.6%	3,995	10.5%	4,468	11.8%	6,305	16.6%
Simonton (C)	838	0.1%	97	11.6%	88	10.5%	25	2.9%	50	6.0%	137	16.3%
Stafford (C)	17,170	2.1%	1,690	9.8%	1,051	6.1%	1,724	10.0%	1,477	8.6%	2,041	11.9%
Sugar Land (C)	110,272	13.7%	18,219	16.5%	4,876	4.4%	6,727	6.1%	8,164	7.4%	5,183	4.7%
Thompsons (T)	265	<0.1%	33	12.5%	0	0.0%	0	0.0%	27	10.2%	25	9.4%
Weston Lakes (C)	3,763	0.5%	927	24.6%	173	4.6%	0	0.0%	148	3.9%	88	2.3%
Unincorporated Fort Bend County	333,360	41.3%	28,849	8.7%	22,473	6.7%	14,638	4.4%	17,552	5.3%	23,146	6.9%
Fort Bend County (Total)	**806,497**	**100.0%**	**91,379**	**11.3%**	**53,007**	**6.6%**	**44,673**	**5.5%**	**57,338**	**7.1%**	**57,216**	**7.1%**

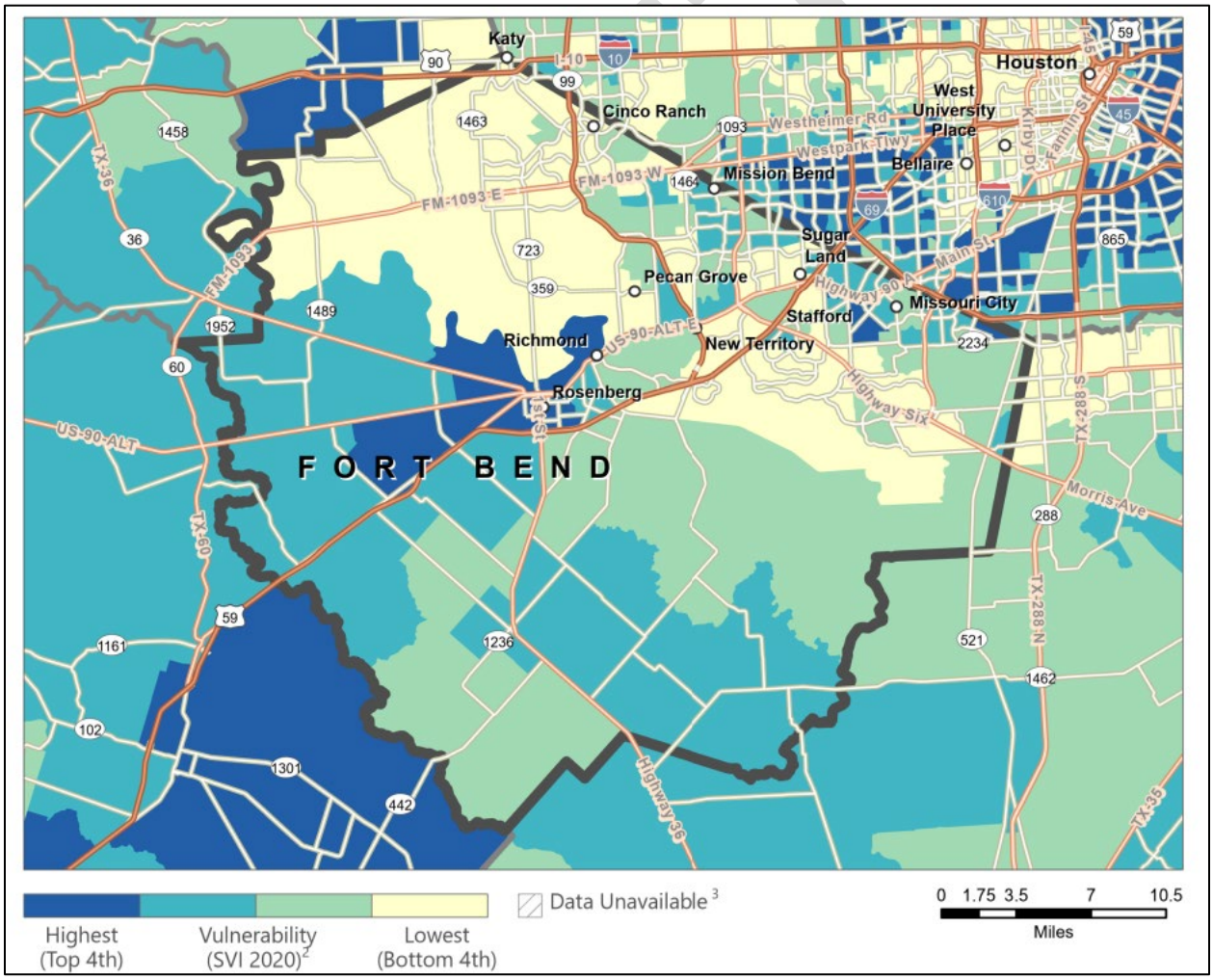
Source: *U.S. Census 2021*
Notes: *(C) = City*
(V) = Village

Socially Vulnerable Populations

> Social vulnerability refers to a community's capacity to prepare for and respond to the stress of hazardous events ranging from natural disasters to human-caused threats.

While age and income have been traditional indicators of vulnerable populations, the CDC Social Vulnerability Index (SVI) is a recent tool used to identify socially vulnerable populations. The CDC defines socially vulnerable population using factors such as poverty, lack of access to transportation, and crowded housing. These factors may weaken a community's ability to prevent human suffering and financial loss in a disaster. The SVI uses U.S. Census data to determine the social vulnerability of every census tract. The SVI ranks each tract on 16 social factors, including poverty, lack of vehicle access, and crowded housing, and groups them into four related themes. Figure 3-5 depicts the social vulnerability of communities in Fort Bend County by census tract (Agency for Toxic Substances and Disease Registry 2022).

Figure 3-5. CDC/ATSDR Overall Social Vulnerability for Fort Bend County (2020)



Source: Agency for Toxic Substances and Disease Registry 2022

Age

Children are considered vulnerable to hazard events because they are dependent on others to safely access resources during emergencies and may experience increased health risks from hazard exposure. Older adults

are more vulnerable before and after disasters and experience more causalities during and after disasters when compared to other age groups. Factors include a greater prevalence of chronic conditions, multi-morbidity, cognitive impairment, and medication concerns during disasters; greater dependence on assistive devices (i.e., walkers, glasses) and support requirements from caregivers and others during disasters; and likelihood of social isolation (American Red Cross 2020).

According to the 2021 ACS, the median age in Fort Bend County is 36.7. Of the County's total population of 806,497, 11.3 percent (91,379 persons) of the County's population is age 65 and older, and 6.6 percent (53,007 persons) are under the age of 5 (U.S. Census Bureau 2023).

Income

The 2021 ACS provides that the median household income in Fort Bend County was $102,590. The U.S. Census Bureau identifies households with two adults and two children with an annual household income below $25,926 per year as *low income* (U. S. Census 2021). The 2021 ACS indicates that 7.1 percent (57,216 persons) of persons are below the poverty level within the County (U.S. Census Bureau 2023).

Physically or Mentally Disabled

According to the Centers for Disease Control, "A disability is any condition of the body or mind (impairment) that makes it more difficult for the person with the condition to do certain activities (activity limitation) and interact with the world around them (participation restrictions) (CDC 2020)." Cognitive impairments can increase the level of difficulty that individuals might face during an emergency and reduce an individual's capacity to receive, process, and respond to emergency information or warnings. Individuals with a physical or sensory disability can face issues of mobility, sight, hearing, or reliance on specialized medical equipment. According to the 2021 ACS, 57,338 persons, or 7.2 percent of residents in Fort Bend County, are living with a disability.

Non-English Speakers

Individuals who are not fluent or do not have a working proficiency in English are vulnerable because they can have difficulty with understanding information being conveyed to them. Cultural differences also can add complexity to how information is being conveyed to populations with limited English proficiency (CDC 2021). According to the 2021 ACS, 40.2 percent of the County's population over the age of 5 primarily speaks a language other than English at home. Approximately 12.7 percent of the population over the age of 5 speaks limited English.

3.4.3 General Building Stock

The 2021 ACS data identifies 259,106 housing units in Fort Bend County. The U.S. Census Bureau defines household as all the persons who occupy a housing unit and a housing unit as a house, an apartment, a mobile home, a group of rooms, or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters. The median price of a single-family home in Fort Bend County was estimated at $319,000 in 2021 (U.S. Census Bureau 2023).

For this update, a customized general building stock was created using building footprints and parcel data from the County, which was supplemented with County-provided data and 2022 RS Means replacement cost value for building and content replacement costs. Contents for residential structures are valued at 50 percent of the

building's value. For non-residential facilities, the value of the contents are valued at 100 percent of the building's structural value.

The updated building inventory contains 281,285 buildings with a total building replacement value (structure and content) of over $226 billion (Table 3-6). This inventory was incorporated into Hazus at the structure and aggregate level. Approximately 96 percent of the buildings (271,123 buildings) and 46 percent of the building stock replacement value (approximately $105 billion) are associated with residential housing. Commercial buildings make up the second building classification at approximately 45.1 percent of the total building replacement value. Figure 3-6 through Figure 3-8 shows the replacement cost value of residential, commercial, and industrial properties in Fort Bend County, respectively.

Table 3-6. Number of Buildings and Improvement Value in Fort Bend County

Jurisdiction	All Occupancies	
	Building Count	Total Replacement Cost Value (Structure + Contents)
Arcola (C)	676	$1,374,107,673
Beasley (C)	367	$467,087,536
Fairchilds (V)	190	$58,400,161
Fulshear (C)	7,869	$6,124,915,172
Houston (C)	11,589	$5,814,576,859
Katy (C)	2,206	$4,980,024,025
Kendleton (C)	329	$241,970,568
Meadows Place (C)	1,676	$1,270,821,734
Missouri City (C)	27,170	$23,213,328,025
Needville (C)	1,346	$1,362,324,702
Orchard (C)	180	$170,795,761
Pearland (C)	2,171	$1,063,851,539
Pleak (V)	436	$672,927,271
Richmond (C)	3,296	$4,128,822,403
Rosenberg (C)	11,894	$22,921,973,230
Simonton (C)	395	$372,092,732
Stafford (C)	4,222	$10,638,345,589
Sugarland (C)	37,506	$36,732,455,899
Thompsons (T)	143	$404,590,514
Weston Lakes (C)	1,589	$1,145,826,270
Unincorporated Fort Bend County	166,035	$103,633,654,804
Fort Bend County (Total)	**281,285**	**$226,792,892,466**

Source: Fort Bend County 2016, 2022; RS Means 2022
Notes: (C) = City, (T) = Town, (V) = Village

Figure 3-6. Replacement Cost Value of Residential Properties in Fort Bend County, Texas

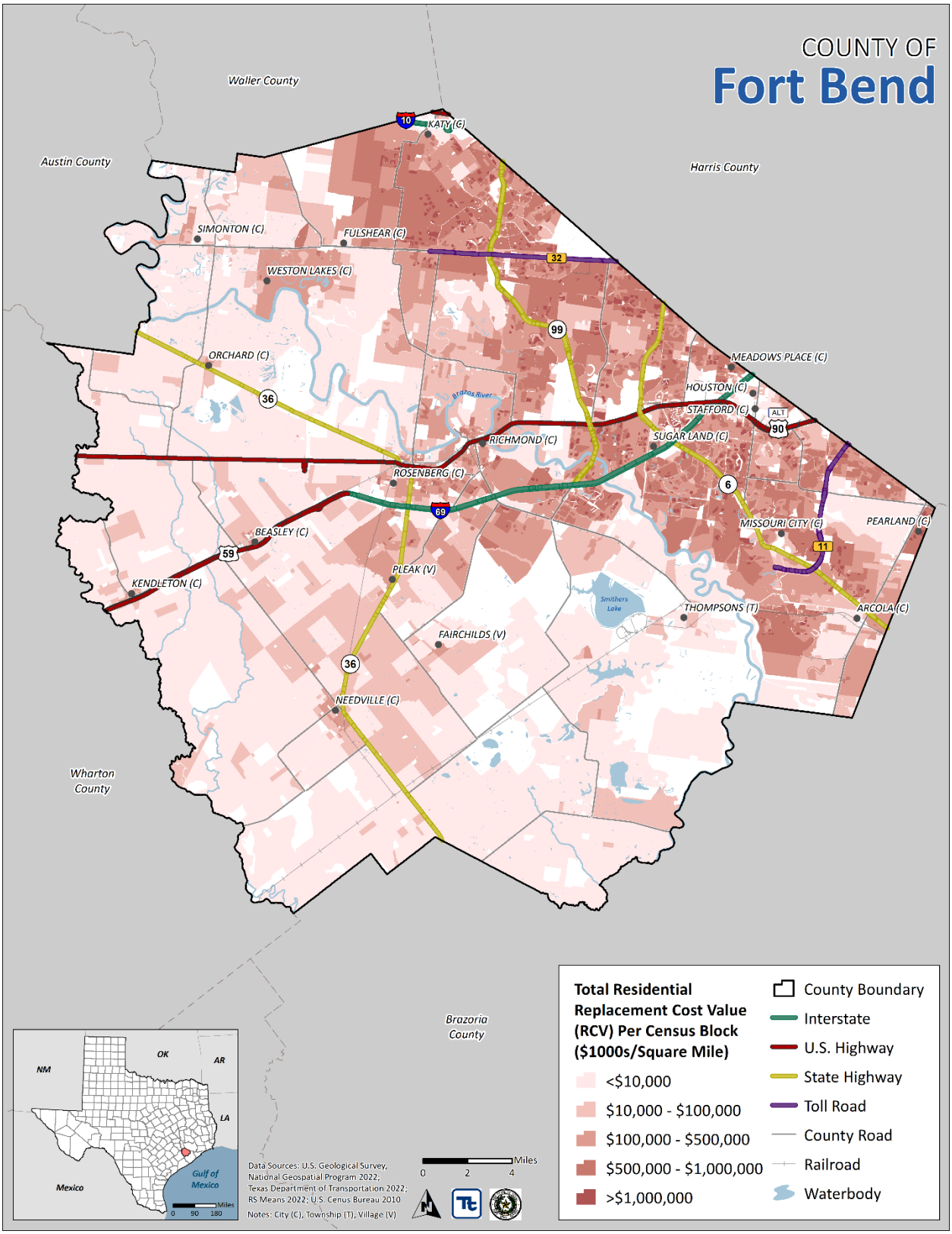


Figure 3-7. Replacement Cost Value of Commercial Properties in Fort Bend County, Texas

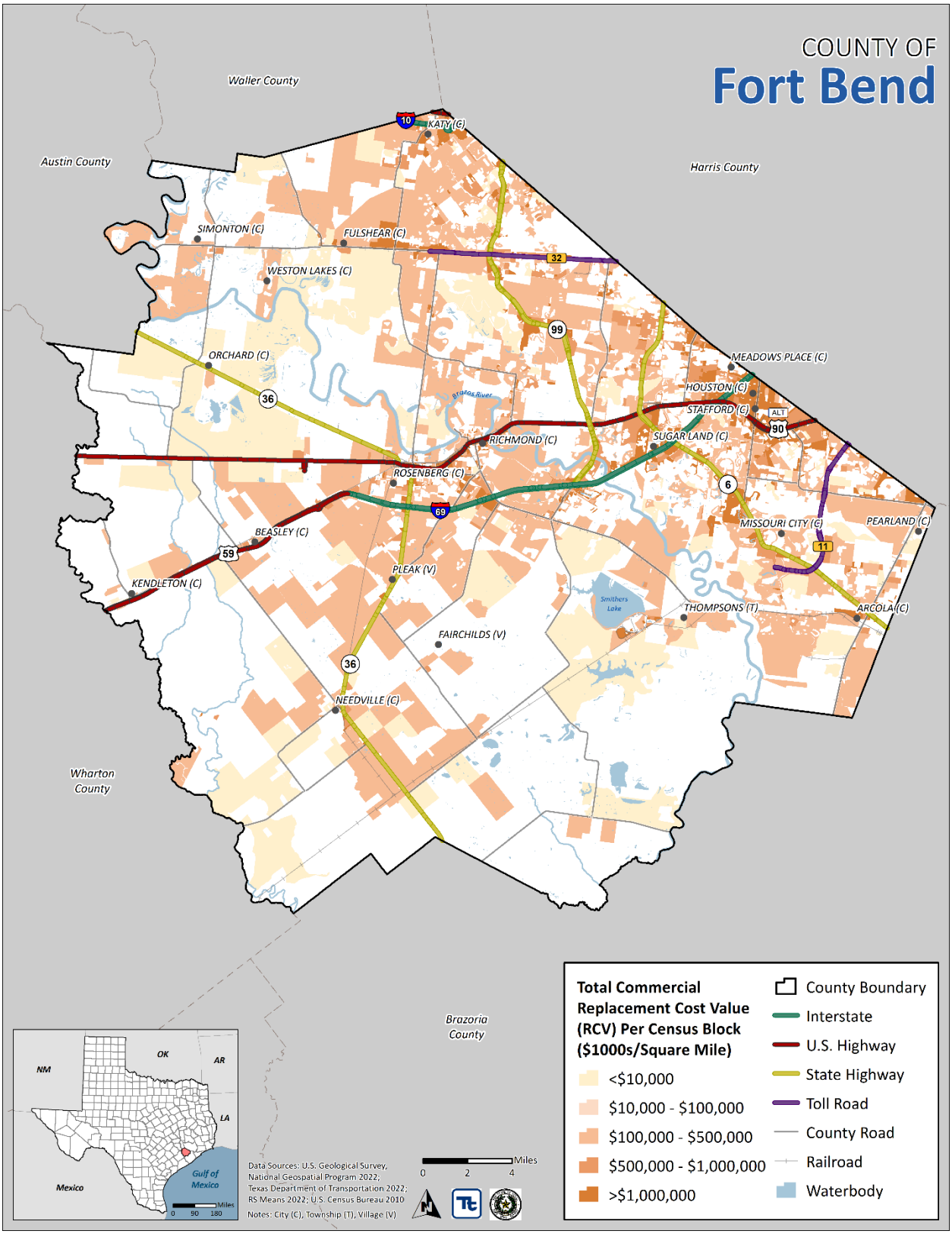
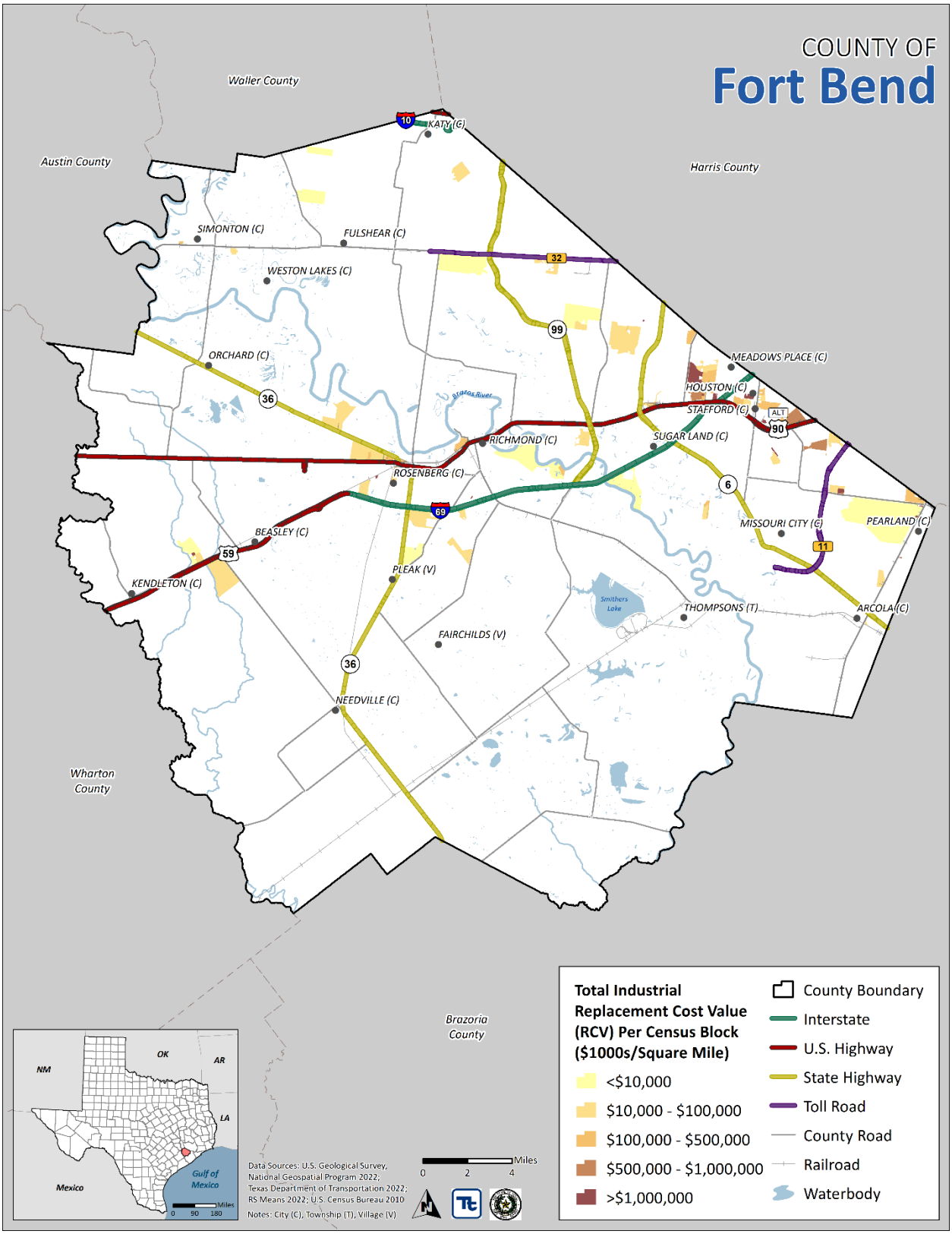


Figure 3-8. Replacement Cost Value of Industrial Properties in Fort Bend County, Texas



3.5 Land Use and Population Trends

DMA 2000 requires that communities consider land use trends, which can impact the need for and priority of mitigation options over time. Land use trends significantly impact exposure and vulnerability to various hazards. For example, significant development in a hazard area increases the building stock and population exposed to that hazard.

This plan provides a general overview of population and land use and types of development occurring within the study area. An understanding of these development trends can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place to protect human health and community infrastructure.

3.5.1 Land Use Trends

Fort Bend County is home to more master-planned communities than any other county in Texas. There are currently 67 major existing or planned master-planned communities in Fort Bend County (Fort Bend County 2007).

Fort Bend County is the ninth-largest county in Texas and one of the fastest-growing counties in Texas in terms of commercial development and population. The County is home to Fortune 500 companies, international businesses, and the brightest innovators. Fort Bend County has grown from 8,600 business establishments or companies to nearly 15,000 in 10 years (Fort Bend County Economic Development Council 2023).

Since 2000, Fort Bend has almost tripled in population and is expected to reach 1 million people in the next several years. However, the story is still being written, as Fort Bend County is only 50 percent developed. Large tracts of land owned by single landowners adjacent to interstates, rail lines, and access to ports attract companies looking for large footprint development. At nearly 900 square miles, Fort Bend continues to see robust commercial activity, growing the Gross Regional Product from $4.3 billion in 1986 to $25 billion in 2021, commercial values totaling more than $20 billion (Fort Bend County Economic Development Council 2023).

3.5.2 Economy

The U.S. Census Bureau's Economic Census provides an annual series of sub-national economic data by industry covering the majority of the country's economic activity. According to the 2021 Fort Bend County Economic Census, the professional, scientific, and technical services sector has the largest number of establishments, while the retail trade sector has the largest number of employees. The professional, scientific, and technical services sector comprises the highest payroll.

Table 3-7. Economic Census for Fort Bend County, Texas

Sector	Number of Establishments	Number of Employees	Annual Payroll ($1,000)
Accommodation and food services	1,377	24,102	$499,259
Administrative and support and waste management and remediation services	757	12,223	$483,213
Agriculture, forestry, fishing, and hunting	8	19	$975
Arts, entertainment, and recreation	233	3,062	$76,748
Construction	1,073	10,861	$819,481
Educational services	354	2,881	$84,558

Sector	Number of Establishments	Number of Employees	Annual Payroll ($1,000)
Finance and insurance	959	6,882	$617,005
Health care and social assistance	2,429	29,908	$1,333,866
Industries not classified	27	56	$2,815
Information	257	2,794	$212,598
Management of companies and enterprises	69	4,904	$612,403
Manufacturing	395	13,446	$801,580
Mining, quarrying, and oil and gas extraction	90	2,067	$230,178
Other services (except public administration)	1,236	8,803	$284,114
Professional, scientific, and technical services	2,570	12,607	$983,657
Real estate and rental and leasing	872	2,762	$126,960
Retail trade	2,177	31,636	$1,103,419
Transportation and warehousing	484	7,239	$309,070
Utilities	37	909	$92,062
Wholesale trade	931	8,283	$640,925
Total (does not include withheld data or range of numbers)	**16,335**	**9,314,886**	**$2,159,000**

Source: U.S. Census 2021

3.5.3 Population Trends

This section discusses population trend information used to estimate future shifts that could significantly change the character of the area. Population trends can provide a basis for making decisions on the type of mitigation approaches to be considered and the locations in which these approaches should be applied. This information can also be used to support planning decisions regarding future development in vulnerable areas.

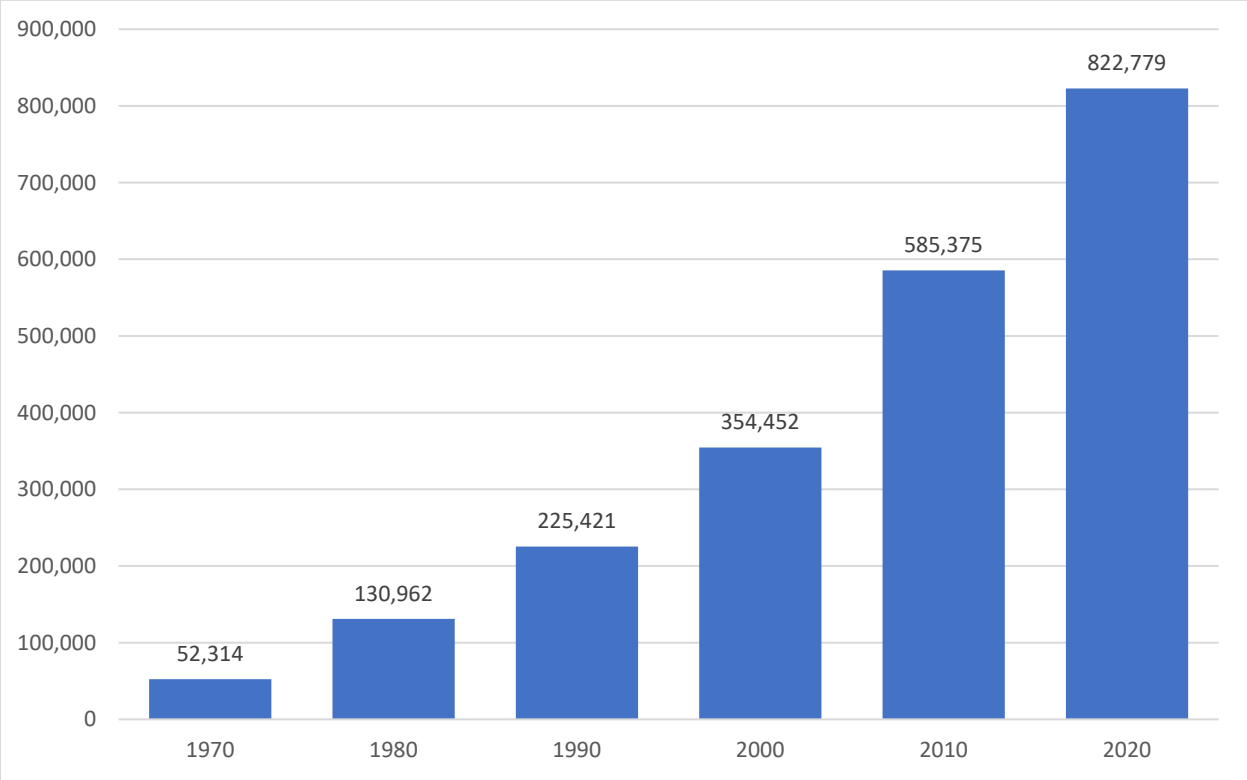
Fort Bend County's population has steadily increased since 1970, as shown in Table 3-8 and Figure 3-9. Fort Bend County is one of the fastest-growing counties in Texas, experiencing a 40.6 percent increase between 2010 and 2020.

Table 3-8. Population Trends in Fort Bend County, 1970 to 2020

	1970	1980	1990	2000	2010	2020
Fort Bend County (Total)	52,314	130,962	225,421	354,452	585,375	822,779

Source: U.S. Census Bureau 2023

Figure 3-9. Fort Bend County U.S. Census Population, 1970 to 2020



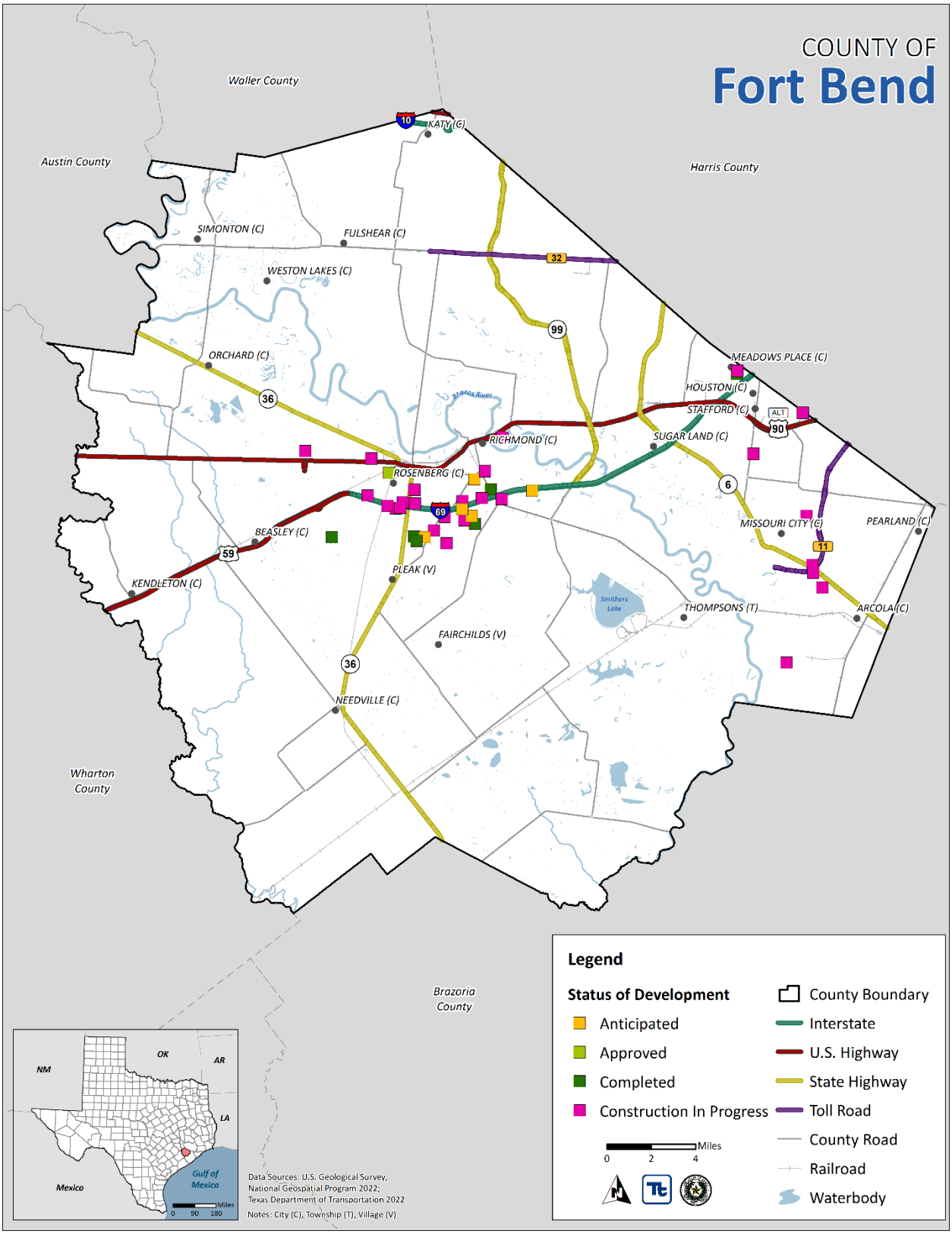
3.6 Future Growth and Development

In an article by Fort Bend County Economic Development Council, Fort Bend County is the fastest-growing region in educational attainment, diversity, cost of living, average household income, safety, and innovation index. The Grand Parkway, Fort Bend Toll Road, and the Westpark Tollway enhance mobility across the County and connects Fort Bend County to the rest of Greater Houston. The expansion of Interstate 69 and access to Interstate 10 allows people and products to move through the County and to locations across the United States (Fort Bend County Economic Development Council 2021).

With the rapid growth across Fort Bend County, drainage remains a priority, and the Fort Bend County Drainage District is responsible for maintaining drainage and enhancing water conveyance. The District also reviews plats and drainage plans of new development to be approved by Commissioners Court to ensure the elimination of an adverse drainage impact on current and future residents. The County maintains an online map that shows development in the County since 2002: https://gisweb.fortbendcountytx.gov/portal/apps/webappviewer/index.html?id=dde884756fde4db697293ea86e4a643f.

During the planning process, the County and each participating jurisdiction provided information on known and anticipated new development over the next five years. Refer to Section 9 (Jurisdictional Annexes) for details on new and anticipated development. Figure 3-10 illustrates the identified areas of development in the County.

Figure 3-10. Known and Anticipated New Development in Fort Bend County



3.7 Community Lifelines and Critical Facilities

Critical infrastructure and facilities are those that are essential to the health and welfare of the population. These facilities are especially important after any hazard event. Critical facilities are those that maintain essential and emergency functions and are typically defined to include police and fire stations, schools, and emergency operations centers. Critical infrastructure can include the roads and bridges that provide ingress and egress and allow emergency vehicles access to those in need and the utilities that provide water, electricity, and communication services to the community. Also included are Tier II facilities (hazardous materials) and rail yards; rail lines hold or carry significant amounts of hazardous materials with the potential to impact public health and welfare in a hazard event.

Critical Facilities are those facilities considered critical to the health and welfare of the population and that are especially important following a hazard. As defined for this HMP, critical facilities include transportation systems, lifeline utility systems, high-potential loss facilities, and hazardous material facilities, and essential facilities

Essential facilities are a subset of critical facilities that include those facilities that are important to ensure a full recovery following the occurrence of a hazard event. For the County risk assessment, this category was defined to include police, fire, EMS, schools/colleges, shelters, senior facilities, and medical facilities.

Lifelines enable the continuous operation of critical business and government functions and are essential to human health and safety or economic security.

Beginning in 2017, FEMA created Community Lifelines to reframe incident information, understand and communicate incident impacts using plain language, and promote unity of effort across the whole community to prioritize efforts to stabilize the lifelines during incident response. Focusing on protecting lifelines, preventing and mitigating potential impacts, and building back stronger will increase resilience in Fort Bend County and its jurisdictions.

Community Lifelines represent the most fundamental services in the community that, when stabilized, enable all other aspects of society. Following a disaster event, intervention is required to stabilize Community Lifelines. Lifelines are divided into seven categories, which include:

- Safety and Security
- Food, Hydration, Shelter
- Health and Medical
- Water Systems
- Energy (Power and Fuel)
- Communications
- Transportation
- Hazardous Materials

To facilitate consistency with the National Response Framework, FEMA Strategic Plan, and guidance for the Building Resilient Infrastructure and Communities grant program, critical facilities in Fort Bend County are discussed in terms of lifelines.

The inventory of critical facilities and Community Lifelines in Fort Bend County was developed from various sources, including input from the Planning Committees. The inventory of critical facilities presented in this section represents the current state of this effort at the time of publication and was used for the risk assessment in Section 4 (Risk Assessment). Table 3-9 summarizes the Community Lifelines by jurisdiction and lifeline category. The critical facilities and Community Lifelines included in the 2023 HMP were provided and

reviewed by Fort Bend County and facilities listed in Hazus v5.1. The list includes facilities owned and/or operated by Fort Bend County, local, or private entities and does not include state-owned or leased facilities.

Table 3-9. Critical Facilities and Community Lifelines in Fort Bend County

Jurisdiction	Safety and Security	Food, Hydration, Shelter	Health and Medical	Water Systems	Energy	Communications	Transportation	Hazardous Materials	Total
Arcola (C)	1	-	-	10	6	-	4	-	21
Beasley (C)	3	-	-	5	4	-	2	-	14
Fairchilds (V)	-	-	-	2	-	-	1	-	3
Fulshear (C)	8	-	5	17	6	-	4	-	40
Houston (C)	8	-	3	23	31	-	19	-	84
Katy (C)	4	-	10	9	12	-	16	-	51
Kendleton (C)	2	-	-	7	1	1	8	-	19
Meadows Place (C)	4	-	3	4	5	-	-	-	16
Missouri City (C)	29	-	104	71	60	-	33	-	297
Needville (C)	4	-	2	11	12	-	4	-	33
Orchard (C)	3	-	1	1	2	-	-	-	7
Pearland (C)	-	-	-	-	-	-	1	-	1
Pleak (V)	1	-	-	6	2	-	6	-	15
Richmond (C)	18	-	18	30	32	-	4	1	103
Rosenberg (C)	23	-	32	63	116	2	58	1	295
Simonton (C)	2	-	-	11	1	-	3	-	17
Stafford (C)	12	-	18	28	59	-	18	2	137
Sugar Land (C)	42	-	63	254	83	-	132	1	575
Thompson (T)	3	-	-	3	-	-	3	-	9
Weston Lakes (C)	-	-	-	7	-	-	-	-	7
Unincorporated	115	-	76	918	152	41	344	8	1,654
Fort Bend County (Total)	**282**	**-**	**335**	**1,480**	**584**	**44**	**660**	**13**	**3,398**

Source: FEMA 2022; Fort Bend County 2022

3.7.1 Safety and Security

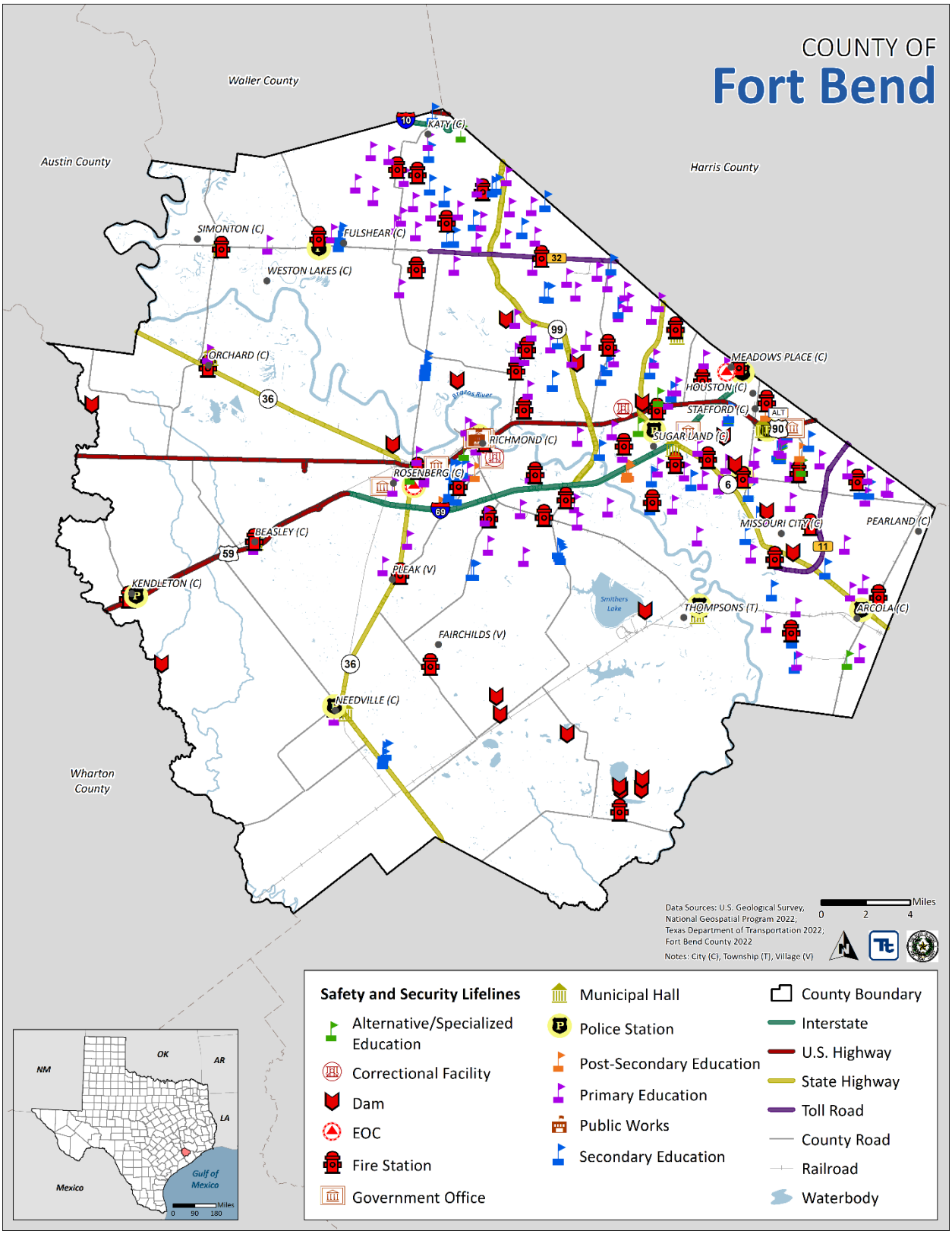
This section provides information on Safety and Security lifelines. Components of this lifeline category include law enforcement/security, fire services, search and rescue services, government services, and community safety (e.g., dams). For the purpose of this HMP update, Fort Bend County included correctional facilities, dams, fire stations, government offices, municipal halls, police stations, schools, and public works facilities. There are 282 safety and security lifelines in Fort Bend County. Table 3-10 summarizes the total number of each safety and security lifeline, and Figure 3-11 illustrates the location of each facility.

Table 3-10. Safety and Security Lifelines in Fort Bend County

Alternative/ Specialized Education	Correctional Facility	Dam	EOC	Fire Station	Government Office	Municipal Hall	Police Station	Post-Secondary Education	Primary Education	Public Works	Secondary Education
10	2	19	3	44	11	8	11	7	104	2	61

Source: FEMA 2022; Fort Bend County 2022

Figure 3-11. Safety and Security Lifelines in Fort Bend County, Texas



3.7.2 Food, Hydration, and Shelter Lifelines

Food, Water, and Shelter lifelines include facilities pertaining to food supply (distribution facilities, programs, and supply chain), hydration (bottled water distribution, commercial water supply chain), shelter (housing and hotels), and agriculture (animals and agriculture). Fort Bend County did not identify any food, hydration, or shelter lifelines.

3.7.3 Health and Medical Lifelines

Health and medical lifelines include medical care (e.g., hospitals, pharmacies, long-term care facilities), patient movement (e.g., EMS), fatality management, public health, and medical supply chain. For the purpose of this HMP update, Fort Bend County included EMS stations, hospitals, medical clinics, pharmacies, senior care, and urgent care facilities as health and medical lifelines. There are 335 health and medical lifelines in Fort Bend County. Table 3-11 summarizes the total number of each health and medical lifeline and Figure 3-13 illustrates the location of each.

Table 3-11. Health and Medical Lifelines in Fort Bend County

EMS Station	Hospital	Medical Clinic	Pharmacy	Senior Care	Urgent Care
7	12	200	49	43	24

Source: FEMA 2022; Fort Bend County 2022

3.7.4 Water Systems

Water systems lifelines include potable water infrastructure (intake, treatment, storage, distribution) and wastewater management (collection, storage, treatment, discharge). For the purpose of this HMP update, Fort Bend County included outfalls, potable water facilities, potable water pump stations, potable water tanks, potable water towers, potable water wells, private water wells, public water wells, stormwater pump stations, wastewater lift stations, wastewater treatment plants, and water treatment facilities as water systems lifelines. There are 1,480 water systems lifelines in Fort Bend County. Table 3-12 summarizes the total number of each water systems lifeline, and Figure 3-12 illustrates the location of each.

Table 3-12. Water Systems Lifelines in Fort Bend County

Outfall	Potable Water Facility	Potable Water Pump Station	Potable Water Tank	Potable Water Tower	Potable Water Well	Private Water Well	Public Water Well	Stormwater Pump Station	Wastewater Lift Station	Wastewater Treatment Plant	Water Treatment Facility
144	59	5	4	3	2	10	959	4	224	64	2

Source: FEMA 2022; Fort Bend County 2022

3.7.5 Energy (Power and Fuel) Lifelines

The energy (power and fuel) lifeline includes facilities pertaining to the power grid and fuel supplies. For the purpose of this HMP update, Fort Bend County included electric power, gas stations, and petroleum storage tanks as energy lifelines. There are 584 energy lifelines in Fort Bend County, as summarized in Table 3-13 and shown in Figure 3-14.

Table 3-13. Energy Lifelines in Fort Bend County

Electric Power	Gas Station	Petroleum Storage Tank
4	143	437

Source: FEMA 2022; Fort Bend County 2022

Figure 3-12. Water Systems Lifelines in Fort Bend County, Texas

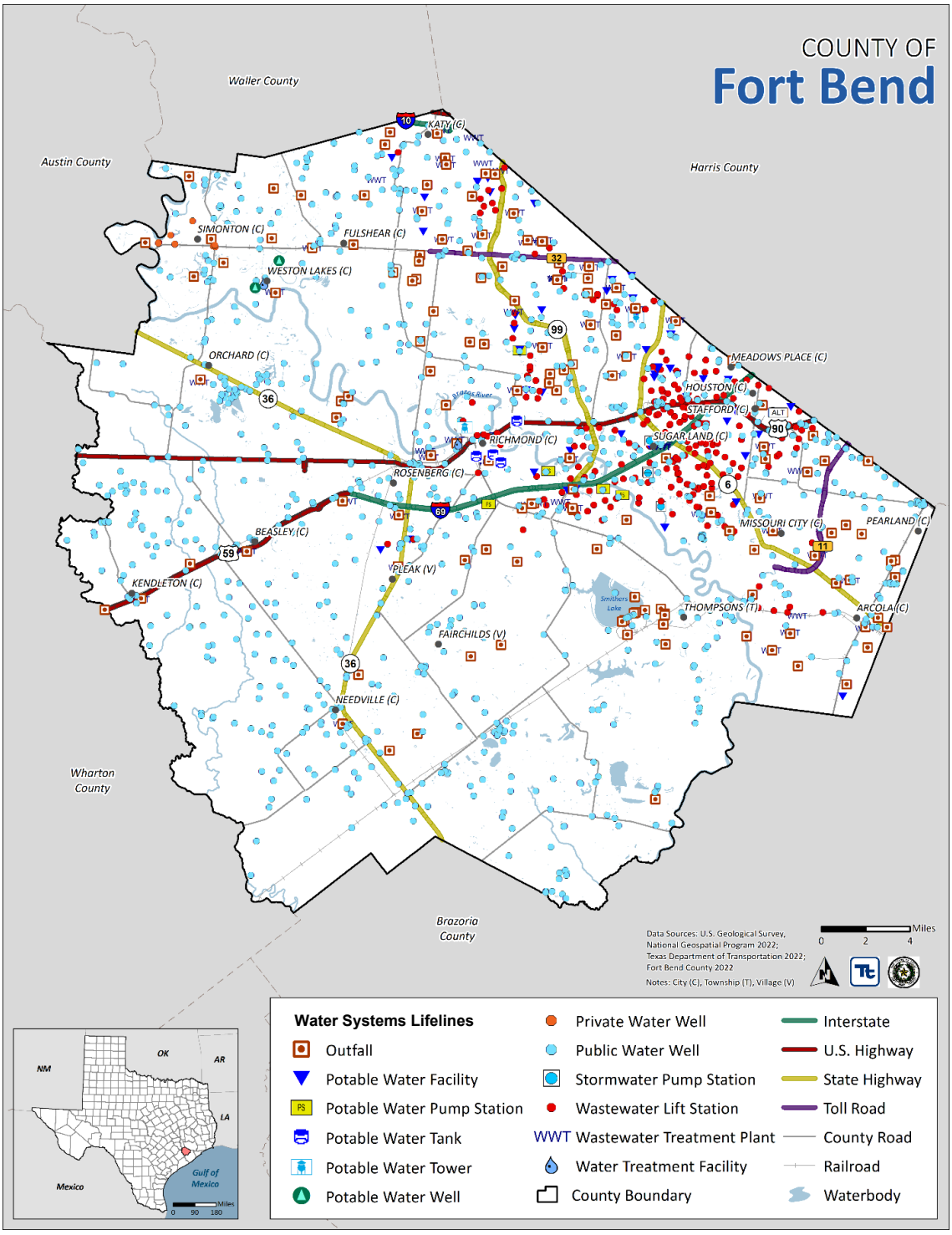


Figure 3-13. Health and Medical Lifelines in Fort Bend County, Texas

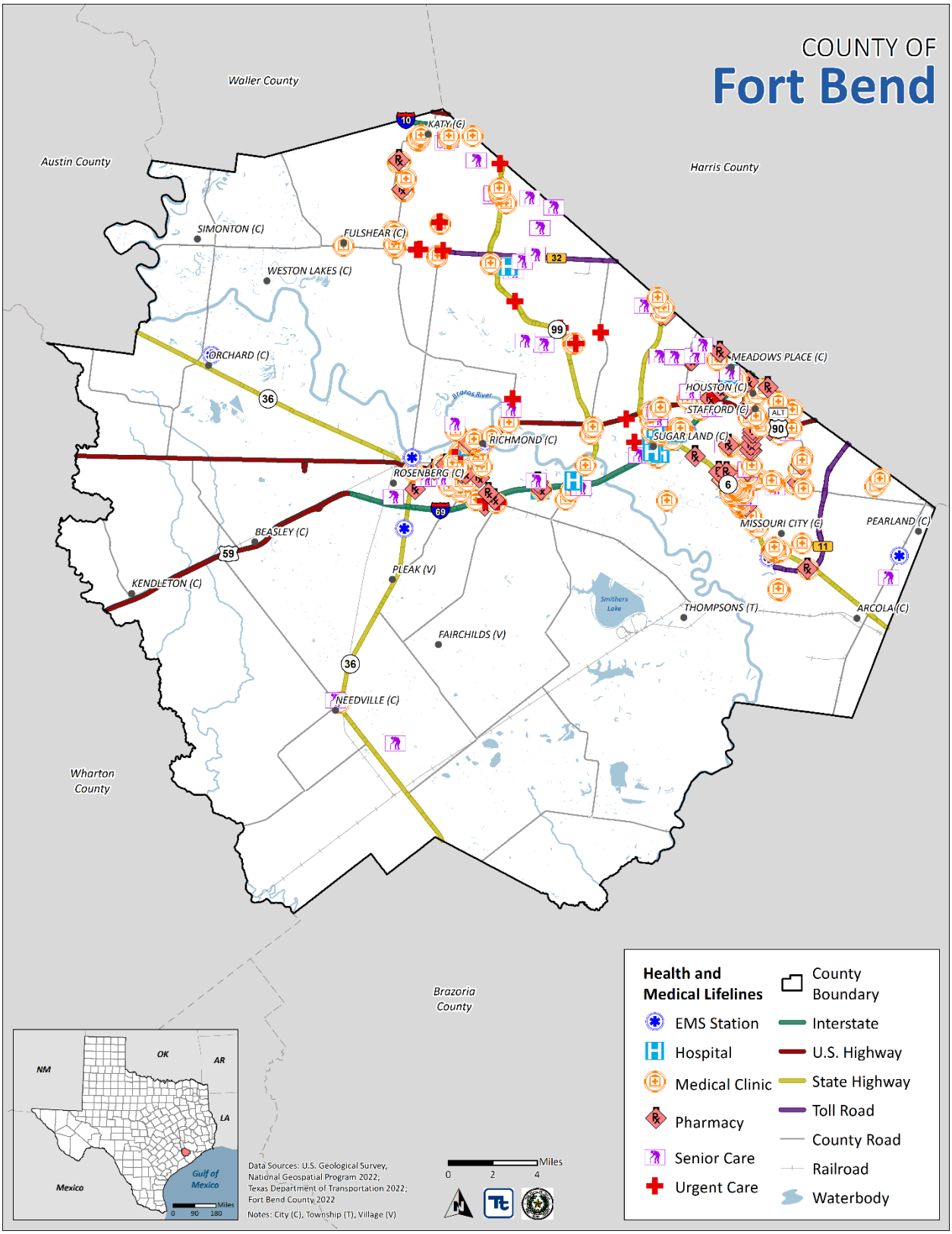
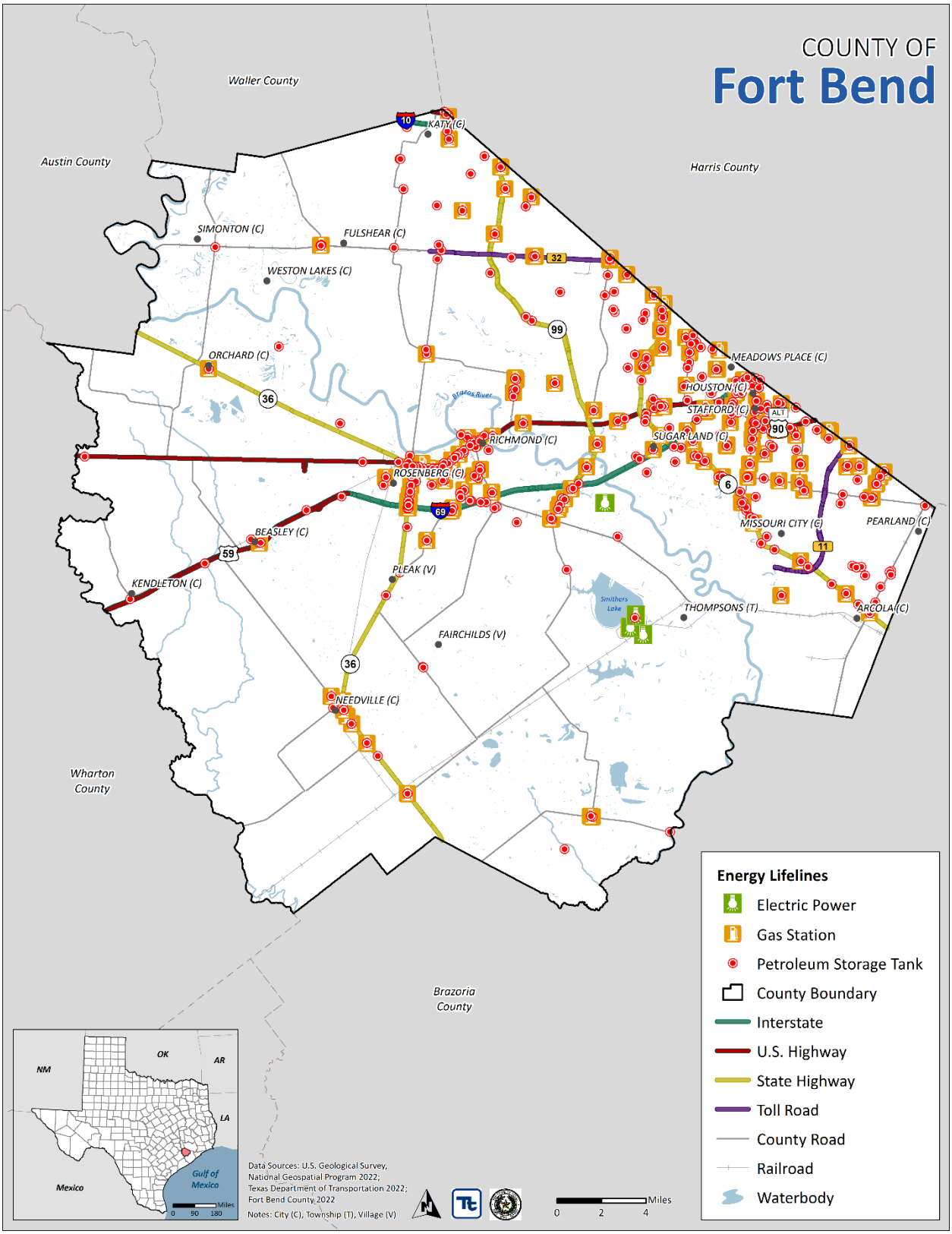


Figure 3-14. Energy Lifelines in Fort Bend County, Texas



3.7.6 Communication Lifelines

Communication lifelines include facilities pertaining to infrastructure, alerts/warnings/messages, 911 and dispatch, responder communications, and finance. For the purpose of this HMP, Fort Bend County included cellular transmission, radio broadcast, and TV broadcast facilities as communication lifelines. There are a total of 44 communication lifelines in the County, as summarized in Table 3-14 and shown in Figure 3-15.

Table 3-14. Communication Lifelines in Fort Bend County

Cellular Transmission	Radio Broadcast	TV Broadcast
11	20	13

Source: FEMA 2022; Fort Bend County 2022

3.7.7 Transportation Lifelines

Transportation lifelines include facilities pertaining to highway/roadway, mass transit, railway, aviation, and maritime. For the purpose of this HMP, Fort Bend County included airports, bridges, and bus stations as transportation lifelines. There are a total of 660 transportation lifelines in the County, as summarized in Table 3-15 and shown in Figure 3-16.

Table 3-15. Transportation Lifelines in Fort Bend County

Airport	Bridge	Bus Station
1	657	2

Source: FEMA 2022; Fort Bend County 2022

3.7.8 Hazardous Materials Lifelines

Hazardous materials lifelines include facilities and hazmat/pollutants/contaminants. There are 13 hazardous material lifelines in Fort Bend County. Figure 3-17 shows the distribution of hazardous materials lifelines throughout the County; please note, the locations of all lifelines are not available.

HAZMAT Facilities

A Superfund site consists of land in the United States that has been contaminated by hazardous waste and identified by the U.S. Environmental Protection Agency (EPA) as a candidate for cleanup because it poses a risk to human health or the environment. These sites are placed on the National Priorities List (NPL), the list of national priorities among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories. The NPL is intended primarily to guide EPA in determining which sites warrant further investigation.

Abandoned hazardous waste sites placed on the Federal NPL include those that EPA has determined present *a significant risk to human health or the environment*, with the sites being eligible for remediation under the Superfund Trust Fund Program. As of March 2023, Fort Bend County does not host any hazardous sites in the Federal Superfund Program that are listed on the NPL (US EPA 2023).

Figure 3-15. Communications Lifelines in Fort Bend County, Texas

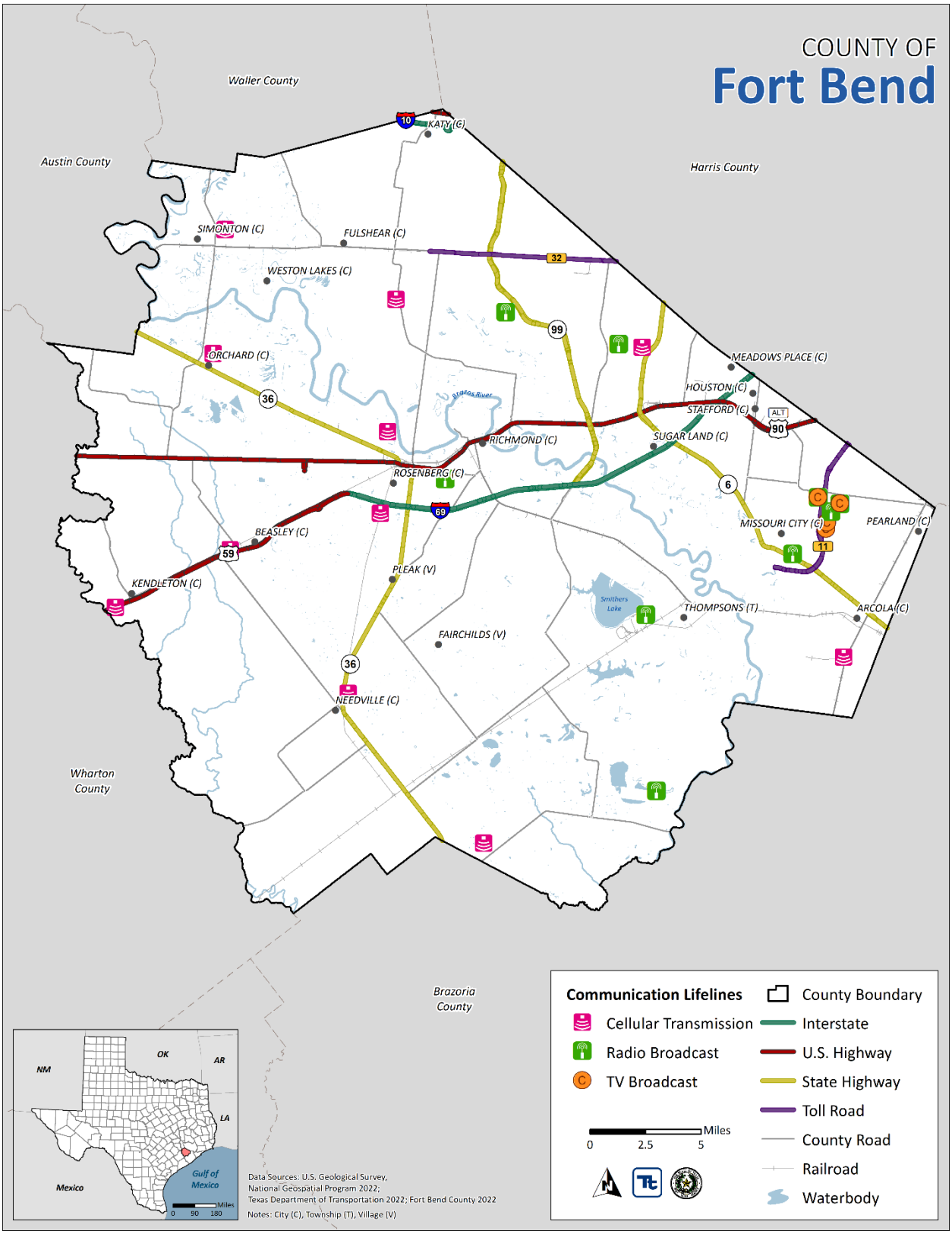


Figure 3-16. Transportation Lifelines in Fort Bend County, Texas

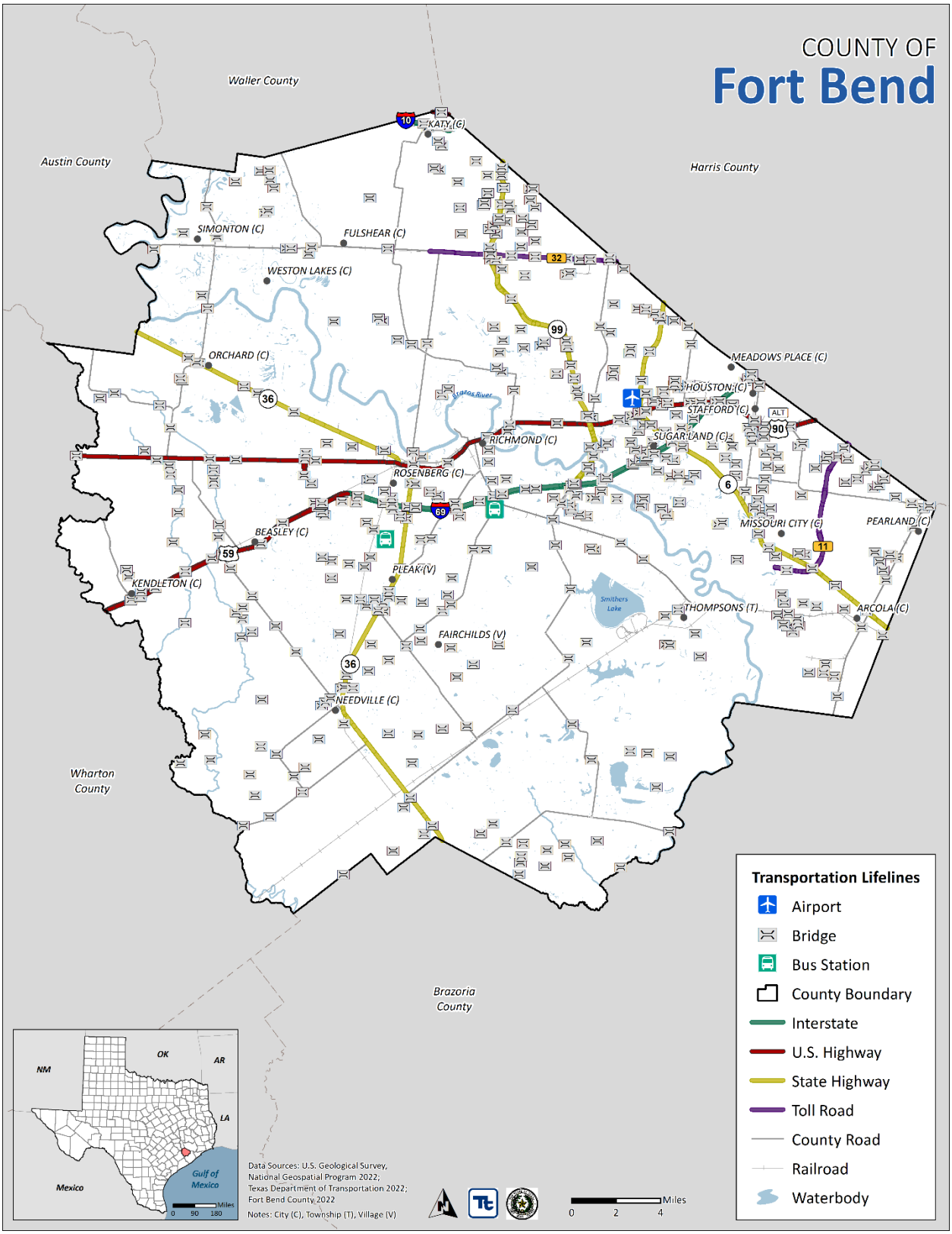
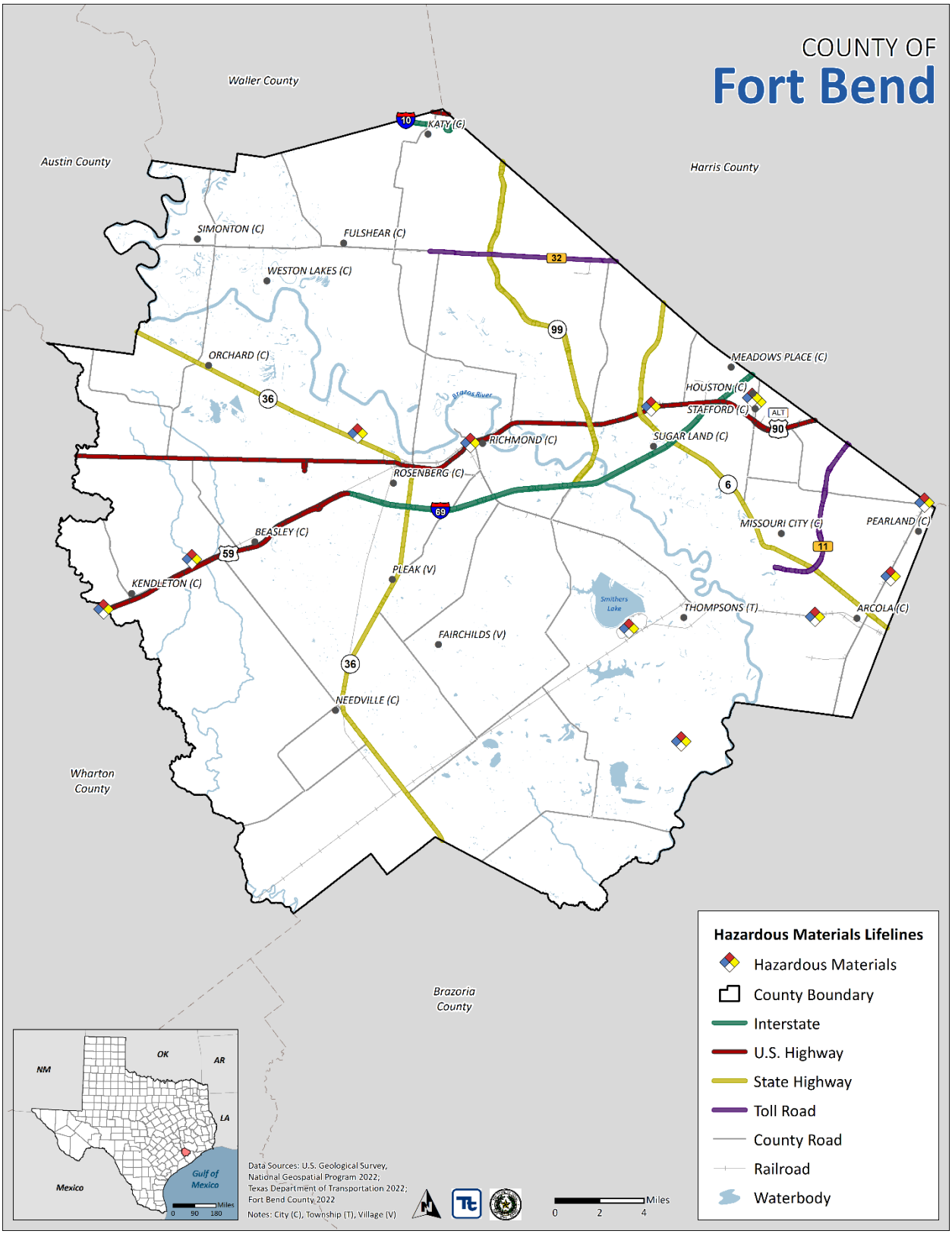


Figure 3-17. Hazardous Materials Lifelines in Fort Bend County, Texas



SECTION 4. RISK ASSESSMENT

4.1 Identification of Hazards of Concern

To provide a strong foundation for mitigation actions considered in Section 6 (Mitigation Strategy), the Planning Team focused on considering a full range of hazards that could impact the area and then identified and ranked those hazards that presented the greatest concern. The hazard of concern identification process incorporated input from the Planning Team; review of the State of Texas Hazard Mitigation Plan (HMP) (2019); review of the 2018 Fort Bend HMP; research and local, state, and federal information on the frequency, magnitude, and costs associated with the various hazards that have previously, or could feasibly, impact the region; and qualitative or anecdotal information regarding natural (not man-made) hazards and the perceived vulnerability of the study area's assets to them. Table 4.1-1 documents the process of identifying the natural hazards of concern for further profiling and evaluation. Specific hazards not identified as a hazard of concern for Fort Bend County will not be further discussed in detail.

4.1.1 Changes to the Hazards of Concern

Since the 2018 HMP was developed, Fort Bend County has experienced hazards and disasters that were not addressed in plan. Stakeholders identified these hazards as areas to be addressed in the 2023 Fort Bend County HMP update. The hazards of concern for Fort Bend County now include two additional hazards and exclude two that were previously listed. Additionally, certain hazards were given new names, and some were separated from combined sections into their own distinct sections.

The 2023 HMP includes the following changes to the hazards of concern:

- The 2018 HMP did not address Pandemic/Disease Outbreak. Beginning in March 2020, Fort Bend County was affected by the COVID-19 pandemic along with the rest of the world. The 2023 HMP includes Pandemic/Disease Outbreak as a hazard of concern.
- The 2018 HMP only addressed Extreme Heat in combination with the Drought hazard of concern. The 2023 HMP update addresses Extreme Temperatures in a separate hazard of concern that includes Extreme Heat and Extreme Cold.
- The 2018 HMP addressed Windstorms as a hazard of concern. The Planning Team agreed to address Windstorms under the Severe Weather hazard of concern.
- Erosion is a newly identified hazard for Fort Bend and was included with Expansive Soils under the Geologic Hazards hazard of concern.
- The 2023 HMP includes the best available data throughout the plan to present an updated understanding of Fort Bend County's risk.

4.1.2 Hazard Groupings

As per the 2018 HMP, the Planning Team maintained the grouping of hazards based on the similarity of hazard events, typical concurrence or impacts, consideration of how hazards have been grouped in Federal Emergency Management Agency (FEMA) guidance documents (*FEMA 386-2 Understanding Your Risks, Identifying Hazards*

and Estimating Losses; *Multi-Hazard Identification and Risk Assessment – The Cornerstone of the National Mitigation Strategy*; *Local Mitigation Planning Handbook*), and consideration of hazard grouping in the State of Texas HMP.

The *Dam/Levee Failure* profile addresses dam/levee failures that may impact Fort Bend County.

The *Drought* hazard profile specifically addresses drought events that may occur in Fort Bend County.

The *Extreme Temperature* hazard profile specifically addresses periods of extreme heat and cold that may occur in Fort Bend County.

The *Flood* hazard includes riverine, flash flooding, coastal, and stormwater flooding. Inclusion of the various forms of flooding is consistent with that used in FEMA's *Multi-Hazard Identification and Risk Assessment* guidance.

The *Geologic Hazards* profile includes erosion and expansive soils that may occur in Fort Bend County.

The *Hurricane and Tropical Storm* profile addresses hurricanes and tropical storms that may occur in or impact Fort Bend County.

The *Pandemic/Disease Outbreak* hazard profile addresses diseases with the potential to impact Fort Bend County, including the novel coronavirus (COVID-19), West Nile virus, and influenza.

The Severe Weather hazard includes lightning, hail, wind, and derecho events that may occur in Fort Bend County.

The *Tornado* hazard profile specifically addresses tornado events that may occur in Fort Bend County.

The *Wildfire* profile addresses wildfire events that may impact Fort Bend County.

The *Winter Weather* profile includes heavy snow, blizzards, and ice storms. This grouping is consistent with the State of Texas HMP.

Table 4.1-1. Identification of Hazards of Concern for Fort Bend County

Hazard	Description
Dam Failure	• The 2018 State of Texas HMP includes dam/levee failure as a hazard of concern for the State. • According to the National Inventory of Dams, there are 16 dams in Fort Bend County: 3 are classified as high hazard, 12 are classified as significant, and 1 is classified as low. • There have been no reported dam or levee incidents in Fort Bend County. • Dam and levee failure was identified as a hazard of concern for Fort Bend County.
Drought	• Fort Bend County has had no FEMA drought declarations. • Fort Bend County has experienced numerous droughts since 2018, according to the NCEI database, most recently one that lasted numerous months in 2022. • Due to the history of occurrence and the impacts drought can have, drought was identified as a hazard of concern for Fort Bend County.
Extreme Temperature (Heat, Cold)	• Extreme heat was identified as a hazard of concern in the 2018 State of Texas HMP. • Fort Bend County was identified in one extreme temperature event in 2021, according to the NCEI database. • Fort Bend County has experienced extreme hot and cold events and will continue to experience them in the future. Therefore, extreme temperatures are identified as a hazard of concern for Fort Bend County.
Flood	• Riverine and coastal flooding are identified as hazards of concern in the 2018 State of Texas HMP; however, they were profiled individually. • Eight flood events have been identified as occurring in Fort Bend County since 2018. The flood events have resulted in five FEMA disaster declarations. • Based on the history of events and losses, flooding was identified as a hazard of concern for Fort Bend County.
Geologic (Erosion, Expansive Soil)	• Erosion is common throughout Fort Bend County along the Brazos River by water and inland erosion caused by wind. • Expansive soils are common throughout Texas because Texas has an abundance of soils with clay that have a high swelling potential and can move and change depending on water ground level. • There is no FEMA-declared disaster; however, expanding soils have led to extensive damages that have destroyed building foundations. • Geologic hazards is identified as a hazard of concern for Fort Bend County.
Hurricane & Tropical Storm	• Hurricanes and tropical storms were identified as a hazard of concern in the 2018 State of Texas HMP. • Fort Bend County has been included in 11 hurricane-related FEMA major disaster and emergency declarations since 1983. • Based on the history of occurrences and losses, the hurricane and tropical storm hazard was identified as a hazard of concern for Fort Bend County.
Pandemic/Disease Outbreak	• Fort Bend County has experienced two separate public health events since 2003. These include West Nile Virus and COVID-19. • COVID-19 continues to impact public health both locally and globally. • Pandemic/disease outbreak was identified as a hazard of concern.
Severe Weather (Lightning, Hail, Wind, Derechos)	• Lightning was identified as a hazard of concern in the 2018 State of Texas HMP. • Lightning occurs frequently in Fort Bend County and has been recorded 23 times by the NCEI database. • Fort Bend has had two recorded hail events since 2018 that affected Fort Bend County. • Fort Bend has not experienced any hailstorm-related major disaster/emergency declarations. • Wind events encompass all occurrences that take place in various storms and weather. • Nine wind events occurred in Fort Bend County, as recorded by the NCEI database since 2018. • There have been no recorded occurrences of a derecho event in Fort Bend County since 2018. • Severe weather was identified as hazards of concern for Fort Bend County.
Tornado	• Tornado was identified as a hazard of concern in the 2018 State of Texas HMP. • Fort Bend County has not been included in any tornado-specific FEMA disaster declarations but has had two incidents recorded in Fort Bend County since 2018. • The tornado hazard was identified as a hazard of concern for Fort Bend County.
Wildfire	• Wildfire was identified as a hazard of concern in the 2018 State of Texas HMP. • Fort Bend has not experienced any fires that have been documented by FEMA or NOAA.

Hazard	Description
	• The wildfire hazard was identified as a hazard of concern for Fort Bend County.
Winter Weather	• Winter weather was identified as a hazard of concern in the 2018 State of Texas HMP. • Fort Bend County has been included in two winter weather-related FEMA major disasters and emergency declarations. • NCEI database has recorded seven winter weather events in Fort Bend County since 1997. • The hazard was identified as a hazard of concern for Fort Bend County.

SECTION 4. RISK ASSESSMENT

4.2 Methodology and Tools

Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from identified hazards. It allows emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. The process focuses on the following elements:

- Hazard identification—Use all available information to determine what types of hazards may affect a jurisdiction, how often they can occur, and their potential severity.
- Exposure identification—Estimate the total number of people and properties in the jurisdiction that are likely to experience a hazard event if it occurs.
- Vulnerability identification and loss estimation—Assess the impact of hazard events on the people, property, environment, economy, and lands of the region, including estimates of the cost of potential damage or cost that can be avoided by mitigation.

The risk assessment for the 2023 Fort Bend County Hazard Mitigation Plan (HMP) update evaluates the risk of natural hazards prevalent in the planning area and meets requirements of the Disaster Mitigation Act (44 CFR, Section 201.6(c)(2)).

To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual personal or public properties.

The following describes the methodology and tools used to conduct the risk assessment for the 2023 Fort Bend County HMP update.

4.2.1 Risk Assessment Tools

Mapping

National, State of Texas, and Fort Bend County databases were reviewed to locate available spatially based data relevant to this planning effort. Maps were produced using geographic information system (GIS) software to show the spatial extent and location of hazards when such datasets were available. These maps are included in the hazard profile chapters of this document.

Hazus

In 1997, the Federal Emergency Management Agency (FEMA) developed the standardized Hazards U.S. (Hazus) model to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. Hazus was later expanded into a multi-hazard methodology with new models for estimating potential losses from hurricanes and floods.

Hazus is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, critical facility, transportation and utility lifeline, and multiple models to estimate potential losses from natural

disasters. The program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that they can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Administered by the local government and can be used to manage and update an HMP throughout its implementation.

Level of Detail for Evaluation

Hazus provides default data for inventory, vulnerability, and hazards; these default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis, depending on the format and level of detail of information about the planning area:

- Level 1—All of the information needed to produce an estimate of losses is included in the software's default data. These data are derived from national databases and describe in general terms the characteristic parameters of the planning area.
- Level 2—More accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics, and building inventory as well as data about utilities and critical facilities. This information is needed in a GIS format.
- Level 3—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

4.2.2 Risk Assessment Approach

The risk assessments in this plan describe the risks associated with each hazard of concern identified. The following steps were used to define the risk of each hazard:

- **Identify and profile each hazard**—The following information is given for each hazard:
  - Geographic areas most affected by the hazard
  - Event frequency estimates
  - Severity estimates
  - Warning time likely to be available for response
- **Determine exposure to each hazard**—Exposure was assessed by overlaying hazard maps with an inventory of structures, facilities, and systems to decide which of them would be exposed to each hazard.
- **Assess the vulnerability of exposed facilities**—Vulnerability of exposed structures and infrastructure was evaluated by interpreting the probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard. Tools such as GIS and FEMA's hazard-modeling program Hazus were used for this assessment for the earthquake, flood, and hurricane hazards. Outputs like those from Hazus were generated for other hazards using data generated through GIS.

Dam/Levee Failure

The Dam Inundation hazard data was provided by the Fort Bend County Drainage District and the U.S. Army Corp of Engineers. Three Dam Inundation areas were assessed: Barker Reservoir Dam, Lake Sommerville Dam, and Kitty Hollow Dam. Asset data (population, building stock, critical facilities, and new development) were used to support an evaluation of assets exposed and potential impacts and losses. To determine what assets are at risk to impacts from dam failure, the County's assets were overlaid with the hazard area. Assets with their centroid located in the hazard area were totaled to estimate the number of persons, buildings, and facilities at risk to impacts from dam failure.

Drought

To assess the vulnerability of Fort Bend County to drought and its associated impacts, a qualitative assessment was conducted. The United States Department of Agriculture (USDA) Census of Agriculture 2017 was used to estimate economic impacts. Information regarding the number of farms and farmland areas was extracted from the report and summarized in the vulnerability assessment. Additional resources from the Texas HMP, Texas Commission on Environmental Quality, and the Environmental Protection Agency were used to assess the potential impacts to the population from a drought event.

Extreme Temperature

All of Fort Bend County is exposed to extreme temperature events. A qualitative assessment was conducted for the extreme temperature hazard. Information from the National Weather Service (NWS), Centers for Disease Control and Prevention (CDC), stakeholder plans/reports, the Texas State HMP, and the Planning Partnership were used to assess the potential impacts to the County's assets.

Geologic Hazards

This updated HMP referenced inland erosion and expansive soil hazard areas to assess the County's risk to the geologic hazards.

The best available data was used to assess Fort Bend County's vulnerability to expansive soils. To help understand the geographic distribution of expansive soils, USDA Natural Resources Conservation Service's (NRCS) 2022 soil data for Fort Bend County was referenced. Soils with linear extensibility greater than or equal to 6 percent were selected as expansive soils. Asset data (population, building stock, critical facilities, and new development) were used to support an evaluation of assets exposed and potential impacts and losses. To determine what assets are at risk to impacts from expansive soils, the County's assets were overlaid with the hazard area. Assets with their centroid located in the hazard area were totaled to estimate the number of persons, buildings, and facilities at risk to impacts from expansive soils.

To assess the vulnerability of the County to inland erosion events and its associated impacts, a quantitative assessment was conducted using the best available data. To help understand the geographic distribution of inland erosion, USDA's NRCS's 2022 soil data for Fort Bend County was referenced. Soils with k-factor greater than or equal to 0.49 were selected as susceptible soil. K-Factor is soil erodibility factor that represents both susceptibility of soil to erosion and the rate of runoff. To estimate potential exposure to the subsidence hazard area, assets (population, building stock, critical facilities and lifelines, new development) with their centroid in the hazard area were totaled to estimate the numbers and values exposed to the subsidence hazard boundary.

Flood

The 1 percent and 0.2 percent annual chance flood events were examined to evaluate the County's risk from the flood hazard. These flood events are generally those considered by planners and evaluated under federal programs such as the National Flood Insurance Program (NFIP).

The following data was used to evaluate exposure and determine potential future losses for this plan update:

- The Fort Bend County effective FEMA Digital Flood Insurance Rate Map (DFIRM) dated January 29, 2021
- The depth grid was developed by the Fort Bend County Drainage District in May 2023. The depth grids that Fort Bend County Drainage District created did not cover the entirety of FEMA's 1 percent annual chance flood event. The effective Fort Bend County FEMA DFIRM published in 2021 was used to fill in these gaps for the depth grids to evaluate exposure and determine potential future losses. The depth grid was generated using the effective DFIRM and a 1-meter resolution Digital Elevation Model (DEM) provided by the County. The final depth grid was integrated into the Hazus v5.1 riverine flood model used to estimate the potential losses for the 1 percent annual chance flood events.

To estimate exposure to the 1 percent and 0.2 percent annual chance flood events, the effective DFIRM flood boundaries were overlaid on the centroids of updated assets (population, building stock, and critical facilities) Centroids that intersected the flood boundaries were totaled to estimate the building replacement cost value and population vulnerable to the flood inundation areas. A Level 2 Hazus riverine flood analysis was performed in Hazus v5.1. Both the critical facility and building inventories were formatted to be compatible with Hazus and its Comprehensive Data Management System (CDMS). Once updated with the inventories, the Hazus riverine flood model was run to estimate potential losses in Fort Bend County for the 1 percent annual chance flood events. A user-defined analysis was also performed for the building stock. Buildings located within the floodplain were imported as user-defined facilities to estimate potential losses to the building stock at the structural level. Hazus calculated the estimated potential losses to the population (default 2010 U.S. Census data across dasymetric blocks), potential damages to the general building stock, and potential damages to critical facility inventories based on the depth grid generated and the default Hazus damage functions in the flood model.

Pandemic/Disease Outbreak

All of Fort Bend County is exposed to disease outbreak events. A qualitative assessment was conducted. Research from the Centers for Disease Control and Prevention was utilized to qualitatively assess the most recent COVID-19 outbreak.

Severe Weather

All of Fort Bend County is exposed to severe summer weather. A qualitative analysis was conducted for this hazard, and information from the State of Texas 2019 HMP, NWS, and FEMA National Risk Index was used to develop the hazard profile and to determine risk and exposure.

Tornado

All of Fort Bend County is exposed to tornadoes. A qualitative analysis was conducted for this hazard, and information from the State of Texas 2019 HMP, NWS, and FEMA National Risk Index was used to develop the hazard profile and to determine risk and exposure.

Wildfire

The 2022 wildfire threat hazard area obtained through Texas A&M Forest Service was referenced to delineate wildfire hazard areas. Wildfire threat was measured by the Texas A&M Forest Service using the Wildland Fire Susceptibility Index (WFSI), which is defined as the likelihood of an acre burning. This data is derived at a 30-meter resolution.

Asset data (population, building stock, critical facilities, and new development) were used to support an evaluation of assets exposed and potential impacts and losses. To determine what assets are at risk to impacts from wildfires, the County's assets were overlaid with the hazard area. Assets with their centroid located within the wildfire hazard areas were totaled to estimate the number of persons, buildings, and facilities at risk to impacts from wildfire events.

Hurricane

A Hazus probabilistic analysis was performed to analyze the wind hazard losses for Fort Bend County for the 100-year and 500-year mean return period events. The probabilistic Hazus hurricane model activates a database of thousands of potential storms that have tracks and intensities reflecting the full spectrum of Atlantic hurricanes observed since 1886 and identifies those with tracks associated with the County. Hazus contains data on historic hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces. Default demographic and updated building and critical facility inventories in Hazus were used for the analysis. Although damages are estimated at the census tract level, results were presented at the jurisdiction level. Because there are multiple census tracts that contain more than one jurisdiction, a density analysis was used to extract the percent of each jurisdiction within each tract. The percentage was multiplied against the results calculated for each tract and summed for each jurisdiction.

Winter Weather

All of Fort Bend County is exposed and vulnerable to the winter storm hazard. In general, structural impacts include damage to roofs and building frames, rather than building content. Current modeling tools are not available to estimate specific losses for this hazard. Information and data from the State of Texas 2019 HMP, NWS, and FEMA National Risk Index was used to develop the hazard profile and to determine risk and exposure.

All Other Assessed Hazards

No GIS format datasets appropriate for an exposure analysis were identified for the following hazards: drought, extreme temperature, hail, lightning, pandemic, thunderstorm wind, and tornadoes.

4.2.3 Sources of Data Used in Hazus Modeling and Exposure Analyses

Fort Bend County assets were identified to assess potential exposure and loss associated with the hazards of concern. For the HMP update, Fort Bend County assessed exposure vulnerability of the following types of assets: population, buildings, critical facilities/infrastructure, and new development. Some assets may be more vulnerable because of their physical characteristics or socioeconomic uses. To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual personal or public properties.

Building and Cost Data

The data for general building stock was provided by Fort Bend County, last updated in 2016. The general building stock is analyzed at the aggregate Census Block and Census Tract levels and incorporates 2010 Census data with the 2022 RS Means replacement cost values. Structural and content replacement cost values (RCV) were calculated for each building utilizing available assessor data and RS Means 2022 values; a regional location factor for Fort Bend County was applied (0.85 for residential structures located within a Houston zip code; 0.77 for residential structures located within a Wharton zip code; 0.80 for residential structures located within a Galveston zip code. 0.85 for all other structure types located within a Houston zip code; 0.82 for all other structure types located within a Wharton zip code; 0.82 for all other structure types located within a Galveston zip code.).

The occupancy classes were condensed into the categories of residential, commercial, industrial, agricultural, religious, governmental, and educational to facilitate analysis and presentation of results. Residential loss estimates addressed both multi-family and single-family dwellings.

Critical Facilities and Lifelines

The 2023 HMP critical facility inventory, which includes essential facilities, utilities, government offices, transportation features, and user-defined facilities, was updated by Fort Bend County. The update involved a review for accuracy, additions, or deletions of new/moved critical assets, identification of backup power for each asset (if known) and whether the critical facility is considered a lifeline in accordance with FEMA's definition. To protect individual privacy and the security of assets, information is presented in aggregate, without details about specific individual properties or facilities.

Population

Fort Bend County used the total population statistics from the 2017–2021 American Community Survey (ACS) 5-year estimate to estimate the exposure and potential impacts to the County's population in place of the 2010 U.S. Census block estimates. City, Township, and Village populations were extracted directly from the Census Bureau and ACS. Limitations of these analyses are recognized, and thus, the results are used only to provide a general estimate for planning purposes.

As discussed in Section 3.0 (County Profile), research has shown that some populations are at greater risk from hazard events because of decreased resources or physical abilities. Vulnerable populations in Fort Bend County included in the risk assessment are children, elderly, and people living in low-income households.

Hazus Data Inputs

The following hazard datasets were used for the Hazus Level 2 analysis conducted for the risk assessment:

- **Flood**—The depth grid was developed by the Fort Bend County Drainage District in May 2023. The depth grids that Fort Bend County Drainage District created did not cover the entirety of FEMA's 1 percent annual chance flood event. The effective Fort Bend County FEMA DFIRM published in 2021 and a 1-meter resolution DEM provided by the County was used to develop a depth grid that could fill in the entirety of FEMA's 1 percent annual chance flood to evaluate exposure and determine potential future losses. The final depth grid was integrated into the Hazus v5.1 riverine flood model used to estimate the potential losses for the 1 percent annual chance flood events.
- **Hurricane**—Hazus hurricane probabilistic data were used for the analysis of this hazard.

Other Local Hazard Data

Locally relevant information on hazards was gathered from a variety of sources. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists, and others. Data sources for specific hazards were as follows:

- **Expansive Soils**—2022 USDA's Natural Resources Conservation Service's soil data for soil types with a linear extensibility >6 percent
- **Inland Erosion** —2022 USDA's Natural Resources Conservation Service's soil data of a K-Factor >=0.49
- **Wildfire**—2022 Texas A&M Forest Service wildfire threat hazard area
- **Dam Inundation Areas** – 2023 Fort Bend County Drainage District; 2023 U.S. Army Corp of Engineers' dam inundation areas based on maximum high (MH) Breach

No GIS format datasets appropriate for an exposure analysis were identified for the following hazards: drought, extreme temperature, pandemic, severe weather, and winter weather.

Data Source Summary

Table 4.2.3-1 summarizes the data sources used for the risk assessment for this plan.

Table 4.2.3-1. Data Source Summary

Data	Source	Date	Format
Population Data	U.S. Census Bureau; American Community Survey 5-Year Estimates	2010/2020; 2017-2021	Digital (GIS) Format; CSV
Building Inventory	Fort Bend County	2016	Digital (GIS) Format
Critical Facilities	Fort Bend County; Hazus v5.1	2023	Digital (GIS) Format
Digitized Effective FIRM Data	FEMA	2021	Digital (GIS) Format
Digital Elevation Model	Texas Natural Resources Information System	2019	Digital (GIS) Format
Flood Depth Grid	Fort Bend County Drainage District	2023	Digital (GIS) Format
Expansive Soils	USDA	2022	Digital (GIS) Format
Dam Inundation	Fort Bend County Drainage District; U.S. Army Corps of Engineers	2023	Digital (GIS) Format
Inland Erosion	USDA	2022	Digital (GIS) Format
Wildfire	Texas A&M Forest Service	2022	Digital (GIS) Format

Notes: FEMA – Federal Emergency Management Agency; USDA – United States Department of Agriculture; USGS – United States Geological Survey

4.2.4 Limitations

Loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

- Approximations and simplifications necessary to conduct a study
- Incomplete or outdated inventory, demographic, or economic parameter data
- The unique nature, geographic extent, and severity of each hazard
- Mitigation measures already employed
- The amount of advance notice residents has to prepare for a specific hazard event.

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate and should be used only to understand relative risk. Over the long term, Fort Bend County will collect additional data to assist in estimating potential losses associated with other hazards.

SECTION 4. RISK ASSESSMENT

4.3 Hazard Profiles

4.3.1 Dam/Levee Failure

This section presents information regarding the description, extent, location, previous occurrences and losses, climate change projections, and probability of future occurrences for the dam/levee failure hazard in Fort Bend County.

Hazard Profile

Hazard Description

Dam Failure

A dam failure is defined as systematic failure of dam structure resulting in the uncontrolled release of water, often resulting in floods that could exceed the 100-year flood plain boundaries. A dam failure could cause mass fatalities and extensive structural damage if populated and/or industrial areas are located near or downstream of the dam structure.

Dam failure can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary hazards of dam failure are landslides around the reservoir perimeter, bank erosion on the rivers, and destruction of downstream habitat.

Dam failure is a collapse or breach in a dam. While most dams have storage volumes small enough that failures have little or no repercussions, dams with large storage amounts can cause significant downstream flooding. Dam failures in the United States typically occur from any one or combination of the following:

- Overtopping of the primary dam structure can occur due to inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors.
- Foundation defects due to differential settlement, slides, slope instability, uplift pressures, and foundation seepage can also cause dam failure.
- Failure due to piping and seepage are caused by internal erosion due to piping and seepage, erosion along hydraulic structures such as spillways, erosion due to animal burrows, and cracks in the dam structure.
- Failure due to problems with conduits and valves are typically caused by the piping of embankment material into conduits through joints or cracks.

Many dam failures in the United States have been secondary results from other disasters. The prominent causes are earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage.

Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that all

operators of public facilities must plan for; these threats are under continuous review by public safety agencies (FEMA 2019).

Levee Failure

A levee is a physical barrier constructed to protect areas from rising floodwaters. Levees typically remove valuable floodplain storage and block the ability of the channel to move water. There are also concerns with rainfall that falls on the levee itself. Most important is the possibility for catastrophic and sudden failure under extreme flood events, potentially resulting in loss of life and total destruction of property (National Geographic 2022).

A levee breach occurs when part of a levee gives way, creating an opening through which floodwaters may pass. A breach may occur gradually or suddenly. The most dangerous breaches happen quickly during periods of high water. Earthen levees can be damaged in several ways. Strong river currents and waves can erode the surface. Trees growing on a levee can blow over, leaving a hole where the root wad and soil used to be. Burrowing animals can create holes that enable water to pass through a levee. If severe enough, any of these situations can lead to a zone of weakness that could cause a levee breach. In seismically active areas, earthquakes and ground shaking can cause a loss of soil strength, weakening a levee and possibly resulting in failure. Seismic activity can also cause levees to slide or slump, both of which can lead to failure (FEMA 2016).

The complicated nature of levee protection was made evident by events such as Hurricane Katrina. Flooding can be exacerbated by levees that are breached or overtopped. As a result, FEMA and USACE are re-evaluating their policies regarding enforcement of levee maintenance and post-flood rebuilding. Both agencies are also conducting stricter inspections to determine how much protection individual levees provide (Federal Register 2021). The Texas Water Development Board's (TWDB) mission is to provide leadership, information, education, and support for planning, financial assistance, and outreach for the conservation and responsible development of water for Texas. TWDB will assist qualifying entities who are in good standing with the National Flood Insurance Program (NFIP) through technical and financial assistance. TWDB assistance may include grant funding, participation in levee inspections, assistance in developing Maintenance Deficiency Correction Plans, site visits, and participation in public hearings. In addition, the TWDB will also discourage the construction of new levees to protect new developments and instead encourage other types of flood mitigation projects (Texas Water Development Board n.d.).

Location

Dam Failure

The majority of dams and lakes in Texas are used for water supply. Dams also provide benefits such as irrigation for agriculture, hydropower, flood control, maintenance of lake levels, and recreation. However, despite the benefits and importance of dams to our public works infrastructure, many safety issues exist for dams as with any complex infrastructure; the most serious threat is dam failure.

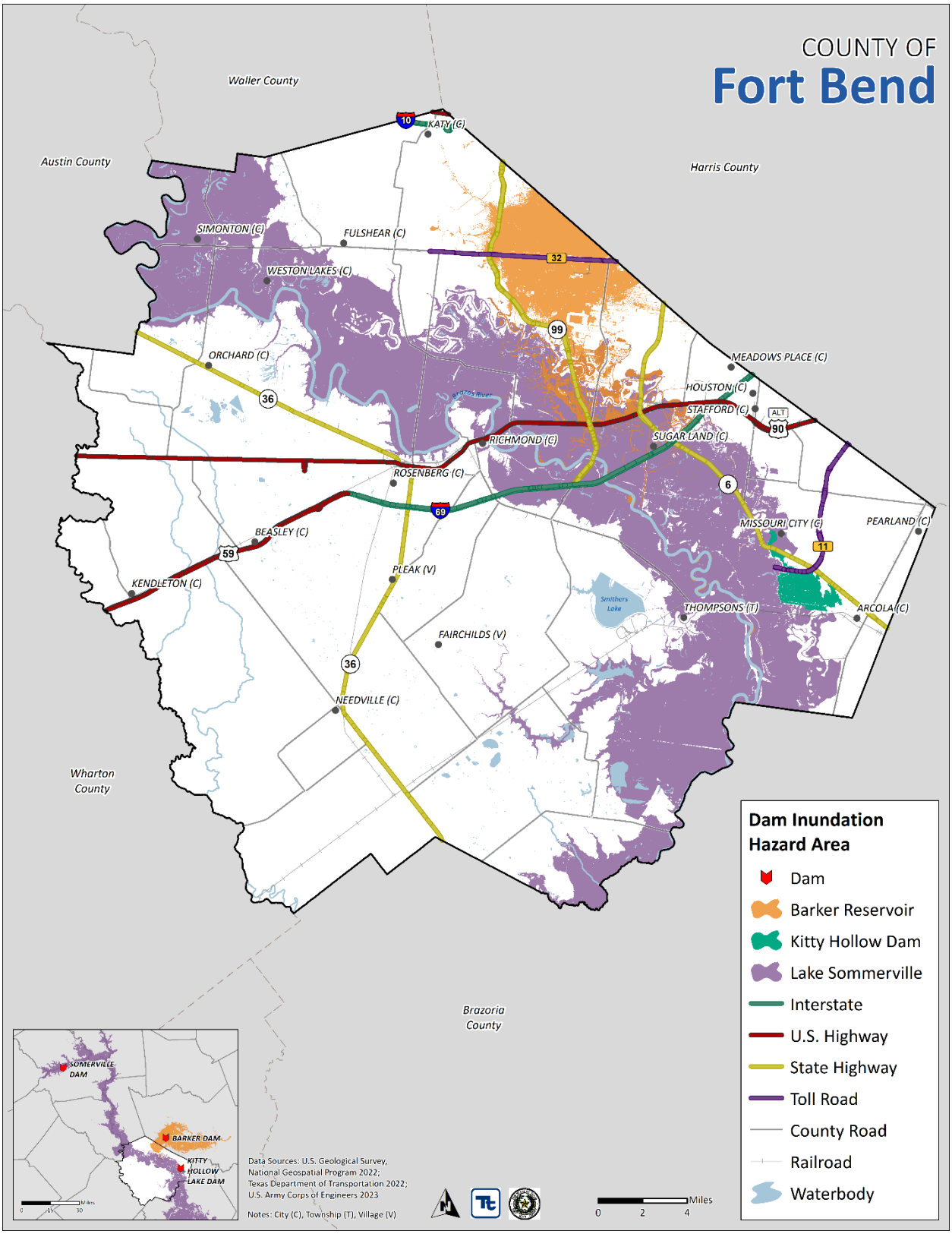
There are 20 total dams located in Fort Bend County. The Nationals Inventory of Dams does not list the hazard potential classification for any of the 20 dams in the County (USACE 2022). Table 4.3.1-1 lists the documented dams in Fort Bend County. Figure 4.3.1-1 shows the dam inundation hazard area for Fort Bend County.

Table 4.3.1-1. Dams in Fort Bend County

Dam Name	State Regulated Dam	Hazard Potential Classification	EAP Prepared
G Fowler Gss	Yes	Not Available	Not Required
Hale Lake Dam	Yes	Not Available	Not Required
Lake Paw Paw Dam	Yes	Not Available	Not Required
Horseshoe Lake Dam	Yes	Not Available	Not Required
Delaro Gss	Yes	Not Available	Not Required
Smithers Lake Dam	Yes	Not Available	Yes
Katy Mills Dam	Yes	Not Available	Not Required
Kitty Hollow Lake Dam	Yes	Not Available	Yes
Dam No 3	Yes	Not Available	Yes
Tx No Name No 43 Dam	Yes	Not Available	Not Required
Old Second Lift Dam	Yes	Not Available	Not Required
Dam No 2	Yes	Not Available	Yes
Dam No 1	Yes	Not Available	Not Required
Penny Lake Dam	Yes	Not Available	Not Required
Booth Estate Pond Dam	Yes	Not Available	Not Required
Elm Lake Dam	Yes	Not Available	Not Required
Frost Reservoir No 2 Dam	Yes	Not Available	Not Required
Pilant Lake Dam	Yes	Not Available	Not Required
40 Acre Lake Dam	Yes	Not Available	Not Required
Key Court Dam	Yes	Not Available	Not Required

Source: USACE 2022

Figure 4.3.1-1. Dam Inundation Areas in Fort Bend County



Levee Failure

The majority of dams and lakes in Texas are used to prevent rivers from flooding cities in a storm surge. Levees may be used to increase available land for habitation or divert a body of water so the fertile soil of a river may be used for agriculture.

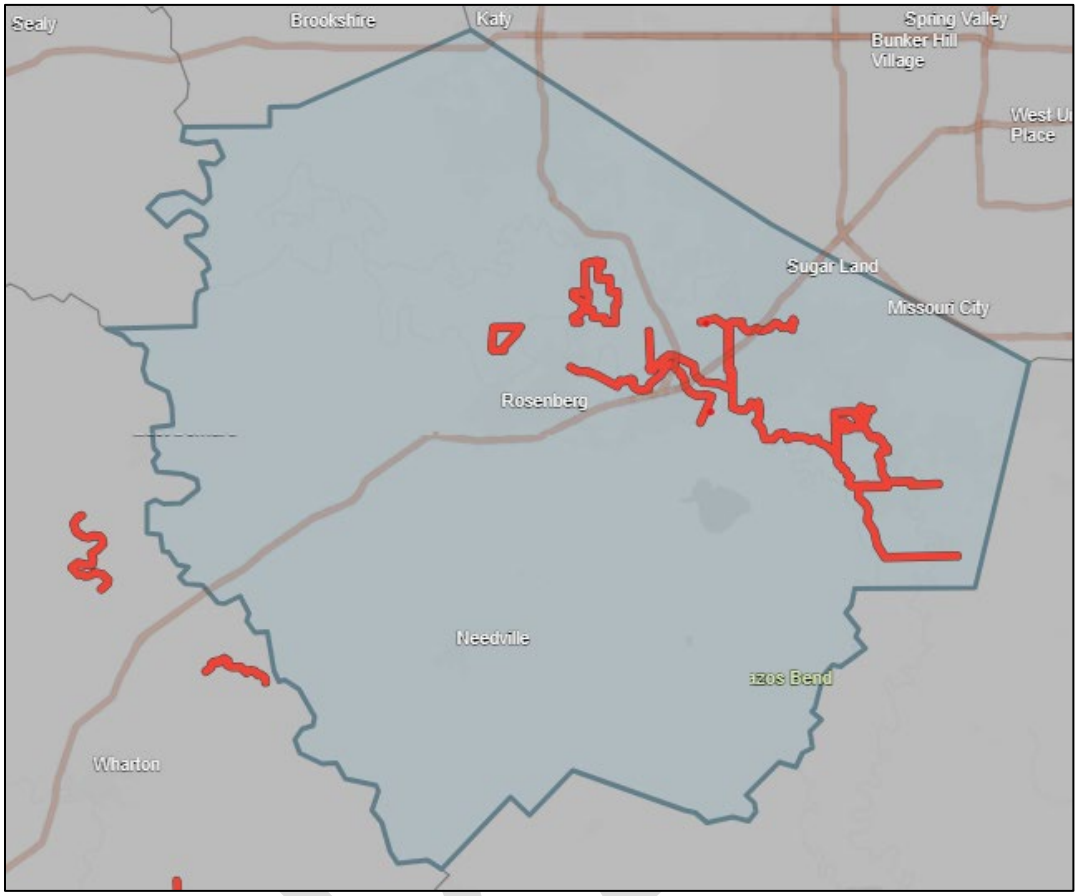
There are 12 total levees located in Fort Bend County, all of which are locally constructed, operated, and maintained (USACE 2023). Table 4.3.1-2 shows the documented levees in Fort Bend County. Figure 4.3.1-2 shows the location of levees in Fort Bend County.

Table 4.3.1-2. Levees in Fort Bend County

Name	Authorization Category	Levee Sponsor(s)
LID 10-11-6_MUD 121 System	Locally Constructed, Locally Operated and Maintained	FBCLID 6, FBCLID 10, FBCLID 11, FBMUD 121
LID 20 Levee System	Locally Constructed, Locally Operated and Maintained	FBCLID 20
LID 7-17 System	Locally Constructed, Locally Operated and Maintained	FBCLID 7, FBCLID 17
MUD 49 Levee	Locally Constructed, Locally Operated and Maintained	FBCMUD 49
Palmer MUD Levee	Locally Constructed, Locally Operated and Maintained	Palmer Plantation MUD 1, Palmer Plantation MUD 2
Pecan Grove LID Levee System	Locally Constructed, Locally Operated and Maintained	Pecan Grove MUD
Pecan Lakes Flood Protection System	Locally Constructed, Locally Operated and Maintained	Pecan Grove MUD
Rio Vista Levee System	Locally Constructed, Locally Operated and Maintained	FBCMUD 145
Sienna Plantation LID South	Locally Constructed, Locally Operated and Maintained	Sienna Parks and Levee Improvement District
Sienna Plantation Levee Systems	Locally Constructed, Locally Operated and Maintained	Sienna Parks and Levee Improvement District
Sugarstone	Locally Constructed, Locally Operated and Maintained	FBCLID 2, FBCLID 14, First Colony LID, First Colony LID 2, FBCLID 15, FBCLID 19, FBCMUD 46
West Wastewater Treatment Plant Levee System	Locally Constructed, Locally Operated and Maintained	City of Sugar Land / Brazos River Authority

Source: USACE 2023; Fort Bend County Levee Districts 2023

Figure 4.3.1-2. Levees in Fort Bend County



Source: USACE 2023

Extent

The extent or magnitude of a dam failure event can be measured in terms of the classification of the dam. Additionally, there are two factors that influence the potential severity of a full or partial dam failure are: (1) the amount of water impounded, and (2) the density, type, and value of development and infrastructure located downstream (Association of State Dam Safety Officials 2020). The following classification system is used by the USACE for the hazard potential of dams.

- **Low Hazard Potential Dams** are dams where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.
- **Significant Hazard Potential Dams** where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, or disruption of lifeline facilities or affect other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
- **High Hazard Potential Dams** are dams where failure or misoperation will probably cause loss of human life (USACE 2022).

Levee Failure

The classification of a levee is dependent on several factors, such as risk assessments, design deviations, policy issues, and life safety. The United States Army Corps of Engineers (USACE) classifies levees to help prioritize its resources and does not define risk (USACE 2021).

- **Very Low:** Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in very low risk.
- **Low:** Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in low risk.
- **Moderate:** Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in moderate risk.
- **High:** Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in high risk.
- **Very High:** Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in very high risk (USACE 2021).

Worst-Case Scenario

While the probability of a dam or levee failure is low, a worst-case scenario would be a hurricane or tropical storm that would stall over Fort Bend County, causing a dam or levee to breach and impacting areas that are supposed to be protected. If a dam or levee failure were to occur, properties protected by the structures could see standing water and minor injuries, but loss of life is not expected.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2022, Fort Bend County was not included in any disaster (DR) or emergency (EM) declarations for dam or levee failure-related events. Generally, these disasters cover a wide region of the state; therefore, they can impact many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2022). Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

U.S. Department of Agriculture Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2017 and 2022, Fort Bend County was not included in any dam or levee failure-related agricultural disaster declarations.

Previous Events

For this 2023 Hazard Mitigation Plan (HMP) update, known dam or levee failure-related events that impacted the County were researched. No events were identified.

Probability of Future Occurrences

For the 2023 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of dam and levee failure events for Fort Bend County. Information from NOAA-NCEI storm events database, the 2018 State of Texas HMP, the 2018 Fort Bend County HMP, and the USACE were used to identify the number of dam and levee failure events that occurred between 1950 and 2022. Using these sources ensures the most accurate probability estimates possible. Table 4.3.1-3 presents the probability of future occurrence of dam and levee failure events in Fort Bend County.

Table 4.3.1-3. Probability of Future Dam/Levee Failure Events in Fort Bend County

Hazard Type	Number of Occurrences Between 1950 and 2022	Percent Chance of Occurrence in Any Given Year
Dam Failure	0	0
Levee Failure	0	0
Total	**0**	**0**

Sources: *NOAA NCEI 2022; State of Texas 2018; Fort Bend County 2018*
Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected dam/levee failure events since 1968.

In Section 4.4, the identified hazards of concern for Fort Bend County were ranked (Table 4.4-2). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Partnership, the probability of occurrence for dam failure in the County is considered “occasional”.

Climate Change Projections

The climate of Texas is changing. Most of the state has warmed between .5 and 1 degree Fahrenheit in the past century. In the eastern two-thirds of the state, rainstorms are more intense, and floods are becoming more severe. In the coming decades, storms are likely to become more severe in Texas (EPA 2016). Periods of extreme precipitation increase the risk of dam and levee failure (Centers for Climate and Energy Solutions n.d.).

Assumptions about a river’s flow behavior, expressed as hydrographs, are influences for dam and levee design. Changes in weather patterns can significantly affect the hydrograph used for the design of a dam or levee. If the hygrograph changes, the dam or levee conceivably could lose some or all of its designed margin of safety, also known as freeboard. Loss of designed margin of safety increases possibility that floodwaters would overtop the dam or levee or create unintended loads, which could lead to a failure.

Vulnerability Assessment

Impact on Life, Health, and Safety

Dam Failure

The impact of dam failure on life, health, and safety is dependent on several factors, such as the class of dam, the area that the dam is protecting, the location of the dam, and the proximity of structures, infrastructure, and critical facilities to the dam structure. The USACE classifies dams based on the potential hazard to the downstream area resulting from failure or mis-operation of the dam or facilities. Please refer to Table 4.3.1-4 below.

Table 4.3.1-4. USACE Hazard Potential Classifications for Dams

Hazard Category (a)	Direct Loss of Life (b)	Lifeline Losses (c)	Property Losses (d)	Environmental Losses (e)
Low	None (rural location, no permanent structures for human habitation)	No disruption of services (cosmetic or rapidly repairable damage)	Private agricultural lands, equipment, and isolated buildings	Minimal incremental damage
Significant	Rural location, only transient or day-use facilities	Disruption of essential facilities and access	Major public and private facilities	Major mitigation required
High	Certain (one or more) extensive residential, commercial, or industrial development	Disruption of essential facilities and access	Extensive public and private facilities	Extensive mitigation cost or impossible to mitigate

Sources: FEMA 2004

Notes:
a. Categories are assigned to overall projects, not individual structures at a project.
b. Loss-of-life potential is based on inundation mapping of area downstream of the project. Analyses of loss-of-life potential should take into account the population at risk, time of flood wave travel, and warning time.
c. Lifeline losses include indirect threats to life caused by the interruption of lifeline services from project failure or operational disruption; for example, loss of critical medical facilities or access to them.
d. Property losses include damage to project facilities and downstream property and indirect impact from loss of project services, such as impact from loss of a dam and navigation pool, or impact from loss of water or power supply.
e. Environmental impact downstream caused by the incremental flood wave produced by the project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.

The estimation for population exposure to the dam inundation hazard area is limited to the following dams – the Barker Reservoir Dam, Lake Sommerville Dam, and Kitty Hollow Dam. Though the Barker Reservoir Dam is located in Harris County, the dam inundation hazard area spans into Fort Bend County. Based on the spatial analysis, there are an estimated 58,074 residents living in the Barker Reservoir Dam Inundation Area, or 7.2 percent of the County's total population. There are an estimated 186,820 residents living in the Lake Sommerville Dam Inundation Area, or 23.2 percent of the County's total population. There are an estimated 1,719 residents living in the Kitty Hollow Dam Inundation Area, or 0.2 percent of the County's total population. The Unincorporated Areas of Fort Bend County has the greatest number of residents living in the Barker Reservoir Dam Inundation Area with approximately 57,665 residents. The City of Sugarland has the greatest number of residents living in the Lake Sommerville Dam Inundation Area with approximately 80,871 residents. Missouri City has the greatest number of residents living in the Kitty Hollow Dam Inundation Area with approximately 1,584 residents. Table 4.3.1-5 summarizes the population exposed to the dam failure hazard by jurisdiction.

Table 4.3.1-5. Estimated Number of Persons in Fort Bend County Living in Dam Inundation Areas

Jurisdiction	Total Population (American Community Survey 2021)	Estimated Population Located in Dam Inundation Area					
		Barker Reservoir Dam Inundation Area		Lake Sommerville Dam Inundation Area		Kitty Hollow Dam Inundation Area	
		Number of People	Percent of Total	Number of People	Percent of Total	Number of People	Percent of Total
Arcola (C)	2,593	0	0.0%	4	0.2%	22	0.9%
Beasley (C)	957	0	0.0%	0	0.0%	0	0.0%
Fairchilds (V)	755	0	0.0%	0	0.0%	0	0.0%
Fulshear (C)	17,259	0	0.0%	2,166	12.6%	0	0.0%
Houston (C)	41,279	0	0.0%	0	0.0%	0	0.0%
Katy (C)	21,926	0	0.0%	0	0.0%	0	0.0%
Kendleton (C)	341	0	0.0%	0	0.0%	0	0.0%

Jurisdiction	Total Population (American Community Survey 2021)	Estimated Population Located in Dam Inundation Area					
		Barker Reservoir Dam Inundation Area		Lake Sommerville Dam Inundation Area		Kitty Hollow Dam Inundation Area	
		Number of People	Percent of Total	Number of People	Percent of Total	Number of People	Percent of Total
Meadows Place (C)	4,755	0	0.0%	0	0.0%	0	0.0%
Missouri City (C)	73,682	0	0.0%	25,043	34.0%	1,584	2.1%
Needville (C)	3,059	0	0.0%	0	0.0%	0	0.0%
Orchard (C)	219	0	0.0%	0	0.0%	0	0.0%
Pearland (C)	122,609	0	0.0%	0	0.0%	0	0.0%
Pleak (V)	1,756	0	0.0%	0	0.0%	0	0.0%
Richmond (C)	11,768	0	0.0%	3,190	27.1%	0	0.0%
Rosenberg (C)	37,871	0	0.0%	670	1.8%	0	0.0%
Simonton (C)	838	0	0.0%	819	97.7%	0	0.0%
Stafford (C)	17,170	0	0.0%	0	0.0%	0	0.0%
Sugarland (C)	110,272	410	0.4%	80,871	73.3%	0	0.0%
Thompsons (T)	265	0	0.0%	110	41.5%	0	0.0%
Weston Lakes (C)	3,763	0	0.0%	3,639	96.7%	0	0.0%
Unincorporated Area	333,360	57,665	17.3%	70,308	21.1%	113	<0.1%
Fort Bend County (Total)	**806,497**	**58,074**	**7.2%**	**186,820**	**23.2%**	**1,719**	**0.2%**

Source: U.S. Census Bureau 2021, STATS America; U.S. Army Corp of Engineers 2023

Levee Failure

The classification of a levee is dependent on several factors, such as the risk assessments, design deviations, policy issues, and life safety. The USACE classifies levees to help prioritize its resources and does not define risk (USACE 2021). Please refer to Table 4.3.1-6 below.

Table 4.3.1-6. USACE Levee Safety Action Classification Table

Risk Classification	Actions for Levee Systems and Leveed Areas in This Class	Risk Characteristics of This Class
Very High (1)	Based on risk drivers, take immediate action to implement interim risk reduction measures. Increase frequency of levee monitoring, communicate risk characteristics to the community within an expedited timeframe; verify emergency plans and flood inundation maps are current; ensure community is aware of flood warning systems and evacuation procedures; and recommend purchase of flood insurance. Support risk reduction actions as very high priority.	Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in very high risk.
High (2)	Based on risk drivers, implement interim risk reduction measures. Increase frequency of levee monitoring; communicate risk characteristics to the community within an expedited timeframe; verify emergency plans and flood inundation maps are current; ensure community is aware of flood warning and evacuation procedures; and recommend purchase of flood insurance. Support risk reduction actions as high priority.	Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in high risk.
Moderate (3)	Based on risk drivers, implement interim risk reduction measures as appropriate. Verify risk information is current and implement routine monitoring program; assure operation and maintenance is up-to-date; communicate risk characteristics to the community in a timely manner; verify emergency plans and flood inundation maps are current; ensure community is aware of flood warning and evacuation	Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in moderate risk.

Risk Classification	Actions for Levee Systems and Leveed Areas in This Class	Risk Characteristics of This Class
	procedures; and recommend purchase of flood insurance. Support risk reduction actions as a priority.	
Low (4)	Verify risk information is current and implement routine monitoring program and interim risk reduction measures if appropriate. Assure operation and maintenance is up-to-date; communicate risk characteristics to the community as appropriate; verify emergency plans and flood inundation maps are current; ensure community is aware of flood warning and evacuation procedures; and recommend purchase of flood insurance. Support risk reduction actions to further reduce risk to as low as practicable.	Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in low risk.
Very Low (5)	Continue to implement routine levee monitoring program, including operation and maintenance, inspections, and monitoring of risk. Communicate risk characteristics to the community as appropriate; verify emergency plans and flood inundation maps are current; ensure community is aware of flood warning and evacuation procedures; and recommend purchase of flood insurance.	Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in very low risk.
No Verdict	Not enough information is available to assign a Levee Safety Action Classification.	

Source: USACE 2021

Dam/levee failure impacts depend on several factors, including severity of the event and whether or not adequate warning time is provided to residents. The population living in or near the inundation areas is considered exposed to the hazard. However, exposure should not be limited to those who reside within a defined hazard zone but should include everyone who may be affected by a hazard event (e.g., people are at risk while traveling in flooded areas, and access to emergency services may be compromised during an event). The degree of that impact varies and is not strictly measurable.

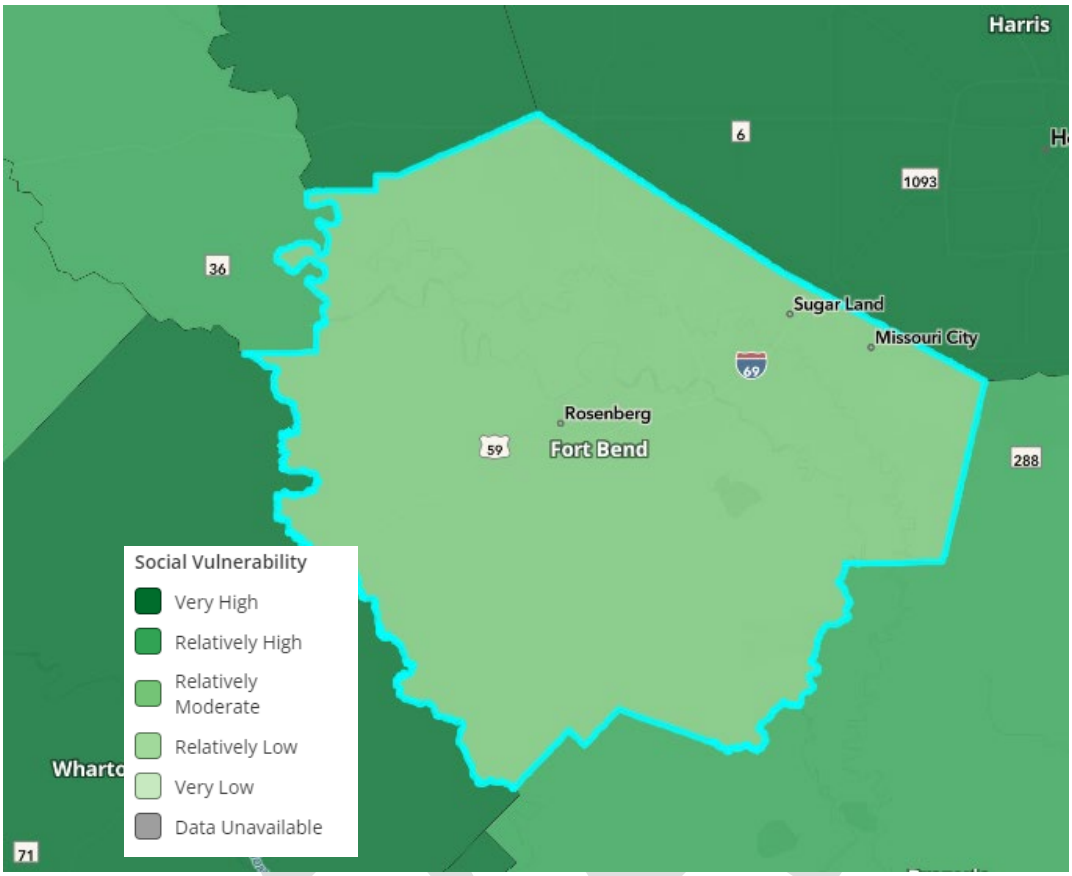
Socially Vulnerable Populations

Social vulnerability is defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards.

Vulnerable populations are all populations downstream from dam/ levee failures that are incapable of escaping the area within the allowable time frame. This population includes elderly individuals, children, and individuals with disabilities or access and functional needs who may be unable to get themselves out of the inundation area. The vulnerable population also includes individuals who would not have adequate warning from the emergency warning system (e.g., television or radio); this would include residents and visitors. The population adversely affected by a dam failure may also include those beyond the disaster area who rely on the dam for providing potable water.

Floods created from a dam/levee failure and their aftermath present numerous threats to public health and safety, including exposure to unsafe food, contaminated drinking and washing water, mosquitoes, animals, mold, and mildew. For more detailed descriptions of these and additional threats to public health and safety, refer to Section 4.3.4 (Flood). Current loss estimation models such as Hazus are not equipped to measure public health impacts such as these. The best preparation for these effects includes awareness that they can occur, education of the public on prevention, and planning to deal with them during responses to dam failure events. Refer to Figure 4.3.1-3 for the social vulnerability index for natural hazards.

Figure 4.3.1-3. FEMA Social Vulnerability Index for Natural Hazards



Source: FEMA NRI

Impact on General Building Stock

Vulnerable properties are those within the dam/levee failure inundation area. These properties would experience the largest, most destructive surge of water. Transportation routes are vulnerable to dam/ levee inundation and have the potential to be wiped out, creating isolation issues. This includes all roads, railroads, and bridges in the path of the dam/levee inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power lines, cable, and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas.

Dam Failure

Table 4.3.1-7 summarizes the number of structures located in the dam inundation hazard area is limited to the following dams – the Barker Reservoir Dam, Lake Sommerville Dam, and Kitty Hollow Dam. Though the Barker Reservoir Dam is located in Harris County, the dam inundation hazard area spans into Fort Bend County. In summary, there are 28,483 buildings located in the Barker Reservoir Dam Inundation Area with an estimated $17.1 billion of replacement cost value (i.e., building and content replacement costs). In total, this represents approximately 10.1 percent of the County's total general building stock inventory. In addition, there are 75,604 buildings located in the Lake Sommerville Dam Inundation Area with an estimated $59.6 billion of building stock and contents exposed, representing 26.9 percent of the County's total general building stock inventory. Lastly, there are 685 buildings located in the Lake Sommerville Dam Inundation Area with an estimated $1.2

billion of building stock and contents exposed, which represents approximately 0.2 percent of the County's total general building stock inventory.

Levee Failure

Spatial analysis is unavailable for the levee inundation areas.

Table 4.3.1-7. Estimated General Building Stock Located in the Dam Inundation Area

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Located in Dam Inundation Area				Estimated Building Stock Located in Dam Inundation Area				Estimated Building Stock Located in Dam Inundation Area			
			Barker Reservoir Dam Inundation Area				Lake Sommerville Dam Inundation Area				Kitty Hollow Dam Inundation Area			
			Number of Buildings	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total	Number of Buildings	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total	Number of Buildings	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total
Arcola (C)	676	$1,374,107,673	0	0.0%	$0	0.0%	1	0.1%	$354,140	<0.1%	5	0.7%	$1,870,233	0.1%
Beasley (C)	367	$467,087,536	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Fairchilds (V)	190	$58,400,161	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Fulshear (C)	7,869	$6,124,915,172	0	0.0%	$0	0.0%	975	12.4%	$434,960,865	7.1%	0	0.0%	$0	0.0%
Houston (C)	11,589	$5,814,576,859	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Katy (C)	2,206	$4,980,024,025	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Kendleton (C)	329	$241,970,568	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Meadows Place (C)	1,676	$1,270,821,734	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Missouri City (C)	27,170	$23,213,328,025	0	0.0%	$0	0.0%	9,395	34.6%	$10,291,185,921	44.3%	623	2.3%	$1,210,610,629	5.2%
Needville (C)	1,346	$1,362,324,702	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Orchard (C)	180	$170,795,761	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Pearland (C)	2,171	$1,063,851,539	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Pleak (V)	436	$672,927,271	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Richmond (C)	3,296	$4,128,822,403	0	0.0%	$0	0.0%	872	26.5%	$1,030,063,800	24.9%	0	0.0%	$0	0.0%
Rosenberg (C)	11,894	$22,921,973,230	0	0.0%	$0	0.0%	211	1.8%	$243,543,331	1.1%	0	0.0%	$0	0.0%
Simonton (C)	395	$372,092,732	0	0.0%	$0	0.0%	382	96.7%	$337,450,141	90.7%	0	0.0%	$0	0.0%
Stafford (C)	4,222	$10,638,345,589	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Sugarland (C)	37,506	$36,732,455,899	158	0.4%	$479,222,553	1.3%	27,280	72.7%	$23,456,180,558	63.9%	0	0.0%	$0	0.0%
Thompsons (T)	143	$404,590,514	0	0.0%	$0	0.0%	56	39.2%	$42,732,786	10.6%	0	0.0%	$0	0.0%
Weston Lakes (C)	1,589	$1,145,826,270	0	0.0%	$0	0.0%	1,537	96.7%	$1,117,060,573	97.5%	0	0.0%	$0	0.0%
Unincorporated Area	166,035	$103,633,654,804	28,325	17.1%	$16,656,636,587	16.1%	34,895	21.0%	$22,664,273,409	21.9%	57	<0.1%	$26,614,331	<0.1%
Fort Bend County (Total)	**281,285**	**$226,792,892,466**	**28,483**	**10.1%**	**$17,135,859,140**	**7.6%**	**75,604**	**26.9%**	**$59,617,805,524**	**26.3%**	**685**	**0.2%**	**$1,239,095,192**	**0.5%**

Impact on Critical Facilities

Transportation routes are vulnerable to dam/levee inundation and have the potential to be wiped out, creating isolation issues and significant disruption to travel, including all roads, railroads, and bridges in areas in and around the dam. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power, cable, and phone lines in the inundation zone could also be vulnerable. If phone lines were lost, significant communication issues may occur in the planning area due to limited cell phone reception in many areas. In addition, emergency response would be hindered due to the loss of transportation routes as well as some protective-function facilities located in the inundation zone. Recovery time to restore many critical functions after an event may be lengthy, as wastewater, potable water, and other community facilities are located in the dam/levee inundation zone.

Dam Failure

Critical facility exposure to the dam inundation hazard area is limited to the following dams – the Barker Reservoir Dam, Lake Sommerville Dam, and Kitty Hollow Dam. Though the Barker Reservoir Dam is located in Harris County, the dam inundation hazard area spans into Fort Bend County. Table 4.3.1-8 lists the lifelines and number of critical facilities within the Barker Reservoir Dam, Lake Sommerville Dam, and Kitty Hollow Dam Inundation Areas. Of the 292 critical facilities located in the Barker Reservoir Dam Inundation Area, the greatest number are transportation facilities (116). Additionally, there are 940 critical facilities located in the Lake Sommerville Dam Inundation Area; 442 are food, water, and shelter facilities. There are 33 critical facilities located in the Kitty Hollow Dam Inundation Area; the greatest number are health and medical facilities (12). The majority of critical facilities located in the Barker Reservoir Dam Inundation Area are in the Unincorporated Areas of Fort Bend County (226); the majority of critical facilities located in the Lake Sommerville Dam Inundation Area are in the City of Sugarland (396); and the majority of critical facilities located in the Kitty Hollow Dam Inundation Area are in Missouri City (30), as shown in Table 4.3.1-9.

Table 4.3.1-8. Lifelines and Critical Facilities Located in the Dam Inundation Areas

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Located in the Barker Reservoir Dam Inundation Area	Number of Lifelines Located in the Lake Sommerville Dam Inundation Area	Number of Lifelines Located in the Kitty Hollow Dam Inundation Area
Communications	44	0	2	0
Energy	584	27	98	4
Food, Water, Shelter	1,480	110	442	7
Hazardous Materials	13	1	1	0
Health and Medical	335	18	112	12
Safety and Security	282	20	70	0
Transportation	660	116	215	10
Fort Bend County (Total)	**3,398**	**292**	**940**	**33**

Source: Fort Bend County 2022; U.S. Army Corp of Engineers 2023

Table 4.3.1-9. Critical Facilities and Lifeline Facilities Located in the 0.2-Percent Annual Chance Flood Event Hazard Area by Jurisdiction

Jurisdiction	Total Critical Facilities Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Located in the Dam Inundation Hazard Area											
			Barker Reservoir Dam Inundation Area				Lake Sommerville Dam Inundation Area				Kitty Hollow Dam Inundation Area			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines	Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines	Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Arcola (C)	22	21	0	0.0%	0	0.0%	1	4.5%	1	4.8%	1	4.5%	1	4.8%
Beasley (C)	18	14	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Fairchilds (V)	3	3	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Fulshear (C)	43	40	0	0.0%	0	0.0%	5	11.6%	4	10.0%	0	0.0%	0	0.0%
Houston (C)	105	84	3	2.9%	3	3.6%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Katy (C)	53	51	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Kendleton (C)	21	19	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Meadows Place (C)	17	16	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Missouri City (C)	339	297	3	0.9%	3	1.0%	174	51.3%	155	52.2%	30	8.8%	29	9.8%
Needville (C)	42	33	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Orchard (C)	7	7	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Pearland (C)	1	1	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Pleak (V)	15	15	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Richmond (C)	123	103	0	0.0%	0	0.0%	35	28.5%	33	32.0%	0	0.0%	0	0.0%
Rosenberg (C)	340	295	0	0.0%	0	0.0%	12	3.5%	9	3.1%	0	0.0%	0	0.0%
Simonton (C)	17	17	0	0.0%	0	0.0%	14	82.4%	14	82.4%	0	0.0%	0	0.0%
Stafford (C)	164	137	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Sugarland (C)	631	575	63	10.0%	63	11.0%	396	62.8%	374	65.0%	0	0.0%	0	0.0%
Thompsons (T)	10	9	0	0.0%	0	0.0%	3	30.0%	2	22.2%	0	0.0%	0	0.0%
Weston Lakes (C)	7	7	0	0.0%	0	0.0%	7	100.0%	7	100.0%	0	0.0%	0	0.0%
Unincorporated Fort Bend County	1,756	1,654	226	12.9%	223	13.5%	361	20.6%	341	20.6%	3	0.2%	3	0.2%
Fort Bend County (Total)	**3,734**	**3,398**	**295**	**7.9%**	**292**	**8.6%**	**1,008**	**27.0%**	**940**	**27.7%**	**34**	**0.9%**	**33**	**1.0%**

Source: Fort Bend County 2022; U.S. Department of Agriculture, Natural Resources Conservation Service 2022; U.S. Army Corp of Engineers 2023

Levee Failure

Spatial analysis to identify critical facility exposure is unavailable for the levee inundation areas.

Impact on Economy

Severe flooding that follows an event like a dam/levee failure can cause extensive structural damage and withhold essential services. The cost to recover from flood damages after a surge will vary depending on the hazard risk of each dam. Severe flooding that follows an event like a dam/levee failure can cause extensive damage to public utilities and disruptions to delivery of services. Loss of power and communications may occur, and drinking water and wastewater treatment facilities may be temporarily out of operation. Debris from surrounding buildings can accumulate should the dam mimic major flood events, such as the 1-percent annual chance flood event that is discussed in Section 4.3.4 (Flood).

Dam/levee failure events can significantly impact the local and regional economy. Similar to flooding, losses include but are not limited to damages to buildings and infrastructure, agricultural losses, business interruption, and impacts on tax base. Loss of power and communications may occur, and drinking water and wastewater treatment facilities may be temporarily out of operation.

Impact on Environment

The environmental impacts of a dam/levee failure can include significant water quality and debris-disposal issues or severe erosion that can impact local ecosystems. Flood waters can back up sanitary sewer systems and inundate wastewater treatment plants, causing raw sewage to contaminate residential and commercial buildings and the flooded waterway. The contents of unsecured containers of oil, fertilizers, pesticides, and other chemicals may get added to flood waters. Hazardous materials may be released and distributed widely across the floodplain. Water supply and wastewater treatment facilities could be offline for weeks. After the flood waters subside, contaminated and flood-damaged building materials and contents must be properly disposed of. Contaminated sediment must be removed from buildings, yards, and properties.

Dam Failure

A dam failure event would inevitably impact Fort Bend County's natural and local environment. Should a dam failure event occur, the land within the inundation area would be altered. Table 4.3.1-10 lists the number of acres exposed to the Barker Reservoir Dam, Lake Sommerville Dam, and Kitty Hollow Dam Inundation Areas.

Table 4.3.1-10. Land Acreage in Fort Bend County Located in the Dam Inundation Areas

Jurisdiction	Total Acres of Land Area	Barker Reservoir Dam Inundation Area		Lake Sommerville Dam Inundation Area		Kitty Hollow Dam Inundation Area	
		Total Acres of Land Area (Excluding Waterbodies) Located in the Dam Inundation Hazard Area	Percent of Total	Total Acres of Land Area (Excluding Waterbodies) Located in the Dam Inundation Hazard Area	Percent of Total	Total Acres of Land Area (Excluding Waterbodies) Located in the Dam Inundation Hazard Area	Percent of Total
Arcola (C)	1,664	0	0%	26	2%	44	3%
Beasley (C)	673	0	0%	0	0%	0	0%
Fairchilds (V)	831	0	0%	0	0%	0	0%
Fulshear (C)	7,962	0	0%	2,068	26%	0	0%
Houston (C)	7,440	2,327	31%	0	0%	0	0%
Katy (C)	2,843	15	1%	0	0%	0	0%
Kendleton (C)	850	0	0%	0	0%	0	0%
Meadows Place (C)	586	2	0%	0	0%	0	0%
Missouri City (C)	20,841	192	1%	9,299	45%	2,027	10%
Needville (C)	1,264	0	0%	0	0%	0	0%
Orchard (C)	250	0	0%	0	0%	0	0%
Pearland (C)	839	0	0%	0	0%	0	0%
Pleak (V)	1,193	0	0%	0	0%	0	0%
Richmond (C)	2,752	64	2%	1,104	40%	0	0%
Rosenberg (C)	23,442	0	0%	1,804	8%	0	0%
Simonton (C)	1,487	0	0%	1,454	98%	0	0%
Stafford (C)	4,467	3	0%	0	0%	0	0%
Sugarland (C)	27,073	2,815	10%	19,859	73%	0	0%
Thompsons (T)	995	0	0%	468	47%	0	0%
Weston Lakes (C)	1,623	0	0%	1,584	98%	0	0%
Unincorporated Area	449,862	18,535	4%	112,627	25%	433	<0.1%
Fort Bend County (Total)	**558,937**	**23,953**	**4%**	**150,293**	**27%**	**2,503**	**<0.1%**

Source: Fort Bend County 2022; U.S. Army Corp of Engineers 2023

Levee Failure

Spatial analysis is unavailable for the levee inundation areas.

Future Changes That May Impact Vulnerability

Understanding future changes that affect vulnerability in Fort Bend County can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

Any areas of growth in Fort Bend County could be potentially impacted by the dam/levee failure hazard because these areas are exposed and vulnerable. Areas downstream of dams or levees are the most vulnerable to losses; therefore, any development in these areas will be more susceptible to dam/levee failure impacts.

Projected Changes in Population

The County has experienced an increase in population between the 2010 American Community Survey (541,983) and the estimated 2020 American Community Survey population of 790,892. The population of the County is expected to increase over the next few years. Increases in population in dam/levee failure inundation areas will result in increased risk to life to the dam/levee failure hazard.

Climate Change

An increasing average annual temperature will directly impact the atmospheric moisture potential. The probability of expanding atmospheric moisture leads to an increasing amount of rainfall during storm events. The increased potential volume of rainfall will directly lead to an increasing pressure placed on dam and levee systems during future riverine flood events (State of Texas HMP 2018).

Change in Vulnerability Since 2018 HMP

Overall, Fort Bend County's vulnerability has increased. As the population of Fort Bend County continues to rise, the number of persons exposed and vulnerable to dam/levee failure events, especially those located within or near downstream inundation zones, will continue to increase.

SECTION 4. RISK ASSESSMENT

4.3 Hazard Profiles

4.3.2 Drought

This section presents information regarding the description, extent, location, previous occurrences and losses, climate change projections, and probability of future occurrences for the drought hazard.

Hazard Profile

Hazard Description

Drought is defined as the consequence of a natural reduction in the amount of precipitation expected over an extended period of time, usually a season or more in length (State of Texas Hazard Mitigation Plan 2018). Drought conditions occur in virtually all climatic zones. Drought characteristics vary significantly from one region to another and are relative to the normal precipitation in that region. Drought can increase wildfire/brush fire risk and can affect agriculture, water supply, aquatic ecology, wildlife, and plant life. There are five classifications of drought:

- ***Meteorological*** drought is an extended period of dry weather patterns.
- ***Hydrological*** drought occurs when these water supplies are below normal. It is related to the effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.
- ***Agricultural*** drought is defined in terms of soil moisture deficiencies relative to water demands of plant life, primarily crops.
- ***Ecological*** drought refers to ecological damage caused by the lack of soil moisture.
- ***Socioeconomic*** drought is associated with the supply and demand of drought commodities, such as water, food grains, and fish (Living with Drought n.d.).

Location

A drought occurs on a regional scale; therefore, all of Fort Bend County is vulnerable and at risk. Droughts can occur at any time and have the potential to impact every person directly or indirectly in the County, as well as the local economy.

Extent

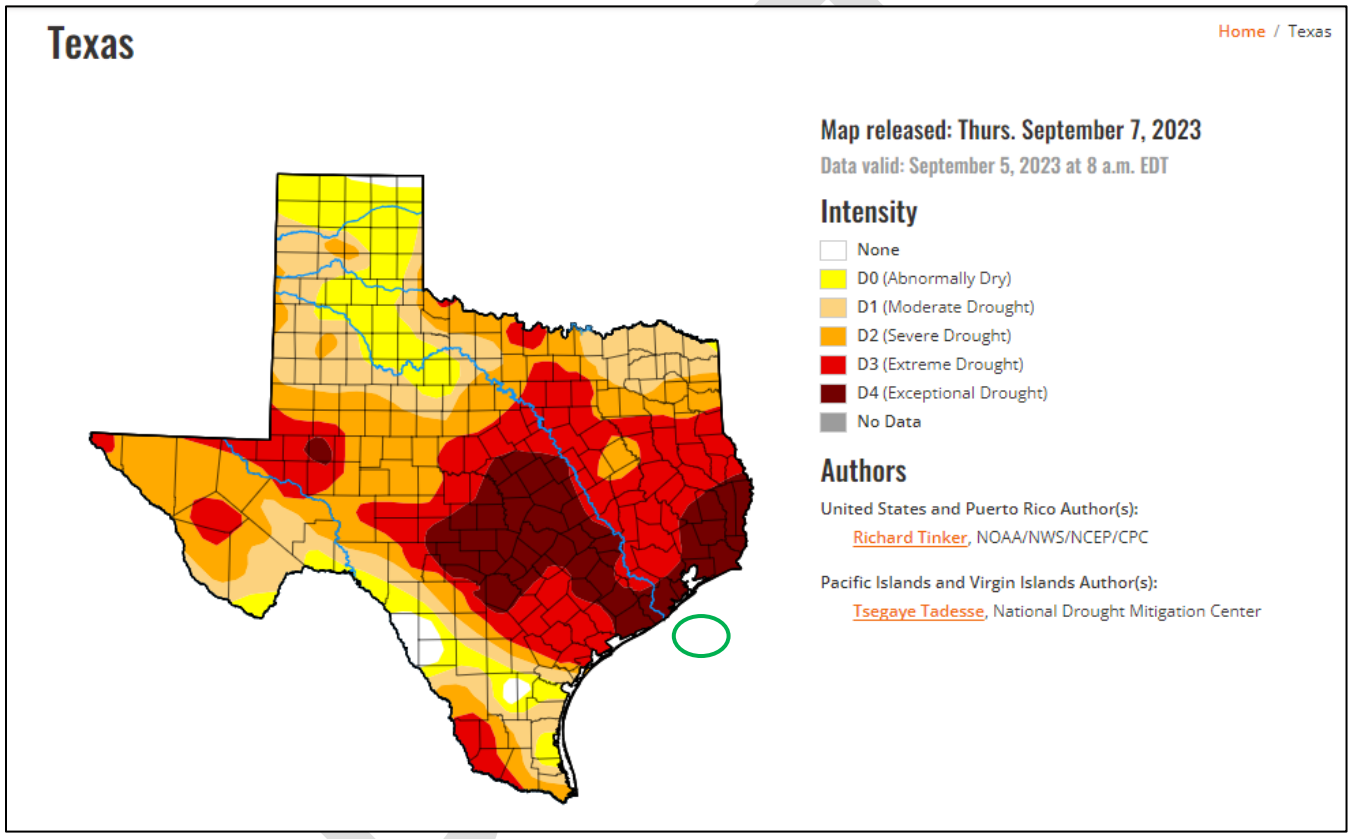
The severity of a drought depends on the degree of moisture deficiency, the duration of the event, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts (University of Nevada, Reno Extension College of Agriculture, Biotechnology & Natural Resources n.d.). Fort Bend County has the potential to experience the entire range of effects, from extreme drought to extremely moist conditions, as described in the Palmer Drought Severity Index (PDSI).

U.S. Drought Monitor

The U.S. Drought Monitor (USDM) is a map that shows the location and intensity of drought across the United States. The data is updated every Thursday. The USDM uses a five-category system: Abnormally Dry (D0) (a precursor to drought, not actually drought), Moderate Drought (D1), Severe Drought (D2), Extreme Drought (D3), and Exceptional Drought (D4).

Drought categories show experts' assessments of conditions related to dryness and drought, including observations of how much water is available in streams, lakes, and soils compared to usual for the same time of year. Figure 4.3.2-1 shows the USDM for November 8, 2022. The figure shows that Fort Bend County had moderate drought conditions for the week of November 8, 2022.

Figure 4.3.2-1. U.S. Drought Monitor for Texas, November 8, 2022



Source: U.S. Drought Monitor 2022
Note: The green circle represents the approximate location of Fort Bend County

Palmer Drought Severity Index

The PDSI is primarily based on soil conditions. Soil with decreased moisture content is the first indicator of an overall moisture deficit. Table 4.3.2-1. lists the PDSI classifications. At the one end of the spectrum, 0 is used as normal, and drought is indicated by negative numbers. For example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The PDSI can reflect excess precipitation using positive numbers; however, this is not shown in Table 4.3.2-1. The PDSI is commonly converted to the Palmer Drought Category (U.S. Drought Monitor n.d.).

Table 4.3.2-1. Palmer Drought Category and Palmer Drought Index Descriptions

Category	Description	Possible Impacts (for Texas)	Palmer Drought Index
D0	Abnormally Dry	• Producers begin supplemental feeding for livestock • Planting is postponed; forage germination is stunted; hay cutting is reduced • Grass fires increase • Surface water levels decline	-1.0 to -1.9
D1	Moderate Drought	• Dryland crops are stunted • Early cattle sales begin • Wildfire frequency increases • Stock tanks, creeks, streams are low; voluntary water restrictions are requested	-2.0 to -2.9
D2	Severe Drought	• Pasture conditions are very poor • Soil is hard, hindering planting; crop yields decrease • Wildfire danger is severe; burn bans are implemented • Wildlife moves into populated areas • Hydroelectric power is compromised; well water use increases; mandatory water restrictions are implemented	-3.0 to -3.9
D3	Extreme Drought	• Soil has large cracks; soil moisture is very low; dust and sandstorms occur • Row and forage crops fail to germinate; decreased yields for irrigated crops and very large yield reduction for dryland crops are reported • Need for supplemental feed, nutrients, protein, and water for livestock increases; herds are sold • Increased risk of large wildfires is noted • Many sectors experience financial burden • Severe fish, plant, and wildlife loss reported • Water sanitation is a concern; reservoir levels drop significantly; surface water is nearly dry; river flow is very low; salinity increases in bays and estuaries	-4.0 to -4.9
D4	Exceptional Drought	• Exceptional and widespread crop loss is reported; rangeland is dead; producers are not planting fields • Culling continues; producers wean calves early and liquidate herds due to importation of hay and water expenses • Seafood, forestry, tourism, and agriculture sectors report significant financial loss • Extreme sensitivity to fire danger; firework restrictions are implemented • Widespread tree mortality is reported; most wildlife species' health and population are suffering • Devastating algae blooms occur; water quality is very poor • Exceptional water shortages are noted across surface water sources; water table is declining • Boat ramps are closed; obstacles are exposed in water bodies; water levels are at or near historic lows	-5.0 or less

Source: U.S. Drought Monitor 2021

Keetch-Byram Drought Index (KBDI)

The KBDI is an index used to determine forest fire potential (refer to Table 4.3.2-2). The drought index is based on a daily water balance, where a drought factor is balanced with precipitation and soil moisture (assumed to have a maximum storage capacity of eight-inches) and is expressed in hundredths of an inch of soil moisture depletion. The index ranges from 0 to 800, where a drought index of 0 represents no moisture depletion, while an index of 800 represents absolutely dry conditions (USFS - Wildland Fire Assessment System n.d.).

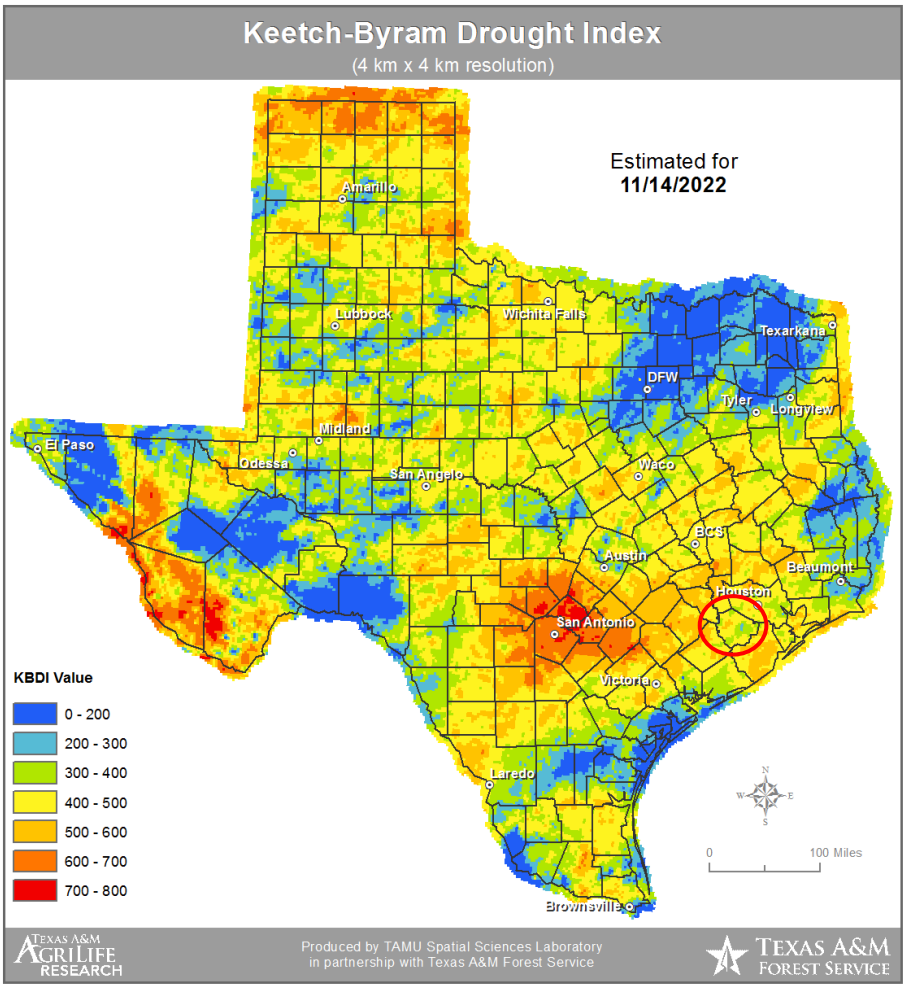
Table 4.3.2-2. KBDI Index

KBDI Value	Description
0 to 200	Soil moisture and large-class fuel moistures are high and do not contribute much to fire intensity. Typical of spring dormant season following winter precipitation
200 to 400	Typical of late spring, early growing season. Lower litter and duff layers are drying and beginning to contribute to fire intensity
400 to 600	Typical of late summer, early fall. Lower litter and duff layers actively contribute to fire intensity and will burn actively.
600 to 800	Often associated with more severe drought with increased wildfire occurrence. Intense, deep burning fires with significant downwind spotting can be expected. Live fuels can also be expected to burn actively at these levels.

Source: TAMU n.d.

This index is currently derived from ground-based estimates of temperature and precipitation resulting from weather stations and interpolated manually by experts at the Texas Forest Service (TFS) for counties across the state. Figure 4.3.2-2 shows the KBDI for the State of Texas for November 14, 2022. The figure shows KBDI value of 0-500 for the County.

Figure 4.3.2-2. KBDI for the State of Texas, November 14, 2022



Source: TAMU 2022

Note: The red circle represents the approximate location of Fort Bend County

Worst-Case Scenario

A multi-year drought with a Palmer Drought Category of D4 that impacts the southeastern portion of Texas, like the 2008 to 2011 drought, is the worst-case scenario for the County. If another severe drought occurs before these systems have a chance to recover, it could exacerbate the stress already placed on existing Planning Area water resources. Severe droughts can also lead to crop and livestock losses, impacting the food supply and economy.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2022, Federal Emergency Management Agency (FEMA) declared that Texas experienced one drought-related major disaster (DR) or emergency (EM). Generally, drought-related disasters affect a wide region of the state and can impact many counties; however, Fort Bend County was not included in the disaster declaration (FEMA 2022).

USDA Disaster Declarations

The U.S. Department of Agriculture (USDA) keeps records of agricultural disasters. Table 4.3.2-3 shows the USDA Drought Disaster Declarations for Fort Bend. Between 2017 and June 2022, Fort Bend County was included in 12 declarations related to drought.

Table 4.3.2-3. USDA Drought Disaster Declarations for Fort Bend County, TX (2017–2022)

Designation Number	Incident Date(s)	Approval Date	Description of Disaster	Crop Disaster Year
S3499	January 29, 2013 – continuing	March 27, 2013	Drought	2013
S3500	February 5, 2013 – continuing	April 3, 2013	Drought	2013
S3507	April 2, 2013 – continuing	April 10, 2013	Drought	2013
S4571	September 3, 2019	January 14, 2020	Drought	2019
S4654	November 1, 2019	March 11, 2020	Drought	2020
S4658	March 3, 2020	March 18, 2020	Drought	2020
S4669	February 18, 2020	May 6, 2020	Drought	2020
S4932	February 2, 2021	March 26, 2021	Drought	2021
S5197	May 10, 2022	May 13, 2022	Drought	2022
S5209	April 5, 2022	May 31, 2022	Drought	2022
S5214	April 12, 2022	June 3, 2022	Drought	2022
S5221	June 14, 2022	June 28, 2022	Drought	2022

Source: USDA Farm Service Agency 2022

Previous Events

For this 2023 Hazard Mitigation Plan (HMP) update, known drought events that impacted the County between 2017 and 2022 were researched. According to the Texas Division of Emergency Management (TDEM), the State of Texas issued and renewed 57 state drought disaster proclamations between 2005 and 2020; however, Fort Bend County was not included in the drought-related proclamations. Table 4.3.2-4 lists known drought events between 2017 and 2022 that have occurred in Fort Bend County, as reported by NCEI, USDA, and U.S. Drought Monitor. Historical drought information shows drought activity across the County; therefore, the drought data for the City of Sugar Land is included as part of Fort Bend County.

Table 4.3.2-4. Drought Events in Fort Bend County (2017–2022)

Dates of Event	Event Type	FEMA Declaration Number	County Designated	Event Details
August 2019	Drought	N/A	N/A	As of August 15, 2019, more than half of Texas' 254 counties had instituted burn bans, including Fort Bend County.
September 3, 2019	Drought	N/A	N/A	The USDA issued a disaster declaration (S4571) for Fort Bend County related to drought conditions.
December 2019 – February 2020	Drought	N/A	N/A	Fort Bend County was under moderate drought conditions for eight consecutive weeks. Between January 21 and February 4, the County experienced three consecutive weeks of severe drought conditions.
February 2020 – May 2020	Drought	N/A	N/A	According to the National Drought Mitigation Center, Fort Bend County was under moderate drought conditions from February to May 2020.
November – December 2020	Drought	N/A	N/A	According to the National Integrated Drought Information System, Fort Bend County was under moderate drought conditions from November to December 2020.
March – May 2021	Drought	N/A	N/A	According to the National Integrated Drought Information System, Fort Bend County was under moderate drought conditions from March to May 2021.
December 2021 – November 2022	Drought	N/A	N/A	According to the National Integrated Drought Information System, Fort Bend County experienced moderate, severe, and extreme drought conditions between December 2021 and November 2022. Moderate conditions began in December 2021, becoming severe in March 2022. Moderate conditions briefly returned in April, followed by severe conditions May–June. Extreme drought conditions began in mid-June, lasting until the end of August. The County returned to moderate conditions from September–December, with a small portion of the County experiencing severe drought conditions from October – November.

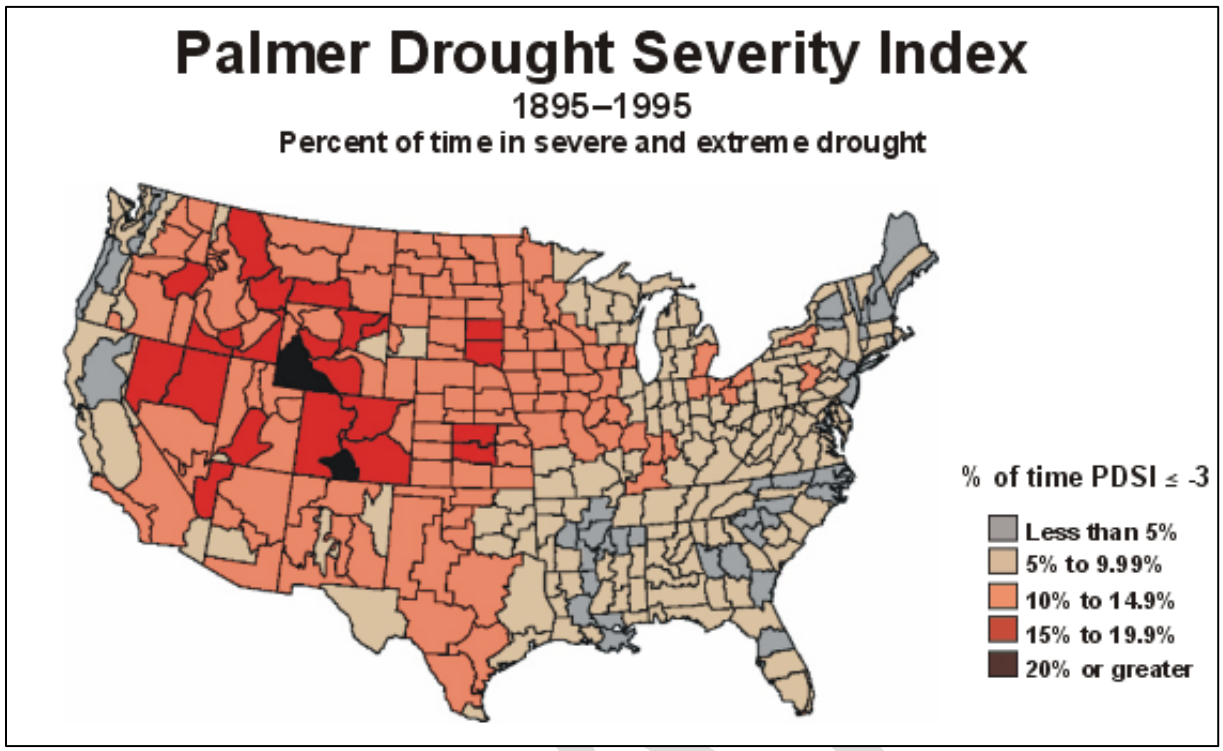
Source: USDA 2022; NDMC 2023; NIDIS 2022

** Many sources were consulted to provide an update of previous occurrences and losses; event details and loss/impact information may vary and has been summarized in the above table.*

Probability of Future Occurrences

The frequency of droughts is difficult to forecast as drought occurrences are cyclical in nature and will occur in the future. Based on national annual data from 1895 to 1995, Fort Bend County underwent severe or extreme conditions approximately 5 to 9.9 percent of the time (illustrated in Figure 4.3.2-3).

Figure 4.3.2-3. Palmer Drought Severity Index (1895–1995)



Source: National Drought Mitigation Center 2020

For the 2023 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of drought events, of all magnitudes, for Fort Bend County. Information from NOAA-NCEI storm events database was used to identify the number of significant drought events that occurred between 1996 and 2022. Using these sources ensures the most accurate probability estimates possible. Table 4.3.2-5 presents the probability of future occurrence of drought events in Fort Bend County.

Table 4.3.2-5. Probability of Future Drought Events in Fort Bend County

Hazard Type	Number of Occurrences Between 1996 and 2022	Percent Chance of Occurrence in Any Given Year
Drought	13	48.15%

Sources: NOAA NCEI 2022; State of Texas 2018; Drought Impact Report 2022; Fort Bend County 2018

Based on the 13 recorded drought events over 26 years, Fort Bend County averages less than one drought per year. A drought event has an 48.15 percent chance of occurring in any given year in the County. Based on the history of events and input from the Planning Partnership, the probability of drought occurring in the County is considered 'frequent' (between 10 and 100 percent annual chance of occurring). Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

Climate Change Projections

Climate is defined not simply as average temperature and precipitation but also by the type, frequency, and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of extremes such as droughts. While predicting changes in drought events under a changing climate is difficult,

understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment (EPA 2016).

With a warmer climate, droughts can become more frequent, more severe, and longer lasting. According to the National Climate Assessment, variable precipitation and rising temperatures are intensifying droughts, increasing heavy downpours, reducing snowpack, and causing declines in water survey quality. Future warming will add to the stress on water supplies and impact the availability of water supply (USGCRP 2018).

Vulnerability Assessment

Impact on Life, Health, and Safety

The entire population of Fort Bend County is vulnerable to drought events (2020 American Community Survey 5-Year Estimate: 790,892 people). Drought conditions can affect public health and safety, including reduced local firefighting capabilities, health problems related to low water flows and poor water quality, and health problems related to dust. If droughts are severe enough, these health problems can lead to loss of human life.

An increased incidence of drought might impact availability of water supplies, primarily placing an increased stress on the population. Other possible impacts include recreational risks; effects on air quality; diminished living conditions related to energy, air quality, and sanitation and hygiene; compromised food and nutrition; and increased incidence of illness and disease. Due to their age, health conditions, and limited ability to mobilize to shelters, cooling, and medical resources, the infirm, young, and elderly are particularly susceptible to drought and extreme temperatures, sometimes associated with drought conditions. Some drought-related health effects are short-term, while others can be long-term (CDC 2012).

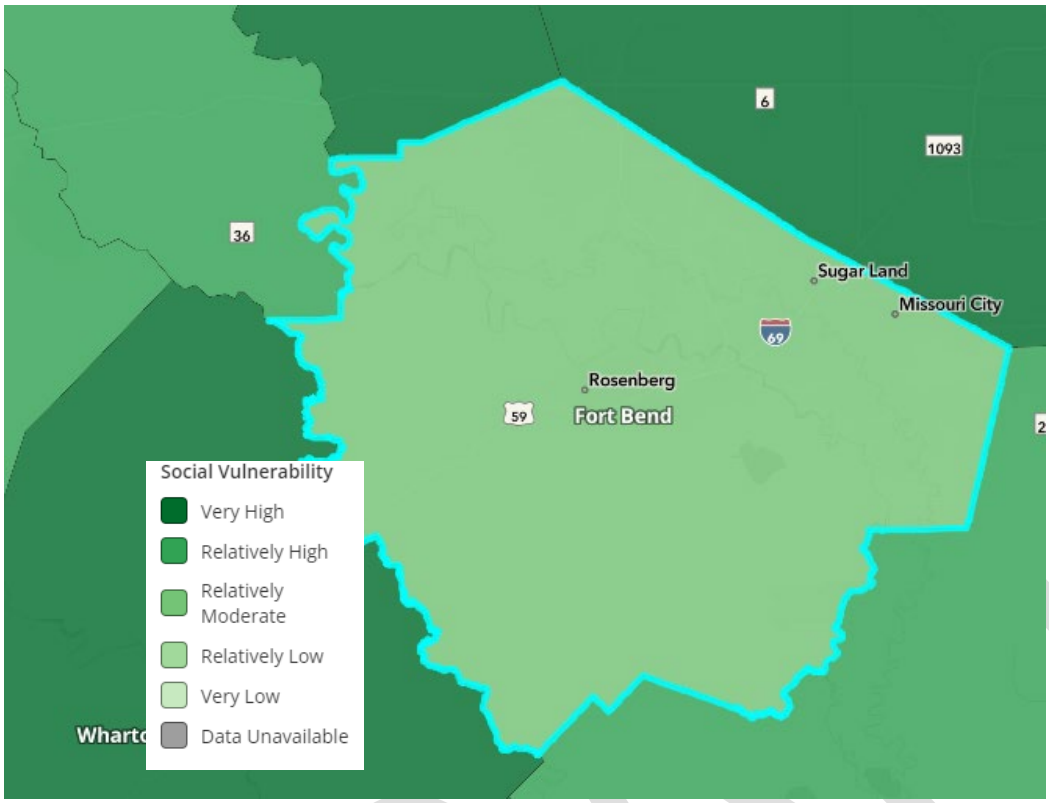
Socially Vulnerable Populations

Social vulnerability is defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards.

According to FEMA's National Risk Index, socially vulnerable populations in Fort Bend County have a relatively moderate susceptibility to the adverse impacts of droughts, when compared to the rest of the United States (FEMA n.d.).

Drought conditions often coincide with periods of extreme heat. Elderly individuals, young children, pregnant women, outdoor workers, and economically disadvantaged individuals are especially vulnerable to these conditions. In periods of extreme heat, these vulnerable populations may have limited access to air conditioning, over-exhaust more easily, or may be unaware of the toll the heat is affecting their bodily functions. Refer to Figure 4.3.2-4 for the social vulnerability index for drought.

Figure 4.3.2-4. FEMA Social Vulnerability Index for Drought



Source: FEMA NRI

Impact on General Building Stock

No structures will be directly affected by drought conditions, though some structures may become vulnerable to wildfires, which are more likely following years of drought. Droughts can have significant impacts on other types of property, such as landscaped areas and economically important natural resources. It is unlikely that structure exposure and vulnerability would increase as a direct result of drought, although secondary impacts of drought, such as wildfire, could increase and threaten structures.

Impact on Critical Facilities

Water supply facilities may be affected by drought events. If a wildfire were to occur during a drought, emergency services might face complications from a water shortage depending on their water source, and critical water-related service sectors might need to adjust management practices and actively manage resources. However, a majority of the critical facilities defined for this plan will continue to be operational during a drought.

Impact on Economy

Drought causes the most significant economic impacts on industries that use water or depend on water for their business, most notably agriculture and related sectors, power plants, and oil refineries. In addition to losses in yields in crop and livestock production, drought is associated with increased insect infestations, plant diseases, and wind erosion. Drought can lead to other losses because so many sectors are affected—losses that include reduced income for farmers and reduced business for retailers and others who provide goods and services to farmers. This leads to unemployment, increased credit risk for financial institutions, capital shortfalls, and loss of tax revenue. Prices for food, energy, and other products may also increase as supplies decrease.

According to the 2017 Census of Agriculture, Fort Bend County has 279,483 acres of farmland, resulting in a $85 billion market value of products sold. According to the 2018 State of Texas HMP, between 1996 and 2016, the County experienced drought-related losses (property plus crop losses) ranging between $143 million and $3.1 billion (State of Texas Hazard Mitigation Plan 2018).

Impact on Environment

Drought can impact the environment because it can trigger wildfires, increase insect infestations, and exacerbate the spread of disease (NOAA 2000). Droughts will also impact water resources that are relied upon by aquatic and terrestrial species. Ecologically sensitive areas, such as wetlands, can be particularly vulnerable to drought periods because they are dependent on steady water levels and soil moisture availability to sustain growth. As a result, these types of habitats can be negatively impacted after long periods of dryness. Extreme heat events can lead to drought events, which can make potential fires worse. In turn, this would also affect crop production.

Future Changes That May Impact Vulnerability

Understanding future changes that affect vulnerability in the Planning Area can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The Planning Area considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

Any areas of growth could be potentially impacted by the drought hazard because the entire County is exposed and vulnerable to droughts. Future growth and development could impact the amount of potable water available due to a drain on the available water resources. An increased drain on water resources would not only impact the County's population, but it would also exacerbate impacts to other areas of the County, as discussed above, including agriculture and recreational facilities.

Projected Changes in Population

The County has experienced an increase in population between the 2010 American Community Survey (541,983) and the estimated 2020 American Community Survey population of 790,892. The population of the County is expected to increase over the next few years. With an increase in population, the demand for water supply will increase. During a drought, the amount of water needed might not be available. This might require reallocation of water resources to meet demands during a drought. If needed, the County can pass special ordinances regulating the amount of water consumed and used during periods of drought to conserve water.

Climate Change

Climate change has the potential to impact the number of and the severity of droughts. With a warmer climate, droughts can become more frequent, more severe, and longer lasting. According to the National Climate Assessment, variable precipitation and rising temperatures are intensifying droughts, increasing heavy downpours, reducing snowpack, and causing declines in water survey quality. Future warming will add to the stress on water supplies and impact the availability of water supply (USGCRP 2018).

Change in Vulnerability Since 2018 HMP

Fort Bend County continues to be vulnerable to the drought hazard. Updated population and building stock statistics were used in the current risk assessment. Further, exposure for both the population and critical facilities was analyzed. These updated datasets provide a more accurate exposure analysis to the drought hazard.

SECTION 4. RISK ASSESSMENT

4.3 Hazard Profiles

4.3.3 Extreme Temperatures

The following section provides the hazard profile and vulnerability assessment for extreme temperatures in Fort Bend County.

Hazard Profile

Hazard Description

Extreme temperatures include both heat and cold events, which can have a significant impact on human health, commercial/agricultural businesses, and primary and secondary effects on infrastructure (e.g., burst pipes and power failure). What constitutes *extreme cold* or *extreme heat* can vary across different areas of the country, based upon what the population is accustomed to.

Extreme Heat

Extreme heat events are defined by the U.S. Environmental Protection Agency (EPA) as "weather that is much hotter than average for a particular time and place- and sometimes more humid too" (EPA 2016). Criteria defining an extreme heat event may differ among jurisdictions and within the same jurisdiction, depending on the time of year. In Texas, extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature during the summer months (Texas Extension Disaster Education Network 2023).

Extreme heat events are often a result of more than just ambient air temperature. Heat index tables (see Figure 4.3.3-1) are commonly used to provide information about how hot it feels, which is based on the interactions between several meteorological conditions. Because heat index values were devised for shady, light wind conditions, exposure to full sunshine can increase heat index values by up to 15 degrees Fahrenheit (°F). Also, strong winds, particularly with very hot, dry air, can be extremely hazardous (State of Texas 2018).

Texas is often affected by extreme heat in the summer months based on its geographical location. Extreme heat happens when the upper atmosphere contains high pressure that stays stationary over a region, which can trap more heat and reduce convection currents. As a result, heat and high humidity accumulate with little to no precipitation, which creates abnormally high temperatures for an area (World Atlas 2018).

Extreme Cold

The thresholds for extreme cold differ greatly by geographic location and temperatures that the area is typically used to experiencing. Extreme cold temperatures are typically associated with winter storms and often occur in the winter months. These temperatures can last for a few hours or multiple days (NCHH 2022). Texas tends to experience fewer extreme cold events because of its southern location; however, extreme cold is considered any temperature below freezing (below 32°F) (University of North Texas 2023).

Location

Extreme Heat

All of the state is vulnerable to extreme heat. In addition, large metropolitan areas, such as Dallas/Fort Worth and Houston, may experience extreme heat since they have an abundance of concrete that absorbs and then radiates solar energy. This effect is known as an urban heat island and can be dangerous to those without air conditioners (State of Texas 2018). All of Fort Bend County is at risk for extreme heat events; however, these events may be exacerbated in urban areas, where reduced airflow, reduced vegetation, and increased generation of waste heat can contribute to temperatures that are several degrees higher than in surrounding rural or less urbanized areas. The record highs for Texas typically occur from May through October. Fort Bend County experiences average summers in the mid 90s°F.

Extreme Cold

Extreme cold can happen anywhere in the state, although its levels can range extensively. In the panhandle, extreme cold means days below 0°F, while in the Rio Grande Valley, it means reaching temperatures below freezing (State of Texas 2018).

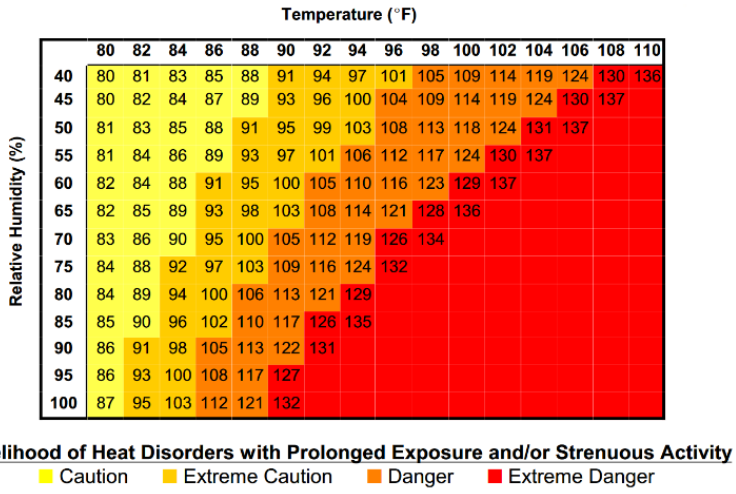
Fort Bend County is susceptible to extremely cold temperatures, especially severe winter storms. As a result of the changing climate, Fort Bend is more susceptible to extreme cold and has experienced a record wind chill in 2021. The record lows for Texas typically occur during October through March. The average first freeze in the 2023 Hazard Mitigation Plan (HMP) update area usually occurs from late November to early December, and the last freeze usually occurs from late February to early March, according to data recorded by the National Weather Service.

Extent

Extreme Heat

When temperatures reach 90°F and above, people are vulnerable to heat cramps, heat exhaustion, and heat stroke. Pets, livestock, and crops are also vulnerable to heat-related injuries. Extreme heat is measured with National Oceanic and Atmospheric Administration's (NOAA) Heat Index.

Figure 4.3.3-1. Heat Index Table



Sources: *NOAA 2022*

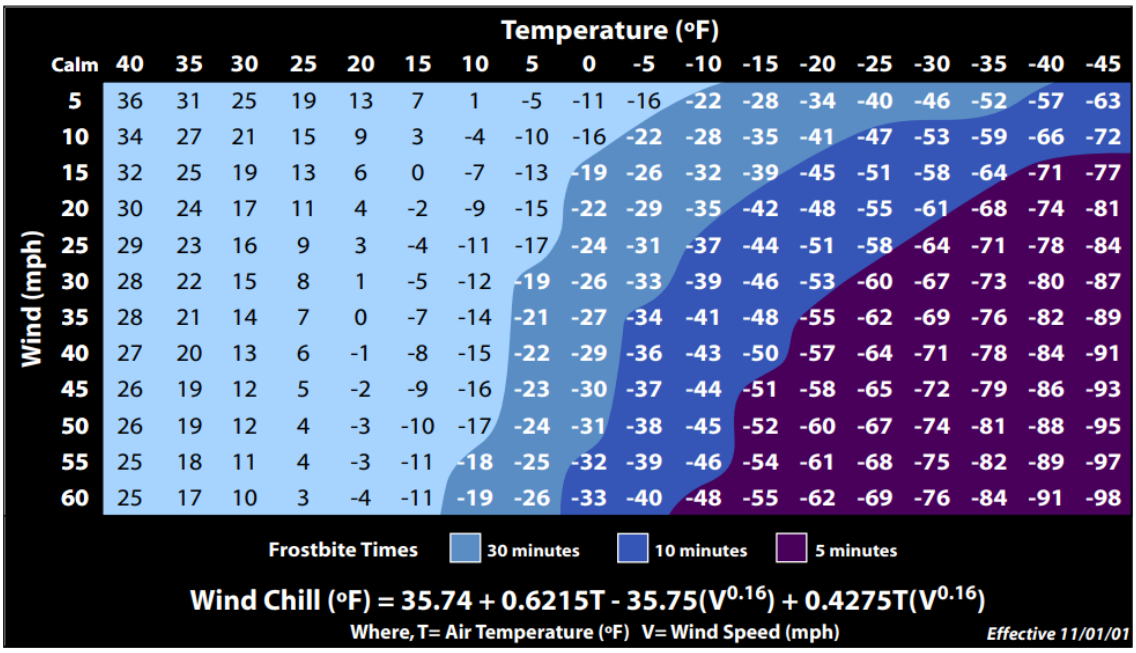
Worst-Case Scenario

An extreme multi-year drought with extreme heat conditions could impact the region with little warning. Combinations of low precipitation and unusually high temperatures could occur over several consecutive years. Intensified by such conditions, extreme wildfires could break out throughout the Planning Area, increasing the need for water. Surrounding communities, also in drought and extreme heat conditions, could increase their demand for water supplies relied upon by the Planning Partnership, causing social and political conflicts. If such conditions persisted for several years, the economy of Fort Bend County could experience setbacks, especially in water-dependent industries.

Extreme Cold

The severity and magnitude of extreme cold temperatures in Fort Bend County are relatively low considering the rarity of this occurrence in the County but can contribute to minor injuries and interruption of critical facilities. Extreme cold temperatures often occur after a severe winter storm. These storms can also result in closed roadways and frozen pipes, resulting in utility failure. Extreme cold can be measured with NOAA's Wind Chill Chart.

Figure 4.3.3-2. NOAA Wind Chill Chart



Sources: NOAA 2022

Worst-Case Scenario

Primarily, the extreme cold faced in Fort Bend County is coupled with severe winter weather. A worst-case event would involve extreme cold with prolonged high winds during a winter storm. Such an event would have both short-term and longer-term effects. Initially, schools and roads would be closed due to power outages caused by high winds and downed tree obstructions. In more rural areas, some subdivisions could experience limited ingress and egress.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2022, Fort Bend County was included in two disaster (DR) or emergency (EM) declarations for extreme temperature-related events; the two declarations, FEMA DR-4586 and FEMA-3554-EM, were for the same event, Winter Storm Uri, which impacted the County between February 11–21, 2021 (FEMA 2022). Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

USDA Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2012 and 2022, Fort Bend County was not included in extreme temperature-related agricultural disaster declarations (USDA FSA 2022).

Previous Events

For this 2023 HMP update, known extreme cold events that impacted the project area between 2017 and 2022 are discussed below. The National Climatic Data Center lists one extreme cold event that impacted Fort Bend County, which was a severe winter storm in February of 2021. Despite severe winter storms being a separate hazard listed for this HMP update, this event was included as an extreme cold temperature event since Winter Storm Uri caused extreme cold temperatures (FEMA 2022) (Donald 2021).

Table 4.3.3-1. Extreme Temperature Events in the Planning Area (2017–2022)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Description
February 15–16, 2021	Cold/Wind Chill	FEMA DR-4586, FEMA-3554-EM	Very cold air and gusty winds overspread SE Texas behind an Arctic front with wind chill indices from near zero to single digits for much of the period from Sunday night to Tuesday morning. Increased power demand, wind, and ice led to widespread power outages. Bursting pipes caused many to be without water as well. The event resulted in three fatalities and $1.6 million in property damage in Fort Bend County.

Sources: NOAA NCEI 2022; FEMA 2022

Probability of Future Occurrences

For the 2023 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of extreme temperature events for the project area. Information from the NOAA-NCEI storm events database, the 2018 State of Texas HMP, and the 2018 Fort Bend County HMP were used to identify the number of extreme temperature events that occurred between 2000 and 2022. Table 4.3.3-2 presents the probability of future events for extreme temperatures in Fort Bend County.

Table 4.3.3-2. Probability of Future Extreme Temperature Events, Fort Bend County

Hazard Type	Number of Occurrences Between 2000 and 2022	% Chance of Occurring in Any Given Year
Extreme Heat (≥100°F)	322	100%
Extreme Cold (≤32°F)	174	100%
Total	**496**	**100%**

Sources: NOAA NCEI 2022; State of Texas 2018; Fort Bend County 2018; Midwestern Regional Climate Center 2023

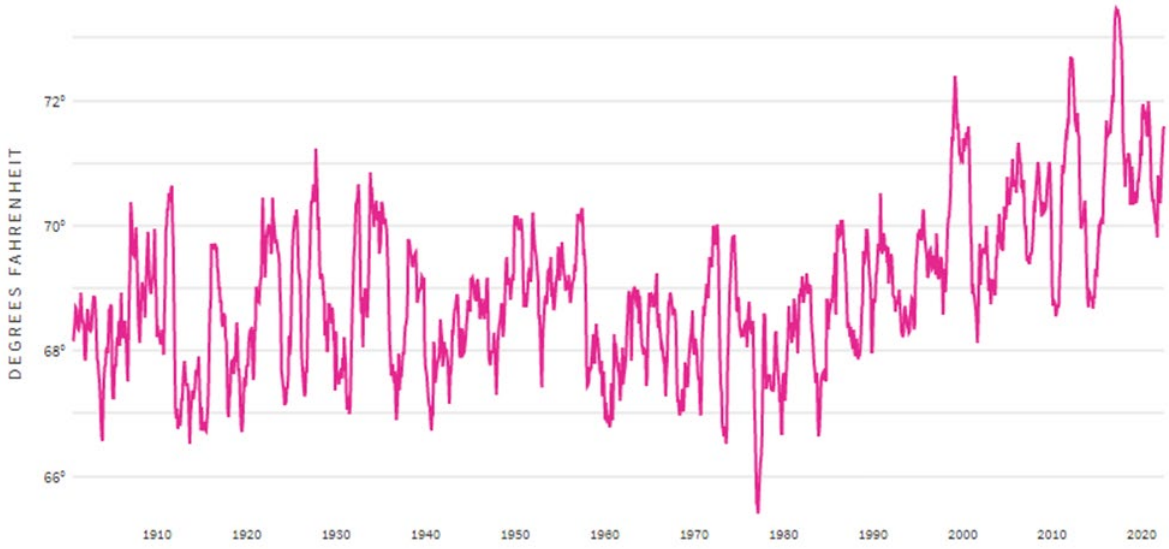
In Section 4.4, the identified hazards of concern for Fort Bend County were ranked (Table 4.4-2). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Partnership, the probability of occurrence for extreme temperatures in the County is considered "frequent".

Climate Change Impacts

The Intergovernmental Panel on Climate Change indicates that the global average temperature has increased by at least 0.72°F since the 1970s and continues to increase, making extreme temperatures a more common problem (National Geographic n.d.). The effects of climate change are most commonly seen in increased extreme heat events, more severe weather events, and precipitation patterns.

Temperature trends in the project area, like the rest of the globe, are increasing and will continue to do so at alarming rates. The 12-month average temperature increased by 3.4°F from September 1900 to August 2022. From September 1900 to August 2022, the 12-month average temperature was 68.9°F (NCEI 2022).

Figure 4.3.3-3. NCEI 12-Month Temperature Average



Source: NOAA

Vulnerability Assessment

Impact on Life, Health, and Safety

The most common problems associated with extreme temperature events are negative health effects on the population and loss of utilities. Power outages can be life-threatening to those dependent on electricity for life support.

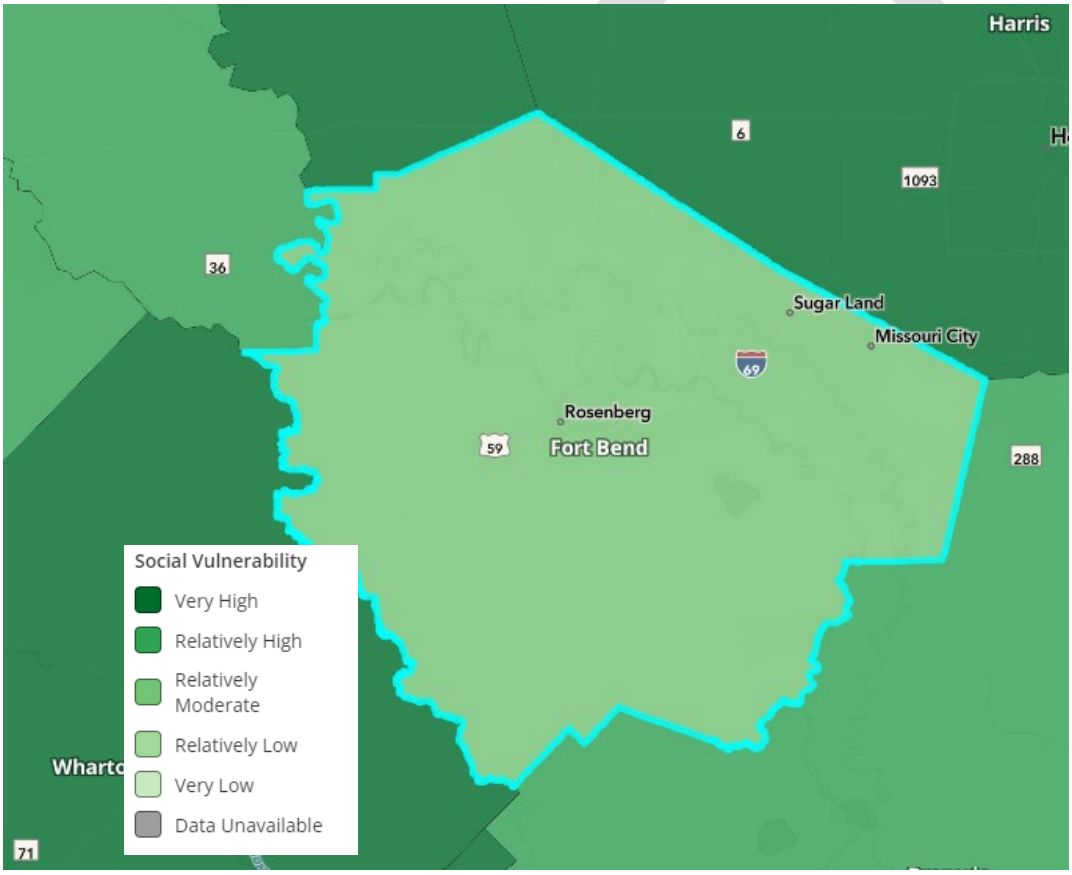
The impact of extreme temperatures on life, health, and safety is dependent upon several factors, including the severity of the event and the population's access to food, water, and shelter. Heat exhaustion and frostbite are common health-related risks in terms of extreme temperatures. In addition, residents can also be displaced or require temporary to long-term sheltering depending on the viability of utilities.

Socially Vulnerable Populations

Social vulnerability is defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards.

Although the entire population of Fort Bend is exposed to strong extreme temperature events, some populations are more vulnerable. Vulnerable populations include the elderly, low-income, linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. In general, populations who lack adequate shelter during an extreme temperature event, those who are reliant on sustained sources of power to survive, and those who live in isolated areas with limited ingress and egress options are the most vulnerable. People with no air conditioning in their homes are especially vulnerable to extreme heat events. Refer to Figure 4.3.3-4 for the social vulnerability index for natural hazards.

Figure 4.3.3-4. FEMA Social Vulnerability Index for Natural Hazards



Source: FEMA NRI

Impact on General Building Stock

All of the building stock in the County is exposed to the extreme temperature hazard; however, direct impacts are expected to be minimal. Extreme temperature swings can crack and break building materials, so building construction plays a major role in the extent of damage resulting from extreme temperatures. Due to differences in construction, residential structures are generally more susceptible to extreme temperatures

than commercial and industrial structures, especially homes and buildings that may lack air conditioning. Wood and masonry buildings, in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings.

Impact on Critical Facilities

Overall, all critical facilities in Fort Bend County are vulnerable to being affected by extreme temperatures. Utility infrastructure could suffer damage from high heat or cold temperatures, resulting in the loss of power or another utility service. Loss of service can impact residents, critical facilities, and business operations alike. Loss of power can impact other public utilities, including potable water, wastewater treatment, and communications. In addition to public water services, property owners with private wells might not have access to potable water until power is restored. Lack of power to emergency facilities, including police, fire, EMS, and hospitals, will inhibit a community's ability to effectively respond to an event and maintain the safety of its citizens.

Impact on Economy

Extreme temperature events also have impacts on the economy, including loss of business function and damage and loss of inventory. Business owners may be faced with increased financial burdens due to unexpected repairs caused to the building (pipes bursting), higher than normal utility bills, or business interruption caused by power failure (loss of electricity and telecommunications). Extreme heat events can lead to drought events, which can make potential fires worse. In turn, this would also affect crop production.

Impact on Environment

Extreme temperature events can have a major impact on the environment. For example, freezing and warming weather patterns create changes in natural processes. An excess amount of snowfall and earlier warming periods may affect natural processes such as flow within water resources (USGS 2020). Extreme heat events can have particularly negative impacts on aquatic systems, contributing to fish kills, aquatic plant die-offs, and increased likelihood of harmful algal blooms. Extreme cold events may launch animals into early hibernation or disrupt their natural cycle of life. Intense cold events can also freeze and kill plants and crops.

Future Changes That May Impact Vulnerability

Understanding future changes that affect vulnerability in the Planning Area can assist in planning for future development and ensure the establishment of appropriate mitigation, planning, and preparedness measures. The Planning Area considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

Understanding future changes that impact vulnerability in the County can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. Areas targeted for potential future growth and development could be potentially impacted by extreme temperatures since the entire County is exposed. However, due to increased standards and codes, new

development can be less vulnerable to extreme temperatures in comparison with the aging building stock currently in Fort Bend.

Projected Changes in Population

Fort Bend County experienced an increase in population between the 2010 Census (585,375) and the 2020 Census (822,779). The population of the County is expected to increase over the next few years. The increase in population will expose more people to tornadoes (US Census Bureau 2022).

Climate Change

The Intergovernmental Panel on Climate Change indicates that the global average temperature has increased by at least 0.72°F since the 1970s and continues to increase making extreme temperatures a more common problem (National Geographic n.d.). The effects of climate change are most commonly seen in increased extreme heat events, more severe weather events, and precipitation patterns.

Change in Vulnerability Since 2018 HMP

Due to population growth in Fort Bend County, the number of people who could be impacted by extreme temperature events is increasing. Climate change is creating warmer climates, making extreme heat more probable than in the previous plan. As existing development and infrastructure continue to age, they can be at increased risk of failed utility and transportation systems if they are not properly maintained and do not adapt to the changing environment.

SECTION 4. RISK ASSESSMENT

4.3 Hazard Profiles

4.3.4 Flood

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the flood hazard in Fort Bend County.

Hazard Profile

Hazard Description

Flooding occurs when water overflows onto land that is normally dry. Flooding can happen during heavy rains, rapid snow melt, or when dams or levees break (NOAA National Severe Storms Laboratory 2023). Floods are one of the most frequent and costly natural disasters in the United States and the State of Texas.

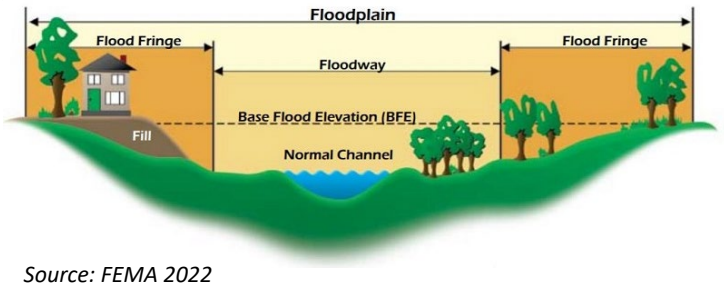
The flood-related hazards most likely to impact Fort Bend County are riverine (inland) flooding, flash flooding, stormwater/urban flooding due to insufficient drainage during heavy rain events, and flooding as a result of a dam or levee break. Dam and levee failure are discussed in Section 4.3.1 (Dam and Levee Failure).

Riverine Flooding

Riverine flooding, or fluvial flooding, is when streams and rivers exceed the capacity of their natural or constructed channels to accommodate water flow and water overflows the banks, spilling out into adjacent low-lying, dry land. This occurs when the flow of a river exceeds the bank sides and causes damage or obstruction to a nearby floodplain. Riverine flooding can turn into a flash flood if the river is at or above its flood stage and if the soil is saturated (FEMA 2019).

A floodplain is defined as the land adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that becomes inundated with water during a flood. In Fort Bend County, floodplains line the rivers, streams, and lakes of the County. The boundaries of the floodplains are altered as a result of changes in land use, the amount of impervious surface, placement of obstructing structures in floodways, changes in precipitation and runoff patterns, improvements in technology for measuring topographic features, and utilization of different hydrologic modeling techniques.

Figure 4.3.4-1. Floodplain

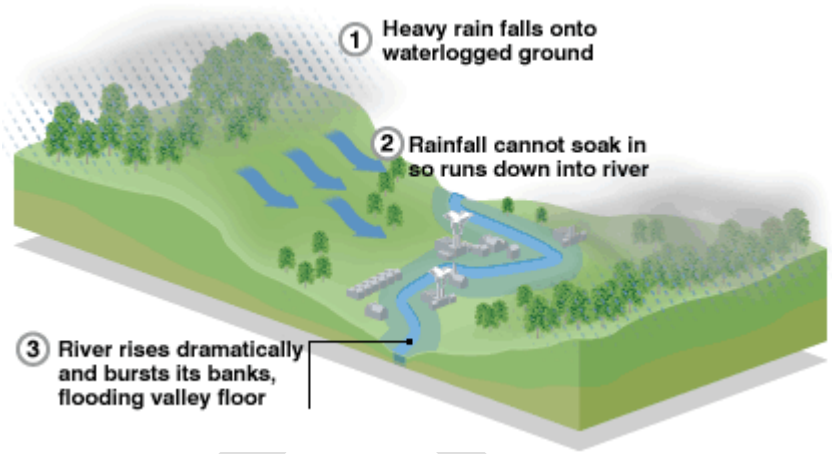


Source: FEMA 2022

Flash Flooding

A flash flood is a rapid inundation of low-lying areas caused by heavy rain associated with severe thunderstorms, tropical systems, or melting water from ice or snow. Flash flooding also occurs far away from water bodies when a large volume of water cannot be absorbed by the soil or storm water systems and travels overland unimpeded (NWS 2019).

Figure 4.3.4-2. How Flash Floods Occur



Source: BBC News 2005

Urban/Stormwater Flooding

Local (urban) drainage systems collect groundwater from heavy rainfall in developed areas. Water that does not evaporate or become absorbed by the ground is carried by conduits to waterways such as creeks, rivers, or the ocean. These systems have two purposes: (1) to control storm water runoff during periods of heavy rainfall; and (2) to minimize disruption of activity from more frequently occurring, less significant storms. Flooding occurs when runoff exceeds system capacity, or because systems are blocked from lack of maintenance. Flooding which results from poorly designed or blocked drainage systems is categorized as urban/stormwater flooding (NOAA 2022).

Dam and Levee Failure

The Barker Reservoir Dam, Lake Sommerville Dam, and Kitty Hollow Dam have the potential to impact over 246,000 Fort Bend County residents and damage over 104,000 buildings. There are 1,265 community lifelines located in the dam inundation areas of all three dams. For details on the risk to dam and levee failure in Fort Bend County, refer to Section 4.3.1 (Dam and Levee Failure).

Location

Texas has the most flash flood deaths of any state in the country. Since 1960, over 600 people have been killed by floods in the State of Texas, with 65 percent of those deaths in vehicles (Fort Bend Homeland Security and Emergency Management 2022). The terrain in the Gulf Coast Prairie area of Texas, in which Fort Bend County is mostly located (a sliver of the western County is in the Flood Plains), is punctuated soils formed in alluvial and marine sediments of (primarily) Quaternary age that were deposited under fluctuating sea-level conditions. The soils are a mix of well-developed, clayey soils with high shrink-swell properties and soils with loamy surface textures and a loamy and clayey subsoil (USDA, NRCS 2008). Shrink-swell soils, also known as expansive soils, can cause significant pressure of homes, foundations, roads, and other infrastructure during heavy rain periods and flooding conditions (Cahoon 2011). For more information on expansive soils, refer to Section 4.3.5 (Geologic Hazards).

Other factors contributing to floods in the area include its location to the Gulf of Mexico. As weather systems stall and dissipate over Texas, they drop intense rains over small areas. In the past, Fort Bend has had significant floods along the Brazos River; however, these floods have been reduced by quality flood mitigation and control

efforts, including levees and drainage basins. This has also helped to reduce the impacts of seasonal floods in the County.

In Fort Bend County, floodplains line the rivers and streams of the County. The boundaries of the floodplains are altered as a result of changes in land use, the amount of impervious surface, placement of obstructing structures in floodways, changes in precipitation and runoff patterns, improvements in technology for measuring topographic features, and utilization of different hydrologic modeling techniques.

See Figure 4.3.4-3 below, which visualizes the FEMA-designated flood hazard areas for Fort Bend County.

Riverine Flooding

Fort Bend County lies completely within the Brazos River basin. The Brazos River runs west to southeast in this area along the northeast boundary, through the center of the County, and exits on the east boundary. Some local waterbodies include Bessies Creek as well as multiple lakes: Fulshear, Triangle, Smithers, Worthington, and Frost. There are additional, non-named bodies of water along the border with Harris County, where residential areas have been constructed (Texas Water Development Board n.d.).

Runoff in Fort Bend County is captured to fill several lakes and reservoirs in the County. The Fort Bend County Levee Improvement Districts (1-19) operate and maintain several levees, drainage ditches, and pump stations throughout the County (Fort Bend County 2022).

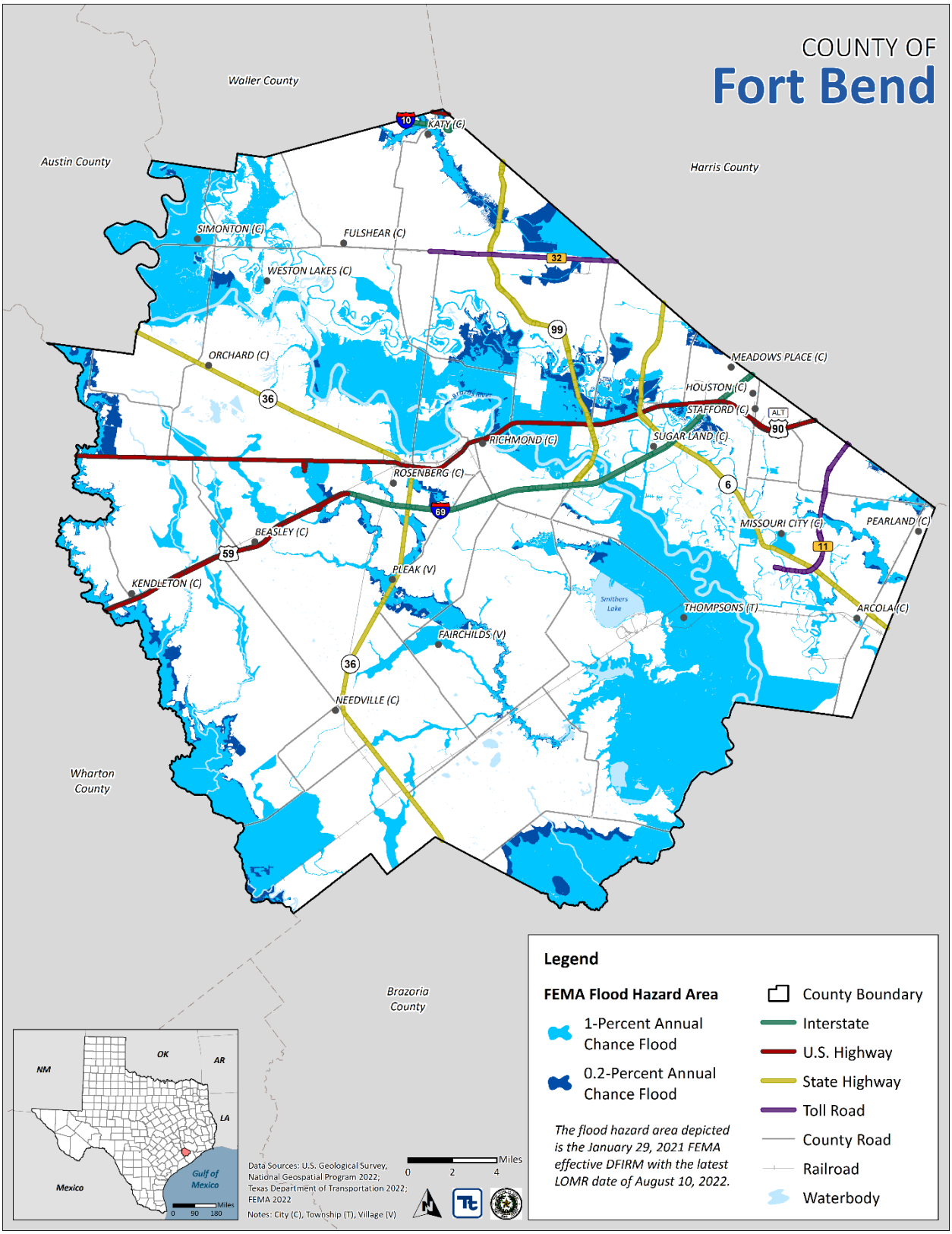
Flash Flooding

Flash flooding poses a deadly danger to residents of the Brazos River Basin. Several roads run through low-lying areas that are prone to sudden and frequent flooding during heavy rains. Motorists often attempt to drive through barricaded or flooded roadways; just 6 inches of slowly moving water is enough to float and carry most cars, even SUVs. Floating cars easily get swept downstream, making rescues difficult and dangerous (Fort Bend Homeland Security and Emergency Management 2022).

Urban/Stormwater Flooding

Urbanization increases runoff two to six times over what would occur on natural terrain. During periods of urban flooding, streets can become swift-moving rivers (NWS 2014). This type of flooding occurs throughout Fort Bend County, particularly in areas where land has been converted from fields or woodlands to roads and parking lots. This causes the ground to lose its ability to absorb rainfall.

Figure 4.3.4-3. Location of the Flood Hazard Area in Fort Bend County



Extent

The strength or magnitude of a flood varies based on meteorological, environmental, and geological factors, including latitude, altitude, topography, and atmospheric conditions. Flood is also affected by seasonal variation, storm characteristics, warning time, speed of onset, and duration. Most floods are preceded by a warning period that allows emergency managers to communicate the need to prepare for the event. A flood may last from minutes to days (O'Connor, Grant and Costa 2002).

Figure 4.3.4-4. NWS Flood Advisories

Source: National Weather Service 2023

Warnings issued through official sources, such as the National Weather Service (NWS) and the Storm Prediction Center, provide the most reliable and timely preparedness information, but the exact flood location and depth depends on the amount, duration, and location of rainfall. Many floods, especially flash floods, occur outside of FEMA-designated flood zones.

Figure 4.3.4-5. NWS Flash Flood Advisories

Source: National Weather Service 2023

In the case of riverine flood hazard, once a river reaches flood stage, the flood extent or severity categories used by the NWS include minor flooding, moderate flooding, and major flooding. Each category has a definition based on property damage and public threat:

- Minor Flooding - Minimal or no property damage, but possibly some public threat or inconvenience.
- Moderate Flooding - Some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary.
- Major Flooding - Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations (NOAA 2021).

The severity of a flood depends not only on the amount of water that accumulates in a period of time but also on the land's ability to manage this water. The size of rivers and streams in an area and infiltration rates are significant factors. When it rains, soil acts as a sponge. When the land is saturated or frozen, infiltration rates decrease and any more water that accumulates must flow as runoff (Harris 2001).

The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels. The flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a 1 percent chance

of being equaled or exceeded in any given year. The "annual flood" is the greatest flood event expected to occur in a typical year. These measurements reflect statistical averages only; it is possible for two or more floods with a 100-year or higher recurrence interval to occur in a short time period. The same flood can have different recurrence intervals at different points on a river.

The extent of flooding associated with a 1 percent annual probability of occurrence (the base flood or 100-year flood) is used by the National Flood Insurance Program (NFIP) as the standard for floodplain management and to determine the need for flood insurance, as well as the regulatory flood boundary by many agencies. Also referred to as the Special Flood Hazard Area (SFHA), this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the water elevation resulting from a given discharge level, which is one of the most important factors used in estimating flood damage. A structure located within an SFHA shown on an NFIP map has a 26 percent chance of suffering flood damage during the term of a 30-year mortgage.

The term "500-year flood" is the flood that has a 0.2 percent chance of being equaled or exceeded each year. The 500-year flood could occur more than once in a relatively short period of time. Statistically, the 0.2 percent (500-year) flood has a 6 percent chance of occurring during a 30-year period of time, the length of many mortgages. The 500-year floodplain is referred to as Zone X500 for insurance purposes on Flood Insurance Rate Maps (FIRM). Base flood elevations or depths are not shown within this zone, and insurance purchase is not required in this zone (FEMA 2022).

Worst-Case Scenario

An intense, short-duration storm could move slowly across the County, creating significant flash floods with little or no warning. Injuries or fatalities may result if residents are caught off guard by the flood event. Stormwater systems could be overwhelmed, and significant flooding could impact a substantial portion of structures within the planning area. Transportation routes could be cut off due to floodwaters, isolating portions of the County. These impacts may last after the floodwater recedes, as flash floods in the area have been known to cause extensive damage to roadway infrastructure. Areas that have recently experienced wildfires would contribute to the extent of flooding impacts.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2022, the State of Texas was included in 40 disaster (DR) or emergency (EM) declarations for flood-related events (FEMA 2021). Generally, these disasters cover a wide region of the state; therefore, they can impact many counties. However, not all counties were included in the disaster declarations as determined by FEMA. Fort Bend County was included in five disaster (DR) or emergency (EM) declarations for flood-related events (FEMA 2021). Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

Table 4.3.4-1. FEMA Disaster Declarations for Flood in Fort Bend County (1954–2022)

Date(s) of Event	Declaration Date	FEMA Declaration Number	Description
December 20, 1991 – January 14, 1992	December 21, 1991	DR-930-TX	Severe Storm, Thunderstorms

Date(s) of Event	Declaration Date	FEMA Declaration Number	Description
October 14, 1994 – November 8, 1994	October 18, 1994	DR-1041-TX	Severe Storm, Thunderstorms, Flooding
October 17, 1998 – November 15, 1998	October 21, 1998	DR-1257-TX	Severe Storms, Flooding and Tornadoes
April 17, 2016 – April 30, 2016	April 25, 2016	DR-4269-TX	Severe Storms and Flooding
May 22, 2016 – June 24, 2016	June 11, 2016	DR-4272-TX	Severe Storms and Flooding

Source: FEMA 2022

USDA Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2017 and 2022, Fort Bend County was included in one flood-related agricultural disaster declaration (USDA FSA 2022).

Table 4.3.4-2. FEMA Disaster Declarations for Flood in Fort Bend County (1954–2022)

Date(s) of Event	Declaration Date	USDA Declaration Number	Description
September 3, 2018 – January 28, 2019	March 11, 2019	S4476	Flood – Flash Flooding and Excessive Rain

Source: USDA FSA 2022

Previous Events

For this 2023 Hazard Mitigation Plan (HMP) update, known flood events that impacted the County between 2017 and 2022 are discussed below. For events prior to 2017, refer to the 2018 Fort Bend County HMP.

Table 4.3.4-3. Flood Events in Fort Bend County (2017–2022)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend County Included in Declaration?	Description
January 18, 2017	Flash Flood	N/A	N/A	Showers and thunderstorms produced 4–6 inches of rainfall totals along and near the U.S. 59 corridor from the Kendleton area to Sugar Land to the Houston area. Several roads were flooded and impassable in and around the U.S. 59 corridor, including the Highway 90A and the Newton Drive areas in and around Richmond. $500,000.00 in property damages were incurred.
January 20, 2017	Flash Flood	N/A	N/A	Slow-moving showers and thunderstorms produced hail and flash flooding in the afternoon through early evening hours. There were several road closures in and around the Rosenberg area. No damages to property or crops were recorded.
April 18, 2017	Flash Flood	N/A	N/A	Strong storms produced high rainfall rates that lead to isolated flash flooding. The intersection of U.S. Highway 59 and FM 762 was flooded. $554,000.00 in property damages were incurred.
August 26–29, 2017	Flash Flood, Hurricane Harvey	DR-4332-TX	Yes	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 and then back over the Gulf of Mexico, making a second landfall along the Louisiana coast during the early morning hours of August 30th. Over that 5-day period over Southeast Texas Harvey produced catastrophic flooding with a large area of 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 copious record amount of rain led to catastrophic flooding. Thousands of homes, businesses, and roads were flooded due to flash flooding and sheet flow from long-duration, intense rain. Main stem rivers and adjoining tributaries, creeks, and bayous reached full capacity and came out of their banks, and this also contributed to the massive flooding across southeastern Texas. There was water over roadways FM 655 and CR 521 near the town of Rosharon. Sections of FM 762 were flooded around SH 69 south of Richmond. FM 1093 closed east of FM 723 due to flooding. There were numerous road closures around the Rosenberg and Richmond areas. Some of these roads included Highway 90 at Highway 36 and Lane Drive, Lane Drive at Mustang Road, and I-69 at FM 762 and Reading Road. Sections of FM 1463 and FM 359 between Fulshear and the Grand Parkway were closed due to flooding. Flooding was reported in or within homes in Missouri City, with water rescues being conducted off the Westpark Tollway in the Jeanetta Sharpstown area. Major record-level flooding of both the Brazos and San Bernard Rivers caused significant home flooding from Richmond to Rosharon. Massive flooding occurred in Tierra Grande subdivision along the San Bernard River in southwestern Fort Bend County. Home flooding occurred at Valley Lodge in Simonton, along Edgewood and Baudet Roads in Richmond, along Bar, Barker, Cumings, Sixth Street, Avenue B, and Rio Brazos Roads in Rosenberg. Sections of FM 2759 as well as the Grand River, Rivers Edge, and Pecan Estates in Thompsons flooded. Many countywide roads became inundated in flood waters, including but not limited to Highway 90A, Pitts Road, FM 1489, FM 723, FM 1093, FM 359, SH 6 feeder roads, Sienna Parkway, Carrol Road, McKeever Road, Knights Court, Miller Road, river Oaks Road, Thompsons Ferry Road, Strange Drive, Greenwood Drive, Second Street and low-lying roads in Quail Valley in Missouri City. Due to record pool levels in Barker Reservoir, homes in Cinco Ranch flooded. Big Creek flooding in Needville caused the flooding of homes on Ansel Road. $41.124 billion in property damages and $340,000.00 in crop damages were incurred.
June 19, 2018	Flash Flood	N/A	N/A	Flash flooding led to a road closure near the intersection of Highway 59 and the 540 Loop in Beasley. No damages to property or crops were recorded.

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend County Included in Declaration?	Description
September 3, 2018 – January 28, 2019	Flood – Flash Flooding and Excessive Rain	S4476	Yes	Excessive moisture and flooding. Declared for Fort Bend County on March 11, 2019.
May 7, 2019	Flash Flood	N/A	N/A	Slow-moving thunderstorms produced several inches of rain near Kingwood and over Fort Bend County. There was street flooding and road closures in the town of Richmond. There were flooded cars at Highway 59 and Williams Trace Blvd. All major roadways were impassable due to flooding in Sugar Land. $245,000.00 in property damages were incurred.
September 19, 2019	Remnants of Tropical Storm Imelda	N/A	N/A	Tropical Storm Imelda brought heavy rains across southeast Texas, with rainfall totals exceeding 40 inches in some areas. In Fort Bend County, street flooding was reported in Stafford and Sugar Land. Approximately $565.4 million in property damage was reported in the County.
May 15, 2020	Flash Flood	N/A	N/A	Slow-moving thunderstorms in Fort Bend County led to roadway flooding with reports of knee to waist-high water in the First Colony area. Most of the flooding reports were located between First Colony and Oyster Creek Park or near the Dulles Road and Cartwright intersection. $100,000.00 in property damages were incurred from this storm.
June 25, 2020	Flash Flood	N/A	N/A	A slow-moving line of showers and thunderstorms produced heavy rain across the Houston metropolitan area. This led to instances of flash flooding to the Southwest of the City of Houston over a period of several hours. There were multiple flooded roads from just south of Katy to Simonton and Fulshear, including FM 1489 and FM 1093. $10,010.00 in property damages were incurred.
May 1, 2021	Flash Flood	N/A	N/A	A series of thunderstorms resulted in flash flooding in Brazoria and Fort Bend counties. Feeder roads and the FM 1093 exit along State Highway 99 were closed due to flooding. $5,000.00 in property damages were incurred.
October 1, 2021	Flash Flood	N/A	N/A	A cluster of showers and thunderstorms developed over southeast Texas during the morning of October 1, producing periods of heavy rain across the area. Heavy downpours resulted in several instances of street flooding, making roads impassable. Heavy rainfall resulted in the US 90 underpass at Thompson Rd becoming impassable due to floodwaters. No damages to property or crops were recorded.

Sources: NOAA 2022; USDA FSA 2022; FEMA 2022; Fort Bend County 2018

Probability of Future Occurrences

For the 2023 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of flood events for the County. Information from NOAA-NCEI storm events database, the 2018 State of Texas HMP, and the previous Fort Bend County HMP was used to identify the number of flood events that occurred between 1950 and 2022. Table 4.3.4-4 presents the probability of future flood events in Fort Bend County.

Table 4.3.4-4. Probability of Future Flood Events in Fort Bend County

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurring in Any Given Year
Flash Flood	48	65.75%
Flood	2	2.77%
Total	**50**	**68.49%**

Sources: NOAA NCEI 2022; State of Texas 2018; Fort Bend County 2018

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected events since 1968. Due to limitations in data, not all flood events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

In Fort Bend County, seasonal flooding on the Brazos River, its tributaries, and the surrounding lakes, creeks, and bayous have increased over time due to increased rainfall events and weather patterns. Flash floods are still considered to be highly likely to occur, with nearly a 65.75 percent chance of occurrence in any given year. This probability is based on the 48 events over 72 years reported in the National Climatic Data Center Storm Events Database and other historical records (local knowledge and news sources).

In Section 4.4, the identified hazards of concern for Fort Bend County were ranked (Table 4.4-2). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Partnership, the probability of occurrence for floods in the County is considered "frequent".

Climate Change Projections

The climate of Texas is changing. Most of the state has warmed between .5°F and 1°F in the past century. In the eastern two-thirds of the state, rainstorms are more intense, and floods are becoming more severe. In the coming decades, storms are likely to become more severe in Texas (EPA 2016). Periods of extreme precipitation increase the risk of flood (Centers for Climate and Energy Solutions n.d.).

High-frequency flood events (e.g., 10-year floods) in particular will likely increase with a changing climate. Scientists project greater storm intensity, resulting in more direct runoff and flooding. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildfires due to climate change, there is potential for more floods following fire, which increase sediment loads and water quality impacts.

As hydrology changes, what is currently considered a 1 percent annual chance flood may strike more often, leaving many communities at greater risk. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams, floodways, bypass channels, and levees, as well as the design of local sewers and storm drains.

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example, historical data are used for flood forecasting models. This method of forecasting assumes that the climate of the future will be similar to that of the period of historical record. However, the hydrologic record cannot be used to predict changes in frequency and severity of extreme climate events such as floods. Going forward, model calibration or statistical relation development must happen more frequently, new forecast-based tools must be developed, and a standard of practice that explicitly considers climate change must be adopted. Climate change is already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management, and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness, and emergency response.

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. To quantitatively assess Fort Bend County's risk to the flood hazard, a spatial analysis was conducted using the January 20, 2021 FEMA effective Digital Flood Insurance Rate Map (DFIRM), with the latest Letter of Map Revision (LOMR) date of August 10, 2022. The 1 and 0.2 percent annual chance flood events were examined to determine the assets located in the hazard areas and to estimate potential loss using the FEMA Hazus riverine flood model. These results are summarized below.

Impact on Life, Health, and Safety

The impact of flooding on life, health, and safety is dependent upon several factors, including the severity of the event and whether or not adequate warning time is provided to residents. Exposure represents the population living in or near floodplain areas that could be impacted should a flood event occur. Additionally, exposure should not be limited to only those who reside in a defined hazard zone, but everyone who may be affected by the effects of a hazard event (e.g., people are at risk while traveling in flooded areas, or their access to emergency services is compromised during an event). The degree of that impact will vary and is not strictly measurable.

To estimate population exposure to the 1 percent- and 0.2 percent annual chance flood events, the DFIRM flood boundaries were used. Based on the spatial analysis, there are an estimated 17,793 residents living in the 1 percent annual chance floodplain, or 2.2 percent of the County's total population. There are an estimated 49,450 residents living in the 0.2 percent annual chance floodplain, or 6.1 percent of the County's total population. The Unincorporated Areas of Fort Bend County has the greatest number of residents living in the 1 percent annual chance flood event hazard area with approximately 10,435 residents, followed by the City of Houston (1,620). The Unincorporated Areas of Fort Bend County also has the greatest number of residents living in the 0.2 percent annual chance flood event with approximately 31,576 residents, followed by The City of Rosenburg (3,302). Table 4.3.4-5 summarizes the population exposed to the flood hazard by jurisdiction.

Table 4.3.4-5. Estimated Number of Persons in Fort Bend County Living in the 1 Percent and 0.2 Percent Annual Chance Flood Event Hazard Areas

Jurisdiction	Total Population (American Community Survey 2021)	Estimated Population Located in the Flood Hazard Areas			
		Number of Persons Located in the 1 Percent Annual Chance Flood Event Hazard Area	Percent of Total	Number of Persons Located in the 0.2 Percent Annual Chance Flood Event Hazard Area	Percent of Total
Arcola (C)	2,593	125	4.8%	125	4.8%
Beasley (C)	957	0	0.0%	0	0.0%
Fairchilds (V)	755	181	23.9%	209	27.7%
Fulshear (C)	17,259	0	0.0%	0	0.0%
Houston (C)	41,279	1,620	3.9%	2,420	5.9%
Katy (C)	21,926	244	1.1%	2,949	13.4%
Kendleton (C)	341	7	2.0%	20	5.8%
Meadows Place (C)	4,755	0	0.0%	79	1.7%
Missouri City (C)	73,682	627	0.9%	945	1.3%
Needville (C)	3,059	0	0.0%	0	0.0%
Orchard (C)	219	0	0.0%	0	0.0%
Pearland (C)	122,609	57	0.0%	1,303	1.1%
Pleak (V)	1,756	232	13.2%	455	25.9%
Richmond (C)	11,768	1,490	12.7%	1,724	14.6%
Rosenberg (C)	37,871	1,279	3.4%	3,302	8.7%
Simonton (C)	838	711	84.9%	711	84.9%
Stafford (C)	17,170	0	0.0%	0	0.0%
Sugarland (C)	110,272	101	0.1%	2,948	2.7%
Thompsons (T)	265	223	84.0%	223	84.0%
Weston Lakes (C)	3,763	462	12.3%	462	12.3%
Unincorporated Area	333,360	10,435	3.1%	31,576	9.5%
Fort Bend County (Total)	**806,497**	**17,793**	**2.2%**	**49,450**	**6.1%**

Source: U.S. Census Bureau 2021; STATS America; FEMA 2022

Flooding events can displace populations along steep topography, particularly in cases when flood waters surge into residential properties or alter the terrain into unsafe conditions requiring evacuation. Displaced populations were estimated for the 1 percent annual chance flood event. It is important to note that the impacts to the households in the FEMA flood hazard area are assessed using the riverine flood model in Hazus. Using 2021 American Community Survey data, Hazus estimates 21,765 people may be displaced by flooding with 1,657 people potentially seeking short-term sheltering. These statistics, by jurisdiction, are presented in Table 4.3.4-6.

Table 4.3.4-6. Estimated Population Seeking Short-Term Shelter from the 1 Percent Annual Chance Flood Event

Jurisdiction	Total Population	1 Percent Annual Chance Flood Event	
		Displaced Population	Persons Seeking Short-Term Sheltering
Arcola (C)	2,593	82	12
Beasley (C)	957	0	0
Fairchilds (V)	755	241	8
Fulshear (C)	17,259	0	0
Houston (C)	41,279	1,826	130
Katy (C)	21,926	244	32
Kendleton (C)	341	16	1
Meadows Place (C)	4,755	0	0
Missouri City (C)	73,682	721	81
Needville (C)	3,059	0	0

Jurisdiction	Total Population	1 Percent Annual Chance Flood Event	
		Displaced Population	Persons Seeking Short-Term Sheltering
Orchard (C)	219	0	0
Pearland (C)	122,609	0	0
Pleak (V)	1,756	399	14
Richmond (C)	11,768	557	24
Rosenberg (C)	37,871	1,928	132
Simonton (C)	838	687	19
Stafford (C)	17,170	0	0
Sugarland (C)	110,272	632	112
Thompsons (T)	265	165	4
Weston Lakes (C)	3,763	314	57
Unincorporated Area	333,360	13,954	1,031
Fort Bend County (Total)	**806,497**	**21,765**	**1,657**

Source: U.S. Census Bureau 2021; STATS America; Fort Bend County Drainage District 2023, Hazus v5.1

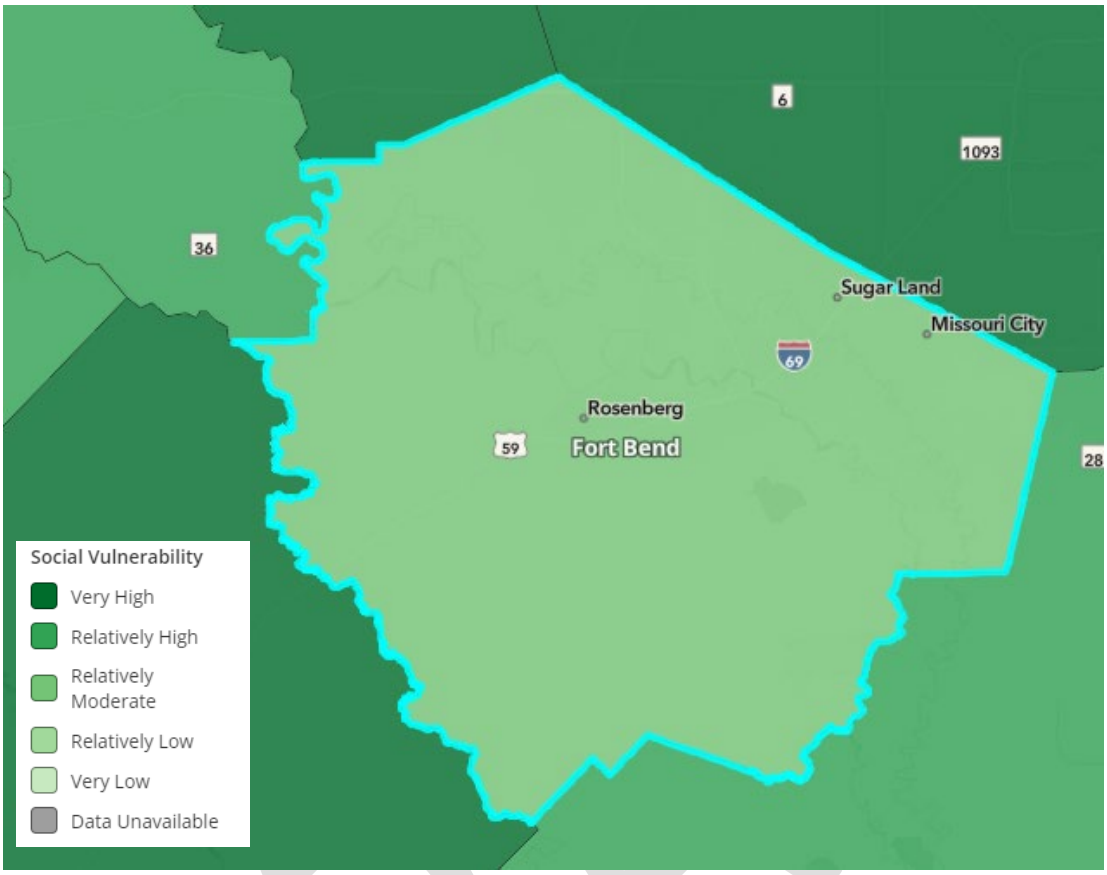
Socially Vulnerable Populations

Social vulnerability is defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards.

According to FEMA's National Risk Index, socially vulnerable populations in Fort Bend County have a relatively moderate susceptibility to the adverse impacts of riverine flooding, when compared to the rest of the United States (FEMA n.d.).

Vulnerable populations are all populations residing or located in the floodplain that are incapable of escaping the area within the required timeframe to reach safety. However, exposure should not be limited only to those who reside within a defined hazard zone but everyone who may be affected by a hazard event (e.g., people are considered at risk if they are traveling in flooded areas or their access to emergency services is compromised during an event). Flash floods can be localized events that affect areas outside of the floodplain due to localized drainage issues and can directly impact populations and comprise access to emergency services. The degree of that impact varies and is not strictly measurable. Refer to Figure 4.3.4-6 for the social vulnerability index for riverine flooding.

Figure 4.3.4-6. FEMA Social Vulnerability Index for Riverine Flooding



Source: FEMA NRI

Impact on General Building Stock

After considering the population exposed and potentially vulnerable to the flood hazard, the built environment was evaluated. Exposure includes those buildings located in the flood hazard areas. Potential damage is the modeled loss that could occur to the exposed inventory, including structural and content replacement cost values.

Table 4.3.4-7 summarizes the number of structures located in the 1 percent and 0.2 percent annual chance flood events by jurisdiction. In summary, there are 8,241 buildings located in the 1 percent annual chance flood boundary with an estimated $17.8 billion of replacement cost value (i.e., building and content replacement costs). In total, this represents approximately 2.9 percent of the County's total general building stock inventory. In addition, there are 21,033 buildings located in the 0.2 percent annual chance flood boundary with an estimated $25.8 billion of building stock and contents exposed. This represents approximately 7.5 percent of the County's total general building stock inventory.

Table 4.3.4-7. Estimated General Building Stock Located in the 1 Percent and 0.2 Percent Annual Chance Flood Event

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Located in the Flood Hazard Area							
			Number of Buildings Located in the 1 Percent Annual Chance Flood Event Hazard Area	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total	Number of Buildings Located in the 0.2 Percent Annual Chance Flood Event Hazard Area	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total
Arcola (C)	676	$1,374,107,673	28	4.1%	$6,848,591	0.5%	28	4.1%	$6,848,591	0.5%
Beasley (C)	367	$467,087,536	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Fairchilds (V)	190	$58,400,161	46	24.2%	$12,377,306	21.2%	54	28.4%	$14,867,714	25.5%
Fulshear (C)	7,869	$6,124,915,172	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Houston (C)	11,589	$5,814,576,859	452	3.9%	$232,720,019	4.0%	738	6.4%	$1,075,713,672	18.5%
Katy (C)	2,206	$4,980,024,025	57	2.6%	$484,627,324	9.7%	336	15.2%	$1,026,315,015	20.6%
Kendleton (C)	329	$241,970,568	8	2.4%	$3,151,602	1.3%	19	5.8%	$5,576,265	2.3%
Meadows Place (C)	1,676	$1,270,821,734	0	0.0%	$0	0.0%	28	1.7%	$11,235,359	0.9%
Missouri City (C)	27,170	$23,213,328,025	278	1.0%	$1,292,817,133	5.6%	392	1.4%	$1,334,766,510	5.8%
Needville (C)	1,346	$1,362,324,702	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Orchard (C)	180	$170,795,761	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Pearland (C)	2,171	$1,063,851,539	2	0.1%	$2,881,232	0.3%	24	1.1%	$13,777,412	1.3%
Pleak (V)	436	$672,927,271	65	14.9%	$114,074,323	17.0%	118	27.1%	$209,781,091	31.2%
Richmond (C)	3,296	$4,128,822,403	413	12.5%	$486,151,762	11.8%	488	14.8%	$601,868,913	14.6%
Rosenberg (C)	11,894	$22,921,973,230	450	3.8%	$8,167,637,250	35.6%	1,027	8.6%	$8,390,874,747	36.6%
Simonton (C)	395	$372,092,732	323	81.8%	$203,181,632	54.6%	323	81.8%	$203,181,632	54.6%
Stafford (C)	4,222	$10,638,345,589	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Sugarland (C)	37,506	$36,732,455,899	53	0.1%	$254,975,690	0.7%	998	2.7%	$949,440,223	2.6%
Thompsons (T)	143	$404,590,514	113	79.0%	$187,849,175	46.4%	113	79.0%	$187,849,175	46.4%
Weston Lakes (C)	1,589	$1,145,826,270	195	12.3%	$130,112,101	11.4%	195	12.3%	$130,112,101	11.4%
Unincorporated Area	166,035	$103,633,654,804	5,758	3.5%	$6,229,188,001	6.0%	16,152	9.7%	$11,659,322,197	11.3%
Fort Bend County (Total)	**281,285**	**$226,792,892,466**	**8,241**	**2.9%**	**$17,808,593,141**	**7.9%**	**21,033**	**7.5%**	**$25,821,530,616**	**11.4%**

Source: FEMA 2022; Fort Bend County 2016, 2022; RS Means 2022

The Hazus flood model estimated potential damages to the buildings in Fort Bend County at the structure level using the custom structure inventory developed for this HMP and the depth grid generated using the effective DFIRM data. The potential damage estimated by Hazus to the general building stock inventory associated with the 1 percent annual chance flood is approximately $1.5 billion. The Unincorporated Area of the County has the greatest amount of estimated building loss—approximately $950 million. Refer to Table 4.3.4-8 for the estimated losses by jurisdiction.

Table 4.3.4-8. Estimated General Building Stock Potential Loss to the 1 Percent Annual Chance Flood Event

Jurisdiction	Total Replacement Cost Value (RCV)	Estimated Loss for All Occupancies	Percent of Total	Estimated Loss for Residential Properties	Estimated Loss for Commercial Properties	Estimated Loss for All Other Occupancies
Arcola (C)	$1,374,107,673	$1,070,987	0.1%	$1,070,987	$0	$0
Beasley (C)	$467,087,536	$0	0.0%	$0	$0	$0
Fairchilds (V)	$58,400,161	$3,744,959	6.4%	$3,699,306	$0	$45,653
Fulshear (C)	$6,124,915,172	$0	0.0%	$0	$0	$0
Houston (C)	$5,814,576,859	$26,571,929	0.5%	$14,287,959	$12,283,970	$0
Katy (C)	$4,980,024,025	$87,481,760	1.8%	$1,636,998	$85,526,620	$318,142
Kendleton (C)	$241,970,568	$351,484	0.1%	$331,710	$0	$19,774
Meadows Place (C)	$1,270,821,734	$0	0.0%	$0	$0	$0
Missouri City (C)	$23,213,328,025	$54,145,888	0.2%	$12,351,146	$28,023,854	$13,770,889
Needville (C)	$1,362,324,702	$0	0.0%	$0	$0	$0
Orchard (C)	$170,795,761	$0	0.0%	$0	$0	$0
Pearland (C)	$1,063,851,539	$137,121	0.0%	$137,121	$0	$0
Pleak (V)	$672,927,271	$17,374,315	2.6%	$5,475,752	$10,531,941	$1,366,621
Richmond (C)	$4,128,822,403	$66,533,619	1.6%	$15,620,594	$47,366,386	$3,546,639
Rosenberg (C)	$22,921,973,230	$109,752,058	0.5%	$14,745,008	$92,768,213	$2,238,838
Simonton (C)	$372,092,732	$67,123,498	18.0%	$39,906,502	$22,391,480	$4,825,515
Stafford (C)	$10,638,345,589	$0	0.0%	$0	$0	$0
Sugarland (C)	$36,732,455,899	$63,024,577	0.2%	$5,756,286	$56,968,320	$299,971
Thompsons (T)	$404,590,514	$67,813,091	16.8%	$7,888,960	$57,310,194	$2,613,937
Weston Lakes (C)	$1,145,826,270	$8,109,050	0.7%	$7,552,840	$556,210	$0
Unincorporated Area	$103,633,654,804	$952,308,691	0.9%	$302,783,447	$567,442,720	$82,082,525
Fort Bend County (Total)	**$226,792,892,467**	**$1,525,543,027**	**0.7%**	**$433,244,616**	**$981,169,908**	**$111,128,504**

Source: FEMA 2022; Fort Bend County 2016, 2022; RS Means 2022

NFIP Statistics

Limited NFIP data was available for the County of Fort Bend. Table 4.3.4-9 summarizes the NFIP policies for Fort Bend County. According to available data, as of 2022, there were 9,699 policies in the County. Over 4,000 claims have been submitted, with nearly $300 million in paid claims.

According to FEMA, a repetitive loss (RL) property is a NFIP-insured structure that has had at least two paid flood losses of more than $1,000 in any 10-year period since 1978. A severe repetitive loss (SRL) property is a NFIP-insured structure that has had four or more separate claim payments made under a standard flood insurance policy, with the amount of each claim exceeding $5,000 and with the cumulative amount of such claims payments exceeding $20,000 or at least two separate claims payments made under a standard flood insurance policy with the cumulative amount of such claim payments exceed the fair market value of the insured building on the day before each loss (FEMA 2022). According to available data from 2018, Fort Bend County has 269 RL properties and 28 SRL properties.

Table 4.3.4-9. Policies per Flood Zone

Municipality	Policies in Force[a]	Number of Paid Claims[a]	Amount of Paid Claims[a]	Number of NFIP RL Properties[b]	Number of NFIP SRL Properties[b]
Arcola (C)	47	14	$626,007.05	0	0
Beasley (C)	9	0	None Documented	0	0
Fairchilds (V)	42	19	$536,771.43	0	0
Fulshear (C)	1316	39	$1,306,218.55	4	N/A
Katy (C)	313	58	$7,229,784.44	N/A	N/A
Kendleton (C)	12	4	$61,312.99	0	0
Meadows Place (C)	354	54	$280,204.52	1	N/A
Missouri City (C)	3449	823	$10,260,560.59	37	N/A
Needville (C)	145	39	$1,535,039.29	2	N/A
Orchard (C)	8	6	$213,258.75	0	0
Pearland (C)	421	3	None Documented	N/A	N/A
Pleak (V)	94	48	$2,870,389.62	0	0
Richmond (C)	338	226	$4,391,812.52	13	0
Rosenberg (C)	946	114	$1,558,635.13	11	N/A
Simonton (C)	170	595	$49,505,014.02	32	N/A
Stafford (C)	511	91	$1,188,509.92	9	N/A
Sugar Land (C)	3440	296	$3,008,495.48	20***	0***
Thompsons (C)	17	22	$932,569.16	0	0
Weston Lakes (C)	684	52	$7,426,026.12	0	0
TOTAL	**9,669****	**4,403****	**$297,594,358.10****	**269***	**28***

Sources:

a BureauNet 2022 (https://nfipservices.floodsmart.gov/reports-flood-insurance-data)

b 2018 Fort Bend County HMP

Notes: Due to a contractual agreement with FEMA, detailed information at the municipal level was not available to incorporate into the 2023 HMP Update. The information presented here was collected from data provided by the State of Texas and from FEMA's HUDEX Report.

**Number of RL and SRL properties provided by the State of Texas*

***Total policies in force and paid claims collected from FEMA's OpenFEMA Dataset: FIMA NFIP Redacted Claims*

****From the Sugar Land Plan 2021*

RL Repetitive Loss

SRL Severe Repetitive Loss

Impact on Critical Facilities

It is important to determine the critical facilities and infrastructure that may be at risk to flooding and who may be impacted should damage occur. Critical services during and after a flood event may not be available if critical facilities are directly damaged or transportation routes to access these critical facilities are impacted. Roads that are blocked or damaged can isolate residents and can prevent access throughout the planning area to many service providers needing to reach vulnerable populations or to make repairs.

Critical facility exposure to the flood hazard was examined. Table 4.3.4-10 and Table 4.3.4-11 list the number of critical facilities and lifelines within the 1 Percent and 0.2 Percent annual chance flood event hazard areas. A majority of the critical facilities located in the 1 Percent and 0.2 Percent annual chance flood event boundaries are the Unincorporated Areas of Fort Bend County and the City of Sugarland.

Table 4.3.4-12 displays the number of facilities in each lifeline category located in the 1 percent and 0.2 percent annual chance flood event hazard area. Of the 684 critical facilities located in the 1 percent annual chance flood event boundary, the greatest number are transportation facilities (368). Additionally, there are 789 critical facilities located in the 0.2 percent annual chance flood event boundary, 379 of which are transportation facilities.

Table 4.3.4-10. Critical Facilities and Lifeline Facilities Located in the 1 Percent Annual Chance Flood Event Hazard Area by Jurisdiction

Jurisdiction	Total Critical Facilities Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Located in the 1 Percent Annual Chance Flood Event Hazard Area			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Arcola (C)	22	21	3	13.6%	3	14.3%
Beasley (C)	18	14	0	0.0%	0	0.0%
Fairchilds (V)	3	3	2	66.7%	2	66.7%
Fulshear (C)	43	40	1	2.3%	1	2.5%
Houston (C)	105	84	6	5.7%	6	7.1%
Katy (C)	53	51	16	30.2%	16	31.4%
Kendleton (C)	21	19	6	28.6%	6	31.6%
Meadows Place (C)	17	16	0	0.0%	0	0.0%
Missouri City (C)	339	297	25	7.4%	24	8.1%
Needville (C)	42	33	1	2.4%	1	3.0%
Orchard (C)	7	7	0	0.0%	1	14.3%
Pearland (C)	1	1	1	100.0%	0	0.0%
Pleak (V)	15	15	7	46.7%	7	46.7%
Richmond (C)	123	103	21	17.1%	21	20.4%
Rosenberg (C)	340	295	53	15.6%	52	17.6%
Simonton (C)	17	17	10	58.8%	10	58.8%
Stafford (C)	164	137	3	1.8%	3	2.2%
Sugarland (C)	631	575	100	15.8%	100	17.4%
Thompsons (T)	10	9	10	100.0%	9	100.0%
Weston Lakes (C)	7	7	2	28.6%	2	28.6%
Unincorporated Fort Bend County	1,756	1,654	432	24.6%	420	25.4%
Fort Bend County (Total)	**3,734**	**3,398**	**699**	**18.7%**	**684**	**20.1%**

Source: FEMA 2022; Fort Bend County 2022

Table 4.3.4-11. Critical Facilities and Lifeline Facilities Located in the 0.2 Percent Annual Chance Flood Event Hazard Area by Jurisdiction

Jurisdiction	Total Critical Facilities Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Located in the 0.2 Percent Annual Chance Flood Event Hazard Area			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Arcola (C)	22	21	3	13.6%	3	14.3%
Beasley (C)	18	14	0	0.0%	0	0.0%
Fairchilds (V)	3	3	2	66.7%	2	66.7%
Fulshear (C)	43	40	1	2.3%	1	2.5%
Houston (C)	105	84	26	24.8%	17	20.2%
Katy (C)	53	51	23	43.4%	22	43.1%
Kendleton (C)	21	19	6	28.6%	6	31.6%
Meadows Place (C)	17	16	1	5.9%	1	6.3%
Missouri City (C)	339	297	25	7.4%	24	8.1%
Needville (C)	42	33	1	2.4%	1	3.0%
Orchard (C)	7	7	0	0.0%	0	0.0%
Pearland (C)	1	1	1	100.0%	1	100.0%
Pleak (V)	15	15	9	60.0%	9	60.0%
Richmond (C)	123	103	21	17.1%	21	20.4%
Rosenberg (C)	340	295	57	16.8%	55	18.6%
Simonton (C)	17	17	10	58.8%	10	58.8%
Stafford (C)	164	137	3	1.8%	3	2.2%
Sugarland (C)	631	575	128	20.3%	126	21.9%
Thompsons (T)	10	9	10	100.0%	9	100.0%
Weston Lakes (C)	7	7	2	28.6%	2	28.6%
Unincorporated Fort Bend County	1,756	1,654	491	28.0%	476	28.8%
Fort Bend County (Total)	**3,734**	**3,398**	**820**	**22.0%**	**789**	**23.2%**

Source: FEMA 2022; Fort Bend County 2022

Table 4.3.4-12. Lifeline Categories Located in the 1 Percent and 0.2 Percent Annual Chance Event Floodplain

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Located in the 1 Percent Annual Chance Flood Event Hazard Area	Number of Lifelines Located in the 0.2 Percent Annual Chance Flood Event Hazard Area
Communications	44	7	7
Energy	584	22	30
Food, Water, Shelter	1,480	250	324
Hazardous Materials	13	3	3
Health and Medical	335	5	9
Safety and Security	282	29	37
Transportation	660	368	379
Fort Bend County (Total)	3,398	684	789

Source: FEMA 2022; Fort Bend County 2022

In cases where short-term functionality is impacted by flooding, other facilities of neighboring municipalities may need to increase support response functions during a disaster event. Mitigation planning should consider means to reduce flood impacts to critical facilities and ensure sufficient emergency and school services remain when a significant event occurs.

Impact on Economy

Flood events can significantly impact the local and regional economy. This includes but is not limited to general building stock damages and associated tax loss, impacts to utilities and infrastructure, business interruption, impacts on tourism, and impacts on the tax base to Fort Bend County. In areas that are directly flooded, renovations of commercial and industrial buildings may be necessary, disrupting associated services. Refer to the Impact on General Building Stock subsection, which discusses direct impacts to buildings in Fort Bend County.

Flooding can cause extensive damage to public utilities and disruptions to delivery of services. Loss of power and communications may occur, and drinking water and wastewater treatment facilities may be temporarily out of operation. Other economic components, such as loss of facility use, functional downtime, and socio-economic factors, are less measurable with a high degree of certainty. As a result of the 1 percent annual chance event, Hazus estimates approximately $105,250 in inventory losses, over $1.6 billion in relocation costs, over $1.2 billion in wage losses, $787,000 in rental losses, and over $769 million in income losses (see Table 4.3.4-13).

Table 4.3.4-13. Estimated Economic Impacts from the 1 Percent Annual Chance Flood Event

Flood Hazard	Inventory Loss	Relocation Loss	Wage Loss	Rental Loss	Income Loss
1 Percent Annual Chance Flood Event	$105,250,000	$1,616,890,000	$1,201,940,000	$787,000,000	$769,410,000

Source: Hazus v5.1

Debris management may also be a large expense after a flood event. Hazus estimates the amount of debris generated from the 1 Percent annual chance event. The model breaks down debris into three categories: (1) finishes (drywall, insulation, etc.), (2) structural (wood, brick, etc.), and (3) foundations (concrete slab and block, rebar, etc.). The distinction is made because of the different types of equipment needed to handle the debris. Table 4.3.4-14 summarizes the debris Hazus estimates for these events. As a result of the 1 percent annual chance event, Hazus estimates approximately 130,683 tons of debris will be generated in total.

Table 4.3.4-14. Estimated Debris Generated from the 1 Percent Annual Chance Flood Event

Jurisdiction	1 Percent Annual Chance Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Arcola (C)	66	34	17	15
Beasley (C)	0	0	0	0
Fairchilds (V)	1,111	427	206	478
Fulshear (C)	0	0	0	0
Houston (C)	4,146	1,252	1,492	1,402
Katy (C)	1,020	302	450	268
Kendleton (C)	82	64	6	13
Meadows Place (C)	0	0	0	0
Missouri City (C)	8,169	3,711	2,647	1,811
Needville (C)	0	0	0	0
Orchard (C)	0	0	0	0
Pearland (C)	68	13	23	32
Pleak (V)	2,401	1,683	256	462
Richmond (C)	3,278	1,695	806	777
Rosenberg (C)	5,790	3,604	1,134	1,053
Simonton (C)	4,017	3,898	55	64
Stafford (C)	0	0	0	0

Jurisdiction	1 Percent Annual Chance Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Sugarland (C)	8,167	3,057	2,855	2,255
Thompsons (T)	488	297	85	106
Weston Lakes (C)	1,237	949	120	168
Unincorporated Area	90,642	40,495	27,258	22,889
Fort Bend County (Total)	**130,683**	**61,482**	**37,409**	**31,792**

Source: Fort Bend County 2016, 2022; Fort Bend County Drainage District 2023; RS Means 2022; Hazus v5.1

Impact on Environment

Flood events will inevitably impact Fort Bend County's natural and local environment. Severe flooding not only influences the habitat of these natural land areas, but it can also be disruptive to species that reside in these natural habitats. Flash floods can destroy wildlife habitats, pollute rivers and streams, carry sediment and silt that can impact water quality, destroy crops and farms, uproot trees, and cause erosion of streambanks and other areas (eSchoolToday 2021).

Table 4.3.4-15 lists the number of acres exposed to the 1 and 0.2 percent annual chance flood extents.

Table 4.3.4-15. Land Acreage in Fort Bend County Located in 1 Percent and 0.2 Percent Flood Extents

Jurisdiction	Total Acres of Land Area	Total Acres of Land Area (Excluding Waterbodies) Located in the Flood Hazard Areas			
		Total Acres Located in the 1 Percent Annual Chance Flood Event	Percent of Total	Total Acres Located in the 0.2 Percent Annual Chance Flood Event	Percent of Total
Arcola (C)	1,664	129	7.8%	129	7.8%
Beasley (C)	673	0	0.0%	0	0.0%
Fairchilds (V)	831	189	22.7%	211	25.4%
Fulshear (C)	7,962	163	2.1%	163	2.1%
Houston (C)	7,440	2,396	32.2%	2,763	37.1%
Katy (C)	2,843	433	15.2%	758	26.6%
Kendleton (C)	850	92	10.8%	113	13.3%
Meadows Place (C)	586	<.01	<0.1%	14	2.4%
Missouri City (C)	20,841	3,265	15.7%	3,373	16.2%
Needville (C)	1,264	5	0.4%	5	0.4%
Orchard (C)	250	0	0.0%	0	0.0%
Pearland (C)	839	25	2.9%	35	4.2%
Pleak (V)	1,193	344	28.9%	496	41.5%
Richmond (C)	2,752	652	23.7%	689	25.0%
Rosenberg (C)	23,442	4,244	18.1%	4,939	21.1%
Simonton (C)	1,487	1,024	68.9%	1,024	68.9%
Stafford (C)	4,467	14	0.3%	15	0.3%
Sugarland (C)	27,073	5,829	21.5%	7,240	26.7%
Thompsons (T)	995	852	85.6%	852	85.6%
Weston Lakes (C)	1,623	432	26.6%	432	26.6%
Unincorporated Area	449,862	128,615	28.6%	143,546	31.9%
Fort Bend County (Total)	**558,937**	**148,704**	**26.6%**	**166,798**	**29.8%**

Source: FEMA 2022; Fort Bend County 2022

Cascading Impacts on Other Hazards

Cascading impacts may also include exposure to pathogens such as mold. After flood events, excess moisture and standing water contribute to the growth of mold in buildings. Mold may present a health risk to building occupants, especially those with already compromised immune systems, such as infants, children, the elderly and pregnant women. The degree of impact will vary and is not strictly measurable. Mold spores can grow in as short a period as 24–48 hours in wet and damaged areas of buildings that have not been properly cleaned. Very small mold spores can easily be inhaled, creating the potential for allergic reactions, asthma episodes, and other respiratory problems. Buildings should be properly cleaned and dried out to safely prevent mold growth (CDC 2020).

Molds and mildews are not the only public health risk associated with flooding. Floodwaters can be contaminated by pollutants such as sewage, human and animal feces, pesticides, fertilizers, oil, asbestos, and rusting building materials. Common public health risks associated with flood events also include:

- Unsafe food
- Contaminated drinking and washing water and poor sanitation
- Mosquitos and animals
- Carbon monoxide poisoning
- Secondary hazards associated with re-entering/cleaning flooded structures
- Mental stress and fatigue

Current loss estimation models such as Hazus are not equipped to measure public health impacts. The best level of mitigation for these impacts is to be aware that they can occur, educate the public on prevention, and be prepared to deal with these vulnerabilities in responding to flood events.

Floods of any type have the potential to impact water and power utilities, which may impact public and private use, as well as cause disruption to critical infrastructure. Refer to the list below to view flooding's harmful effects on the water supply:

- **Water Supply Contamination:** Excess floodwater can contaminate private drinking water sources, such as wells and springs. Floodwater picks up debris, increasing the number of bacteria, sewage, and other industrial waste and chemicals into the water source or leaky pipes. Excess water also makes it more difficult for water treatment plants to treat the water efficiently and effectively. If there is contamination at any step of the water flow process, this puts consumers at risk of exposure to dangerous toxins that could result in serious harm, such as wound infections, skin rashes, gastrointestinal illnesses, and tetanus; in extreme cases, death may occur.
- **Disruption to Clean Drinking and Cooking Water:** In the event of only having access to contaminated water, consumers are unable to cook or clean in their home the water is certified as safe. Depending on the severity of the flood and the storm, this could take days, weeks, months, and in some cases, even years. Without access to clean drinking and cooking water, consumers ultimately become reliant on bottled water. In impoverished communities, this reality is even more detrimental because those affected may not have the economic means to "stock up" on bottled water. Moreover, in a flood, retail locations are often inaccessible and/or low on water supply (Andrew 2021).

Floodwaters can also cause damage to power utilities. In particular, flooded buildings may have the utilities disrupted if the service panel, generator, meter, etc. are not elevated above the flood protection level. Oversaturated soils from periods of heavy rain and flooding may cause utility poles to tip over or fall completely, interrupting the power grid for a potentially large area, especially if the transformer is impacted.

Future Changes That May Impact Vulnerability

Understanding future changes that affect vulnerability in Fort Bend County can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

As discussed and illustrated in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. New development that has occurred in the last five years within the County and potential future development in the next five years as identified by the County and each municipality is included in the jurisdictional annexes in Section 9, along with an indication of proximity to known hazard zones. Refer to Section 3 and Volume II, Section 9 for more information about the potential new development in Fort Bend County.

Projected Changes in Population

According to the 2021 United States Census Bureau population estimates, the population of the County has increased by approximately 40.4 percent since 2010. The County's population is anticipated to increase over the next decade, continuing with the population growth trend that has been occurring since 1970. Increased population trends will change the County's overall risk to flood events. Refer to Section 3 (County Profile), which includes a discussion on population trends for the County.

Climate Change

The climate of Texas is changing. Most of the state has warmed between .5°F and 1°F in the past century. In the eastern two-thirds of the state, rainstorms are more intense, and floods are becoming more severe. In the coming decades, storms are likely to become more severe in Texas (EPA 2016). Periods of extreme precipitation increase the risk of flood (Centers for Climate and Energy Solutions n.d.).

High-frequency flood events (e.g., 10-year floods) in particular will likely increase with a changing climate. Scientists project greater storm intensity, resulting in more direct runoff and flooding. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildfires due to climate change, there is potential for more floods following fire, which increase sediment loads and water quality impacts.

Change in Vulnerability Since 2018 HMP

The County of Fort Bend continues to be vulnerable to floods. Since the 2018 HMP was drafted, updated inventory data has become available to assess additional flood hazard areas in Fort Bend County. This data includes the 2021 United States Census Bureau population estimates, updated 2022 tax assessor parcel data, 2022 general building stock data provided by the County, 2022 RS Means for building stock replacement cost valuation, and updated critical facility data provided by the County's Planning Partners. Hazus v5.1 was also used to assess the losses in the County to the overall risk from 100-year flood risk. Overall, this vulnerability assessment uses a more accurate and updated asset inventory which provides more accurate estimated exposure to the flood hazard.

SECTION 4. RISK ASSESSMENT

4.3 Hazard Profiles

4.3.5 Geologic Hazards

The following section provides the hazard profile and vulnerability assessment for geologic hazards in Fort Bend County.

Hazard Profile

Hazard Description

For the 2023 Hazard Mitigation Plan (HMP) update, the geologic hazards profile includes erosion and expansive soils.

Erosion

Erosion is the process of the wearing-away or removal of soil by large storms, flooding, strong wave action, sea level rise, fluvial (riverine) currents, and human activities. In the State of Texas, there are two types of erosion: coastal erosion and inland erosion. Fort Bend County can be impacted by inland erosion.

Soil erosion on cropland is of particular interest because of its on-site impacts on soil quality and crop productivity and its off-site impacts on water quantity and quality, air quality, and biological activity. Erosion is measured as a rate of change in the position or displacement of a river or stream bank over a period of time or the amount of soil removal. Short-term erosion results from periodic flooding and wind. Long-term erosion is a result of repetitive events of this type and of prolonged drought (State of Texas Hazard Mitigation Plan 2018).

Erosion caused by water is the primary concern for the County. Water erosion is the detachment and removal of soil by water. The process can occur naturally or be accelerated by human activity. The rate of erosion can be a slow process that continues relatively unnoticed or can occur very rapidly. The rate is dependent on the type of soil, the local landscape, and weather conditions (Ritter 2018, USDA 2000).

Three types of water erosion can occur: sheet, rill, and gully. Sheet erosion is the most difficult to see as it is a uniform soil layer being removed from an area over the surface. Rill erosion starts as water flowing over the soil surface concentrates into small streams, creating channels of water flow. Gully erosion is when rill erosion is not kept under control and creates gullies (deeper and wider cuts) (Soil Science Society of America n.d.).

Erosion can be most severe where urbanization, development, recreational activities, logging, and agricultural practices take place. Extreme rainfall events, lack of vegetative cover, fragile soils, and steep slopes combine to accelerate erosion (Ritter 2018).

Expansive Soils

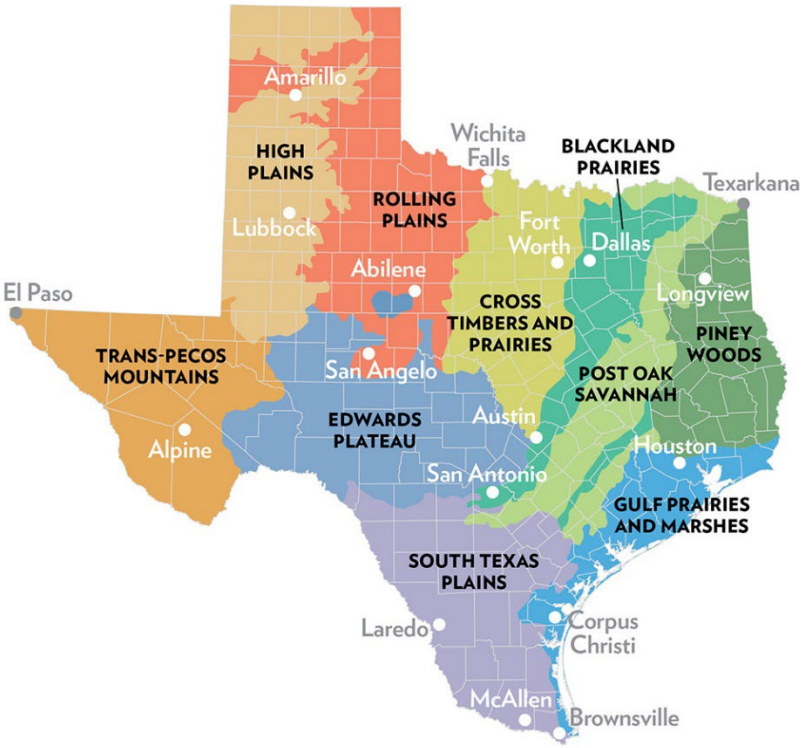
Expansive soils are soils that expand when water is added and shrink when they dry out. This continuous change in soil volume can cause structures to move unevenly and crack and roads and sidewalks to buckle. Soils with a high clay content exhibit high expansive properties. Slab-on-grade construction is the most susceptible to damage from expansive clays.

Location

Erosion

In the State of Texas, inland erosion is more prominent in the High Plains, Rolling Plains, and Coastal Sand Plains. Although Fort Bend County is located in the Gulf Coast Prairies & Marshes ecoregion, inland erosion is a more common hazard and a more significant concern than coastal erosion (Figure 4.3.5-1).

Figure 4.3.5-1. Ecoregions in the State of Texas



Source: Texas Highways 2020

Fort Bend County is located in three major water basins, including the San Jacinto-Brazos Coastal Basin, the Brazos River Basin, and the Brazos-Colorado River Basin. Erosion along the Brazos River has been an ongoing concern in Fort Bend County for years, with the County regularly participating in the Brazos River Authority's Lower Brazos Floodplain Protection Planning Study.

A measure of soil erodibility is the K-factor, which represents both susceptibility of soil to erosion and the rate of runoff. Soils high in clay have low K values, about 0.05 to 0.15, because they are resistant to detachment. Coarse textured soils, such as sandy soils, have low K values, about 0.05 to 0.2, because of low runoff even though these soils are easily detached. Medium textured soils, such as the silt loam soils, have a moderate K values, about 0.25 to 0.4, because they are moderately susceptible to detachment and they produce moderate

runoff. Soils having a high silt content are most erodible of all soils and have K values greater than 0.4. They are easily detached, tend to crust, and produce high rates of runoff (Michigan State University 2002).

For this HMP, the inland erosion hazard area includes areas with K values of 0.49 or higher. Much of Fort Bend County lies within the inland erosion hazard area. Figure 4.3.5-2 below shows the inland erosion hazard within the County, shown in purple.

Expansive Soils

Most of Fort Bend County lies within the expansive soils hazard area. As seen in Figure 4.3.5-3 below, the areas with expansive soil border are located near bodies of water. Fort Bend County is located within the Gulf Coast Prairie region of Texas and is composed of mainly Lake Charles-Bernard-Edna soils. Lake Charles soils are well-developed, clayey soils with high shrink-swell properties, while the Bernard and Edna soils have loamy surface textures and loamy and clayey subsoil horizons; these soil types differ primarily on drainage class and mineralogy (NRCS 2008).

Damage to buildings and critical infrastructure due to expansive soils can occur throughout Fort Bend County. The hazard is most prevalent in areas with clay or sandy soil which are prone to expanding and contracting in periods of heavy precipitation followed by periods of drought.

While all infrastructures in the higher-risk areas are vulnerable, slab-on-grade structures are most likely to suffer damages from expansive soils. In addition, older structures built to less stringent building codes may be more susceptible to damages than new construction. Bridges, highways, streets, and parking lots are especially vulnerable if they are constructed when clays are dry, such as during a drought, and then subsequent soaking rains swell the clay (Texas Division of Emergency Management 2018, State of Texas Hazard Mitigation Plan 2018, State of Texas Hazard Mitigation Plan 2018).

Figure 4.3.5-2. Location of the Inland Erosion Hazard Area in Fort Bend County

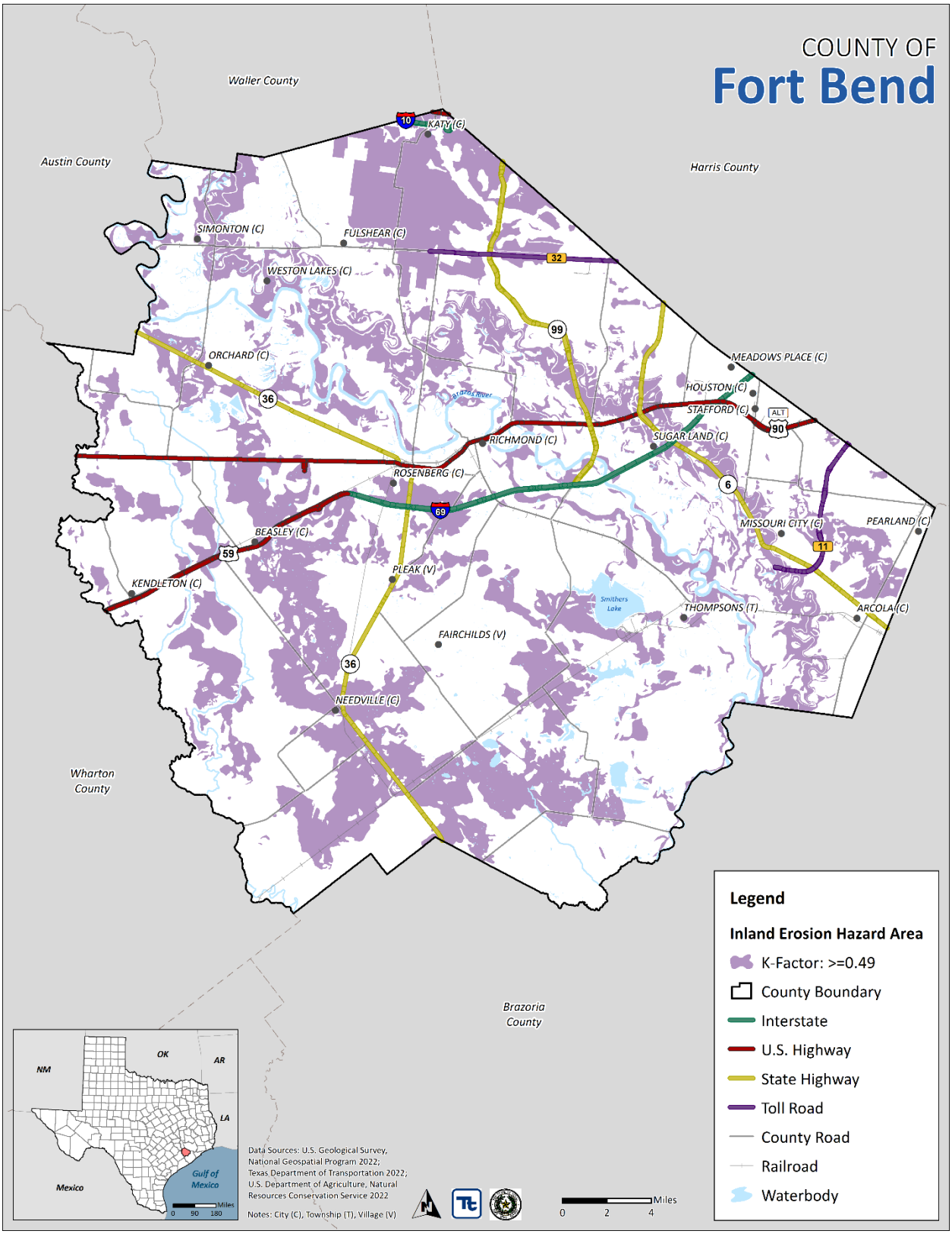
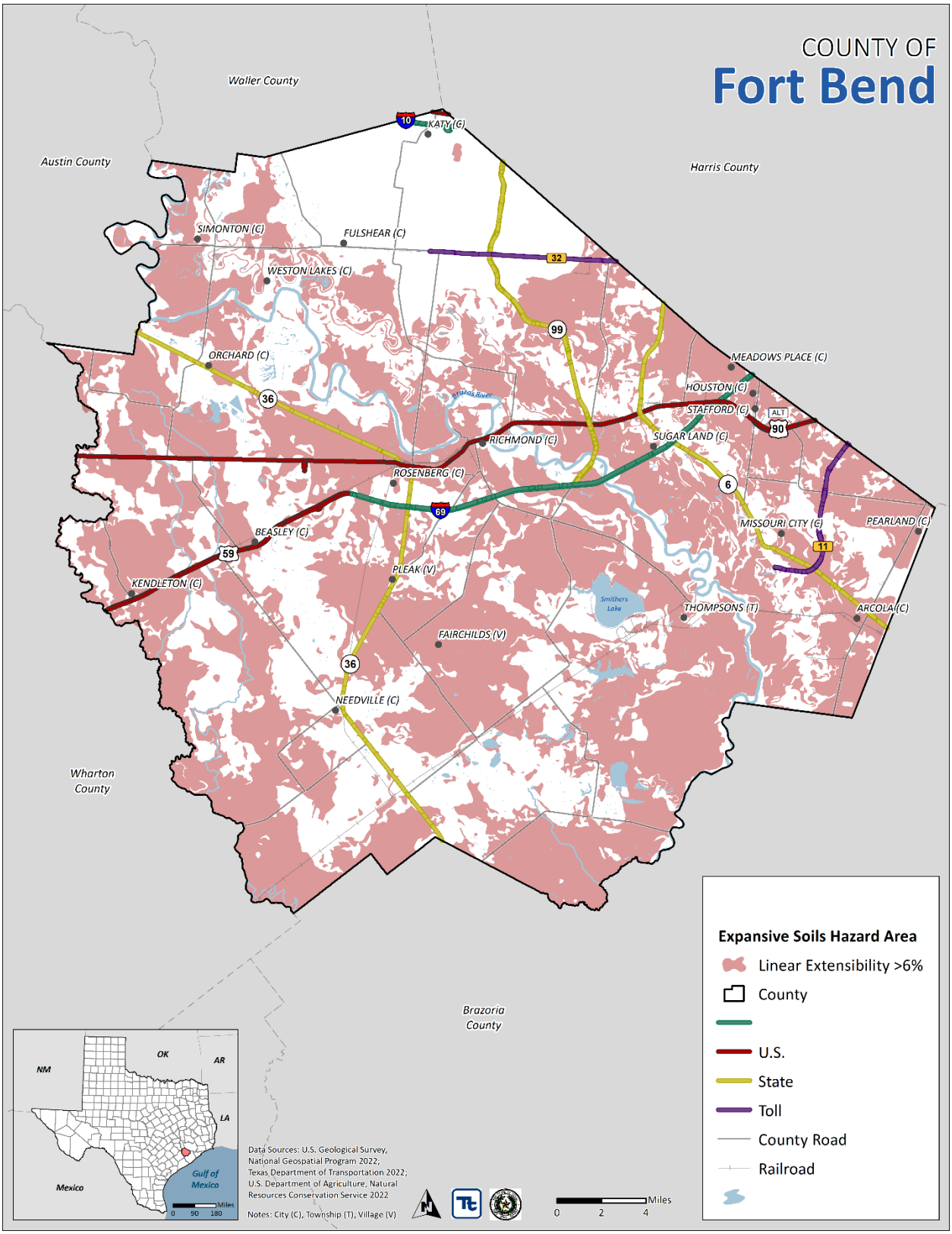


Figure 4.3.5-3. Location of the Expansive Soils Hazard Area in Fort Bend County



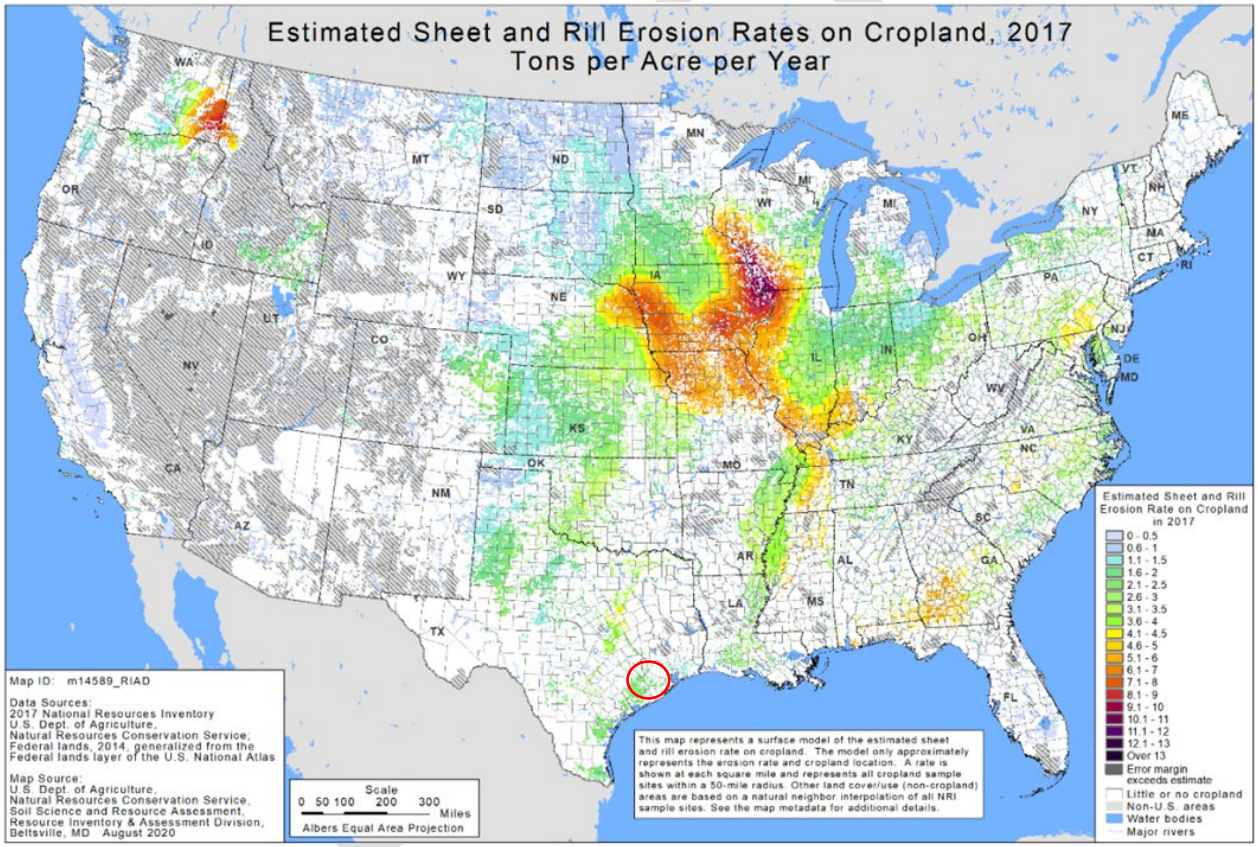
Extent

Erosion

It is difficult to directly measure erosion and the risk of erosion. There are other properties, however, that can be used to measure erosion: soil surface stability, aggregate stability, infiltration, compaction, and content of organic matter. Measuring these properties can help with understanding the susceptibility of erosion at a specific location. Comparing visual observations along with quantitative measurements can help provide information about soil surface stability, sedimentation, and soil loss (USDA 2001).

Figure 4.3.5-4 illustrates the location and rate of sheet and rill (water) erosion on croplands across the United States. According to this figure, the rates of erosion on croplands due to sheet and rill (water) in Fort Bend County ranged from 2.1 to 2.5 tons per acre each year.

Figure 4.3.5-4. Estimated Sheet and Rill Erosion Rates (Tons per Acre per Year) on Cropland, 2017



Source: *USDA 2020*

Note: *The red circle represents the approximate location of Fort Bend County.*

Expansive Soils

Expansive soils can be measured through linear extensibility. Linear extensibility refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. It is an expression of the volume change as a percentage change for the soil. The amount and type of clay minerals in the soil influence volume change. Figure 4.3.5-3 shows the locations where soil extensibility ratings of greater than 6 percent are found in the County. Soil extensibility ratings over 9 percent are considered to be very high. Inland soil

extensibility rates vary greatly by location. For the high and very high extensibility areas, the extent of damages may include cracking foundations, shifting and/or disruption of underground utilities, and shifting of roadways.

Worst-Case Scenario

Erosion

Any storm that produces significant amounts of rain in a short period of time could lead to a worst-case scenario for an erosion incident along the riverbanks of Fort Bend County. Rainfall events can create flood stages and high flow rates, which cause water to move at higher speeds through the County, leading to erosion along the banks of rivers and tributaries. Impacts from such events include road closures, damage to infrastructure and buildings, and inaccessible areas that can disrupt emergency response.

Expansive Soils

A season of flooding with rapid drying conditions, such as in a drought, would present a worst-case scenario for the expansive soils hazard. Underground utility pipes, foundations, roadways, and sidewalks would be vulnerable to cracking or buckling, causing damage to the built environment.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2022, Fort Bend County was not included in any disaster (DR) or emergency (EM) declarations for geologic hazard-related events. Generally, these disasters cover a wide region of the state; therefore, they can impact many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2022). Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

U.S. Department of Agriculture Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2017 and 2022, Fort Bend County was not included in any geologic hazard-related agricultural disaster declarations.

Previous Events

For this plan update, there was limited information regarding inland erosion in Fort Bend County. Statistical data for individual erosion events is not readily available.

Probability of Future Occurrences

It is anticipated that geologic hazards will continue to occur in Fort Bend County. As the frequency of storms and drought occur due to climate change, the probability for future events will likely increase as well. In Section 4.4, the identified hazards of concern for Fort Bend County were ranked (Table 4.4-2). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Partnership, the probability of occurrence for geologic hazards in the County is considered “rare”.

Climate Change Projections

The climate of Texas is changing. Most of the state has warmed between .5°F and 1°F in the past century. In the eastern two-thirds of the state, rainstorms are more intense, and floods are becoming more severe. In the coming decades, storms are likely to become more severe in Texas (EPA 2016). Periods of extreme precipitation increase the risk of flood (Centers for Climate and Energy Solutions n.d.). High frequency flood events (e.g., 10-year floods) in particular will likely increase with a changing climate. Scientists project greater storm intensity, resulting in more direct runoff and flooding. This is likely to result in higher rates of erosion and more frequent erosion events.

Climate change is likely to have significant impacts on the performance of buildings constructed on expansive soils. Precipitation and temperature are the primary weather parameters used for determining ground movement (Sun, Li and Zhou 2017).

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the erosion hazard, all of Fort Bend County has been identified as the hazard area. Therefore, all assets in the County (population, structures, critical facilities, and lifelines), as described in the County Profile (Section 3), are vulnerable to geologic hazards.

Impact on Life, Health, and Safety

A geologic hazard would likely be associated with another hazard, such as flooding, drought, or a hurricane; the conditions felt from these events would impact the populations within the immediate area of the incident. In addition to causing damages to residential buildings and potentially displacing residents, geologic hazards can block off or damage major roadways and inhibit travel for emergency responders or populations trying to evacuate the area.

To estimate population exposure to the inland erosion hazard area, information from the United States Department of Agriculture and the United States Census Bureau was used. Based on the analysis, there are an estimated 228,162 residents living in the hazard area, or 28 percent of the County's total population. The Unincorporated Areas of Fort Bend have the greatest number of residents living in the hazard area with approximately 333,360 residents, followed by the City of Pearland (122,609). Table 4.3.5-1 summarizes the population exposed to the inland erosion hazard by jurisdiction.

Table 4.3.5-1. Estimated Number of Persons in Fort Bend County Living in the Inland Erosion Hazard Area

Jurisdiction	Total Population (American Community Survey 2021)	Estimated Population Located in the Inland Erosion (K-Factor: >= 0.49) Hazard Area	
		Number of Persons	Percent of Total
Arcola (C)	2,593	22	0.9%
Beasley (C)	957	87	9.1%
Fairchilds (V)	755	0	0.0%
Fulshear (C)	17,259	12,940	75.0%
Houston (C)	41,279	2,966	7.2%
Katy (C)	21,926	21,061	96.1%
Kendleton (C)	341	3	1.0%
Meadows Place (C)	4,755	0	0.0%
Missouri City (C)	73,682	16,542	22.5%
Needville (C)	3,059	2,270	74.2%
Orchard (C)	219	21	9.8%
Pearland (C)	122,609	0	0.0%
Pleak (V)	1,756	623	35.5%
Richmond (C)	11,768	44	0.4%
Rosenberg (C)	37,871	7,806	20.6%
Simonton (C)	838	279	33.3%
Stafford (C)	17,170	0	0.0%
Sugarland (C)	110,272	31,716	28.8%
Thompsons (T)	265	143	53.8%
Weston Lakes (C)	3,763	2,579	68.5%
Unincorporated Area	333,360	129,058	38.7%
Fort Bend County (Total)	**806,497**	**228,162**	**28.3%**

Source: U.S. Census Bureau 2021; U.S. Department of Agriculture, Natural Resources Conservation Service 2022

To estimate population exposure to the expansive soils hazard area, information from the United States Department of Agriculture and the United States Census Bureau was used. Based on the analysis, there are an estimated 462,717 residents living in the hazard area, or 57 percent of the County's total population. The Unincorporated Areas of Fort Bend have the greatest number of residents living in the hazard area with approximately 148,560 residents, followed by the City of Pearland (92,013). Table 4.3.5-2 summarizes the population exposed to the expansive soils hazard by jurisdiction.

Table 4.3.5-2. Estimated Number of Persons in Fort Bend County Living in the Expansive Soils Hazard Area

Jurisdiction	Total Population (American Community Survey 2021)	Estimated Population Located in the Expansive Soils (Linear Extensibility >6%) Hazard Area	
		Number of Persons	Percent of Total
Arcola (C)	2,593	2,338	90.2%
Beasley (C)	957	795	83.1%
Fairchilds (V)	755	755	100.0%
Fulshear (C)	17,259	1,322	7.7%
Houston (C)	41,279	32,078	77.7%
Katy (C)	21,926	0	0.0%
Kendleton (C)	341	235	69.0%
Meadows Place (C)	4,755	4,703	98.9%
Missouri City (C)	73,682	47,509	64.5%
Needville (C)	3,059	582	19.0%
Orchard (C)	219	57	26.2%
Pearland (C)	122,609	92,013	75.0%
Pleak (V)	1,756	974	55.4%
Richmond (C)	11,768	9,795	83.2%
Rosenberg (C)	37,871	25,523	67.4%
Simonton (C)	838	559	66.7%
Stafford (C)	17,170	15,570	90.7%
Sugarland (C)	110,272	78,061	70.8%
Thompsons (T)	265	120	45.3%
Weston Lakes (C)	3,763	1,170	31.1%
Unincorporated Area	333,360	148,560	44.6%
Fort Bend County (Total)	**806,497**	**462,717**	**57.4%**

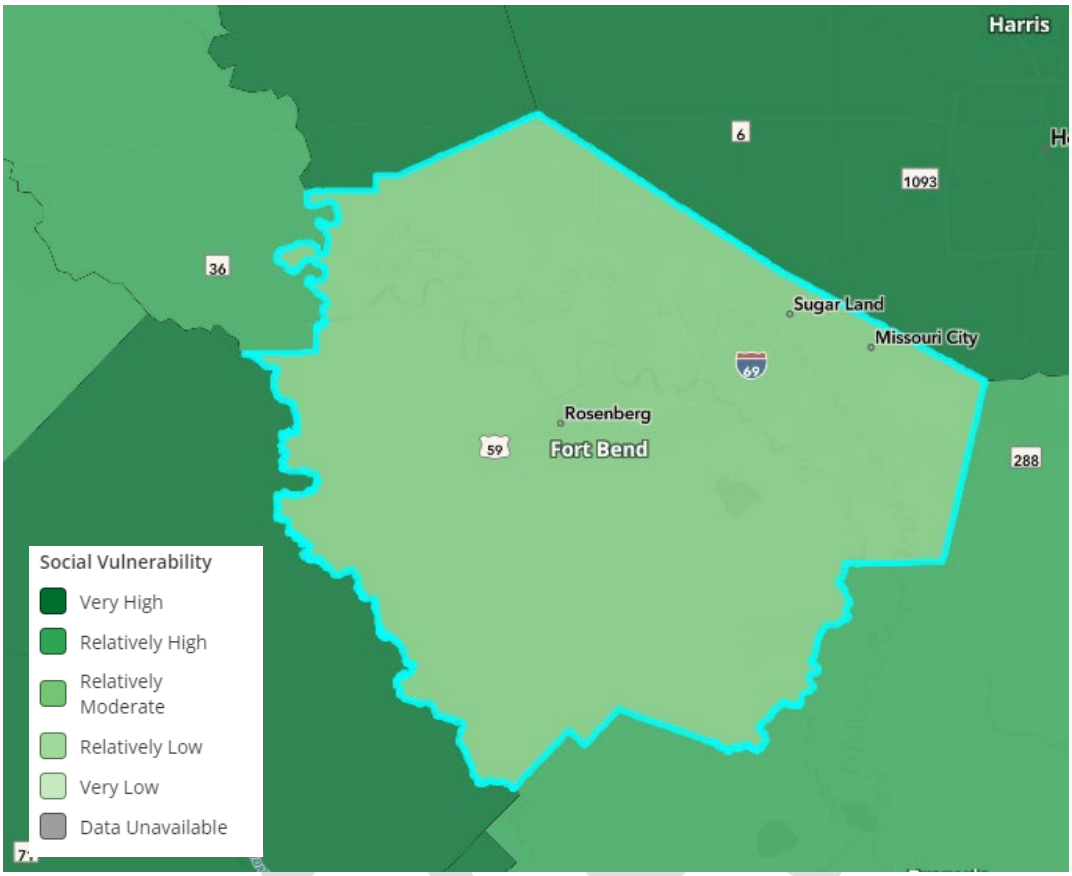
Source: U.S. Census Bureau 2021; U.S. Department of Agriculture, Natural Resources Conservation Service 2022

Socially Vulnerable Populations

Social vulnerability is defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards.

Geologic hazards threaten socially vulnerable populations who may live in other hazard areas. As previously mentioned, geologic hazards, such as erosion, occurs primarily when dirt is left exposed to strong winds, hard rains, and flowing water. Populations in the floodplain of Fort Bend County are subject to higher rates of erosion from the hurricane and flood hazards. The heavy rain associated with these events transports soil out of the ocean and/or riverbed and inland; in some cases, the soil which a structure is on may be transported, causing the structure to collapse. Inland populations may face more wind erosion; in extreme cases, wind erosion can become a dust storm, which could increase in frequency as temperatures continue to rise and times of drought increase (NRDC 2021). The combination of dry, arid conditions followed by heavy rainfall, which saturates the soil, causes the expansion of soils. Nearly the entirety of Fort Bend County is vulnerable to the expansive soil hazard, including socially vulnerable populations. Refer to the figure below for the social vulnerability index for natural hazards.

Figure 4.3.5-5. FEMA Social Vulnerability Index for Natural Hazards



Source: FEMA NRI

Impact on General Building Stock

The erosion hazard has the potential to destabilize the foundation of structures, which may result in monetary losses to businesses and residents. These events can expose the underlying bedrock adjacent to structures, which can erode and threaten the structural integrity and safety of the structure above.

Table 4.3.5-3 summarizes the number of structures located in the erosion hazard area by jurisdiction. In summary, there are 94,987 buildings located in the hazard area, with an estimated $73 billion of replacement cost value (i.e., building and content replacement costs). In total, this represents approximately 33 percent of the County's total general building stock inventory.

Table 4.3.5-3. Estimated General Building Stock Located in the Inland Erosion Hazard Area

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Number and Total Replacement Cost Value of Structures Located in the Inland Erosion (K-Factor: >= 0.49) Hazard Area			
			Number of Buildings	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total
Arcola (C)	676	$1,374,107,673	5	0.7%	$1,917,616	0.1%
Beasley (C)	367	$467,087,536	37	10.1%	$116,406,289	24.9%
Fairchilds (V)	190	$58,400,161	0	0.0%	$0	0.0%
Fulshear (C)	7,869	$6,124,915,172	5,854	74.4%	$4,425,178,070	72.2%

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Number and Total Replacement Cost Value of Structures Located in the Inland Erosion (K-Factor: >= 0.49) Hazard Area			
			Number of Buildings	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total
Houston (C)	11,589	$5,814,576,859	843	7.3%	$618,284,118	10.6%
Katy (C)	2,206	$4,980,024,025	2,105	95.4%	$4,573,298,559	91.8%
Kendleton (C)	329	$241,970,568	3	0.9%	$802,101	0.3%
Meadows Place (C)	1,676	$1,270,821,734	0	0.0%	$0	0.0%
Missouri City (C)	27,170	$23,213,328,025	6,232	22.9%	$7,065,601,763	30.4%
Needville (C)	1,346	$1,362,324,702	1,025	76.2%	$1,160,149,511	85.2%
Orchard (C)	180	$170,795,761	18	10.0%	$30,595,278	17.9%
Pearland (C)	2,171	$1,063,851,539	0	0.0%	$0	0.0%
Pleak (V)	436	$672,927,271	149	34.2%	$193,692,484	28.8%
Richmond (C)	3,296	$4,128,822,403	32	1.0%	$420,331,439	10.2%
Rosenberg (C)	11,894	$22,921,973,230	2,426	20.4%	$3,152,534,225	13.8%
Simonton (C)	395	$372,092,732	148	37.5%	$233,135,597	62.7%
Stafford (C)	4,222	$10,638,345,589	1	0.0%	$15,739,005	0.1%
Sugarland (C)	37,506	$36,732,455,899	10,862	29.0%	$10,762,097,536	29.3%
Thompsons (T)	143	$404,590,514	86	60.1%	$310,211,305	76.7%
Weston Lakes (C)	1,589	$1,145,826,270	1,090	68.6%	$800,005,792	69.8%
Unincorporated Area	166,035	$103,633,654,804	64,071	38.6%	$39,360,030,238	38.0%
Fort Bend County (Total)	**281,285**	**$226,792,892,466**	**94,987**	**33.8%**	**$73,240,010,927**	**32.3%**

Source: Fort Bend County 2016, 2022; RS Means 2022; U.S. Department of Agriculture, Natural Resources Conservation Service 2022

Table 4.3.5-4 summarizes the number of structures located in the expansive soils hazard area by jurisdiction. In summary, there are 148,120 buildings located in the hazard area, with an estimated $125 billion in replacement cost value (i.e., building and content replacement costs). In total, this represents approximately 53 percent of the County's total general building stock inventory.

Table 4.3.5-4. Estimated General Building Stock Located in the Expansive Soils Hazard Area

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Number and Total Replacement Cost Value of Structures Located in the Expansive Soils (Linear Extensibility >6%) Hazard Area			
			Number of Buildings	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total
Arcola (C)	676	$1,374,107,673	615	91.0%	$1,353,953,941	98.5%
Beasley (C)	367	$467,087,536	302	82.3%	$342,428,037	73.3%
Fairchilds (V)	190	$58,400,161	190	100.0%	$58,400,161	100.0%
Fulshear (C)	7,869	$6,124,915,172	593	7.5%	$273,681,675	4.5%
Houston (C)	11,589	$5,814,576,859	9,004	77.7%	$4,452,834,950	76.6%
Katy (C)	2,206	$4,980,024,025	0	0.0%	$0	0.0%
Kendleton (C)	329	$241,970,568	227	69.0%	$189,452,177	78.3%
Meadows Place (C)	1,676	$1,270,821,734	1,650	98.4%	$985,874,377	77.6%
Missouri City (C)	27,170	$23,213,328,025	17,442	64.2%	$14,205,389,317	61.2%
Needville (C)	1,346	$1,362,324,702	234	17.4%	$148,362,088	10.9%
Orchard (C)	180	$170,795,761	46	25.6%	$39,348,457	23.0%
Pearland (C)	2,171	$1,063,851,539	1,629	75.0%	$811,904,923	76.3%
Pleak (V)	436	$672,927,271	244	56.0%	$387,984,065	57.7%

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Number and Total Replacement Cost Value of Structures Located in the Expansive Soils (Linear Extensibility >6%) Hazard Area			
			Number of Buildings	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total
Richmond (C)	3,296	$4,128,822,403	2,602	78.9%	$2,188,170,998	53.0%
Rosenberg (C)	11,894	$22,921,973,230	8,094	68.1%	$17,697,117,553	77.2%
Simonton (C)	395	$372,092,732	247	62.5%	$138,957,135	37.3%
Stafford (C)	4,222	$10,638,345,589	3,751	88.8%	$8,486,948,055	79.8%
Sugarland (C)	37,506	$36,732,455,899	26,457	70.5%	$25,404,128,002	69.2%
Thompsons (T)	143	$404,590,514	55	38.5%	$68,360,081	16.9%
Weston Lakes (C)	1,589	$1,145,826,270	493	31.0%	$341,910,070	29.8%
Unincorporated Area	166,035	$103,633,654,804	74,245	44.7%	$47,521,558,886	45.9%
Fort Bend County (Total)	**281,285**	**$226,792,892,466**	**148,120**	**52.7%**	**$125,096,764,947**	**55.2%**

Source: Fort Bend County 2016, 2022; RS Means 2022; U.S. Department of Agriculture, Natural Resources Conservation Service 2022

Impact on Critical Facilities

Critical facility exposure to the erosion hazard was examined. Table 4.3.5-5 lists the critical facilities and number of lifelines within the inland erosion hazard area. Of the 1,009 critical facilities located in the hazard area, the greatest number are food, water, and shelter facilities. A majority of the critical facilities located in the inland erosion hazard area are in the Unincorporated Areas of Fort Bend County (548), followed by the City of Sugarland (202), shown in Table 4.3.5-6.

Table 4.3.5-5. Critical Facilities and Lifelines Located in the Inland Erosion Hazard Area

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Located in the Inland Erosion (K-Factor: >= 0.49) Hazard Area
Communications	44	13
Energy	584	190
Food, Water, Shelter	1,480	449
Hazardous Material	13	1
Health and Medical	335	126
Safety and Security	282	86
Transportation	660	144
Fort Bend County (Total)	**3,398**	**1,009**

Source: Fort Bend County 2022; U.S. Department of Agriculture, Natural Resources Conservation Service 2022

Table 4.3.5-6. Critical Facilities and Lifeline Facilities Located in the Inland Erosion Hazard Area by Jurisdiction

Jurisdiction	Total Critical Facilities Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Located in the Inland Erosion (K-Factor: >= 0.49) Hazard Area			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Arcola (C)	22	21	1	4.5%	1	4.8%
Beasley (C)	18	14	5	27.8%	5	35.7%
Fairchilds (V)	3	3	0	0.0%	0	0.0%
Fulshear (C)	43	40	13	30.2%	12	30.0%
Houston (C)	105	84	10	9.5%	10	11.9%
Katy (C)	53	51	35	66.0%	33	64.7%
Kendleton (C)	21	19	1	4.8%	1	5.3%
Meadows Place (C)	17	16	0	0.0%	0	0.0%
Missouri City (C)	339	297	117	34.5%	103	34.7%
Needville (C)	42	33	39	92.9%	31	93.9%
Orchard (C)	7	7	0	0.0%	0	0.0%
Pearland (C)	1	1	0	0.0%	0	0.0%
Pleak (V)	15	15	1	6.7%	1	6.7%
Richmond (C)	123	103	8	6.5%	8	7.8%
Rosenberg (C)	340	295	94	27.6%	91	30.8%
Simonton (C)	17	17	9	52.9%	9	52.9%
Stafford (C)	164	137	0	0.0%	0	0.0%
Sugarland (C)	631	575	202	32.0%	187	32.5%
Thompsons (T)	10	9	4	40.0%	4	44.4%
Weston Lakes (C)	7	7	2	28.6%	2	28.6%
Unincorporated Fort Bend County	1,756	1,654	548	31.2%	511	30.9%
Fort Bend County (Total)	**3,734**	**3,398**	**1,089**	**29.2%**	**1,009**	**29.7%**

Source: Fort Bend County 2022; U.S. Department of Agriculture, Natural Resources Conservation Service 2022

Critical facility exposure to the expansive soils hazard was examined. Table 4.3.5-7 lists the number of lifelines within the inland erosion hazard area. Of the 1,847 critical facilities located in the hazard area, the greatest number are food, water, and shelter facilities. A majority of the critical facilities located in the inland erosion hazard area are in the Unincorporated Areas of Fort Bend County (865), followed by the City of Sugarland (401), shown in Table 4.3.5-8.

Table 4.3.5-7. Lifelines Located in the Expansive Soils Hazard Area

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Located in the Expansive Soils (Linear Extensibility >6%) Hazard Area
Communications	44	29
Energy	584	319
Food, Water, Shelter	1,480	801
Hazardous Material	13	9
Health and Medical	335	168
Safety and Security	282	147
Transportation	660	374

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Located in the Expansive Soils (Linear Extensibility >6%) Hazard Area
Fort Bend County (Total)	**3,398**	**1,847**

Source: Fort Bend County 2022; U.S. Department of Agriculture, Natural Resources Conservation Service 2022

Table 4.3.5-8. Critical Facilities and Lifeline Facilities Located in the Expansive Soils Hazard Area by Jurisdiction

Jurisdiction	Total Critical Facilities Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Located in the Expansive Soils (Linear Extensibility >6%) Hazard Area			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Arcola (C)	22	21	21	95.5%	20	95.2%
Beasley (C)	18	14	12	66.7%	8	57.1%
Fairchilds (V)	3	3	3	100.0%	3	100.0%
Fulshear (C)	43	40	3	7.0%	3	7.5%
Houston (C)	105	84	75	71.4%	57	67.9%
Katy (C)	53	51	0	0.0%	0	0.0%
Kendleton (C)	21	19	14	66.7%	12	63.2%
Meadows Place (C)	17	16	17	100.0%	16	100.0%
Missouri City (C)	339	297	181	53.4%	154	51.9%
Needville (C)	42	33	2	4.8%	2	6.1%
Orchard (C)	7	7	2	28.6%	2	28.6%
Pearland (C)	1	1	1	100.0%	1	100.0%
Pleak (V)	15	15	14	93.3%	14	93.3%
Richmond (C)	123	103	72	58.5%	63	61.2%
Rosenberg (C)	340	295	225	66.2%	186	63.1%
Simonton (C)	17	17	8	47.1%	8	47.1%
Stafford (C)	164	137	125	76.2%	106	77.4%
Sugarland (C)	631	575	401	63.5%	360	62.6%
Thompsons (T)	10	9	6	60.0%	5	55.6%
Weston Lakes (C)	7	7	5	71.4%	5	71.4%
Unincorporated Fort Bend County	1,756	1,654	865	49.3%	822	49.7%
Fort Bend County (Total)	**3,734**	**3,398**	**2,052**	**55.0%**	**1,847**	**54.4%**

Source: Fort Bend County 2022; U.S. Department of Agriculture, Natural Resources Conservation Service 2022

In addition to critical facilities, a significant amount of infrastructure can be exposed to geologic hazards:

- **Roads** – Access to major roads is crucial to life-safety after a disaster event and to response and recovery operations. Egress and ingress can be blocked on roads, causing isolation for neighborhoods, traffic problems, and delays for public and private transportation. This can result in economic losses for businesses.
- **Bridges** – Geologic hazards can significantly impact road bridges. Movements can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use.
- **Power Lines** – While power lines are generally elevated, the towers supporting them can be subject to geologic hazards. Soil underneath a tower could become unstable, causing it to collapse and ripping down the lines. Power and communication failures due to erosion can create problems for vulnerable populations and businesses.
- **Rail Lines** – Similar to roads, rail lines are important for response and recovery operations after a disaster. Geologic hazards can block travel along the rail lines, which would become especially troublesome because it would not be as easy to detour a rail line as it is on a local road or highway.

Several other types of infrastructure may also be exposed to geologic hazards, including water and sewer infrastructure. In some cases, water infrastructure may even be the cause of a hazard's formation due to the lines leaking.

Impact on Economy

The impact of geologic hazards on the economy and estimated dollar losses is difficult to measure. As stated earlier, these hazards can impose direct and indirect impacts on society. Direct costs include the actual damage sustained by buildings, property, and infrastructure. Indirect costs, such as clean-up costs, business interruption, loss of tax revenues, reduced property values, and loss of productivity are difficult to measure. Additionally, geologic hazards threaten transportation corridors, fuel and energy conduits, and communication lines (USGS 2000).

Direct building losses are the estimated costs to repair or replace the damage caused to the building. Geologic hazards can cause several types of secondary effects, such as blocking access to roads, which can isolate residents and businesses and delay commercial, public, and private transportation.

Impact on Environment

Geologic hazards can potentially alter rivers or streams, potentially harming water quality, fisheries, and spawning habitat; they can also create new depressions that can fill with water, creating new aquatic habitat. Table 4.3.5-9 lists the number of acres exposed to the inland erosion hazard area; Table 4.3.5-10 lists the number of acres exposed to the expansive soils hazard area.

Table 4.3.5-9. Land Acreage in Fort Bend County Located in the Inland Erosion Hazard Areas

Jurisdiction	Total Acres of Land Area	Total Acres of Land Area (Excluding Waterbodies) Located in the Inland Erosion (K-Factor: >= 0.49) Hazard Area	Percent of Total
Arcola (C)	1,664	15	0.9%
Beasley (C)	673	229	34.1%
Fairchilds (V)	831	0	0.0%
Fulshear (C)	7,962	3,743	47.0%
Houston (C)	7,440	745	10.0%
Katy (C)	2,843	2,348	82.6%
Kendleton (C)	850	24	2.8%
Meadows Place (C)	586	0	0.0%
Missouri City (C)	20,841	5,228	25.1%
Needville (C)	1,264	1,024	81.0%
Orchard (C)	250	26	10.3%
Pearland (C)	839	0	0.0%
Pleak (V)	1,193	354	29.7%
Richmond (C)	2,752	255	9.3%
Rosenberg (C)	23,442	6,845	29.2%
Simonton (C)	1,487	800	53.8%
Stafford (C)	4,467	3	0.1%
Sugarland (C)	27,073	7,294	26.9%
Thompsons (T)	995	391	39.3%
Weston Lakes (C)	1,623	1,031	63.5%
Unincorporated Area	449,862	136,055	30.2%
Fort Bend County (Total)	**558,937**	**166,410**	**29.8%**

Source: Fort Bend County 2022; U.S. Department of Agriculture, Natural Resources Conservation Service 2022

Table 4.3.5-10. Land Acreage in Fort Bend County Located in the Expansive Soils Hazard Areas

Jurisdiction	Total Acres of Land Area	Total Acres of Land Area (Excluding Waterbodies) Located in the Expansive Soils (Linear Extensibility >6%) Hazard Area	Percent of Total
Arcola (C)	1,664	1,493	89.7%
Beasley (C)	673	408	60.6%
Fairchilds (V)	831	831	100.0%
Fulshear (C)	7,962	1,363	17.1%
Houston (C)	7,440	4,498	60.5%
Katy (C)	2,843	6	0.2%
Kendleton (C)	850	704	82.9%
Meadows Place (C)	586	554	94.6%
Missouri City (C)	20,841	12,438	59.7%
Needville (C)	1,264	190	15.0%
Orchard (C)	250	77	30.9%
Pearland (C)	839	618	73.7%
Pleak (V)	1,193	722	60.5%
Richmond (C)	2,752	1,758	63.9%
Rosenberg (C)	23,442	14,267	60.9%
Simonton (C)	1,487	686	46.1%
Stafford (C)	4,467	3,633	81.3%
Sugarland (C)	27,073	16,996	62.8%
Thompsons (T)	995	594	59.7%
Weston Lakes (C)	1,623	555	34.2%
Unincorporated Area	449,862	246,608	54.8%
Fort Bend County (Total)	**558,937**	**308,998**	**55.3%**

Source: Fort Bend County 2022; U.S. Department of Agriculture, Natural Resources Conservation Service 2022

Future Changes That May Impact Vulnerability

Understanding future changes that affect vulnerability in Fort Bend County can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

As discussed and illustrated in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. New development that has occurred in the last five years within the County and potential future development in the next five years as identified by the County and each municipality is included in the jurisdictional annexes in Section 9, along with an indication of proximity to known hazard zones. Refer to Section 3, and Volume II Section 9 for more information about the potential new development in Fort Bend County.

Projected Changes in Population

According to the U.S. Census Bureau, the population of the County has increased by approximately 40.4 percent since 2010. Increased population trends will change the County's overall risk to geologic hazards. Refer to Section 3 (County Profile), which includes a discussion on population trends for the County.

Climate Change

The climate of Texas is changing. Most of the state has warmed between.5°F and 1°F in the past century. In the eastern two-thirds of the state, rainstorms are more intense, and floods are becoming more severe. In the coming decades, storms are likely to become more severe in Texas (EPA 2016). Periods of extreme precipitation increase the risk of flood (Centers for Climate and Energy Solutions n.d.). High frequency flood events (e.g., 10-year floods) in particular will likely increase with a changing climate. Scientists project greater storm intensity, resulting in more direct runoff and flooding. This is likely to result in higher rates of erosion and more frequent erosion events.

Climate change is likely to have significant impacts on the performance of buildings constructed on expansive soils. Precipitation and temperature are the primary weather parameters used for determining ground movement (Sun, Li and Zhou 2017).

Change in Vulnerability Since 2018 HMP

Fort Bend County continues to be vulnerable to geologic hazards. Updated population and building stock statistics were used in the current risk assessment. Further, exposure for both the population and critical facilities was analyzed. These updated datasets provide a more accurate exposure analysis to geologic hazards.

SECTION 4. RISK ASSESSMENT

4.3 Hazard Profiles

4.3.6 Hurricane/Tropical Storm

The following section provides the hazard profile and vulnerability assessment for the hurricane and tropical storm hazard in Fort Bend County.

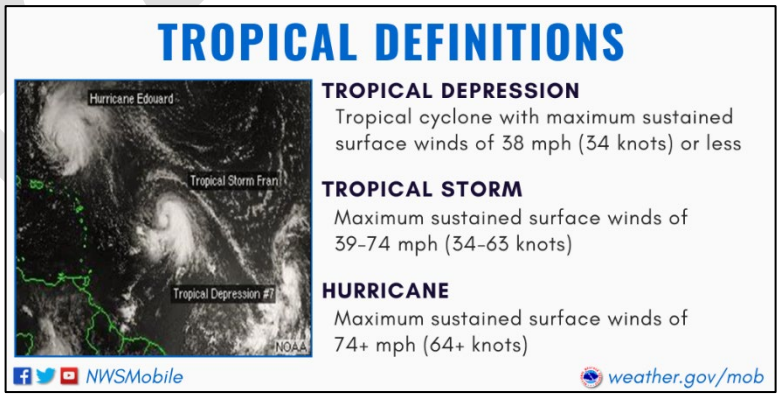
Hazard Profile

Hazard Description

Hurricanes, tropical storms, and tropical depressions that impact Texas form over warm tropical waters of the Gulf of Mexico or the Atlantic Ocean. The warm, moist air over the ocean rises upward from near the surface, creating an area of lower air pressure. These areas of relative low pressure draw in new air from the surrounding high-pressure areas. Quickly cyclonic (counterclockwise) circulation begins, and rain bands spin out from a wall of wind that surrounds a central area of low barometric pressure (the "eye"). Such storms can grow to a thousand miles in diameter and sustain winds near the eye that approach 200 miles an hour (TDEM 2018). According to National Oceanic and Atmospheric Administration (NOAA), tropical cyclones are classified into three main categories (per intensity): tropical depressions, tropical storms, and hurricanes.

Tropical depressions have maximum sustained winds of 38 mph. Though not as strong as its successors, tropical depressions can bring heavy downpours and sustained winds strong enough to generate rough surf and life-threatening rip currents. When a tropical depression approaches, the National Weather Service may issue a tropical storm watch or warning for the area.

Figure 4.3.6-1. Tropical Cyclone Definitions



Source: National Weather Service 2023

A tropical storm is a tropical cyclone in which the maximum sustained surface wind speeds range from 39 to 73 mph. At this time, the tropical cyclone is assigned a name. During this time, the storm itself becomes more organized and begins to become more circular in shape, resembling a hurricane.

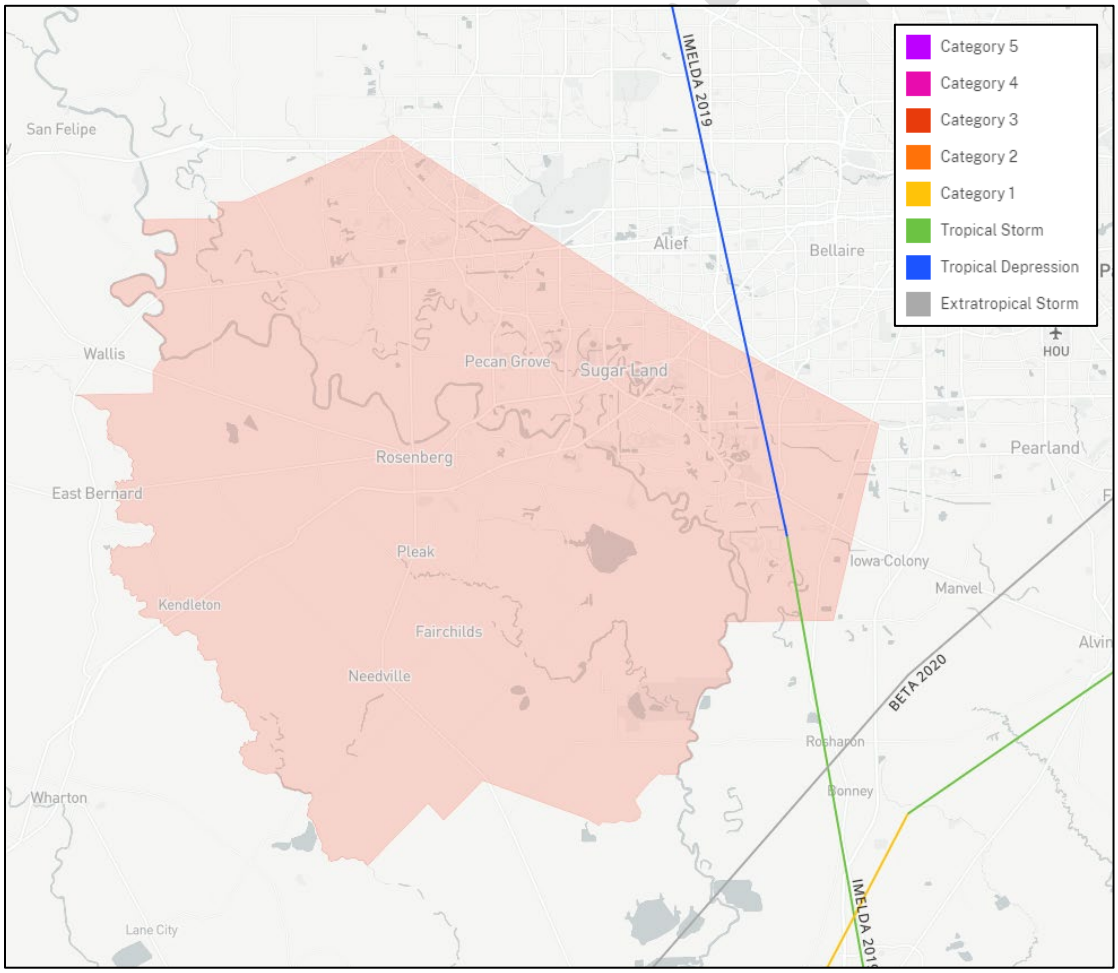
Hurricanes are areas of disturbed weather in the tropics with closed isobars and strong and very pronounced rotary circulation. An area of clear weather called an "eye" is present in the center of the circulation. To qualify as a hurricane, the wind speed is 74 miles per hour (mph) or more. Hurricanes are classified into categories based on wind speed.

Tropical cyclones can produce intense rainall resulting in flooding, battering wave action, storm surge, localized coastal erosion, and significant winds.

Location

Fort Bend County is at risk of exposure to hurricanes and tropical storms. Fort Bend's proximity to the coastline increases the likelihood of hurricanes and tropical storms. The location of the County also increases the chances of second-hand windstorm from hurricanes and tropical storms that touched down in proximity to the County. Figure 4.3.6-2 displays tropical cyclone tracks that tracked within 65 nautical miles of Fort Bend County between 2018 and 2022 (only two events – Tropical Storms Marco and Laura and Hurricane Hanna in 2020). Refer to the Previous Occurrences and Losses section for further information regarding hurricane and tropical storm events that impacted Fort Bend County.

Figure 4.3.6-2. Historical Tropical Storm and Hurricane Tracks Impacting Fort Bend County 2018-2022



Source: NOAA 2023

Extent

The extent of a hurricane or tropical storm is commonly categorized in accordance with the Saffir-Simpson Hurricane Wind Scale, which assigns a designation of tropical storm for storms with sustained wind speeds below 74 mph and a hurricane category rating of 1–5 based on a hurricane's increasing sustained wind speed.

This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered *major hurricanes* because of their potential for significant loss of life and damage. Tropical storms and Category 1 and 2 storms are still dangerous and require preventative measures (NWS NOAA n.d.). Table 4.3.6-1 below shows the categories in the Saffir-Simpson Hurricane Wind Scale and the types of damage associated with each category.

Table 4.3.6-1. Saffir-Simpson Hurricane Wind Scale

Category	Sustained Winds (miles per hour)	Types of Damage Due to Hurricane Winds
1	74-95	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding, and gutters. Large branches of trees will snap, and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (Major)	111-129	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (Major)	130-156	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted, and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (Major)	157 or higher	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: NOAA n.d.
Note: Other non-hurricane classifications are tropical storms (39-73 miles per hour) and tropical depressions (0-38 miles per hour)

The NWS issues hurricane and tropical storm watches and warnings. These watches and warnings are issued or will remain in effect after a tropical cyclone becomes post-tropical, when such a storm poses a significant threat to life and property. The NWS allows the National Hurricane Center (NHC) to issue advisories during the post-tropical stage. The following are the definitions of the watches and warnings:

Hurricane Warning is issued when sustained winds of 74 mph or higher are expected somewhere within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparation activities become difficult once winds reach tropical storm force, the warning is issued 36-hours in advance of the anticipated onset of tropical storm-force winds. The warning can remain in effect when dangerously high water or combination of dangerously high water and waves continue, even though winds may be less than hurricane force.

Hurricane Watch is issued when sustained winds of 74 mph or higher are possible within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities

become difficult once winds reach tropical storm force, the hurricane watch is issued 48-hours prior to the anticipated onset of tropical storm-force winds.

Tropical Storm Warning is issued when sustained winds of 39 to 73 mph are expected somewhere within the specified area within 36 hours in association with a tropical, subtropical, or post-tropical storm.

Tropical Storm Watch is issued when sustained winds of 39 to 73 mph are possible within the specified area within 48 hours in association with a tropical, subtropical, or post-tropical storm (NHC NOAA 2010).

Mean Return Period

In evaluating the potential for hazard events of a given magnitude, a mean return period (MRP) is often used. The MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events. The MRP is the average period of time in years between occurrences of a particular hazard event, equal to the inverse of the annual frequency of exceedance.

Peak wind speed projections were generated using Hazus v5.0. Hazus v5.0 estimated the maximum 3-second gust wind speeds for Fort Bend County:

- 100-year MRP – between 96 and 129 mph (Category 2 and 3)
- 500-year MRP – between 111 and 129 mph (Category 3)

Refer to Figure 4.3.6-3 and Figure 4.3.6-4 below to view the 100- and 500-year MRPs, respectively.

Figure 4.3.6-3. Wind Speeds for the 100-Year MRP Event in Fort Bend County

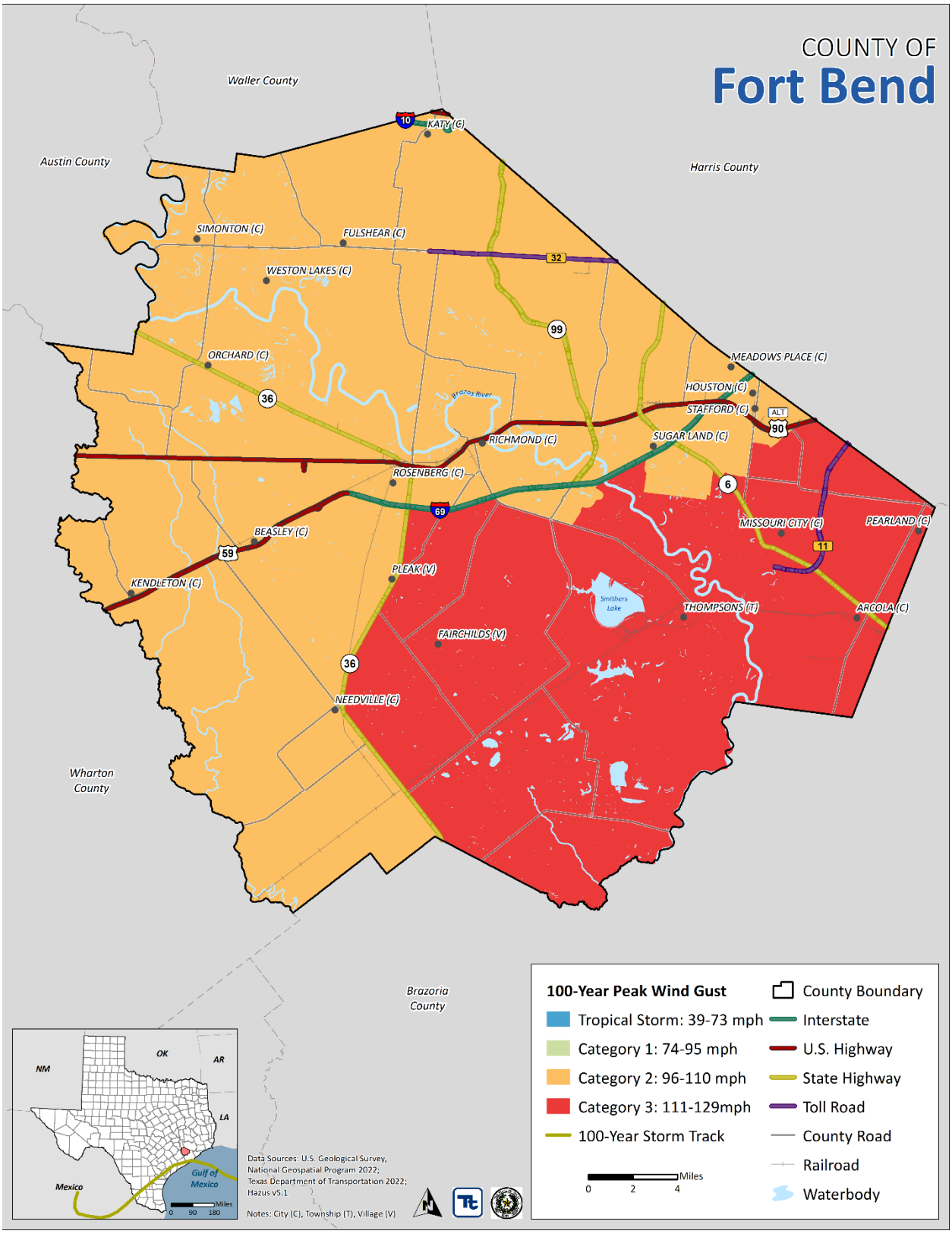
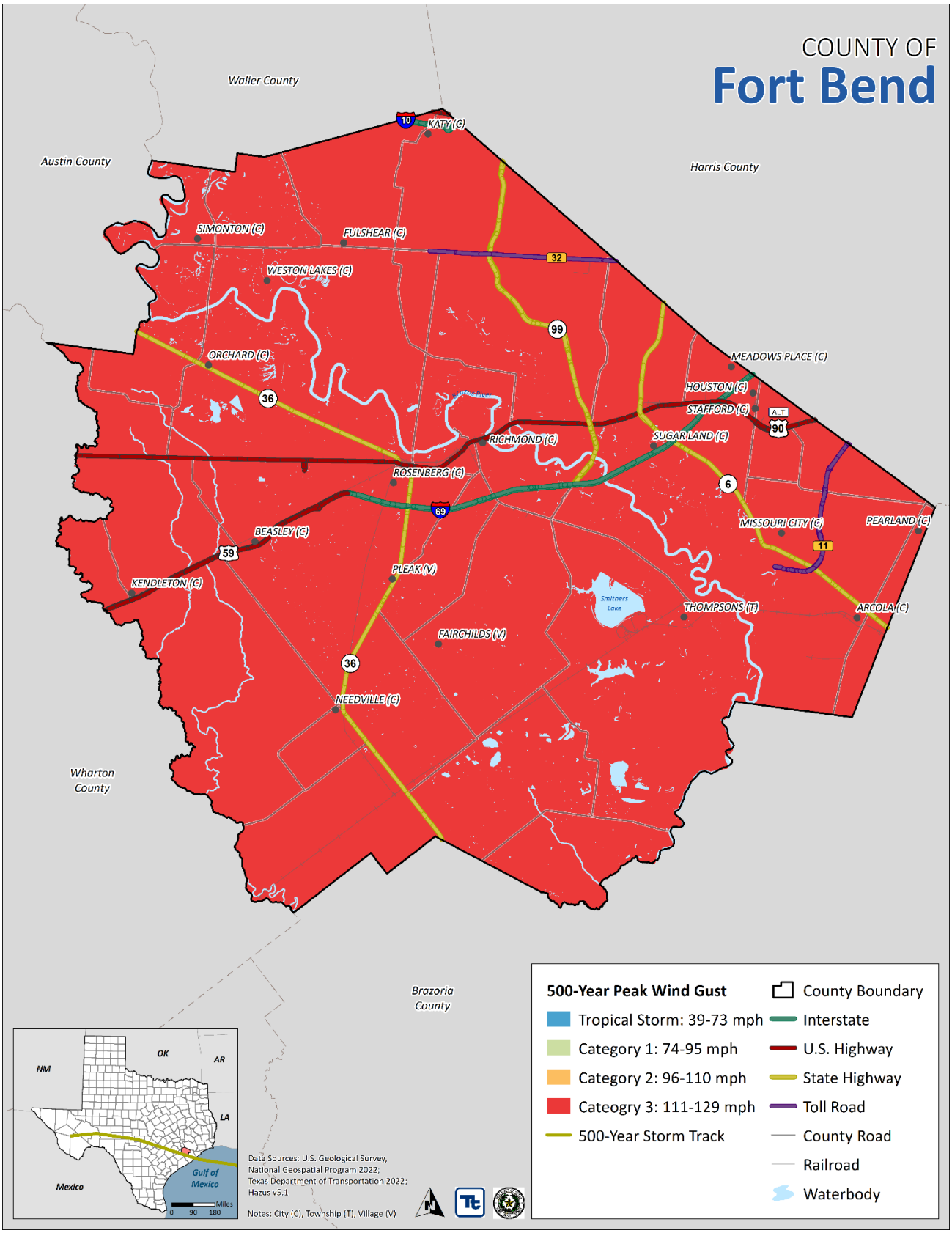


Figure 4.3.6-4. Wind Speeds for the 500-Year MRP Event in Fort Bend County



Worst-Case Scenario

The 500-year MRP event (Category 3 Hurricane for Fort Bend County) would be the worst-case scenario. A storm of this magnitude could cause severe damages to 18,372 occupied buildings and would destroy 10,299 occupied buildings. Critical facilities in the County would likely sustain moderate to severe damages, particularly to police and educational facilities. There would be over $12.6 billion in building damages, causing over 2 million tons of debris. The winds associated with a Category 3 (speeds between 111 and 129 mph) would cause devastating damage. Well-built framed homes may incur major damage or removal of roof decking and gable ends; trees will be snapped or uprooted, blocking numerous roads; and electricity and water will be unavailable for several days to weeks after the storm passes.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2022, Fort Bend County was included in 11 disaster (DR) or emergency (EM) declarations for hurricane/tropical storm-related events. Generally, these disasters cover a wide region of the state; therefore, they can impact many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2022). Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

Table 4.3.6-2. FEMA Disaster Declaration for the Project Area (1954-2022)

Date(s) of Event	Declaration Date	FEMA Declaration Number	Description
August 18 – 20, 1983	August 19, 1983	DR-689-TX	Texas Hurricane Alicia
August 22 – 31, 1998	August 26, 1998	DR-1239-TX	Texas Tropical Storm Charley
August 29, 2005 – October 1, 2005	September 2, 2005	EM-3216-TX	Texas Hurricane Katrina evacuation
September 20, 2005 – October 14, 2005	September 21, 2005	EM-3261-TX	Texas Hurricane Rita
September 20, 2005 – October 14, 2005	September 24, 2005	DR-1606-TX	Texas Hurricane Rita
August 17, 2007 – September 5, 2007	August 18, 2007	EM-3277-TX	Texas Hurricane Dean
August 27, 2008 – September 7, 2008	August 29, 2008	EM-3290-TX	Texas Hurricane Gustav
September 7-26, 2008	September 10, 2008	EM-3294-TX	Texas Hurricane Ike
September 7, 2008 – October 2, 2008	September 13, 2008	DR-1791-TX	Texas Hurricane Ike
August 23, 2017 – September 15, 2017	August 25, 2017	DR-4332-TX	Texas Hurricane Harvey
July 25 – 31, 2020	July 26, 2020	EM-3530-TX	Texas Hurricane Hanna
August 23 – 27, 2020	August 24, 2020	EM-3540-TX	Texas Tropical Storms Marco and Laura

Source: FEMA 2023

USDA Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in

counties that are contiguous to a designated county. Between 2012 and 2022, Fort Bend County was included in one hurricane and tropical storm-related agricultural disaster declaration.

Table 4.3.6-3. USDA Disaster Declaration for the Project Area (2012–2022)

USDA Declaration Number	Date(s) of Event	Event Name
2021-S5115	September 14, 2021	Hurricane Nicholas

Source: USDA 2023

Previous Events

Between 2017 and 2022, Fort Bend County was impacted by four tropical depression, tropical storm, or hurricane events.

Table 4.3.6-4. Hurricane and Tropical Storm Events in Fort Bend County (2017 to 2022)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend County included in Declaration?	Description
August 23 – September 15, 2017	Hurricane	DR-4332-TX	Yes	Hurricane 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. Over that 5 day period over Southeast Texas, Harvey produced catastrophic flooding with a large area of 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 copious record amount of rain over a led to catastrophic flooding. There was water over roadways FM 655 and CR 521 near the town of Rosharon. Major record-level flooding of both the Brazos and San Bernard Rivers caused significant home flooding from Richmond to Rosharon. Massive flooding occurred in Tierra Grande subdivision along the San Bernard River in southwestern Fort Bend County. Home flooding occurred at Valley Lodge in Simonton, along Edgewood and Baudet Roads in Richmond, along Bar, Barker, Cumings, Sixth Street, Avenue B, and Rio Brazos Roads in Rosenberg. Sections of FM 2759 as well as the Grand River, Rivers Edge and Pecan Estates in Thompsons flooded. Many countywide roads became inundated in flood waters, including, but not limited to Highway 90A, Pitts Road, FM 1489, FM 723, FM 1093, FM 359, SH 6 feeder roads, Sienna Parkway, Carrol Road, McKeever Road, Knights Court, Miller Road, river Oaks Road, Thompsons Ferry Road, Strange Drive, Greenwood Drive, Second Street and low lying roads in Quail Valley in Missouri City. Due to record pool levels in Barker Reservoir, homes in Cinco Ranch flooded. Big Creek flooding in Needville caused the flooding of homes on Ansel Road. FM 1093 was closed east of FM 723 due to flooding. There were numerous road closures around the Rosenberg and Richmond areas. Some of these roads included Highway 90 at Highway 36 and Lane Drive, Lane Drive at Mustang Road, and I-69 at FM 762 and Reading Road. Major record-level flooding of both the Brazos and San Bernard Rivers caused significant home flooding from Richmond to Rosharon. Massive flooding occurred in Tierra Grande subdivision along the San Bernard River in southwestern Fort Bend County. Home flooding occurred at Valley Lodge in Simonton, along Edgewood and Baudet Roads in Richmond, along Bar, Barker, Cumings, Sixth Street, Avenue B, and Rio Brazos Roads in Rosenberg. Sections of FM 2759 as well as the Grand River, Rivers Edge, and Pecan Estates in Thompsons flooded. Many countywide roads became inundated in flood waters, including but not limited to Highway 90A, Pitts Road, FM 1489, FM 723, FM 1093, FM 359, SH 6 feeder

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend County included in Declaration?	Description
				roads, Sienna Parkway, Carrol Road, McKeever Road, Knights Court, Miller Road, river Oaks Road, Thompsons Ferry Road, Strange Drive, Greenwood Drive, Second Street and low lying roads in Quail Valley in Missouri City. Due to record pool levels in Barker Reservoir, homes in Cinco Ranch flooded. Big Creek flooding in Needville caused the flooding of homes on Ansel Road. Flooding was reported within homes in Missouri City, with water rescues being conducted off of the Westpark Tollway in the Jeanetta Sharpstown area. Roof damage to a home near Westpark Tollway and Grand Parkway resulted in $30,000 in property damage. An EF-1 tornado resulted in damage to 28 homes in the Woodland West subdivision. Damage path extends from Stafford into Missouri City. $2 million in property damage was reported. An EF-1 tornado touched down near Trailer World RV and Boat Storage facility, then crossed Interstate 10. It did minor damage to Bucees car wash area, then ripped large air conditioning units off top of Pepperl Fuchs building. Finally, it damaged awnings near Builders First building. Tornado crossed from Fort Bend into Waller County. $800,000 in property damage occurred. An EF-1 tornado touched down southeast of Juliff and tracked from Brazoria into Fort Bend County. Damage occurred to some roofs. Several trees there were either snapped or downed. The damage path crossed the county line from Brazoria to Fort Bend County. $500,000 in property damages occurred. An EF-1 tornado tracked across Sienna Plantation subdivision, downing trees and damaging roofs on about 25 homes. Vieux Carre Ct and Steve Ct were hardest hit. $500,000 in property damages occurred.
July 25 – 31, 2020	Hurricane	EM-3530-TX	Yes	Texas Hurricane Hanna
August 23 – 27, 2020	Tropical Storm	EM-3540-TX	Yes	Texas Tropical Storms Marco and Laura
September 13 – 14, 2021	Hurricane	2021-S5115	Yes	Nicholas formed on September 12 in the Southwestern Gulf of Mexico, slowly advancing northeastward along the Middle Texas Coast. It eventually made landfall 10 miles west of Sargent just after midnight on September 14, with maximum sustained wind speeds of 75 mph. Heavy rain bands associated with Nicholas brought widespread rainfall totals of 6 to 10 inches to the Southeast Texas Coast, while strong wind gusts

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend County included in Declaration?	Description
				resulted in tree and structural damage as well as widespread power outages across the area. Hurricane Nicholas produced several hours of tropical storm-force sustained winds and gusts. There were numerous power outages and minor to moderate damage to some structures and roofs.

Source: FEMA 2022; USDA 2023; NOAA NCEI 2023

Probability of Future Occurrences

For the 2023 Hazard Mitigation Plan (HMP) update, the most up-to-date data was collected to calculate the probability of future occurrence of flood events for the County. Information from NOAA's Historical Hurricane Track tool was used to identify the number of hurricane and tropical storm events that came within 60 nautical miles of Fort Bend County between 1950 and 2022. Table 4.3.6-5 presents the probability of future events for the hurricane and tropical storm hazard. Fort Bend County has historically experienced hurricane or tropical storm impacts every other year.

Table 4.3.6-5. Probability of Future Hurricane and Tropical Storm Events

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurring in Any Given Year
Hurricane	12	16.44
Tropical Storm	26	35.62
Total	**38**	**52.05**

Sources: NOAA NHC 2023

Note: NOAA's Historical Hurricane tracker was used to identify hurricanes and tropical storms in Fort Bend County. Because hurricanes and tropical storms are large storm systems, impacts extend well beyond the center of rotation. 60 nautical miles was used to determine the likely edge of impacts of hurricanes and tropical storms that passed by the County but did have the center of rotation move over the County.

In Section 4.4, the identified hazards of concern for Fort Bend County were ranked (Table 4.4-2). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Partnership, the probability of occurrence for floods in the County is considered "occasional".

Climate Change Projections

Temperatures are predicted to increase in Fort Bend County. Ocean temperatures are forecast to continue to increase, which may lead to an increase in intensity and frequency of hurricanes. As oceans warm, the length of hurricane season may extend. Recent hurricane seasons have featured a tropical system occurring before the official start of the season. According to NOAA's database, 40 storms formed in the Atlantic Basin before June 1 from 1851 through 2021, a long-term average of one such early storm every four to five years. The 2010s had the most such storms, and there has been a steady increase since the 1990s. However, the 1950s had six such storms, the 1930s had four, and there was another four preseason storm streak from 1887 through 1890. It is possible there were other such storms in the era before satellites – before the mid-1960s – that were missed by ship observations or reports from areas impacted. It is still unknown whether expansion of the traditional hurricane season is a long-term trend or a common occurrence (The Weather Channel 2020). It remains to be seen if other factors, such as steering currents, atmospheric sheer, and the presence of Saharan dust, will increase or decrease the risk of hurricanes in the County.

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The County of Fort Bend is vulnerable to the hurricane and tropical storm hazard. The following text evaluates and estimates the potential impact of the hurricane and tropical storm hazard in the County.

Impact on Life, Health, and Safety

The impact of hurricanes and tropical storms on life, health, and safety is dependent upon several factors, including the severity of the event and whether or not adequate warning time was provided to residents. All residents in Fort Bend County (806,497) are exposed to the hurricane and tropical storm hazard.

Residents may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by high winds can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors, including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Hazus estimates that 2,168 households in Fort Bend County will be displaced, and 1,547 persons will seek short-term shelter during the 100-year MRP hurricane wind event; in both instances, the greatest number of households and persons will be from the Unincorporated areas of Fort Bend County, followed by Missouri City. It is estimated that during the 500-year MRP hurricane wind event, 12,168 households will be displaced, and 8,542 persons will seek short-term shelter. The greatest number of households and persons will be from the Unincorporated areas of Fort Bend County, followed by the City of Sugarland. Please note that estimates are only based on wind speed and do not account for sheltering needs associated with flooding and storm surge that may accompany hurricane and tropical storm events.

Table 4.3.6-6. Estimated Population Displaced and Seeking Short-Term Shelter from the 100-Year Mean Return Period Hurricane

Jurisdiction	100-Year Mean Return Period Hurricane	
	Displaced Households	Persons Seeking Short-Term Sheltering
Arcola (C)	10	8
Beasley (C)	5	4
Fairchilds (V)	15	11
Fulshear (C)	2	1
Houston (C)	102	94
Katy (C)	1	0
Kendleton (C)	4	3
Meadows Place (C)	6	3
Missouri City (C)	239	164
Needville (C)	104	69
Orchard (C)	2	2
Pearland (C)	13	12
Pleak (V)	13	9
Richmond (C)	22	20
Rosenberg (C)	139	110
Simonton (C)	0	0
Stafford (C)	48	31
Sugarland (C)	230	134
Thompsons (T)	3	2
Weston Lakes (C)	2	1
Unincorporated Area	1,209	870
Fort Bend County (Total)	**2,168**	**1,547**

Source: Hazus v5.1

Table 4.3.6-7. Estimated Population Displaced and Seeking Short-Term Shelter from the 500-Year Mean Return Period Hurricane

Jurisdiction	500-Year Mean Return Period Hurricane	
	Displaced Households	Persons Seeking Short-Term Sheltering
Arcola (C)	37	28
Beasley (C)	38	32
Fairchilds (V)	19	13
Fulshear (C)	132	74
Houston (C)	368	336
Katy (C)	20	13
Kendleton (C)	37	30
Meadows Place (C)	43	23
Missouri City (C)	1,272	855
Needville (C)	129	86
Orchard (C)	20	16
Pearland (C)	40	35
Pleak (V)	35	26
Richmond (C)	298	281
Rosenberg (C)	1,067	878
Simonton (C)	7	4
Stafford (C)	231	154
Sugarland (C)	2,130	1,256
Thompsons (T)	9	6
Weston Lakes (C)	100	50
Unincorporated Area	6,136	4,344
Fort Bend County (Total)	**12,168**	**8,542**

Source: Hazus v5.1

Socially Vulnerable Populations

Social vulnerability is defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards.

According to FEMA's National Risk Index, socially vulnerable populations in Fort Bend County have a relatively moderate susceptibility to the adverse impacts of hurricanes, when compared to the rest of the United States (FEMA n.d.).

Research has shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted. This is due to many factors, including their physical and financial ability to react or respond during a hazard. Economically disadvantaged populations are vulnerable because they are likely to evaluate their risk and make decisions based on the major economic impact to their family and may not have funds to evacuate. The population over the age of 65 is also vulnerable and, physically, they may have more difficulty evacuating. Additionally, the elderly are considered vulnerable because they require extra time or outside assistance during evacuations and are more likely to seek or need medical attention, which may not be available due to isolation during a storm event. Please refer to Section 3 (County Profile) for the statistics of these populations. Refer to Figure 4.3.6-5 for the social vulnerability index for hurricanes.

Figure 4.3.6-5: FEMA Social Vulnerability Index for Hurricane

Source: FEMA NRI

Impact on General Building Stock

Damage to buildings is dependent upon several factors, including wind speed, hail size, storm duration, and storm path. Building construction also plays a major role in the extent of damage resulting from a storm. Due to differences in construction, residential structures are generally more susceptible to storm damage than commercial and industrial structures. Wood and masonry buildings, in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings. Lightning can spark wildfires or building fires, especially if structures are not protected by surge protectors on critical electronic, lighting, or information technology systems.

Table 4.3.6-8. Expected Damage for 100-Year Mean Return Period Hurricane Event in Fort Bend County

Occupancy Class	Total Number of Buildings Assessed in Occupancy	Severity of Expected Damage	100-Year Mean Return Period Hurricane	
			Building Count	Percent of Buildings in Occupancy Class
Residential Exposure (Single and Multi-Family Dwellings)	271,123	NONE	173,130	63.9%
		MINOR	73,708	27.2%
		MODERATE	19,066	7.0%
		SEVERE	3,273	1.2%
		DESTRUCTION	1,946	0.7%
Commercial Buildings	7,129	NONE	4,693	65.8%
		MINOR	2,000	28.1%
		MODERATE	406	5.7%
		SEVERE	30	0.4%

Occupancy Class	Total Number of Buildings Assessed in Occupancy	Severity of Expected Damage	100-Year Mean Return Period Hurricane	
			Building Count	Percent of Buildings in Occupancy Class
		DESTRUCTION	0	0.0%
Industrial Buildings	163	NONE	106	64.7%
		MINOR	33	20.1%
		MODERATE	19	12.0%
		SEVERE	5	3.2%
		DESTRUCTION	0	0.0%
Government, Religion, Agricultural, and Education Buildings	2,870	NONE	1,456	50.7%
		MINOR	682	23.8%
		MODERATE	433	15.1%
		SEVERE	243	8.5%
		DESTRUCTION	56	2.0%

Source: Hazus v5.1

Table 4.3.6-9. Expected Damage for 500-Year Mean Return Period Hurricane Event in Fort Bend County

Occupancy Class	Total Number of Buildings Assessed in Occupancy	Severity of Expected Damage	500-Year Mean Return Period Hurricane	
			Building Count	Percent of Buildings in Occupancy Class
Residential Exposure (Single and Multi-Family Dwellings)	271,123	NONE	80,028	29.5%
		MINOR	107,242	39.6%
		MODERATE	56,052	20.7%
		SEVERE	17,618	6.5%
		DESTRUCTION	10,182	3.8%
Commercial Buildings	7,129	NONE	2,179	30.6%
		MINOR	3,274	45.9%
		MODERATE	1,484	20.8%
		SEVERE	186	2.6%
		DESTRUCTION	5	0.1%
Industrial Buildings	163	NONE	56	34.6%
		MINOR	39	23.9%
		MODERATE	42	25.8%
		SEVERE	26	15.7%
		DESTRUCTION	0	0.0%
Government, Religion, Agricultural, and Education Buildings	2,870	NONE	647	22.5%
		MINOR	796	27.7%
		MODERATE	773	26.9%
		SEVERE	542	18.9%
		DESTRUCTION	112	3.9%

Source: Hazus v5.1

Impact on Critical Facilities

Critical facilities are at risk of being impacted by high winds associated with structural damage or falling tree limbs/flying debris, which can result in the loss of power. Power loss can greatly impact households, business operations, public utilities, and emergency personnel. For example, vulnerable populations in the Planning Area are at risk if power loss results in interruption of heating and cooling services, stagnated hospital operations, and potable water supplies. Emergency personnel such as police, fire, and EMS will not be able to effectively respond in a power loss event to maintain the safety of its citizens.

Hazus estimates that critical facilities in Fort Bend County have increased probabilities of sustaining minor to moderate damages from the 100-year MRP hurricane wind event; similarly, during the 500-year MRP hurricane wind event, Fort Bend County has increased probabilities of experiencing moderate to severe damages.

Table 4.3.6-10. Impact of 100-Year Mean Return Period Hurricane Event on Critical Facilities in Fort Bend County

Facility Type	100-Year Mean Return Period Hurricane				
	Loss of Days	Percent-Probability of Sustaining Damage			
		Minor	Moderate	Severe	Complete
Medical Facilities	0-6	4.7% - 15.7%	1.0% - 41.8%	0.0% - 16.2%	0.0% - 1.2%
Police Stations	0	15.2% - 23.4%	5.7% - 30.1%	0.6% - 32.8%	0.0% - <0.1%
Fire Stations	0	3.3% - 14.8%	0.5% - 28%	<0.1% - 19.1%	0.0% - 1.5%
Schools	0-53	4.6% - 12.3%	2.6% - 46.7%	<0.1% - 26.9%	0.0% - 0.63%
EOC	0	16.8% - 20.8%	7.0% - 12.7%	0.75% - 2.2%	0.0%

Source: Hazus v5.1

Table 4.3.6-11. Impact of 500-Year Mean Return Period Hurricane Event on Critical Facilities in Fort Bend County

Facility Type	500-Year Mean Return Period Hurricane				
	Loss of Days	Percent-Probability of Sustaining Damage			
		Minor	Moderate	Severe	Complete
Medical Facilities	0-14	7.5% - 15.6%	21.0% - 42.2%	1.3% - 26.1%	<0.1% - 2.9%
Police Stations	0	14.7% - 23.5%	20.5% - 31.5%	7.3% - 38.8%	0.0% - <0.2%
Fire Stations	0	10.7% - 14.9%	13.3% - 30.2%	2.7% - 23.9%	0.04% - 2.3%
Schools	0-78	3.4% - 11.3%	31.5% - 47.9%	2.5% - 35.3%	0.0% - 1.3%
EOC	0	19.5% - 23.4%	23.1% - 30.6%	9.5% - 25.9%	0.0%

Source: Hazus v5.1

At this time, Hazus does not estimate losses to transportation lifelines and utilities as part of the hurricane model. Transportation lifelines are not considered particularly vulnerable to the wind hazard; they are more vulnerable to cascading effects such as flooding, falling debris etc. Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting) transportation needs. Furthermore, evacuation routes are vulnerable to hurricane wind events.

Impact on Economy

Damage to structures from wind can be the most immediate result of hurricane and tropical storm events; however, this damage can have long-lasting impacts on the economy. When a business is closed during storm recovery, there is lost economic activity in the form of day-to-day business and wages to employees. Overall, economic impacts include the loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, wage loss, and rental loss due to the repair/replacement of buildings.

Table 4.3.6-12. Estimated Losses from the 100-Year and 500-Year Hurricane Events in Fort Bend County

Mean Return Period (MRP)	Income Loss	Relocation Loss	Building Losses	Wages Losses	Rental Losses
100-Year	$22,345,770	$687,352,290	$3,613,767,790	$44,712,830	$271,295,250
500-Year	$45,910,040	$2,674,113,840	$12,626,493,300	$87,903,200	$1,013,279,800

Source: Hazus v5.1

Hazus estimates the total economic loss associated with each storm scenario (direct building losses and business interruption losses). Direct building losses are the estimated costs to repair or replace the damage caused to the building. This is reported in the "Impact on General Building Stock" section discussed earlier.

Business interruption losses are the losses associated with the inability to operate a business because of the wind damage sustained during the storm or the temporary living expenses for those displaced from their home because of the event.

Building losses for the 100-year and 500-year hurricane events are categorized by structure type in Table 4.3.6-13 and Table 4.3.6-14. For the 100-year hurricane event, residential structures account for an estimated 66.46 percent of the total estimated building losses, commercial structures account for an estimated 27.39 percent, and all other occupancy structures are 6.15 percent of the total estimated building losses. For the 500-year hurricane event, residential structures account for an estimated 68.58 percent of the total estimated building losses, commercial structures account for an estimated 24.77 percent, and all other occupancy structures are 6.65 percent of the total estimated building losses.

Table 4.3.6-13. Estimated Building Losses from the 100-Year Hurricane Event in Fort Bend County

Jurisdiction	Estimated Building Losses Caused by the 100-Year Mean Return Period Hurricane	Estimated Building Losses Caused by the 100-Year Mean Return Period Hurricane for Residential Structures Only	Estimated Building Losses Caused by the 100-Year Mean Return Period Hurricane for Commercial Structures Only	Estimated Building Losses Caused by the 100-Year Mean Return Period Hurricane for All Other Occupancies Structures Only
Arcola (C)	$16,873,085	$14,159,190	$2,510,381	$203,513
Beasley (C)	$18,869,635	$5,061,144	$3,877,356	$9,931,135
Fairchilds (V)	$10,654,227	$6,939,494	$2,925,218	$789,515
Fulshear (C)	$29,245,741	$24,510,066	$4,452,452	$283,223
Houston (C)	$103,540,847	$71,811,571	$27,119,674	$4,609,603
Katy (C)	$6,958,886	$5,671,061	$1,261,680	$26,145
Kendleton (C)	$5,745,393	$3,005,911	$1,524,858	$1,214,624
Meadows Place (C)	$9,577,581	$5,686,236	$3,789,498	$101,848
Missouri City (C)	$402,194,047	$285,511,668	$109,160,806	$7,521,572
Needville (C)	$70,495,330	$35,895,005	$28,994,398	$5,605,926
Orchard (C)	$3,143,376	$1,644,572	$834,269	$664,536
Pearland (C)	$43,022,355	$32,771,167	$8,522,744	$1,728,444
Pleak (V)	$19,815,264	$10,054,308	$5,717,300	$4,043,656
Richmond (C)	$32,064,822	$16,090,981	$13,281,558	$2,692,283
Rosenberg (C)	$269,949,438	$135,316,765	$104,287,358	$30,345,315
Simonton (C)	$1,470,744	$1,232,673	$223,757	$14,314
Stafford (C)	$88,456,616	$19,923,475	$63,477,220	$5,055,921
Sugarland (C)	$455,114,155	$295,811,460	$148,766,848	$10,535,848
Thompsons (T)	$5,362,787	$3,715,152	$1,458,967	$188,668
Weston Lakes (C)	$9,900,512	$8,419,447	$1,280,292	$200,773
Unincorporated Area	$2,011,312,951	$1,418,732,066	$456,001,104	$136,579,781
Fort Bend County (Total)	**$3,613,767,790**	**$2,401,963,413**	**$989,467,736**	**$222,336,641**

Source: Hazus v5.1

Table 4.3.6-14. Estimated Building Losses from the 500-Year Hurricane Event in Fort Bend County

Jurisdiction	Estimated Building Losses Caused by the 500-Year Mean Return Period Hurricane	Estimated Building Losses Caused by the 500-Year Mean Return Period Hurricane for Residential Structures Only	Estimated Building Losses Caused by the 500-Year Mean Return Period Hurricane for Commercial Structures Only	Estimated Building Losses Caused by the 500-Year Mean Return Period Hurricane for All Other Occupancies Structures Only
Arcola (C)	$38,111,410	$32,189,632	$5,424,743	$497,036
Beasley (C)	$71,949,106	$18,427,027	$13,917,424	$39,604,655
Fairchilds (V)	$12,494,022	$8,145,014	$3,443,703	$905,305
Fulshear (C)	$370,378,301	$312,714,349	$53,313,015	$4,350,937
Houston (C)	$231,125,969	$159,513,051	$58,338,518	$13,274,400
Katy (C)	$68,061,699	$55,081,733	$12,464,140	$515,825
Kendleton (C)	$23,453,115	$12,041,283	$6,156,380	$5,255,453
Meadows Place (C)	$31,963,900	$19,476,238	$11,992,850	$494,811
Missouri City (C)	$1,100,284,897	$791,278,922	$283,450,259	$25,555,716
Needville (C)	$81,059,222	$41,236,900	$33,464,769	$6,357,553
Orchard (C)	$12,831,492	$6,587,936	$3,368,232	$2,875,324
Pearland (C)	$83,803,524	$64,528,310	$15,701,051	$3,574,163
Pleak (V)	$47,878,436	$21,356,313	$12,056,946	$14,465,176
Richmond (C)	$190,950,919	$93,824,329	$69,930,423	$27,196,168
Rosenberg (C)	$928,117,050	$418,776,577	$383,986,546	$125,353,927
Simonton (C)	$18,618,819	$15,721,816	$2,677,621	$219,381
Stafford (C)	$262,176,152	$63,118,478	$177,855,834	$21,201,841
Sugarland (C)	$1,821,366,191	$1,221,069,967	$539,838,347	$60,457,877
Thompsons (T)	$11,417,672	$7,932,744	$3,083,081	$401,847
Weston Lakes (C)	$114,716,515	$99,447,793	$12,942,331	$2,326,391
Unincorporated Area	$7,105,734,888	$5,197,203,063	$1,423,418,608	$485,113,217
Fort Bend County (Total)	**$12,626,493,299**	**$8,659,671,473**	**$3,126,824,823**	**$839,997,003**

Source: Hazus v5.1

Debris management can be costly and may also impact the local economy. Hazus estimates the amount of building and tree debris that may be produced as result of the 100- and 500-year MRP wind events. Because the estimated debris production does not include flooding, this is likely a conservative estimate and may be higher if multiple impacts occur. According to the Hazus Hurricane User Manual, estimates of weight and volume of eligible tree debris consist of downed trees that would likely be collected and disposed at public expense. Refer to the User Manual for additional details regarding these estimates.

Hazus estimates the 100-year and 500-year hurricane events in Fort Bend County would generate a combined total of 673,661 tons and 2,077,726 tons of debris, respectively.

Table 4.3.6-15. Estimated Debris Created During the 100-Year Mean Return Period Hurricane Wind Event in Fort Bend County

Jurisdiction	Estimated Debris Created During the 100-Year Mean Return Period Hurricane Wind Event			
	Brick and Wood (Tons)	Concrete and Steel (Tons)	Tree (Tons)	Eligible Tree Volume (Cubic Yards)
Arcola (C)	2,848	16	118	276
Beasley (C)	1,615	8	0	0
Fairchilds (V)	1,688	27	532	260
Fulshear (C)	5,298	0	1,048	951
Houston (C)	18,577	38	169	333
Katy (C)	1,282	0	74	65
Kendleton (C)	908	7	0	0
Meadows Place (C)	1,949	0	53	473
Missouri City (C)	74,104	183	1,989	9,876
Needville (C)	10,865	108	3,405	1,883
Orchard (C)	497	4	0	0
Pearland (C)	7,171	21	588	967
Pleak (V)	2,679	16	440	271
Richmond (C)	6,133	6	542	1,840
Rosenberg (C)	44,578	128	3,742	5,099
Simonton (C)	266	0	53	48
Stafford (C)	18,760	9	19	142
Sugarland (C)	88,301	171	3,050	14,216
Thompsons (T)	869	4	131	96
Weston Lakes (C)	1,784	0	31,431	583
Unincorporated Area	333,249	1,486	621	38,382
Fort Bend County (Total)	**623,422**	**2,233**	**48,006**	**75,761**

Source: Hazus v5.1

Table 4.3.6-16. Estimated Debris Created During the 500-Year Mean Return Period Hurricane Wind Event in Fort Bend County

Jurisdiction	Estimated Debris Created During the 500-Year Mean Return Period Hurricane Wind Event			
	Brick and Wood (Tons)	Concrete and Steel (Tons)	Tree (Tons)	Eligible Tree Volume (Cubic Yards)
Arcola (C)	6,174	46	157	368
Beasley (C)	5,407	70	0	0
Fairchilds (V)	1,973	34	532	260
Fulshear (C)	61,036	353	3,144	2,854
Houston (C)	38,034	159	174	355
Katy (C)	11,679	49	222	195
Kendleton (C)	3,564	83	0	0
Meadows Place (C)	5,750	23	80	710
Missouri City (C)	183,775	881	2,458	12,557
Needville (C)	12,411	134	3,405	1,883
Orchard (C)	1,950	45	0	0
Pearland (C)	13,220	64	588	967
Pleak (V)	5,476	52	440	271
Richmond (C)	28,897	143	1,099	3,577
Rosenberg (C)	135,160	731	3,999	6,264
Simonton (C)	3,068	18	159	144
Stafford (C)	46,506	59	29	212
Sugarland (C)	304,425	1,244	4,391	21,092
Thompsons (T)	1,780	12	133	99
Weston Lakes (C)	18,512	126	39,574	1,750

Jurisdiction	Estimated Debris Created During the 500-Year Mean Return Period Hurricane Wind Event			
	Brick and Wood (Tons)	Concrete and Steel (Tons)	Tree (Tons)	Eligible Tree Volume (Cubic Yards)
Unincorporated Area	1,114,786	7,370	1,862	58,468
Fort Bend County (Total)	**2,003,584**	**11,696**	**62,446**	**112,026**

Source: Hazus v5.1

Impact on Environment

Wind from hurricanes and tropical storms can knock overpower lines sparking fires, which can destroy forests and habitats. Winds can also carry debris and litter across areas, which can negatively impact ecosystems and habitats, including water bodies.

Flooding from hurricane and tropical storms impact the natural and local environment. The surrounding environment may not be able to withstand and recover from flash flood events. Flash floods can destroy wildlife habitats, pollute rivers and streams, carry sediment and silt that can impact water quality, destroy crops and farms, uproot trees, and cause erosion of streambanks and other areas, (eSchoolToday 2021). Riverine flooding not only influences the habitat of natural land areas, but it can also be disruptive to species that reside in the natural habitats.

Future Changes That May Impact Vulnerability

Understanding future changes that affect vulnerability in Fort Bend County can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

As discussed and illustrated in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. New development that has occurred in the last five years within the County, and potential future development in the next five years as identified by the County and each municipality, is included in the jurisdictional annexes in Section 9, along with an indication of proximity to known hazard zones. Refer to Section 3 and Volume II, Section 9 for more information about the potential new development in Fort Bend County.

Any areas of growth could be potentially impacted by the hurricane and tropical storm hazard because the entire Planning Area is exposed and vulnerable; however, due to increased standards and codes, new development can be less vulnerable to the hazard compared with the aging building stock in the Planning Area.

Projected Changes in Population

According to the 2021 United States Census Bureau population estimates, the population of the County has increased by approximately 40.4 percent since 2010. The County's population is anticipated to increase over the next decade, continuing with the population growth trend which has been occurring since 1970. Increased population trends will change the County's overall risk to hurricane and tropical storm events. Refer to Section 3 (County Profile), which includes a discussion on population trends for the County.

Climate Change

As noted previously, the entire State of Texas is projected to experience an increase in the frequency and severity of extreme storms and rainfall. Temperatures are predicted to increase in Fort Bend County and ocean temperatures are forecast to continue to increase, which may lead to an increase in intensity and frequency of hurricanes. As oceans warm, the length of hurricane season may extend. Overall, the County will continue to remain vulnerable to the hurricane and tropical storm hazard.

Change in Vulnerability Since 2018 HMP

Fort Bend County continues to be vulnerable to hurricanes and tropical storms. Building losses were based on annualized losses instead of the 100 and 500-year mean return period events analyzed in this HMP update. Overall, the vulnerability assessment presented in this update uses Hazus v5.1 and a more accurate and updated building inventory. This provides more accurate estimated exposure and potential losses for the County.

SECTION 4. RISK ASSESSMENT

4.3 Hazard Profiles

4.3.7 Pandemic/Disease Outbreak

The following section provides the hazard profile and vulnerability assessment for the pandemic/disease outbreak hazard in Fort Bend County.

Hazard Profile

Hazard Description

An outbreak or an epidemic occurs when new cases of a certain disease, in a given population, substantially exceed what is expected. An epidemic may be restricted to one locale, or it may be global, at which point it is called a pandemic. Pandemic is defined as a disease occurring over a wide geographic area and affecting a high proportion of the population. A disease outbreak can cause sudden, pervasive illness in all age groups on a local or global scale. A pandemic is a novel virus to which humans have no natural immunity that spreads from person to person. A pandemic will cause both widespread and sustained effects and is likely to stress the resources of both the state and federal government (Madhav, et al. 2017). In addition to health impacts, disease outbreaks reaching pandemic proportions can cause social and economic impacts on a global scale (Shang, Li and Zhang 2021).

Coronavirus

Coronavirus disease (COVID-19) is an infectious disease first identified in 2019. The virus rapidly spread into a global pandemic by spring of 2020. Older people and those with underlying medical problems, like cardiovascular disease, diabetes, chronic respiratory disease, and cancer, are more likely to develop serious illness (World Health Organization n.d.). With the virus being relatively new, information regarding transmission and symptoms of the virus is still new. The COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes. Reported illnesses have ranged from mild symptoms to severe illness. Reported symptoms include fever or chills, cough, shortness of breath or difficulty breathing, and fatigue. Symptoms may appear 2–14 days after exposure to the virus (CDC 2021).

In an effort to slow the spread of the virus, the federal government and states have urged the public to avoid touching of the face, properly wash hands often, and use various social distancing measures. At the time of this plan update, there are three approved and authorized vaccines available in the United States to reduce risk of severe illness (CDC 2021).

Influenza

The risk of a global influenza pandemic has increased over the last several years. This disease is capable of claiming thousands of lives and adversely affecting critical infrastructure and key resources. An influenza pandemic has the ability to reduce the health, safety, and welfare of the essential services workforce; immobilize core infrastructure; and induce fiscal instability.

Pandemic influenza is different from seasonal influenza (or "the flu") because outbreaks of seasonal flu are caused by viruses that are already among people. An influenza pandemic is a global outbreak of a new influenza A virus. Pandemics happen when new (novel) influenza A viruses emerge that are able to infect people easily and spread from person to person in an efficient and sustained way (CDC n.d.).

At the national level, the CDC's Influenza Division has a long history of supporting the World Health Organization (WHO) and its global network of National Influenza Centers (NIC). With limited resources, most international assistance provided in the early years was through hands-on laboratory training of in-country staff, the annual provision of WHO reagent kits (produced and distributed by CDC), and technical consultations for vaccine strain selections. The Influenza Division also conducts epidemiologic research, including vaccine studies and serologic assays, and provides international outbreak investigation assistance (CDC n.d.).

West Nile Virus

West Nile Virus (WNV) encephalitis is a mosquito-borne viral disease that can cause brain inflammation. WNV is commonly found in Africa, West Asia, the Middle East, and Europe. WNV was first reported in Texas in 2002. In a small number of cases, WNV has been spread by blood transfusion, which has resulted in the screening of blood donations for the virus in the U.S., or by organ transplantation. WNV can also be spread from mother to baby during pregnancy, delivery, or breastfeeding in a small number of cases. The symptoms of severe infection (West Nile encephalitis or meningitis) can include headache, high fever, neck stiffness, muscle weakness, stupor, disorientation, tremors, seizures, paralysis, and coma. WNV can cause serious illness, and in some cases, death. Usually, symptoms occur from 2 to 14 days after being bitten by an infected mosquito (Texas Department of State Health Services n.d.).

Location

Disease outbreaks can occur without regard for location. However, factors such as density, visitation, and the length of time in which the public spends in a location all contribute to the spread of infectious diseases. For example, COVID-19 is more likely to be spread by persons in close contact. Indoor areas in which people are in close contact with each other appear to be significant vectors for the disease, which is spread through respiratory droplets. Infectious diseases spread by insects may be subject to other types of location hazards. For example, the prevalence of standing water can provide breeding grounds for diseases such as WNV. Diseases that can infect humans are variable in nature and methods of transmission. Ultimately, residents need to be vigilant about diseases altogether to better understand and respond to disease outbreak hazards.

Extent

The exact size and extent of an infected population depends on how easily the illness is spread, the mode of transmission, and the amount of contact between infected and uninfected individuals. The transmission rates of pandemic illnesses are often higher in more densely populated areas. The transmission rate of infectious diseases will depend on the mode of transmission of a given illness.

Worst-Case Scenario

The worst-case pandemic/disease outbreak scenario for Fort Bend County is the introduction of an emerging infectious disease which spreads rapidly and for which there is no vaccine readily available. As COVID-19 has recently demonstrated, proper testing of and vaccination for a novel disease under the most ideal circumstances can take years.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2022, Fort Bend County was included in two disaster (DR) or emergency (EM) declarations for pandemic-related events. Generally, these disasters cover a wide region of the state; therefore, they can impact many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2022). Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

USDA Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2012 and 2022, Fort Bend County was not included in any pandemic-related agricultural disaster declarations.

Previous Events

For this 2023 Hazard Mitigation Plan (HMP) update, known pandemic events that impacted Fort Bend County between 2017 and 2022 are discussed below.

Table 4.3.7-1. Pandemic/Health and Safety Events in Fort Bend County (2017 to 2022)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend County Included in Declaration?	Description
2017	West Nile Virus	N/A	N/A	The State of Texas reported 135 cases of WNV in 2017. Cases were identified in Fort Bend County, but the number of cases was not identified.
2017	Influenza	N/A	N/A	According to the 2016–2017 Statewide Influenza Activity Map, Fort Bend County had at least one individual test positive for influenza via rapid test in 2017. The type of Influenza was not identified.
2018	Influenza	N/A	N/A	According to the 2017–2018 Statewide Influenza Activity Map, Fort Bend County had at least one Influenza-like illness with no laboratory confirmation. The type of Influenza was not identified.
2019	Influenza	N/A	N/A	According to the 2018–2019 Statewide Influenza Activity Map, Fort Bend County had at least one individual test positive for influenza via rapid test in 2019. The type of Influenza was not identified.
01/20/2020 – continuing	Biological (COVID-19)	EM-3501, DR-4485-TX, EM-3458-TX	No, Yes, Yes	As of May 2, 2023, Fort Bend County had 206,013 confirmed cases and 1,365 reported deaths related to COVID-19. COVID-19, 95,200 were male, and 109,600 were female; there are 1,200 cases where gender was not reported. The age groups with the highest total number of cases were those aged between 0–17 years old, followed by those aged 40–49.
2021	West Nile Virus	N/A	N/A	The State of Texas reported 143 cases of WNV in 2021. Cases were identified in Fort

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend County Included in Declaration?	Description
				Bend County, but the number of cases was not identified.

Sources: FEMA 2022; Texas Health and Human Services 2023; Texas Health and Human Services 2020; Texas Health and Human Services 2023
Note: The majority of influenza cases are not reportable by law in Texas. The data retrieved is from sentinel sites and only accounts for influenza and ILI cases that were reported to public health. Positive laboratory results are reported according to specimen collection date, or date received in the laboratory if the former is unknown.

Probability of Future Occurrences

Though occurrences of disease outbreaks overall are often difficult to predict at the local level, it is anticipated that Fort Bend County will continue to be impacted by disease outbreaks for the foreseeable future. Additionally, seasonality for cold and flu is well established and anticipated in Texas on an annual basis.

In Section 4.4, the identified hazards of concern for the Planning Area were ranked (Table 4.4-2). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Team, the probability of occurrence for pandemic/health and safety events in the Planning Area is considered “occasional”.

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The following discusses Fort Bend County’s vulnerability, in a qualitative nature, to disease outbreak.

Impact on Life, Health, and Safety

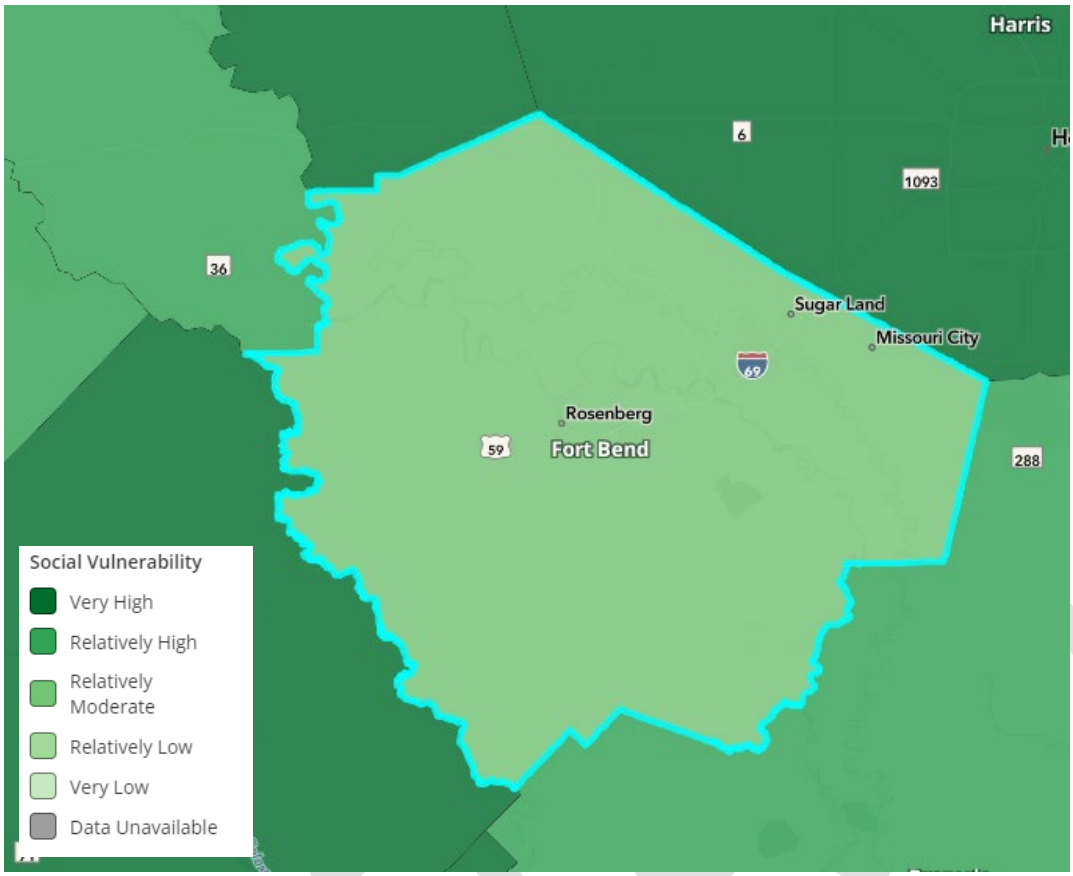
The entire population of Fort Bend County is vulnerable to disease outbreak. Due to a lack of quantifiable loss information, a qualitative assessment was conducted to evaluate the assets exposed to this hazard and the potential impacts associated with this hazard. Healthcare providers and first responders have an increased risk of exposure due to their frequent contact with infected populations. Areas with a higher population density also have an increased risk of exposure or transmission of disease due to the closer proximity of the population to potentially infected people.

Socially Vulnerable Populations

Social vulnerability is defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards.

Most recently with COVID-19, the Centers for Disease Control and Prevention have indicated that persons over 65 years and older, persons living in a nursing home or long-term care facility, and persons with underlying medical conditions such as diabetes, severe obesity, serious heart conditions, etc., are at a higher risk of getting severely ill (CDC 2021). According to the 2021 United States Census, 11.3 percent of Fort Bend County residents (approximately 91,379 people) are over the age of 65. Refer to Figure 4.3.7-1 for the social vulnerability index for natural hazards.

Figure 4.3.7-1: FEMA Social Vulnerability Index for Natural Hazards



Source: FEMA NRI

Impact on General Building Stock

No structures are anticipated to be directly affected by pandemic events.

Impact on Critical Facilities

No critical facilities are anticipated to be affected by disease outbreaks. Hospitals and medical facilities will likely see an increase in patients, but it is unlikely that there will be damages or interruption of services. However, large rates of infection may result in an increase in the rate of hospitalization, which may overwhelm hospitals and medical facilities and lead to decreased services for those seeking medical attention. The 2020 coronavirus pandemic has led to overwhelmed hospitals in numerous hotspots throughout Fort Bend County.

Impact on Economy

Disease outbreaks impacts on the economy and estimated dollar losses are difficult to measure and quantify. Costs associated with the activities and programs implemented to conduct surveillance and address disease outbreaks have not been quantified in available documentation. As evidenced in the COVID-19 outbreak, quarantines, shutdowns, and social distancing measures can have outsized economic impacts, particularly on the leisure, tourism, and food/accommodations sectors.

Impact on Environment

As seen during the COVID-19 pandemic, widespread public health emergencies can benefit the environment due to diminished impact from humans. As a result of the pandemic, many parts of the world saw improved air quality, lower rates of water pollution, reduced greenhouse gas emissions, and reduced visitation to tourist destinations, which may assist with the restoration of the ecological system (Islamb 2020).

Conversely, a spike in the production and use of personal protective equipment (PPE) can lead to increased litter and pollution. The majority of PPE currently used contains plastic components that take decades to break down and contribute to microplastic poisoning of wildlife. Medical waste from vaccinations is often incinerated, adding harmful heavy metals, particulate matter, and gases into the atmosphere. High concentrations of cleaning chemicals that exceed the capacity of water treatment facilities can negatively affect local freshwater sources, presenting further health risks for human consumption and the environment alike (Johns Hopkins University 2021).

Future Changes That May Impact Vulnerability

Understanding future changes that effect vulnerability in Fort Bend County can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

Any areas of growth could be potentially impacted by the pandemic/disease outbreak hazard because Fort Bend County is exposed and vulnerable. Additional development of structures in close proximity to waterbodies or areas with high population density are at an increased risk.

Projected Changes in Population

Fort Bend County has experienced an increase in population between the 2010 Census (590,177) and the 2020 Census population of 828,632. The population of the County is expected to increase over the next few years. The Texas Demographic Center projects the region's total population to reach 2,267,998 people by 2050 (Texas Demographic Center n.d.).

An increase in population will expose more people to the pandemic hazard as residents move into the area and the population exposed increases. Population density changes when households move throughout the Planning Area could influence the number of persons exposed to disease outbreaks. Higher density jurisdictions are not only at risk of greater exposure to disease outbreak, but density may also reduce available basic services provided by critical facilities such as hospitals and emergency facilities for persons that are not affected by a disease.

Climate Change

Climate change will likely have significant indirect impacts on disease outbreaks. In Texas, higher temperatures, decreased water availability, and more severe storm events are anticipated due to climate change. According to the WHO, changing climatic conditions are being studied for impacts upon disease transmission. Seasonal infectious diseases that are influenced by meteorological conditions may see significant variability in recurrence and duration. The WHO concludes that variations in infectious disease transmission patterns are likely major consequences of climate change (WHO 2021).

In the publication "What Climate Change Means for Texas," the US Environmental Protection Agency (EPA) notes that warming temperatures will exacerbate current public health concerns. "Seventy years from now, Texas is likely to have three or four times as many days per year above 100°F as it has today. Certain people are especially vulnerable, including children, the elderly, the sick, and the poor. High air temperatures can cause heat stroke and dehydration and affect people's cardiovascular and nervous systems" (EPA 2016).

Change of Vulnerability Since 2018 HMP

Disease outbreak was not included as a hazard of concern in the 2018 HMP. However, with an increase in population, it can be assumed that the vulnerability to pandemic/disease outbreak events has slightly increased since 2018.

SECTION 4. RISK ASSESSMENT

4.3 Hazard Profiles

4.3.8 Severe Weather

The following section provides the hazard profile and vulnerability assessment for the severe weather hazard in Fort Bend County.

Hazard Profile

Hazard Description

Hail

Hail forms inside a thunderstorm where there are strong updrafts of warm air and downdrafts of cold water. If a water droplet is picked up by the updrafts, it can be carried well above the freezing level. Water droplets freeze when temperatures reach 32°F or colder. As the frozen droplet begins to fall, it might thaw as it moves into warmer air toward the bottom of the thunderstorm or the droplet might be picked up again by another updraft and carried back into the cold air to re-freeze. With each trip above and below the freezing level, the frozen droplet adds another layer of ice. The frozen droplet, with many layers of ice, falls to the ground as hail (NSSL 2021).

Thunderstorms and Lightning

A thunderstorm is a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder (NWS 2021). A thunderstorm forms from a combination of moisture, rapidly rising warm air, and a force capable of lifting air, such as a warm and cold front, a sea breeze, or a mountain. Thunderstorms form from the equator to as far north as Alaska. Although thunderstorms generally affect a small area when they occur, they have the potential to become dangerous due to their ability to generate tornadoes, hailstorms, strong winds, flash flooding, and lightning. The NWS considers a thunderstorm *severe* only if it produces damaging wind gusts of 58 miles per hour (mph) or higher or large hail one inch (quarter size) in diameter or larger or tornadoes (NWS 2021).

Thunderstorms include heavy rainfall and occasional, gusty winds but often include hail and lightning. Damage from severe thunderstorm winds accounts for half of all severe summer weather reports in the lower 48 states and is more common than damage from tornadoes. Heavy rainfall produced by thunderstorms may result in several types of flooding, including riverine, flash floods, and local drainage floods. Thunderstorms can also range in magnitude and severity (NOAA n.d.).

Lighting is a bright flash of electrical energy produced by a thunderstorm. The resulting clap of thunder is the result of a shock wave created by the rapid heating and cooling of the air in the lightning channel. All thunderstorms produce lightning and are very dangerous. Lightning ranks as one of the top weather killers in the United States, killing approximately 50 people and injuring hundreds each year. Lightning can occur anywhere there is a thunderstorm (NOAA n.d.). There are two main types of lighting: intra-cloud and cloud-to-ground.

- Intra-cloud lightning is an electrical discharge between oppositely charged areas within the thunderstorm cloud (National Weather Service 2023).
- Cloud-to-ground lightning is a discharge between opposite charges in the cloud and on the ground. Cloud-to-ground lightning can either occur between negative charges in the cloud and positive charges on the ground (a negative flash) or between positive charges in the cloud and negative charges on the ground (a positive flash) (National Weather Service 2023).

Wind

Wind begins with differences in air pressures. It is rough horizontal movement of air caused by uneven heating of the earth's surface. Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth. High winds are often associated with other severe weather events such as thunderstorms, tornadoes, hurricanes, and tropical storms (NWS 2012). The following are descriptions of types of damaging winds:

- **Straight-line Wind**: Used to define thunderstorm wind, which is not linked with rotation and is mainly used to differentiate from tornadic winds (NOAA n.d.)
- **Down Draft**: A small-scale column of air that sinks toward the ground (NOAA n.d.)
- **Macroburst**: An outward burst of strong winds that are more than 2.5 miles in diameter (NOAA n.d.)
- **Microburst**: A small, concentrated downburst that produces an outward burst of relatively strong winds near the surface (NOAA n.d.)
- **Downburst:** General term to describe macro and microbursts (NOAA n.d.)
- **Gust Front:** Leading edge of rain-cooled air that clashes with a warm thunderstorm inflow (NOAA n.d.)
- **Derecho:** Long-lived windstorm associated with rapidly moving precipitation or thunderstorms. If wind damage swatch is more than 240 miles and includes gusts of wind that reach 58 mph or greater, then the event can be classified as a derecho (NOAA n.d.)

Location

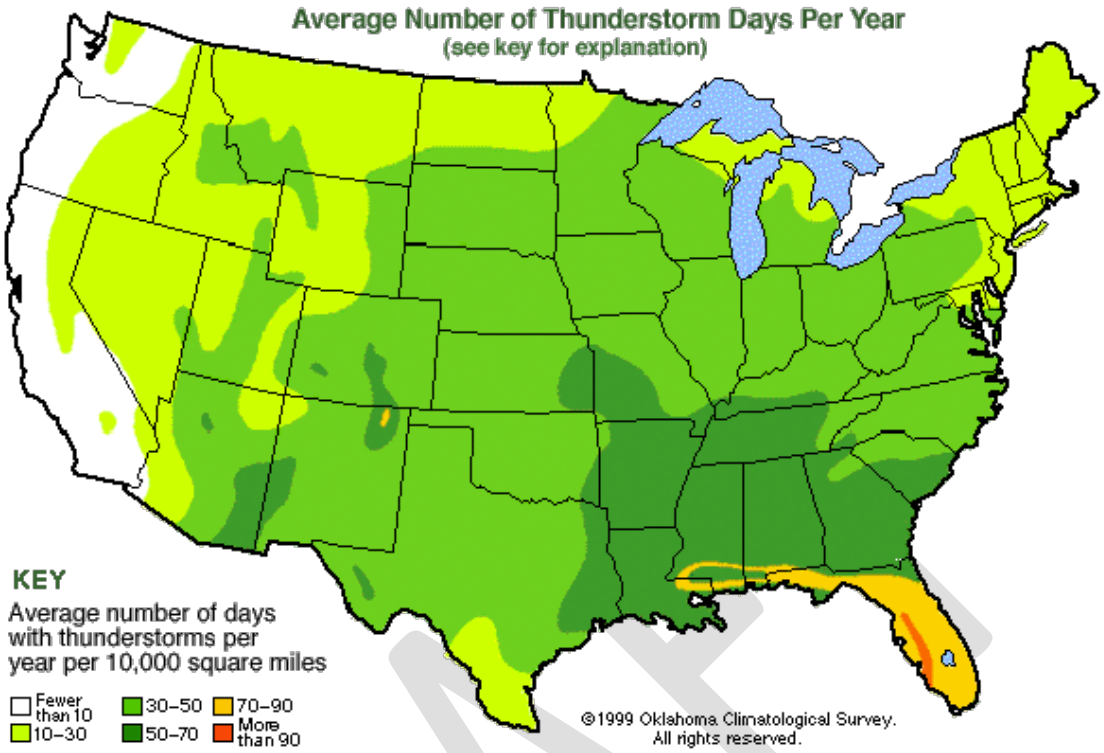
Hail

Hailstorms can form anywhere; however, they are more likely to fall in areas that have the most thunderstorms. The longer a hailstone spends in the clouds, the larger it becomes as more droplets continue to freeze. Hail falls when it becomes heavy enough to overcome the strength of the thunderstorm updraft and is pulled to the earth by gravity. Smaller hailstones may be blown away from the updraft by horizontal winds, so larger hail typically falls closer to the updraft than smaller hail (NOAA n.d.).

Thunderstorms and Lightning

Thunderstorms tend to take place during the spring and summer months, and during the warmest times of the day, which tend to be late afternoon and early evening (NOAA n.d.). Figure 4.3.8-1 displays thunderstorm days per year across the United States. The map shows that Fort Bend County is likely to have between 50 and 70 thunderstorms each year (University Corporation for Atmospheric Research 2023).

Figure 4.3.8-1. Average Number of Thunderstorms in the US

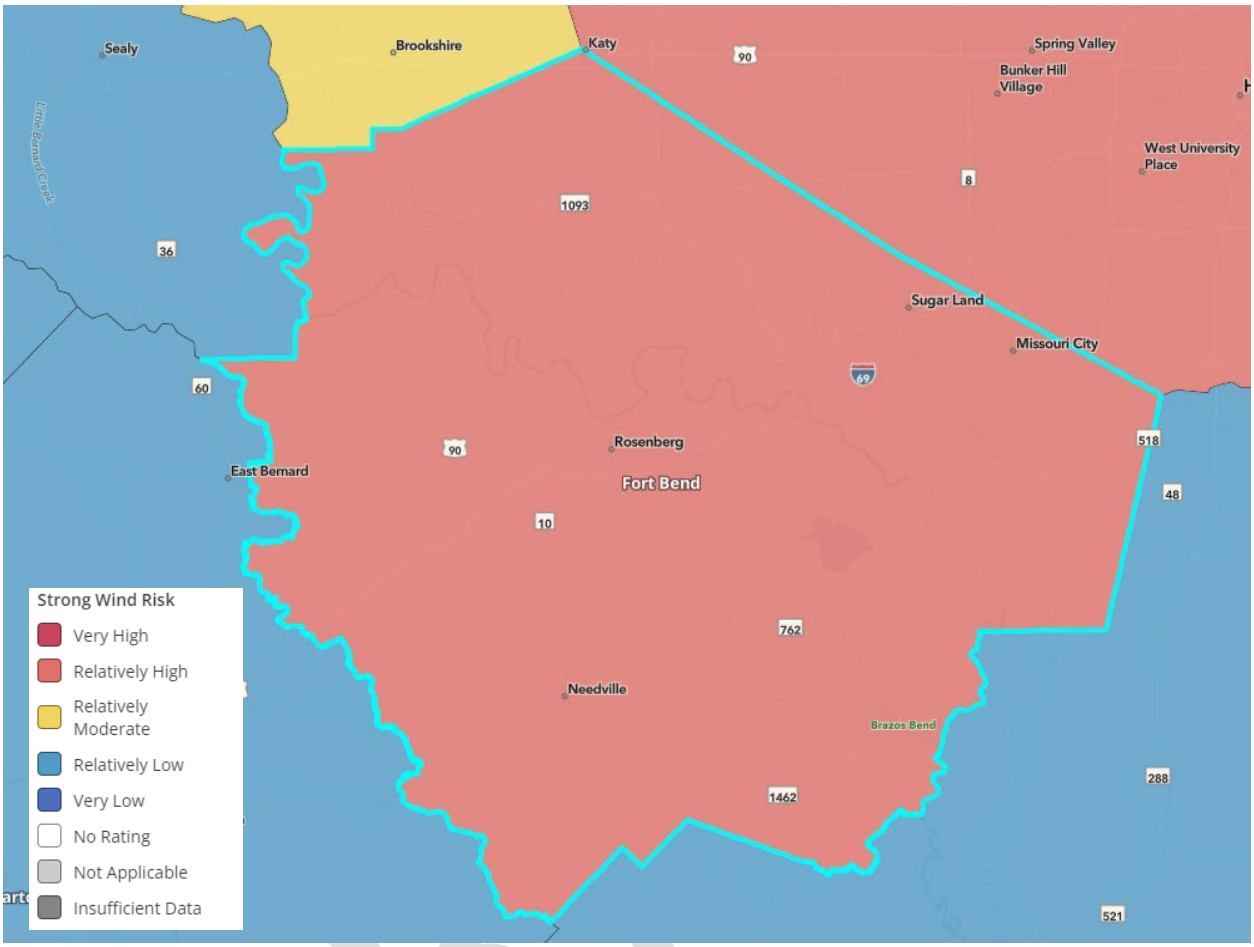


Source: University Corporation for Atmospheric Research 2023

Wind

Severe summer weathers have the power to produce powerful winds; therefore, strong and powerful winds have a higher chance of occurring in locations that are more likely to experience these storms (NOAA n.d.). In addition, high wind events may occur without a thunderstorm, tornado, or hurricane present and can be just as dangerous and destructive as those hazards. Figure 4.3.8-2 displays the strong wind risk index for Fort Bend County. According to the figure, the County has a "relatively high" risk to strong winds.

Figure 4.3.8-2. NRI Strong Wind Risk Index Score

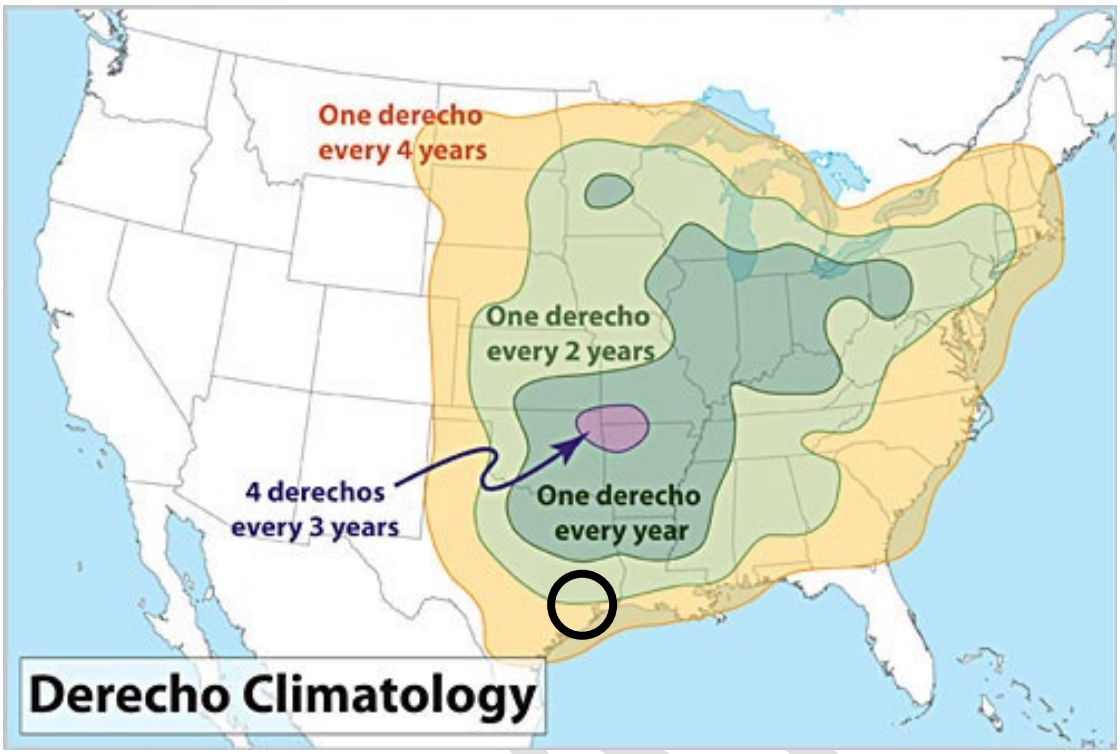


Source: FEMA 2023

Derecho

Derechos in the United States most commonly occur along two axes. One extends along the Corn Belt, from the upper Mississippi Valley southeast into the Ohio Valley, and the other from the southern Plains northeast into the mid-Mississippi Valley, as shown in Figure 4.3.8-3. During the cool season (September through April), derechos are relatively infrequent but are most likely to occur from east Texas into the southeastern states. Although derechos are extremely rare west of the Great Plains, isolated derechos have occurred over interior portions of the western United States, especially during spring and early summer (NOAA 2015). According to Figure 4.3.8-3 below, Fort Bend County can anticipate one derecho every four years.

Figure 4.3.8-3. Frequency of Derechos in the United States



Source: NOAA 2015

Note: The black circle shows the approximate location of Fort Bend County.

Extent

Hail

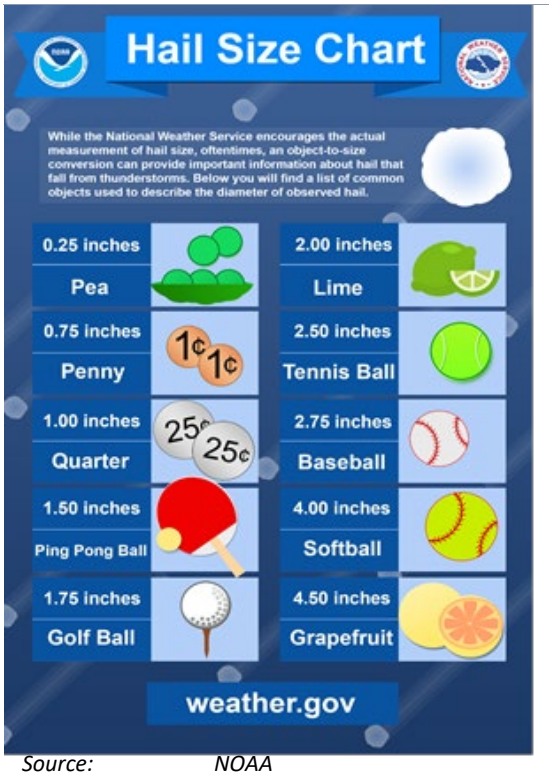
The severity of hail is measured by duration, hail size, and geographic extent. Hail can exhibit a variety of sizes, though only the very largest hail stones pose serious risk to people, if exposed. It is often estimated by comparing it to a known object (Figure 4.3.8-4). Most hailstorms are made up of a mix of different sizes, and only the very largest hail stones pose serious risk to people caught in the open (NSSL 2021).

Thunderstorms and Lightning

Severe thunderstorm statements, watches, and warnings are issued by the local NWS office and the Storm Prediction Center (SPC). The NWS and SPC will update the watches and warnings and notify the public when they are no longer in effect. NWS issues statements, watches, and warnings for thunderstorms:

- **Special Weather Statement:** Issued for strong storms that are below severe levels but may have impacts. Usually reserved for the threat of wind gust of 40–57

Figure 4.3.8-4. Hail Size Chart



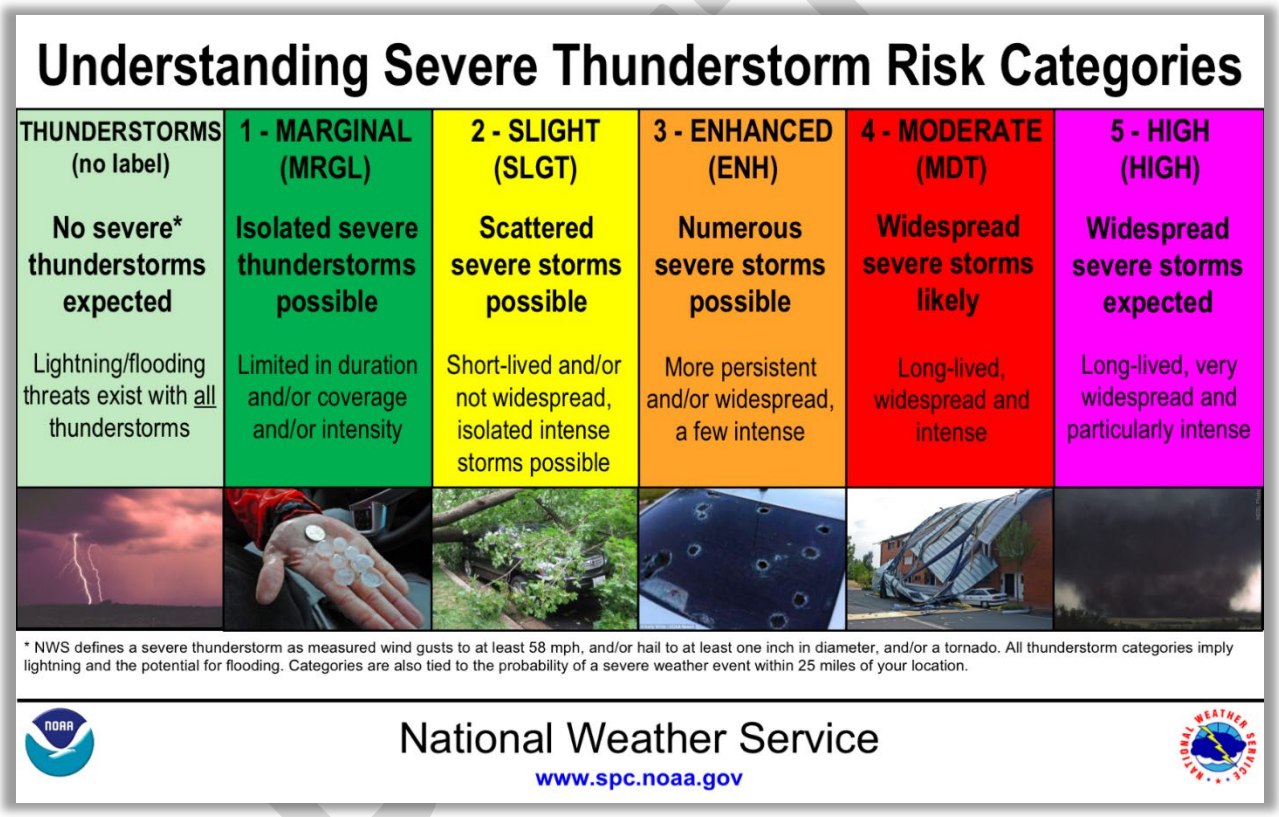
Source: NOAA

mph or hail of 0.5 inches to 0.99 inches in diameter (NWS 2023).

- **Severe Thunderstorm Watches:** A severe thunderstorm watch is issued when severe thunderstorms are possible in and near watch areas (NWS 2023).
- **Severe Thunderstorm Warning:** A severe thunderstorm is imminent or occurring; it is either detected by weather radar or reported by storm spotters. A severe thunderstorm is one that produces winds 58 mph or stronger and/or hail 1 inch in diameter or larger. A warning means to take shelter (NWS 2023).

The NWS has five risk categories for severe weather: marginal, slight, enhanced, moderate, and high. The probabilistic forecast directly expresses the best estimate of a severe weather event occurring within 25 miles of a point (NWS 2022). Figure 4.3.8-5 details the thunderstorm risk categories.

Figure 4.3.8-5. Thunderstorm Risk



Source: NOAA

Currently, cloud-to-ground (CG) and intra-cloud (IC) lightning flashes are detected and mapped in real-time by two different networks in the United States: the National Lightning Detection Network (NLDN) and the Earth Networks Total Lightning Network. These systems work by detecting radio waves (sferics) emitted by fast electric currents (strokes) in lightning channels. A "stroke" can be a fast current within the cloud or a "return stroke" in a channel to ground (NOAA n.d.).

Wind

The NWS issues advisories and warnings for winds that are typically site-specific. The NWS issues high wind advisories, watches, and warnings when wind speeds can pose a hazard or are life-threatening. The criterion

for each of these varies from state to state. According to the NWS (2020), wind warnings and advisories for the State of Texas are as follows:

- **High Wind Watch/Warnings:** Issued when sustained wind speeds of 40 mph or greater lasting for one hour or longer or for winds of 58 mph or greater for any duration or widespread damage are possible (NWS 2023).
- **Wind Advisories:** Issued when sustained winds of 30–39 mph are forecast for one hour or longer or wind gusts of 46–57 mph for any duration (NWS 2023).

Worst-Case Scenario

Although severe local storms are infrequent, impacts can be significant, particularly when secondary hazards of flood and erosion occur. A worst-case event would involve prolonged high winds, an intense hail event, and a lightning strike at a critical facility (such as an emergency service station) during a thunderstorm. Such an event would have both short-term and longer-term effects. Initially, schools and roads would be closed due to power outages caused by high winds and downed tree obstructions. In more rural areas, some subdivisions could experience limited ingress and egress. Prolonged rain could produce flooding, overtopped culverts with ponded water on roads, and landslides on steep slopes. Flooding could further obstruct roads and bridges, further isolating residents. Important issues associated with severe weather in the Planning Area include the following:

- Older building stock in the Planning Area is built to low code standards or none. These structures could be highly vulnerable to severe weather events such as windstorms.
- Redundancy of power supply must be evaluated.
- The capacity for backup power generation is limited.
- The potential for isolation after a severe storm event is high.
- There is limited information available for local weather forecasts.
- The lack of proper management of trees may exacerbate damage from high winds.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2022, Fort Bend County was included in six disaster (DR) or emergency (EM) declarations for severe weather-related events. Generally, these disasters cover a wide region of the state; therefore, they can impact many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2022). Detailed information about the declared disasters since 1954 is provided in the County Profile.

Table 4.3.8-1. FEMA Declared Severe Weather Disaster (1954–2022) in Fort Bend County

FEMA Declaration Number	Date(s) of Event	Incident Title
DR-930-TX	December 20, 1991 - January 14, 1992	Texas Severe Storm, Thunderstorms
DR-1041-TX	October 14, 1994 - November 8, 1994	Texas Severe Storm, Thunderstorms, Flooding
DR-1257-TX	October 17, 1998 - November 15, 1998	Texas Severe Storms, Flooding, and Tornadoes
DR-1379-TX	June 5, 2001 - June 20, 2001	Texas Severe Storms and Flooding
DR-1439-TX	October 24, 2002 - November 15, 2002	Texas Severe Storms, Tornadoes, and Flooding
DR-4223-TX	May 4, 2015 - June 22, 2015	Texas Severe Storms, Tornadoes, Straight-line Winds, and Flooding

Source: FEMA 2022

USDA Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2012 and 2022, Fort Bend County was not included in five severe weather-related agricultural disaster declarations.

Table 4.3.8-2. USDA Declared Severe Weather Disaster (1954–2022) in Fort Bend County

USDA Declaration Number	Date(s) of Declaration	Incident Title
2012-S3288	July 12, 2012	Wind, High Winds
2013-S3499	March 27, 2013	Wind, High Winds
2013-S3500	April 03, 2013	Wind, High Winds
2013-S3507	April 10, 2013	Wind, High Winds
2014-S3693	May 14, 2014	Wind, High Winds

Source: USDA FSA 2022

Previous Events

For this 2023 Hazard Mitigation Plan (HMP) update, known severe weather events that impacted Fort Bend County between 2017 and 2022 are discussed below.

Table 4.3.8-3. Severe Weather Events in Fort Bend County (2017–2022)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend County Included in Declaration?	Description
January 16, 2017	Thunderstorm Wind	N/A	N/A	Several weak tornadoes formed in an unstable air mass from a thunderstorm. Severe thunderstorm wind damage also occurred, which knocked many fences down.
May 22, 2017-May 23, 2017	Thunderstorm Wind, Hail	N/A	N/A	Morning storms became severe and produced severe wind damage, some flooding, and two tornadoes. Caused $100,000 in property damages. Severe thunderstorms developed and produced damaging winds and large hail. Significant downburst wind damage occurred with an estimated 100 mph wind. Simonton experienced $30,000 in property damages, and Arcola experienced $5,000 in property damages. Severe thunderstorms developed along and ahead of a cold front and produced damaging winds and large hail. Significant downburst wind damage occurred near Sealy with an estimated 100 mph wind.
September 5, 2018	Lightning	N/A	N/A	Lightning started a residential fire near the intersection of Lakebridge Lane and Hollow Lane. Approximately $10,000 in property damages occurred.
April 6-7, 2019	Thunderstorm Wind	N/A	N/A	A storm system moved across the area during the day and produced large hail, damaging winds and tornadoes. Dewalt experienced $6,000 in property damages and $3,000 in crop damages. Sugar Land experienced $3,000 in crop damages.

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend County Included in Declaration?	Description
April 13, 2019	Hail	N/A	N/A	A storm system moving eastward across the state produced several tornadoes, some wind damage, and large hail.
May 9, 2019	Thunderstorm Wind, Hail	N/A	N/A	Shortwave disturbances traveling across a slow-moving frontal boundary within a moist air mass allowed for the development of high rainfall, producing storms and downed trees from strong winds. Shortwave disturbances traveling across a slow-moving frontal boundary within a moist air mass allowed for the development of high rainfall-producing storms.
June 6, 2019	Thunderstorm Wind	N/A	N/A	Shortwave disturbances traveling across a slow-moving frontal boundary with severe wind produced which knocked down trees and power lines. Orchard experienced $7,000 in property damages, Fulshear experienced $6,000 in property damages, and Crabb experienced $7,100 in property damages.
January 10, 2020	Thunderstorm Wind	N/A	N/A	A strong storm system produced a squall line that moved eastward across the area and produced a lot of wind damage and one tornado. Richmond experienced $18,000 in property damages, and Stafford experienced $11,000 in damages.
May 16, 2020	Thunderstorm Wind	N/A	N/A	A passing squall line produced wind damage that knocked down trees and damaged houses. Hobby experienced $15,000 in property damages.
May 27, 2020	Thunderstorm Wind	N/A	N/A	Severe thunderstorms developed and produced wind damage, hail, and a few tornadoes, which knocked down power lines in the Katy area. Katy experienced $5,200 in property damages.
May 18, 2021	Thunderstorm Wind	N/A	N/A	Showers and thunderstorms moved across the area in the evening through late night hours and produced wind damage, lightning damage, and some flooding. City of Houston reported downed trees.
May 28, 2021	Thunderstorm Wind	N/A	N/A	Strong thunderstorms resulted in wind damage across Greater Houston area and flash flooding. Trees were downed, and roof damage was reported in Katy. Katy experienced $25,000 in property damages.
June 15, 2021	Thunderstorm Wind, Lightning	N/A	N/A	A number of severe thunderstorms developed across the area, resulting in many reports of tree damage, 1-inch hail, and building damage and power outages due to both winds and lightning strikes. Fairchilds experienced $5,000 in property damages. A home in Fort Bend County caught fire after being struck by lightning. Approximately $10,000 in property damages occurred.
August 10, 2022	Thunderstorm Wind	N/A	N/A	Showers and thunderstorms moved southward across the area, producing wind damage and lightning strikes. Roof damage was reported in a community in Fulshear.

Sources: *NOAA 2022; USDA FSA 2022; FEMA 2022; Fort Bend County 2018*

Notes: *Multiple hail-related events occurred in the project area between 2017 and 2022. No declarations were issued by FEMA or the USDA.*

Probability of Future Occurrences

For the 2023 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of severe weather events for the County. Information from NOAA-NCEI storm events database, the 2018 State of Texas HMP, and the 2018 Fort Bend County HMP were used to identify the number of severe weather events that occurred between 1950 and 2022. Table 4.3.8-4 presents the probability of future severe weather events for Fort Bend County. Fort Bend County will continue experiencing the direct and indirect impacts of severe weather events each year. Local knowledge indicates many more instances of lightning strikes occurring in the County. Therefore, the calculated probability based on recorded incidents might not represent the actual probability of occurrence.

Table 4.3.8-4. Probability of Future Severe Weather Events, Fort Bend County

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurring in Any Given Year
Hail	120	100%
Thunderstorms and Lightning	23	33.3%
Wind/Derecho	286	100%
Total	**429**	**100%**

Sources: NOAA 2022; State of Texas 2018; Fort Bend County 2018

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected events since 1968. Due to limitations in data, not all severe weather events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

In Section 4.4, the identified hazards of concern for Fort Bend County were ranked (Table 4.4-2). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Team, the probability of occurrence for severe weather events in the County is considered “frequent”.

Climate Change Impacts

The climate of Texas is changing. Most of the state has warmed between .5°F and 1°F in the past century. In the eastern two-thirds of the state, rainstorms are more intense, and floods are becoming more severe. In the coming decades, storms are likely to become more severe in Texas (EPA 2016). Periods of extreme precipitation increase the risk of hail and lightning (Centers for Climate and Energy Solutions n.d.). Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later this century in a changing climate, leading to increased rainfall and posing a greater threat of flooding across wide areas (UCAR 2017).

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The entire Planning Area is exposed to the severe weather hazard. The following text evaluates and estimates the potential impact of the severe weather hazard in the Planning Area as a whole.

Impact on Life, Health, and Safety

The impact of severe weather on life, health, and safety is dependent upon several factors, including the severity of the event and whether adequate warning time was provided to residents. As a result of severe weather events, residents can be displaced or require temporary to long-term sheltering.

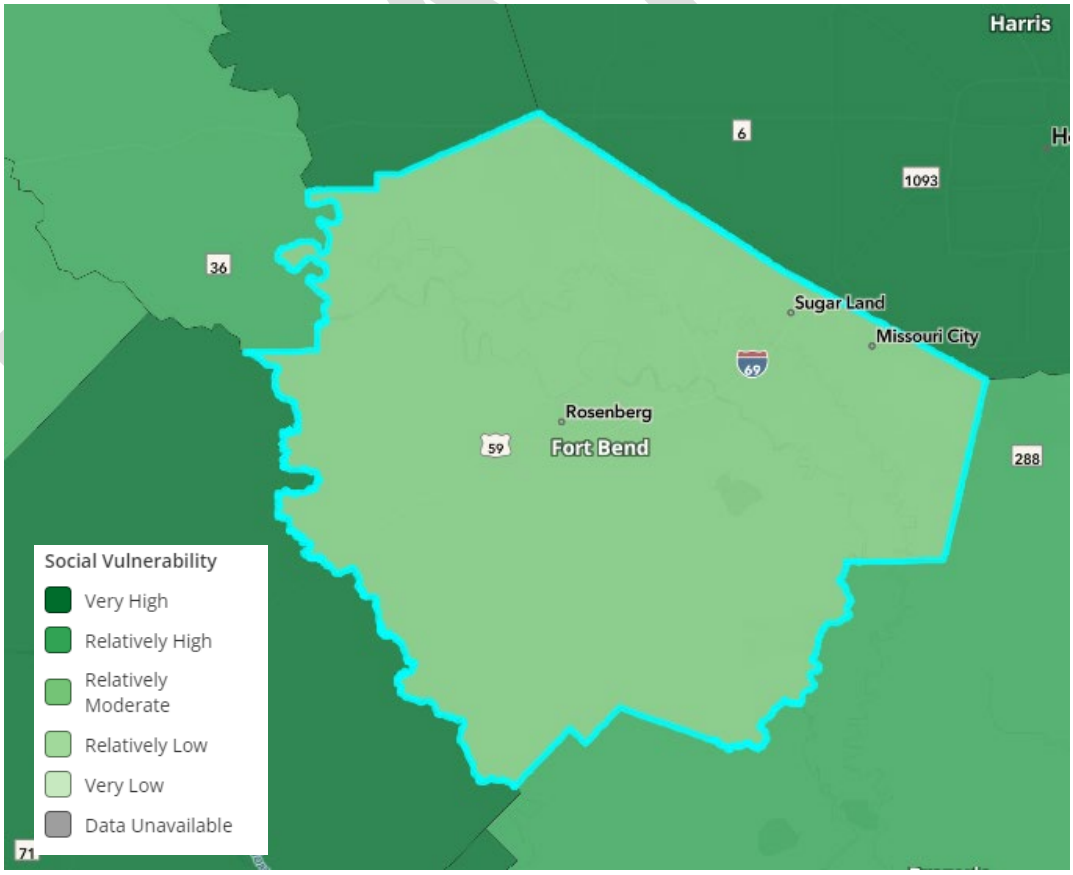
The most common problems associated with severe storms are immobility and loss of utilities. Residents impacted by severe weather may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by winds associated with severe weather can lead to injury or loss of life.

Socially Vulnerable Populations

Social vulnerability is defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards.

Although the entire population is exposed to severe weather, some populations are more vulnerable. Vulnerable populations include people who are elderly, people with low income, linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life-threatening to those dependent on electricity for life support. In general, populations who lack adequate shelter during a severe weather event, those who are reliant on sustained sources of power in order to survive, and those who live in isolated areas with limited ingress and egress options are the most vulnerable. Refer to Figure 4.3.8-6 for the social vulnerability index for natural hazards.

Figure 4.3.8-6. FEMA Social Vulnerability Index for Natural Hazards



Source: FEMA NRI

Impact on General Building Stock

The County's building stock is exposed to the severe weather hazard. Damage to buildings depends on several factors, including wind speed, storm duration, and path of the storm track. Building construction also plays a major role in the extent of damage resulting from a storm. Due to differences in construction, residential structures are generally more susceptible to storm damage than commercial and industrial structures. Wood and masonry buildings, in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings. Lightning can spark wildfires or building fires, especially if structures are not protected by surge protectors on critical electronic, lighting, or information technology systems.

Manufactured housing (i.e., mobile homes) is particularly vulnerable to high winds. The U.S. Census Bureau defines manufactured homes as "movable dwellings, 8 feet or wider and 40 feet or more long, design to be towed on its own chassis, with transportation gear integral to the unit when it leaves the factory, and without need of a permanent foundation (U. S. Census 2020)." They can include multi-wide and expandable manufactured homes but exclude travel trailers, motor homes, and modular housing. Due to their lightweight and often unanchored design, manufactured housing is extremely vulnerable to high winds and will generally sustain the most damage.

Hailstorms can crack, break, and dent building materials, so building construction plays a major role in the extent of damage resulting from hails. Due to differences in construction, residential structures are generally more susceptible to hail than commercial and industrial structures. Wood and masonry buildings, in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings.

Impact on Critical Facilities and Community Lifelines

Overall, all critical facilities in Fort Bend County are vulnerable to being affected by severe weather. Utility infrastructure could suffer damage from lightning, hail, and high winds, resulting in the loss of power or other utility service. Loss of service can impact residents, critical facilities, and business operations alike. Interruptions in heating or cooling utilities can affect populations, such the young and elderly, who are particularly vulnerable to temperature-related health impacts. Loss of power can impact other public utilities, including potable water, wastewater treatment, and communications. In addition to public water services, property owners with private wells might not have access to potable water until power is restored. Lack of power to emergency facilities, including police, fire, EMS, and hospitals, will inhibit a community's ability to effectively respond to an event and maintain the safety of its citizens.

Impact on Economy

Impacts include loss of business function, damage to inventory, relocation costs, wage loss, and rental loss due to the repair or replacement of buildings. Business interruption losses include losses associated with the inability to operate a business because of the damage sustained during a storm or the temporary living expenses for those displaced from their home because of an event. Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. Utility infrastructure (power lines, gas lines, electrical systems) could suffer damage and impacts can result in the loss of power, which can impact business operations and can impact heating or cooling provision to the populations.

The wind's power to erode the land can be detrimental to agriculture. Loess, a sediment that can develop into one of the richest soils for farming, is easily swept up by wind. Even when farmers take precautions to protect

it, the wind can erode up to 2.5 kilograms of loess per square meter. (1.6 pound per square foot) every year (Turgeon and Morse 2022).

Wind is a renewable resource that does not directly cause pollution. Wind energy is harnessed through powerful turbines. Wind turbines have a tall tubular tower with two or three propeller-like blades rotating at the top. When the wind turns the blades, the blades turn a generator and create electricity. The economic drawback to wind farms, however, is the wind itself. If it is not blowing, there's no electricity generated. (Turgeon and Morse 2022).

According to National Oceanic and Atmospheric Administration (NOAA) Technical Paper on *Lightning Fatalities, Injuries, and Damage Reports in the United States from 1959–1994*, monetary losses for lightning events range from less than $50 to greater than $5 million (larger losses associated with forest fires with homes destroyed and crop loss) (NOAA 1997).

Hail-producing severe storms impact the economy; impacts include loss of business function, damage to inventory, relocation costs, wage loss, and rental loss due to the repair or replacement of buildings. Additionally, vehicles parked outdoors are vulnerable to hail damage and could increase the economic impacts of a storm.

Impact on Environment

The impact of severe weather events on the environment varies, but researchers are finding that the long-term impacts of more severe weather can be destructive to the natural and local environment. National organizations such as United States Geological Survey (USGS) and NOAA have been studying and monitoring the impacts of extreme weather phenomena as it impacts long-term climate change, streamflow, river levels, reservoir elevations, rainfall, floods, landslides, erosion, etc. (USGS 2020). For example, severe weather that creates longer periods of rainfall can erode natural banks along waterways and degrade soil stability for terrestrial species. Severe wind events can tear apart habitats, causing fragmentation across ecosystems. Researchers also believe that a greater number of diseases will spread across ecosystems because of impacts that severe weather and climate change will have on water supplies (NOAA 2019). Overall, as the physical environment becomes more altered, species will begin to contract or migrate in response, which may cause additional stressors to the entire ecosystem within Fort Bend County.

Future Changes That May Impact Vulnerability

Understanding future changes that affect vulnerability in Fort Bend County can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

Understanding future changes that impact vulnerability in the County can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. Areas targeted for potential future growth and development could be potentially impacted by hailstorms since

the entire County is exposed. However, due to increased standards and codes, new development can be less vulnerable to extreme temperatures in comparison with the aging building stock currently in Fort Bend.

Projected Changes in Population

The County experienced an increase in population between the 2010 Census (585,375) and the estimated 2016–2020 American Community Survey estimated population of 790,892. The population of the County is expected to increase over the next few years. The increase in population will expose more people to the severe weather hazard.

Climate Change

Scientists must attempt to predict how climate change might affect the individual weather "ingredients" that produce storms that produce strong wind events. These weather ingredients are (Geographic n.d.):

- Warm, moist air
- An unstable atmosphere
- Wind at different levels moving in different directions at different speeds, a phenomenon known as wind shear

As global temperatures rise, the hotter atmosphere can hold more moisture. This increases atmospheric instability, a vital supercell ingredient. On the other hand, as the planet warms, wind shear (another vital ingredient) is likely to decrease. These two forces work against each other, and it is difficult to anticipate which might have a greater impact on tornado formation (Geographic n.d.).

The entire State of Texas is projected to experience an increase in the frequency and severity of extreme storms and rainfall. Climate change may lead to an increase in the number of lightning strikes and lightning-producing storms. Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later this century in a changing climate, unleashing far more rain and posing a greater threat of flooding across wide areas (UCAR 2017). The changing climate may also increase the frequency of lightning flashes, which could rise by an estimated 50 percent across the continental United States over the next century. A warmer atmosphere can hold more moisture, and moisture is one of the key ingredients for triggering a lightning strike (Sanders 2014).

Change in Vulnerability Since 2018 HMP

As the population grows in Fort Bend County, the number of people who could be impacted by wind events increases. Climate change is creating stronger storms, making the occurrence of severe weather more probable than in the previous plan. As existing development and infrastructure continue to age, they can be at increased risk to failed utility and transportation systems if they are not properly maintained and do not adapt to the changing environment.

SECTION 4. RISK ASSESSMENT

4.3 Hazard Profiles

4.3.9 Tornado

The following section provides the hazard profile and vulnerability assessment for tornadoes in Fort Bend County.

Hazard Profile

Hazard Description

The National Oceanic Atmospheric Association (NOAA) defines a tornado as a narrow, violently rotating column of air that extends from the base of a thunderstorm to the ground (NOAA 2011). Because wind is invisible, it is hard to see a tornado unless it forms a condensation funnel made up of water droplets, dust, and debris. Tornadoes are the most violent of all atmospheric storms and the most hazardous when they occur in populated areas. Tornadoes can topple mobile homes, lift cars, snap trees, and turn objects into destructive missiles. Among the most unpredictable of weather phenomena, tornadoes can occur at any time of day, in any state in the union, and in any season. While the majority of tornadoes cause little or no damage, some are capable of tremendous destruction, reaching wind speeds of 200 mph or more (NOAA 2023).

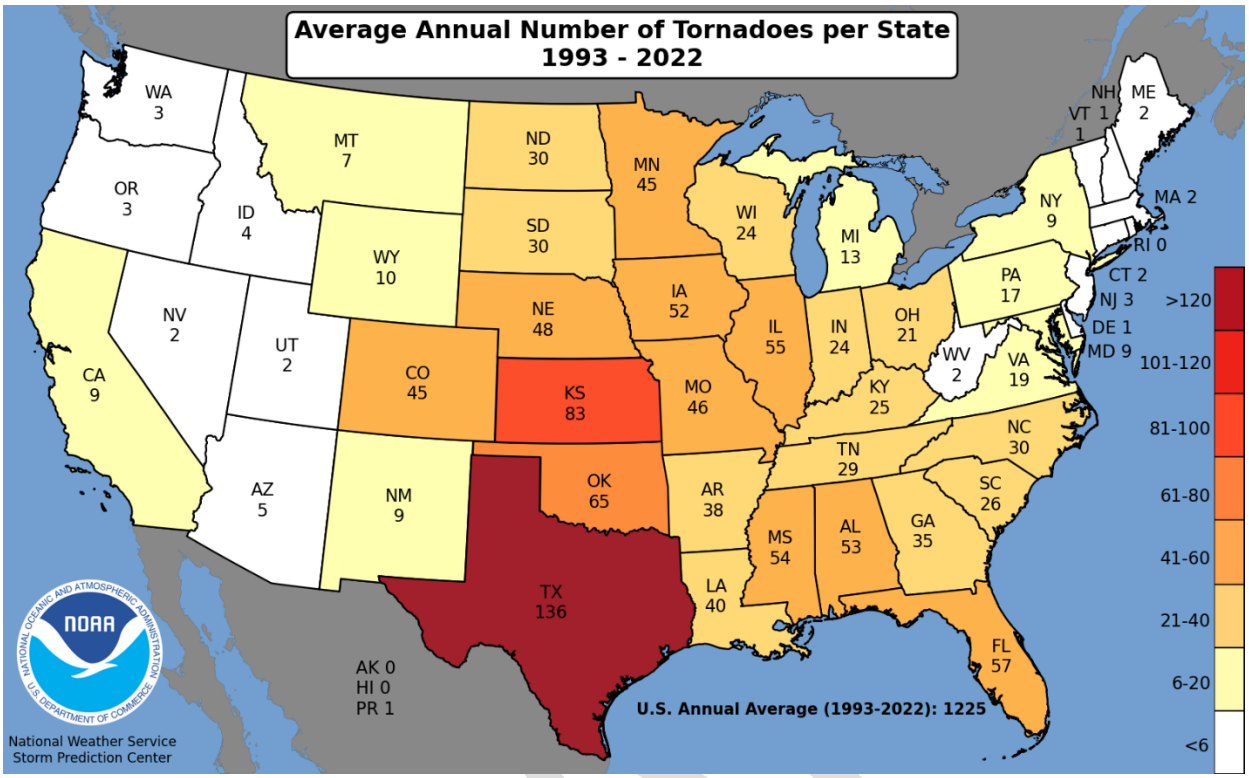
Damage paths for tornadoes can be greater than 1 mile wide and 50 miles long. Tornadoes typically develop from either a severe thunderstorm or hurricane as cool air rapidly overrides a layer of warm air. Tornadoes typically move at speeds of 30–125 mph and can generate combined wind speeds (forward motion and speed of the whirling winds) exceeding 300 mph. Most tornadoes are on the ground for less than 15 minutes (NWS n.d.).

Tornadoes can occur at any time of the year, with peak season for Texas from May into early June (NOAA n.d.). An average of 1,224 tornadoes occur in the United States each year, based on tornadoes recorded between 1991 and 2015. The State of Texas averages 147 tornadoes each year (Livingston 2016).

Location

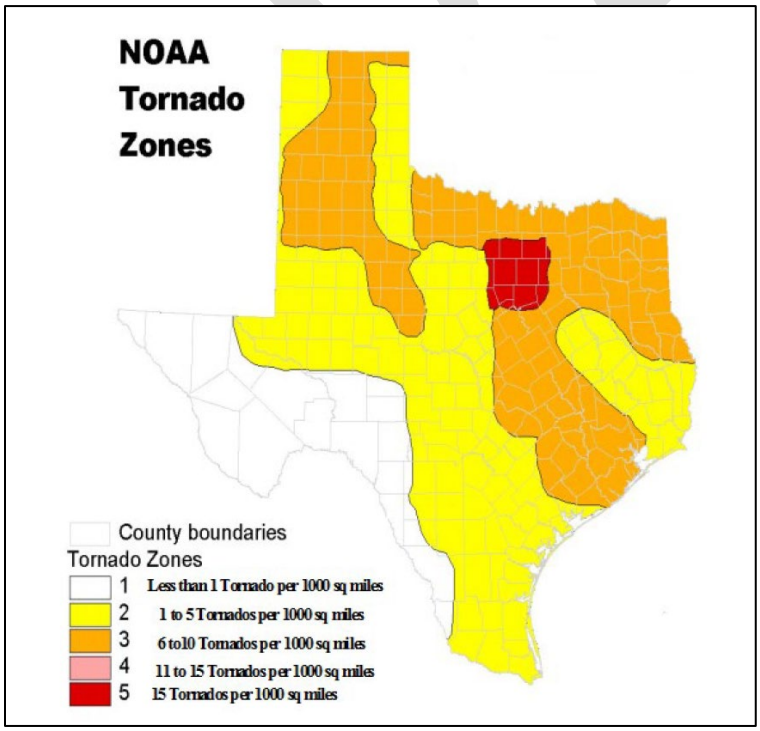
Similar to that of thunderstorms, tornadoes do not have any specific geographic boundary and can occur anywhere in Fort Bend County. Based on 30 years of data, the State of Texas has the highest average annual number of tornadoes per state, with an average of 136 tornadoes (Figure 4.3.9-1) (Storm Prediction Center 2023). Tornadoes occur annually and frequently in the northern two-thirds of Texas. Tornadoes that occur in the remainder of the state are primarily caused as a cascading hazard from tropical storms.

Figure 4.3.9-1. Average Annual Number of Tornadoes Per State, 1993–2022



Source: Storm Prediction Center 2023

Figure 4.3.9-2. Tornado Zones in Texas



Source: State of Texas 2018

Extent

Damage from tornadoes can vary from minor damage that breaks tree limbs to massive damage that demolishes homes in its path. The type of damage depends on the intensity, size, and duration of the tornado. The magnitude or severity of a tornado is categorized using the Enhanced Fujita Tornado Intensity Scale (EF Scale). This is the scale now used exclusively for determining tornado ratings by comparing wind speed and actual damage. Figure 4.3.9-3 illustrates the relationship between EF ratings, wind speed, and expected tornado damage.

Tornadoes are not measured as they happen. It takes surveyors to look at the damage to determine what wind speed could have caused the destruction. Also, they need to differentiate whether the wind damage was caused by a tornado or just straight-line winds (Beddoes 2022).

Figure 4.3.9-3. EF Scale

EF Rating	Wind Speeds	Expected Damage	
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.	
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.	
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.	
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.	
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.	
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.	

Source: Beddoes 2022

The National Weather Service (NWS) issues tornado watches and warnings. They are issued when conditions are favorable for the development of tornadoes in and close to the watch area. Their size can vary depending on the weather situation. Watches are typically issued for a duration of four to eight hours. A tornado warning is issued by the local NWS office and will include where the tornado was located and what municipalities will be in its path. It is issued when a tornado is indicated by a radar or spotters. Warnings are issued for a duration

of 30 minutes (NWS 2020). The current average lead time for tornado warnings is 13 minutes. Occasionally, tornadoes develop so rapidly that little, if any, advance warning is possible (NOAA 2011).

Worst-Case Scenario

A worst-case scenario would be an EF-3 tornado crossing through Fort Bend County with 3-second wind gusts ranging from 136 to 165 mph, causing severe damage. A tornado of this magnitude would tear off roofs and tear down walls, uproot trees, and lift vehicles off the ground. This could lead to downed utility poles, street signals, and debris on roadways, disrupting normal operations and impacting emergency response times. Critical and essential facilities could also be impacts, resulting in periods of service disruption to residents due to facility damages or lack of back-up power.

Previous Occurrences and Losses

Many sources have provided historical information regarding previous occurrences and losses associated with tornado events in Fort Bend County. According to NOAA-NCEI Storm Events Database, Fort Bend County has been impacted by 46 tornado events.

FEMA Disaster Declarations

Between 1954 and 2022, Fort Bend County was included in two disaster (DR) or emergency (EM) declarations for tornado-related events. Generally, these disasters cover a wide region of the state; therefore, they can impact many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2022). Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

USDA Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2017 and 2022, Fort Bend County was not included in any tornado-related agricultural disaster declarations.

Previous Events

For this 2023 Hazard Mitigation Plan (HMP) update, known tornado events that impacted Fort Bend County between 2017 and 2022 are discussed below.

Table 4.3.9-1. Tornado Events in the Fort Bend County (2017–2022)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend Included in Declaration	Description
February 14, 2017	Tornado	N/A	N/A	Several morning tornadoes developed as a storm system moved eastward across the state. Crabb experienced an EF-2 tornado with peak winds reaching 115 mph, destroying houses and farm infrastructure, totaling approximately $1,000,000 in property damages. Crabb also experienced an EF-0 tornado, which led to spotty roof damage and a wind peak of 80 mph, totaling approximately $500,000 in property damages. Stafford experienced an EF-0 tornado, which damaged storage buildings and

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend Included in Declaration	Description
				greenhouses with peak winds hitting 80 mph, totaling approximately $200,000 in damages. Smada experienced an EF-0 tornado with peak winds up to 80 mph, which damaged houses and produced approximately $150,000 in property damages.
August 25, 2017-August 26, 2017	Tornado	DR-4332-TX	Yes	Hurricane Harvey made landfall as a Category 4 hurricane near Rockport, Texas, during the evening of August 25th into the 26th. The storm then weakened to a tropical storm and slowed, looping back and tracking over SE Texas. Over the 5-day period, 23 tornadoes were spawned. Juliff experienced both an EF-0 and EF-1 tornado, which damaged homes and roads, with property damages totaling approximately $1,000,000. Sugarland experienced an EF-1 tornado, which damaged roofs with property damages totaling $500,000. Clodine experienced an EF-0 tornado, which produced roof damages totaling $30,000 in property damages. Katy experienced an EF-1 tornado, which damaged business infrastructure with property damages totaling approximately $800,000. Hobby experienced an EF-1 tornado, which damaged over 25 homes, with property damages totaling approximately $2,000,000.
May 23, 2018	Funnel Cloud	N/A	N/A	Severe thunderstorms made their way over the region, and several funnel clouds were sighted.
March 22, 2022	Tornado	N/A	N/A	Discrete supercell thunderstorms developed ahead of an advancing cold front, producing strong wind gusts, hail, and tornadoes. Later, a squall line formed along the front itself as it moved through SE TX, resulting in additional straight-line wind and tornado damage across the area. Kindleton experienced an EF-0 tornado with 4 documented injuries due to a flipped RV and approximately $100,000 in property damages due to tree uprooting and home injuries.

Sources: NOAA 2022; FEMA 2022; Fort Bend County 2018

Probability of Future Occurrences

For the 2023 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of tornado events for the County. Information from NOAA-NCEI Storm Events Database, the 2019 State of Texas HMP, the 2018 Fort Bend County HMP, and FEMA Disaster Declaration database were used to identify the number of tornado events that occurred between 1950 and 2022. Table 4.3.9-2 presents the probability of future events for tornadoes in Fort Bend County.

Table 4.3.9-2. Probability of Future Tornado Events

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurring in Any Given Year
Tornado	46	63%
Funnel Cloud	15	20.5%
Total	**61**	**83.6%**

Sources: NOAA-NCEI 2022, State of Texas 2018

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected events since 1968. Due to limitations in data, not all Tornado events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated. Information regarding Tornadic and Funnel Cloud occurrences was also gathered from the HMP Steering Committee.

In Section 4.4, the identified hazards of concern for Fort Bend County were ranked (Table 4.4-2). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Partnership, the probability of occurrence for tornadoes in the County is considered "frequent".

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the hazard area identified. The entire County has been identified as exposed for the tornado hazard. Therefore, all assets in the County (population, structures, critical facilities, and lifelines), as described in the County Profile (Section 3), are exposed and potentially vulnerable.

Impact on Life, Health, and Safety

Impacts of a tornado on life, health, and safety depend on several factors, including severity of the event and whether adequate warning time was provided to residents. All residents in Fort Bend County are exposed to tornadoes.

Residents impacted by tornadoes may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by winds associated with tornadoes can lead to injury or loss of life. Like other natural hazards, socially vulnerable populations are most susceptible based on several factors, including their physical and financial ability to react or respond during a hazard and locations and construction quality of their housing.

Socially Vulnerable Populations

Social vulnerability is defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards.

According to FEMA's National Risk Index, socially vulnerable populations in Fort Bend County have a relatively moderate susceptibility to the adverse impacts of tornadoes, when compared to the rest of the United States (FEMA n.d.).

Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions based on the major economic impact on their family and may not have funds to evacuate. The population over the age of 65 is also more vulnerable and they may have more difficulty evacuating. The elderly are considered most vulnerable because they require extra time or outside assistance during evacuations and are more likely to seek or need medical attention that may not be available due to isolation during a storm event. Section 3 (County Profile) presents the statistical information regarding these populations in the County. Refer to Figure 4.3.9-4 for the social vulnerability index for tornadoes.

Figure 4.3.9-4. FEMA Social Vulnerability Index for Tornado

Source: FEMA NRI

Impact on General Building Stock

The entire County's building stock is exposed to tornadoes. Damage to buildings depends on several factors, including wind speed, storm duration, path of the storm track and tornado, and distance from the tornado funnel. Manufactured housing (i.e., mobiles homes) can be particularly vulnerable to high winds and tornadoes. Due to their lightweight and often unanchored design, they are extremely vulnerable to high winds and will generally sustain the most damage out of all building stock.

Impact on Critical Facilities and Community Lifelines

Utility infrastructure could suffer damage from tornadoes associated with falling tree limbs or other debris, resulting in the loss of power or other utility service. Loss of service can impact residents, critical facilities, and business operations alike. Interruptions in heating or cooling utilities can affect populations, such the young and elderly, who are particularly vulnerable to temperature-related health impacts. Loss of power can impact other public utilities, including potable water, wastewater treatment, and communications. In addition to public water services, property owners with private wells might not have access to potable water until power is restored and could suffer from dehydration. Lack of power to emergency facilities, including police, fire, EMS, and hospitals, will inhibit a community's ability to effectively respond to an event and maintain the safety of its citizens.

Impact on Economy

Tornadoes also impact the economy, including loss of business function (e.g., tourism, recreation), damage to inventory, relocation and reconstruction costs, and wage and rental loss due to repair/replacement of buildings. Impacts on transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. Utility infrastructure (power lines, gas lines, electrical systems) could sustain damage, and impacts could result in loss of power, which can affect business operations and provision of heating or cooling to the population.

Impact on Environment

The impact of tornado events on the environment varies, but researchers are finding that the long-term impacts of more severe weather can be destructive to the natural and local environment. National organizations such as United States Geological Service (USGS) and NOAA have been studying and monitoring the effects of extreme weather phenomena as they impact long-term climate change, streamflow, river levels, reservoir elevations, rainfall, floods, landslides, erosion, etc. (USGS 2020). Tornadoes can tear apart habitats, causing fragmentation across ecosystems. Overall, as the physical environment becomes more altered, species will begin to contract or migrate in response, which may cause additional stressors to the entire ecosystem within Fort Bend County.

Future Changes That May Impact Vulnerability

Understanding future changes that affect vulnerability in the Planning Area can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The Planning Area considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

Any areas of growth could be potentially impacted by the tornado hazard because the entire County is exposed and vulnerable. Residential development, specifically manufactured homes, may be considered more vulnerable to tornadoes. In general, any development that has weak building and/or construction materials that could be impacted by high winds would be highly impacted by tornadoes.

Projected Changes in Population

Fort Bend County experienced an increase in population between the 2010 Census (585,375) and the 2020 Census (822,779). The population of the County is expected to increase over the next few years. The increase in population will expose more people to tornadoes (US Census Bureau 2022).

Climate Change

For all their destructive fury, tornadoes are relatively small and are also very short-lived, lasting from a few seconds to a few hours as opposed to days or weeks at a time. This makes them very difficult to model in the climate simulations that scientists use to project the effects of climate change.

Instead, scientists must attempt to predict how climate change might affect the individual weather "ingredients" that support the development of supercell thunderstorms (the type that produce tornadoes). These weather ingredients are (Geographic n.d.):

- Warm, moist air
- An unstable atmosphere
- Wind at different levels moving in different directions at different speeds, a phenomenon known as wind shear

As global temperatures rise, the hotter atmosphere can hold more moisture. This increases atmospheric instability, a vital supercell ingredient. On the other hand, as the planet warms, wind shear (another vital ingredient) is likely to decrease. These two forces work against each other, and it is difficult to anticipate which might have a greater impact on tornado formation.

There have been changes in tornado patterns in recent years, as it has been recorded that there are fewer days with at least 1 tornado but more days with over 30. The total number of tornadoes per year has remained relatively stable but are becoming more clustered (Geographic n.d.).

Change in Vulnerability Since 2018 HMP

There has been an increase in population within the County. Climate change is producing stronger storms, making tornadoes more probable in 2023 than in 2018 when the previous plan developed.

SECTION 4. RISK ASSESSMENT

4.3 Hazard Profiles

4.3.10 Wildfire

The following section provides the hazard profile and vulnerability assessment for the wildfire hazard in Fort Bend County.

Hazard Profile

Hazard Description

Wildfire is defined as any fire burning wildland vegetation fuels; it includes prescribed fire, wildland fire use, and wildfire. Prescribed fires are planned fires started by land managers to accomplish specific natural resource objectives. Fires that occur from natural causes, such as lightning, that are then used to achieve management purposes under carefully controlled conditions with minimal suppression costs are known as wildland fire use (WFU) (National Park Service n.d.).

Wildfires are unwanted and unplanned fires that result from natural ignition, unauthorized human-caused fire, escaped WFU, or escaped prescribed fire (National Park Service n.d.).

A wildland-urban interface (WUI) fire is a wildfire occurring in the wildland-urban interface. The WUI is described as the area where structures and other human improvements meet and intermingle with undeveloped wildland or vegetative fuels. Population growth within the WUI substantially increases the risk from wildfire.

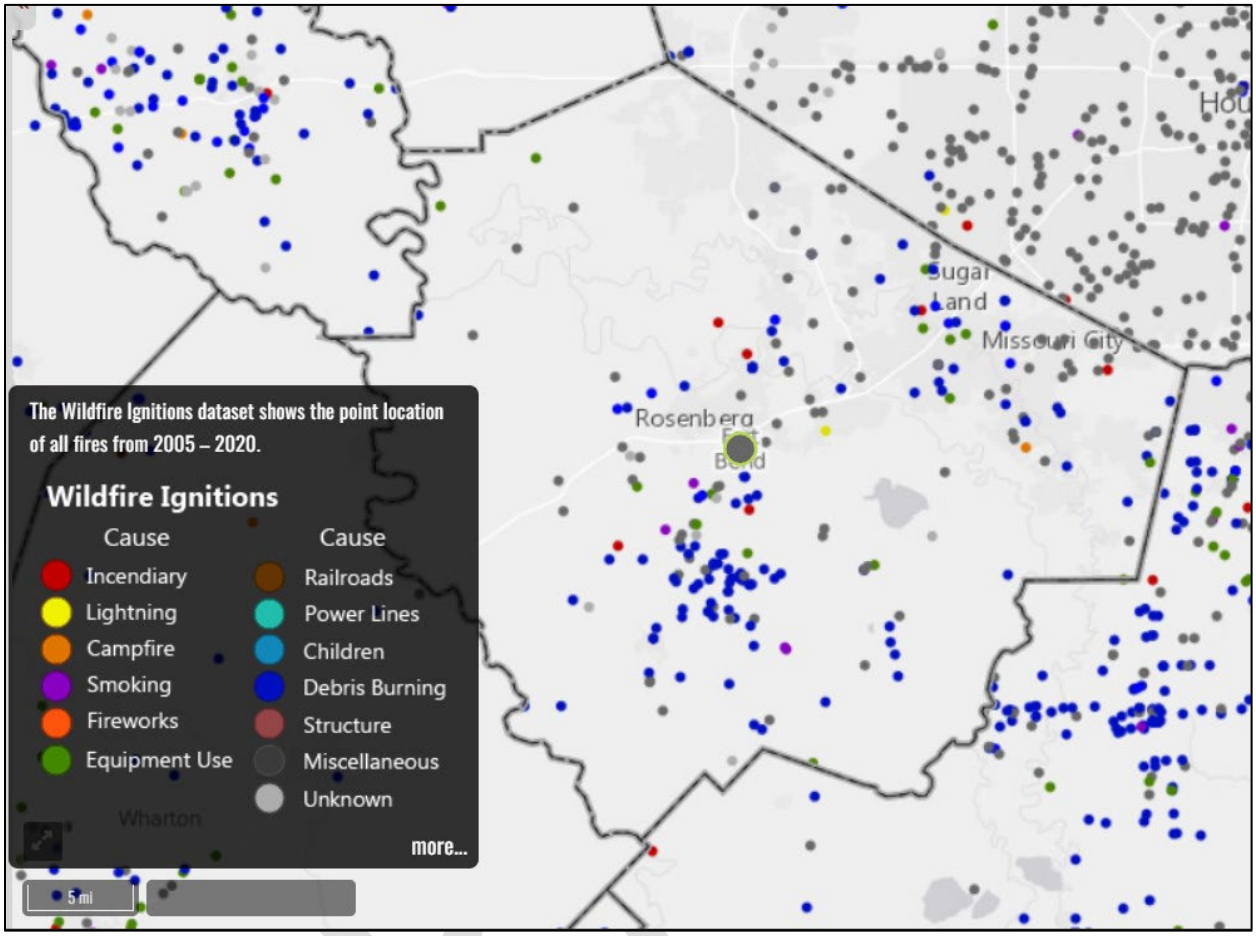
Prescribed burning, also known as controlled burning, is the deliberate use of fire under specified and controlled conditions. Prescribed burning is used by forest management professionals and individual landowners to accomplish one or more of the following tasks:

- Fuel Reduction – The reduction of accumulated grass, weeds, pine needles, and hardwood leaves. This type of vegetation can encourage wildfires in young stands and hinder regeneration of older stands.
- Hardwood Control – Prevents hardwood trees from competing with pines for nutrients and moisture; impeding visibility and access through the stands; and interfering with natural regeneration in areas better suited for growing pines (National Park Service n.d.).

Location

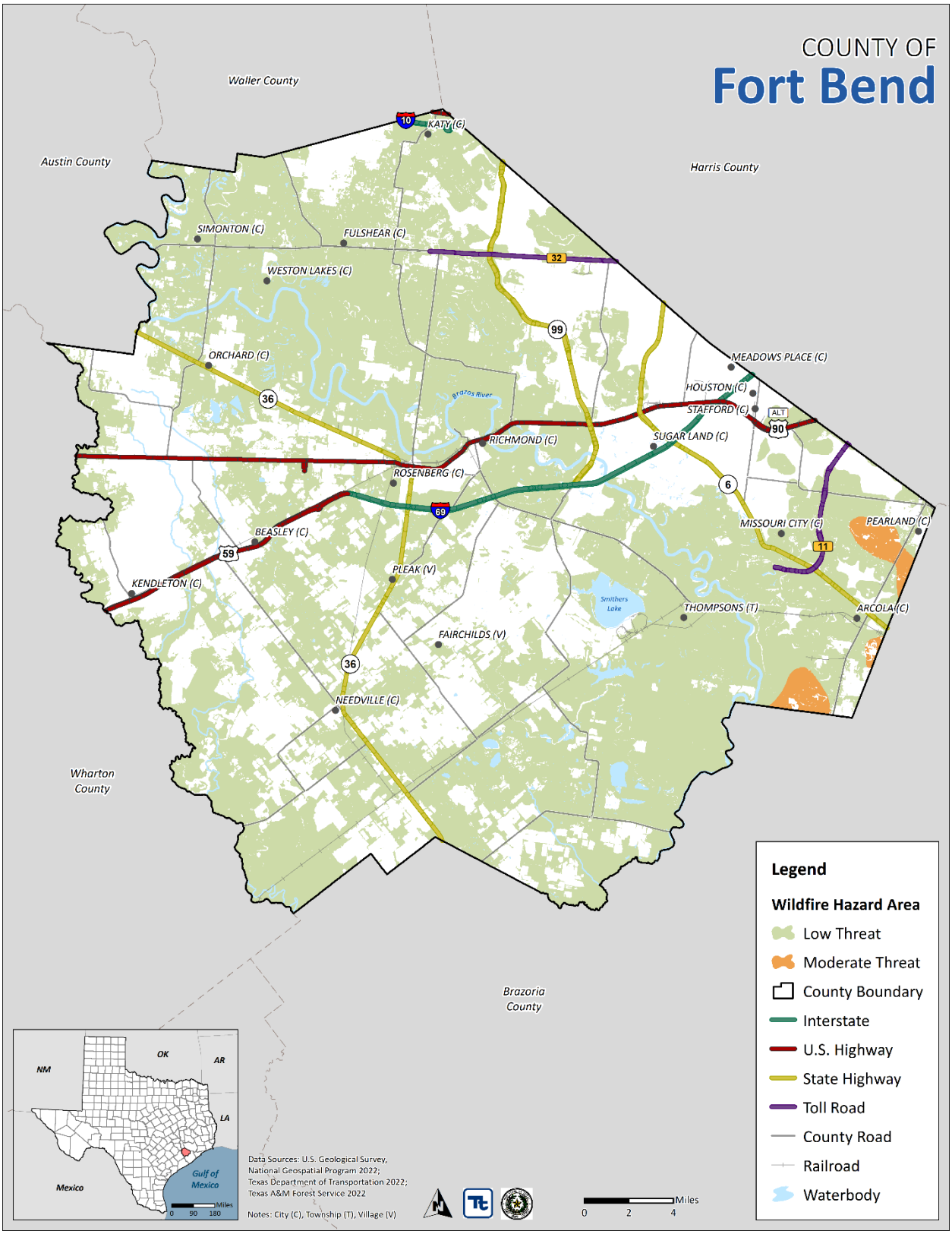
While they are not confined to any specific geographic location and can vary greatly in terms of size, location, intensity, and duration, wildfires are most likely to occur in open grasslands. The threat to people and property is greater in the fringe areas where developed areas meet open grasslands (U.S. Forest Service 2020). See Figure 4.3.10-1 for wildfire ignition locations in Fort Bend County. According to Texas A&M Forest Service, none of those wildfires were considered “large”, which means none of them reached 500 acres (TAMU 2021). Figure 4.3.10-2 shows the location of the low and moderate threat levels for the wildfire hazard in Fort Bend County.

Figure 4.3.10-1. Wildfire Ignition Locations in Fort Bend County, 2005–2020



Source: Texas A&M Forest Service 2022

Figure 4.3.10-2. Location of the Low and Moderate Threat to Wildfires in Fort Bend County

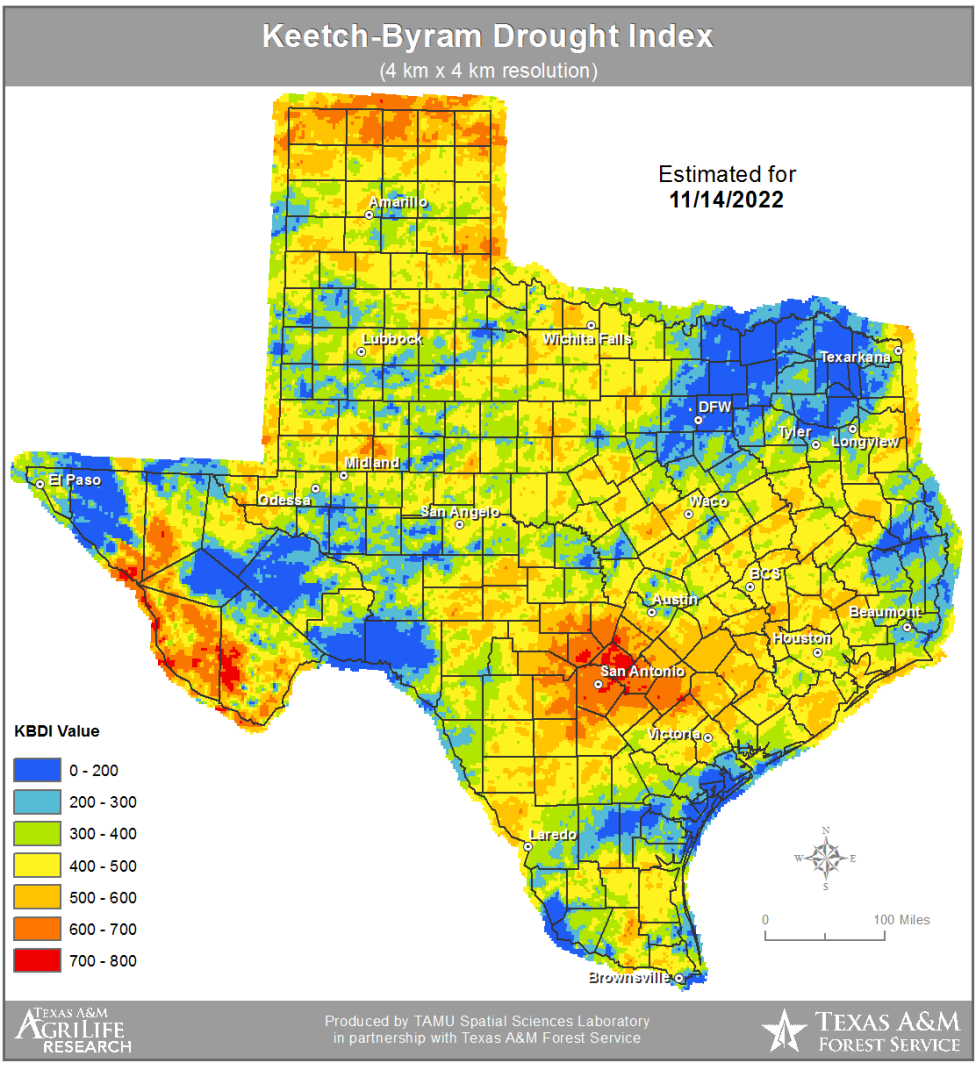


Extent

Fire risk is measured in terms of magnitude and intensity using the Keetch-Byram Drought Index (KBDI), a mathematical system for relating current and recent weather conditions to potential or expected fire behavior. The KBDI determines forest fire potential based on a daily water balance, where a drought factor is balanced with precipitation and soil moisture (assumed to have a maximum storage capacity of eight inches) and is expressed in hundredths of an inch of soil moisture depletion (NOAA NIDIS n.d.).

Each color on the map represents the drought index at that location. The index ranges from zero, the point of no moisture deficiency, to 800, the maximum drought that is possible (NOAA NIDIS n.d.).

Figure 4.3.10-3. Keetch-Byram Drought Index for the State of Texas, November 14, 2022



Source: Texas Weather Connection 2022
Note: The black circle denotes the approximate location of Fort Bend County.

Fire behavior can be categorized at four distinct levels:

- 0-200 – Soil and fuel moisture are high. Most fuels will not readily ignite or burn. However, with sufficient sunlight and wind, cured grasses and some light surface fuels will burn in spots and patches.

- 200-400 – Fires more readily burn and will carry across an area with no gaps. Heavier fuels will still not readily ignite and burn. Expect smoldering and the resulting smoke to carry into and possibly through the night.
- 400-600 – Fire intensity begins to significantly increase. Fires will readily burn in all directions, exposing mineral soils in some locations. Larger fuels may burn or smolder for several days, causing possible smoke and control problems.
- 600-800 – Fires will burn to mineral soil. Stumps will burn to the end of underground roots, and spotting will be a major problem. Fires will burn through the night and heavier fuels will actively burn and contribute to fire intensity (Wildland Fire Assessment System n.d.).

Using the KBDI index is a good measure of the readiness of fuels for wildland fire. Caution should be exercised in dryer, hotter conditions, and the KBDI should be referenced as the area experiences changes in precipitation and soil moisture.

Worst-Case Scenario

A worst-case scenario would involve a wildfire during a high wind event, preceded by prolonged elevated temperatures and drought; however, because historical records are insufficient, it is not possible to use previous records to project-specific damages for a worst-case scenario in the future. Nevertheless, this type of event would have both short- and long-term effects on the planning area. The fire could burn structures and infrastructure, causing power and communication outages. Parts of the planning area could experience limited ingress and egress as transportation corridors are blocked by fire. Air quality would be affected and could pose serious risks for the elderly and those with compromised respiratory systems.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1988 and 2022, Texas had 250 FEMA disaster (DR), emergency (EM), and fire management (FM) declarations for wildfire. Fort Bend County was included in three declarations for wildfire-related events (FEMA 2022). Detailed information about the declared DR and EM disasters since 1954 is provided in Section 3 (County Profile).

Table 4.3.10-1. FEMA Disaster Declarations for Wildfire in Fort Bend County (1954–2022)

Date(s) of Event	Declaration Date	FEMA Declaration Number	Description
August 1, 1999 – December 10, 1999	September 01, 1999	EM-3142-TX	Texas Extreme Fire Hazards
November 27, 2005 – May 14, 2006	January 11, 2006	DR-1624-TX	Texas Extreme Wildfire Threat
May 26, 2006	May 26, 2006	FM-2639-TX	Texas Lake Olympia Fire

Source: FEMA 2022

USDA Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2012 and 2022, Fort Bend County was not included in any wildfire-related agricultural disaster declarations.

Previous Events

For the 2023 HMP update, the number of wildfire events that impacted Fort Bend County between 2017 and 2021 are listed in Table 4.3.10-2; there is currently no available data for 2022. For this HMP update, there was limited information regarding these wildfire events in the planning area.

Table 4.3.10-2. Wildfire Events in Fort Bend County (2017–2021)

Year	Number of Wildfires	Acres Burned
2017	12	305
2018	4	50
2019	12	31
2020	15	28
2021	5	2

Sources: Texas A&M Fire Service 2017; Texas A&M Forest Service 2018; Texas A&M Forest Service 2019; Texas A&M Forest Service 2020; Texas A&M Forest Service 2021

Probability of Future Occurrences

For the 2023 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of wildfire events for the project area. Information from FEMA, USDA, the NOAA-NCEI storm events database, the 2018 State of Texas HMP, the 2018 Fort Bend County HMP, and information from Texas A&M Fire Service were used to identify the number of wildfire events that occurred between 2017 and 2022 (the most reliable dataset available). Table 4.3.10-3 presents the probability of future wildfires in Fort Bend County.

Table 4.3.10-3. Probability of Future Wildfire Events, Fort Bend County

Hazard Type	Number of Occurrences Between 2017 and 2021	% Chance of Occurring in Any Given Year
Wildfire	48	100

Sources: NOAA NCEI 2022; State of Texas 2018; Fort Bend County 2018; Texas A&M Fire Service 2017; Texas A&M Forest Service 2018; Texas A&M Forest Service 2019; Texas A&M Forest Service 2020; Texas A&M Forest Service 2021
Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act and selected events since 1968. Due to limitations in data, not all wildfires occurring between 1954 and 2022 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

In Section 4.4, the identified hazards of concern for Fort Bend County were ranked (Table 4.4-2). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Partnership, the probability of occurrence for wildfire in the County is considered "occasional".

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The entirety of Fort Bend County is exposed and vulnerable to the wildfire hazard; therefore, all assets within the County (population, structures, critical facilities, and lifelines), as described in Section 3 (County Profile), are potentially vulnerable to a wildfire event. The following text evaluates and estimates the potential impact of the wildfire hazard in the County.

Impact on Life, Health, and Safety

Wildfires have the potential to impact human health and life of residents and responders, structures, infrastructure, and natural resources. The most vulnerable populations include emergency responders and those within a short distance of the interface between the built environment and the wildland environment.

First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. Table 4.3.10-4 summarizes the estimated population exposed to the wildfire hazard by municipality.

Based on the analysis, an estimated 351,163 residents, or 43.5 percent of the County's population, are located in the low wildfire hazard areas. An estimated 8,284, or 1 percent of the County's population, reside in the moderate wildfire hazard area. Overall, the Unincorporated Areas of Fort Bend have the greatest number of individuals located in the low wildfire area (170,978); the City of Pearland has the greatest number of individuals located in the moderate wildfire hazard area (6,856).

Table 4.3.10-4. Estimated Population Located Within the WUI

Jurisdiction	Total Population (American Community Survey 2021)	Estimated Population Located Within the Low and Moderate Wildfire Hazard Areas			
		Number of People in the Low Wildfire Hazard Area	Percent of Total	Number of People in the Moderate Wildfire Hazard Area	Percent of Total
Arcola (C)	2,593	1,922	74.1%	0	0.0%
Beasley (C)	957	309	32.3%	0	0.0%
Fairchilds (V)	755	534	70.7%	0	0.0%
Fulshear (C)	17,259	15,769	91.4%	0	0.0%
Houston (C)	41,279	11,690	28.3%	0	0.0%
Katy (C)	21,926	12,149	55.4%	0	0.0%
Kendleton (C)	341	5	1.4%	0	0.0%
Meadows Place (C)	4,755	0	0.0%	0	0.0%
Missouri City (C)	73,682	32,094	43.6%	0	0.0%
Needville (C)	3,059	2,038	66.6%	0	0.0%
Orchard (C)	219	115	52.4%	0	0.0%
Pearland (C)	122,609	55,809	45.5%	6,856	5.6%
Pleak (V)	1,756	1,724	98.2%	0	0.0%
Richmond (C)	11,768	5,783	49.1%	0	0.0%
Rosenberg (C)	37,871	17,022	44.9%	0	0.0%
Simonton (C)	838	812	96.9%	0	0.0%
Stafford (C)	17,170	1,378	8.0%	0	0.0%
Sugarland (C)	110,272	17,708	16.1%	0	0.0%
Thompsons (T)	265	265	100.0%	0	0.0%
Weston Lakes (C)	3,763	3,057	81.2%	0	0.0%
Unincorporated Area	333,360	170,978	51.3%	1,428	0.4%
Fort Bend County (Total)	**806,497**	**351,163**	**43.5%**	**8,284**	**1.0%**

Source: U.S. Census Bureau 2021; Texas A&M Forest Service 2022

Socially Vulnerable Populations

Social vulnerability is defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards.

According to FEMA's National Risk Index, socially vulnerable populations in Fort Bend County have a relatively moderate susceptibility to the adverse impacts of wildfire, when compared to the rest of the United States (FEMA n.d.).

All persons exposed to the wildfire hazard are potentially vulnerable to wildfire impacts. Smoke and air pollution from wildfires can be a severe health hazard, especially for sensitive populations, including children, the elderly, and those with respiratory and cardiovascular diseases. In addition, wildfire may threaten the health and safety of those fighting the fires. First responders are exposed to dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on net economic impacts on their families. The population over age 65 is also more vulnerable because they are more likely to seek or need medical attention that may not be available due to isolation during a wildfire event, and they may have more difficulty evacuating. Refer to the figure below for the social vulnerability index for wildfire.

Figure 4.3.10-4. FEMA Social Vulnerability Index for Wildfire

Source: FEMA NRI

Impact on General Building Stock

All property exposed to the wildfire hazard is vulnerable. Structures that were not constructed to standards designed to protect a building from a wildfire may be especially vulnerable. As of 2008, the International Building Code requires minimum standards be met for new buildings in fire hazard severity zones. It is unknown how many buildings in the County were built to these standards.

Buildings constructed of wood or vinyl siding are generally more likely to be impacted by the fire hazard than buildings constructed of brick or concrete. Table 4.3.10-5 summarizes the estimated building stock inventory located in the low wildfire hazard area by municipality. Approximately 43.4 percent ($98.3 billion) of the

County's building replacement cost value is located in the low wildfire hazard area. The Unincorporated Areas of Fort Bend have the greatest number of buildings located in the low wildfire hazard area (127,325 structures – 51.6 percent of its total) and has the greatest replacement cost value located in the hazard area (approximately $57.3 billion – 55.4 percent of its total). Table 4.3.10-6 summarizes the estimated building stock inventory located in the moderate wildfire hazard area by municipality. Approximately 0.2 percent ($540 million) of the County's building replacement cost value is located in the moderate wildfire hazard area. The Unincorporated Areas of Fort Bend have the greatest number of buildings located in the moderate wildfire hazard area (722 structures – 0.4 percent of its total) and the greatest replacement cost value located in the hazard area (approximately $491 million – 0.5 percent of its total).

Table 4.3.10-5. Building Stock Located within the Low Wildfire Hazard Area

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Located Within the Low Wildfire Hazard Areas			
			Number of Buildings in the Hazard Area	Percent of Total	Total RCV of Buildings	Percent of Total
Arcola (C)	676	$1,374,107,673	518	76.6%	$1,244,478,981	90.6%
Beasley (C)	367	$467,087,536	121	33.0%	$202,057,551	43.3%
Fairchilds (V)	190	$58,400,161	134	70.5%	$44,859,463	76.8%
Fulshear (C)	7,869	$6,124,915,172	7,193	91.4%	$5,525,141,244	90.2%
Houston (C)	11,589	$5,814,576,859	3,276	28.3%	$1,715,142,656	29.5%
Katy (C)	2,206	$4,980,024,025	1,308	59.3%	$4,104,723,486	82.4%
Kendleton (C)	329	$241,970,568	4	1.2%	$798,843	0.3%
Meadows Place (C)	1,676	$1,270,821,734	0	0.0%	$0	0.0%
Missouri City (C)	27,170	$23,213,328,025	11,800	43.4%	$10,865,697,217	46.8%
Needville (C)	1,346	$1,362,324,702	874	64.9%	$759,826,705	55.8%
Orchard (C)	180	$170,795,761	98	54.4%	$130,448,721	76.4%
Pearland (C)	2,171	$1,063,851,539	987	45.5%	$436,470,466	41.0%
Pleak (V)	436	$672,927,271	427	97.9%	$666,909,180	99.1%
Richmond (C)	3,296	$4,128,822,403	1,648	50.0%	$2,538,321,463	61.5%
Rosenberg (C)	11,894	$22,921,973,230	5,293	44.5%	$6,935,493,022	30.3%
Simonton (C)	395	$372,092,732	383	97.0%	$354,422,794	95.3%
Stafford (C)	4,222	$10,638,345,589	357	8.5%	$1,068,838,729	10.0%
Sugar Land (C)	37,506	$36,732,455,899	5,852	15.6%	$3,075,448,799	8.4%
Thompsons (T)	143	$404,590,514	143	100.0%	$404,590,514	100.0%
Weston Lakes (C)	1,589	$1,145,826,270	1,291	81.2%	$914,910,842	79.8%
Unincorporated Area	166,035	$103,633,654,804	85,618	51.6%	$57,373,041,129	55.4%
Fort Bend County (Total)	**281,285**	**$226,792,892,466**	**127,325**	**45.3%**	**$98,361,621,804**	**43.4%**

Source: Fort Bend County 2016, 2022; RS Means 2022; Texas A&M Forest Service 2022

Table 4.3.10-6. Building Stock Located within the Moderate Wildfire Hazard Area

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Located Within the Moderate Wildfire Hazard Areas			
			Number of Buildings in the Hazard Area	Percent of Total	Total RCV of Buildings Located in the Hazard Area	Percent of Total
Arcola (C)	676	$1,374,107,673	0	0.0%	$0	0.0%
Beasley (C)	367	$467,087,536	0	0.0%	$0	0.0%
Fairchilds (V)	190	$58,400,161	0	0.0%	$0	0.0%
Fulshear (C)	7,869	$6,124,915,172	0	0.0%	$0	0.0%
Houston (C)	11,589	$5,814,576,859	0	0.0%	$0	0.0%

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Located Within the Moderate Wildfire Hazard Areas			
			Number of Buildings in the Hazard Area	Percent of Total	Total RCV of Buildings Located in the Hazard Area	Percent of Total
Katy (C)	2,206	$4,980,024,025	0	0.0%	$0	0.0%
Kendleton (C)	329	$241,970,568	0	0.0%	$0	0.0%
Meadows Place (C)	1,676	$1,270,821,734	0	0.0%	$0	0.0%
Missouri City (C)	27,170	$23,213,328,025	0	0.0%	$0	0.0%
Needville (C)	1,346	$1,362,324,702	0	0.0%	$0	0.0%
Orchard (C)	180	$170,795,761	0	0.0%	$0	0.0%
Pearland (C)	2,171	$1,063,851,539	121	5.6%	$48,688,822	4.6%
Pleak (V)	436	$672,927,271	0	0.0%	$0	0.0%
Richmond (C)	3,296	$4,128,822,403	0	0.0%	$0	0.0%
Rosenberg (C)	11,894	$22,921,973,230	0	0.0%	$0	0.0%
Simonton (C)	395	$372,092,732	0	0.0%	$0	0.0%
Stafford (C)	4,222	$10,638,345,589	0	0.0%	$0	0.0%
Sugar Land (C)	37,506	$36,732,455,899	0	0.0%	$0	0.0%
Thompsons (T)	143	$404,590,514	0	0.0%	$0	0.0%
Weston Lakes (C)	1,589	$1,145,826,270	0	0.0%	$0	0.0%
Unincorporated Area	166,035	$103,633,654,804	722	0.4%	$491,621,034	0.5%
Fort Bend County (Total)	**281,285**	**$226,792,892,466**	**843**	**0.3%**	**$540,309,856**	**0.2%**

Source: Fort Bend County 2016, 2022; RS Means 2022; Texas A&M Forest Service 2022

Impact on Critical Facilities

Critical facilities not built to fire protection standards. Utility poles and lines and facilities containing hazardous materials are most vulnerable to the wildfire hazard. Most roads and railroads would not sustain damage except in the worst scenarios, although roads and bridges can be blocked by debris or other wildfire-related conditions and become impassable. If a wildfire reached the following critical facilities, their vulnerability could complicate response and recovery efforts during and following an event:

- **Hazardous Materials and Fuel Storage**—During a wildfire event, these materials could rupture due to excessive heat and act as fuel for the fire, causing rapid spreading and escalating the fire to unmanageable levels. In addition, they could leak into surrounding areas, saturating soils, and seeping into surface waters, and have a disastrous effect on the environment.
- **Communication Facilities**—If these facilities are damaged and become inoperable, it would exacerbate already difficult communication in the planning area.
- **Fire Stations**—If fire stations were compromised during a wildfire event, it would make fire suppression and support services even more challenging.

Table 4.3.10-7 lists the lifelines and number of critical facilities within the low and moderate wildfire hazard areas. Of the 1,652 critical facilities located in the low wildfire hazard area, the greatest number are food, water, and shelter facilities (794). Additionally, there are 14 critical facilities located in the moderate wildfire hazard areas, 8 of which are food, water, and shelter facilities.

Table 4.3.10-7. Critical Facilities and Lifelines Located in the Low and Moderate Wildfire Hazard Areas

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Located in the Low Wildfire Hazard Area	Number of Lifelines Located in the Moderate Wildfire Hazard Area
Communications	44	39	0
Energy	584	239	0
Food, Water, Shelter	1,480	794	8
Hazardous Materials	13	7	0
Health and Medical	335	107	1
Safety and Security	282	112	0
Transportation	660	354	5
Fort Bend County (Total)	**3,398**	**1,652**	**14**

Source: Fort Bend County 2022; Texas A&M Forest Service 2022

As shown in Table 4.3.10-8, the majority of the critical facilities located in the low wildfire hazard area are the Unincorporated Areas of Fort Bend County (1,070) and the City of Rosenburg (186). In the moderate wildfire hazard area, all critical facilities are located in the Unincorporated Areas of Fort Bend County (14).

Table 4.3.10-8. Critical Facilities and Lifelines Located in the Low and Moderate Wildfire Hazard Areas by Jurisdiction

Jurisdiction	Total Critical Facilities Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Located in the Low to Moderate							
			Low Risk				Moderate Risk			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines	Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Arcola (C)	22	21	19	86.4%	18	85.7%	0	0.0%	0	0.0%
Beasley (C)	18	14	10	55.6%	8	57.1%	0	0.0%	0	0.0%
Fairchilds (V)	3	3	2	66.7%	2	66.7%	0	0.0%	0	0.0%
Fulshear (C)	43	40	42	97.7%	39	97.5%	0	0.0%	0	0.0%
Houston (C)	105	84	34	32.4%	32	38.1%	0	0.0%	0	0.0%
Katy (C)	53	51	48	90.6%	46	90.2%	0	0.0%	0	0.0%
Kendleton (C)	21	19	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Meadows Place (C)	17	16	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Missouri City (C)	339	297	113	33.3%	101	34.0%	0	0.0%	0	0.0%
Needville (C)	42	33	26	61.9%	21	63.6%	0	0.0%	0	0.0%
Orchard (C)	7	7	4	57.1%	4	57.1%	0	0.0%	0	0.0%
Pearland (C)	1	1	1	100.0%	1	100.0%	0	0.0%	0	0.0%
Pleak (V)	15	15	13	86.7%	13	86.7%	0	0.0%	0	0.0%
Richmond (C)	123	103	77	62.6%	68	66.0%	0	0.0%	0	0.0%
Rosenberg (C)	340	295	186	54.7%	170	57.6%	0	0.0%	0	0.0%
Simonton (C)	17	17	17	100.0%	17	100.0%	0	0.0%	0	0.0%
Stafford (C)	164	137	22	13.4%	22	16.1%	0	0.0%	0	0.0%
Sugarland (C)	631	575	72	11.4%	70	12.2%	0	0.0%	0	0.0%
Thompsons (T)	10	9	10	100.0%	9	100.0%	0	0.0%	0	0.0%
Weston Lakes (C)	7	7	7	100.0%	7	100.0%	0	0.0%	0	0.0%
Unincorporated Fort Bend County	1,756	1,654	1,070	60.9%	1,004	60.7%	14	0.8%	14	0.8%
Fort Bend County (Total)	**3,734**	**3,398**	**1,773**	**47.5%**	**1,652**	**48.6%**	**14**	**0.4%**	**14**	**0.4%**

Source: Fort Bend County 2022; Texas A&M Forest Service 2022

Impact on Economy

Wildfire events can have major economic impacts on a community from the initial loss of structures and the subsequent loss of revenue from destroyed business and decrease in tourism. Wildfires can cost thousands of taxpayer dollars to suppress and control and can involve hundreds of operating hours on fire apparatus and thousands of volunteer man hours from the volunteer firefighters. There are also many direct and indirect costs to local businesses that excuse volunteers from working to fight these fires.

Impact on Environment

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, affecting the types, structure, and spatial extent of native vegetation. However, it also can cause severe environmental impacts:

- **Damaged Fisheries**—Critical fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality.
- **Soil Erosion**—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats.
- **Spread of Invasive Plant Species**—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes and become difficult and costly to control.
- **Disease and Insect Infestations**—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- **Destroyed Endangered Species Habitat**—Fire can have negative consequences for endangered species.
- **Soil Sterilization**—Some fires burn so hot that they can sterilize the soil. Topsoil exposed to extreme heat can become water-repellant, and soil nutrients may be lost.
- **Reduced Timber Harvesting**—Timber can be destroyed and lead to smaller available timber harvests.
- **Reduced Agricultural Resources**—Wildfire can have disastrous consequences on agricultural resources, removing them from production and necessitating lengthy restoration programs.
- **Damaged Cultural Resources**—Scenic vistas can be damaged, access to recreational areas can be reduced, and destruction of cultural resources may occur (USFS 1994).

Table 4.3.10-9 lists the number of acres exposed to the low and moderate wildfire hazard areas.

Table 4.3.10-9. Land Acreage in Fort Bend County Located in the Low and Moderate Wildfire Hazard Areas

Jurisdiction	Total Acres of Land Area	Total Acres of Land Area (Excluding Waterbodies) Located in the Low and Moderate Wildfire Hazard Areas			
		Total Acres Located in the Low Wildfire Hazard Areas	Percent of Total	Total Acres Located in the Moderate Wildfire Hazard Areas	Percent of Total
Arcola (C)	1,664	1,439	86.5%	2	0.1%
Beasley (C)	673	255	37.8%	0	0.0%
Fairchilds (V)	831	383	46.2%	0	0.0%
Fulshear (C)	7,962	7,477	93.9%	0	0.0%
Houston (C)	7,440	4,242	57.0%	0	0.0%

Jurisdiction	Total Acres of Land Area	Total Acres of Land Area (Excluding Waterbodies) Located in the Low and Moderate Wildfire Hazard Areas			
		Total Acres Located in the Low Wildfire Hazard Areas	Percent of Total	Total Acres Located in the Moderate Wildfire Hazard Areas	Percent of Total
Katy (C)	2,843	2,311	81.3%	0	0.0%
Kendleton (C)	850	10	1.2%	0	0.0%
Meadows Place (C)	586	0	0.0%	0	0.0%
Missouri City (C)	20,841	12,730	61.1%	212	1.0%
Needville (C)	1,264	810	64.1%	0	0.0%
Orchard (C)	250	145	57.8%	0	0.0%
Pearland (C)	839	412	49.2%	32	3.8%
Pleak (V)	1,193	1,093	91.6%	0	0.0%
Richmond (C)	2,752	1,721	62.5%	0	0.0%
Rosenberg (C)	23,442	13,875	59.2%	0	0.0%
Simonton (C)	1,487	1,455	97.8%	0	0.0%
Stafford (C)	4,467	534	11.9%	0	0.0%
Sugarland (C)	27,073	5,927	21.9%	0	0.0%
Thompsons (T)	995	993	99.8%	0	0.0%
Weston Lakes (C)	1,623	1,350	83.2%	0	0.0%
Unincorporated Area	449,862	275,964	61.3%	4,673	1.0%
Fort Bend County (Total)	**558,937**	**333,126**	**59.6%**	**4,919**	**0.9%**

Source: Fort Bend County 2022; Texas A&M Forest Service 2022

Future Changes That May Impact Vulnerability

Understanding future changes that affect vulnerability in Fort Bend County can assist in planning for future development and ensure the establishment of appropriate mitigation, planning, and preparedness measures. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

As a highly urbanized planning area, wildfire risk exposure is low. Urbanization tends to alter the natural fire regime and can create the potential for the expansion of urbanized areas into wildland areas. The expansion of development toward wildfire hazard areas can be managed with strong land use and building codes. The International Building Code includes minimum standards related to the design and construction of buildings in fire hazard zones. The planning area is well equipped with these tools, and this planning process has assessed capabilities with regard to the tools. As the planning area experiences future growth, it is anticipated that the exposure to this hazard will remain as assessed or even decrease over time due to these capabilities.

Projected Changes in Population

The County experienced an increase in population between the 2010 Census (585,375) and the estimated 2016–2020 American Community Survey estimated population of 790,892. The population of the County is

expected to increase over the next few years. The increase in population will expose more people to the wildfire hazard.

Climate Change

Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. Changes in climate patterns may impact the distribution and perseverance of insect outbreaks that create dead trees (increase fuel). When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain and are more likely to expand into residential neighborhoods.

Change in Vulnerability Since 2018 HMP

For the 2023 Hazard Mitigation Plan (HMP) update, the Wildfire Threat Hazard Area from the Texas A&M Forest Service 2022 was referenced to determine areas within Fort Bend County that are vulnerable to wildfires. Population statistics have also been updated using the 2021 United States Census Population Estimates. Overall, this vulnerability assessment uses a more accurate and updated building inventory, which provides more accurate estimated exposure and potential losses for the County.

SECTION 4. RISK ASSESSMENT

4.3 Hazard Profiles

4.3.11 Winter Weather

The following section provides the hazard profile and vulnerability assessment for the winter weather hazard in Fort Bend County.

Hazard Profile

Hazard Description

Severe winter weather brings the threat of snow, freezing rain, and ice storms to Fort Bend County. Winter weather involves weather events in which the main types of precipitation are snow, sleet, or freezing rain. They can be a combination of heavy snow, blowing snow, and dangerous wind chills. According to the National Severe Storms Laboratory, the three basic components needed to make a winter weather include the following:

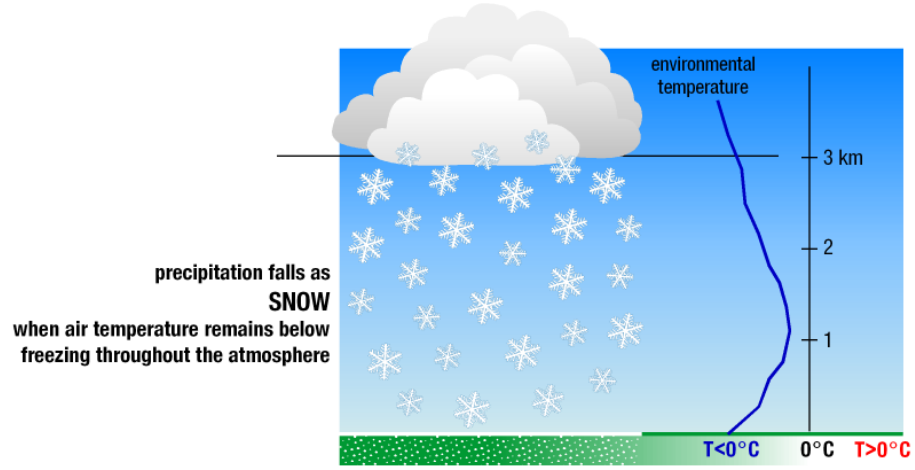
- Below-freezing temperatures (cold air) in the clouds and near the ground to make snow and ice
- Lift to raise the moist air to form clouds and cause precipitation, such as warm air colliding with cold air and being forced to rise over the cold dome or air flowing up a mountainside (oliographic lifting)
- Moisture to form clouds and precipitation, such as air blowing across a large lake or the ocean (NSSL n.d.)

Winter weather might immobilize an entire region or only affect a single community. Winter weather typically is accompanied by low temperatures, high winds, freezing rain or sleet, and heavy snowfall. The aftermath of winter weather can have an impact on a community or region for days, weeks, or even months, potentially causing cold temperatures, flooding, storm surge, closed and blocked roadways, downed utility lines, and power outages. In Fort Bend County, winter weather includes snowstorms, blizzards, and ice storms. Extreme cold temperatures and wind chills are associated with winter weather; however, they are discussed in Section 4.3.3 (Extreme Temperature).

Heavy Snow

According to the National Snow and Ice Data Center (NSIDC), snow is precipitation in the form of ice crystals. It originates in clouds when temperatures are below the freezing point (32°F) and water vapor in the atmosphere condenses directly into ice without going through the liquid stage. Once an ice crystal has formed, it absorbs and freezes additional water vapor from the surrounding air, growing into snow crystals or snow pellet, which then falls to the earth. Snow falls in different forms: snowflakes, snow pellets, or sleet. Snowflakes are clusters of ice crystals that form from a cloud. Figure 4.3.11-1 depicts snow creation.

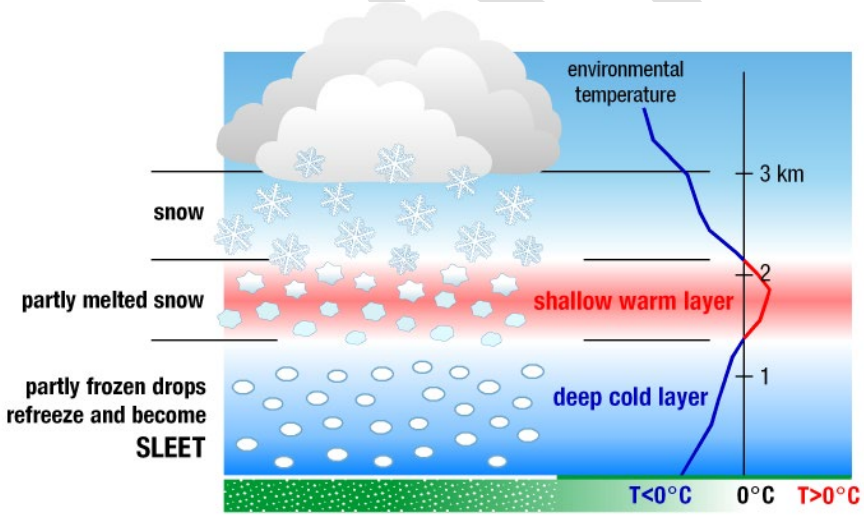
Figure 4.3.11-1. Snow Creation



Source: NOAA NSSL n.d.

Snow pellets are opaque ice particles in the atmosphere. They form as ice crystals fall through super-cooled cloud droplets, which are below freezing but remain a liquid. The cloud droplets then freeze to the crystals. Sleet is made up of drops of rain that freeze into ice as they fall through colder air layers. They are usually smaller than 0.30 inches in diameter (NSIDC 2020).

Figure 4.3.11-2. Sleet Creation



Source: NOAA NSSL n.d.

Blizzards

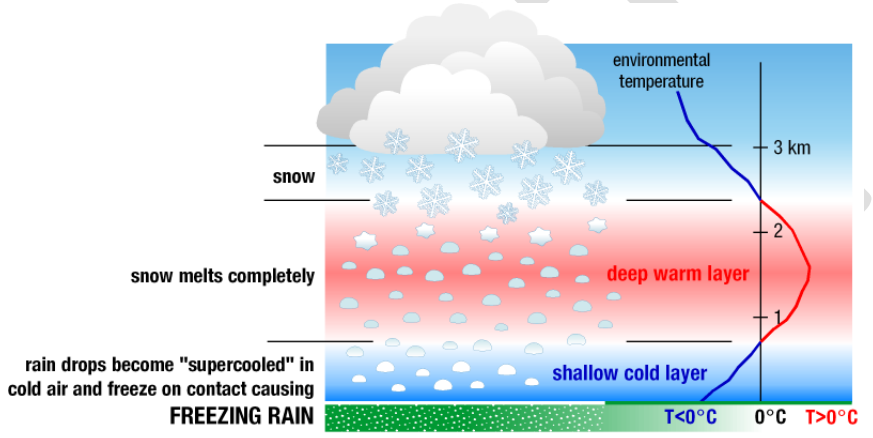
A blizzard is a winter snowstorm with sustained or frequent wind gusts of 35 miles per hour (mph) or more, accompanied by falling or blowing snow reducing visibility to or below 0.25 mile, as the predominant conditions over a 3-hour period. Extremely cold temperatures often are associated with blizzard conditions but are not a formal part of the definition. The hazard, created by the combination of snow, wind, and low visibility, significantly increases when temperatures are below 20°F. A severe blizzard is categorized as having temperatures near or below 10°F, winds exceeding 45 mph, and visibility reduced by snow to near zero. Storm systems powerful enough to cause blizzards usually form when the jet stream dips far to the south, allowing

cold air from the north to clash with warm, moister air from the south. Blizzard conditions often develop on the northwest side of an intense storm system. The difference between the lower pressure in the storm and the higher pressure to the west creates a tight pressure gradient, resulting in strong winds and extreme conditions caused by the blowing snow (NWS n.d.).

Ice Storms

An ice storm describes those events when damaging accumulations of ice are expected during freezing rain situations. Significant ice accumulations typically are accumulations of 0.25 inches or greater. Heavy accumulations of ice can bring down trees, power lines, utility poles, and communication towers. Ice can disrupt communications and power for days. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians (NWS 2018).

Figure 4.3.11-3. Freezing Rain Creation



Source: NOAA NSSL n.d.

Location

Winter weather occurs on a regional scale and can happen anywhere in the State of Texas; therefore, all of Fort Bend County can experience winter weather events.

Extent

The magnitude or severity of severe winter weather depends on several factors, including a region's climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, time of occurrence during the day and week (e.g., weekday versus weekend), and time of season.

The extent of severe winter weather can be classified by meteorological measurements and by evaluating its societal impacts. The National Oceanic and Atmospheric Administration's (NOAA's) National Climatic Data Center (NCDC) is currently producing the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from 1 to 5 and is based on the spatial extent of the storm, the amount of snowfall, and the interaction of the extent and snowfall totals with population (based on the 2000 Census). The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA NCEI n.d.). Table 4.3.11-1 presents the five RSI ranking categories.

Table 4.3.11-1. RSI Ranking Categories for the South Climate Region

Category	Description	RSI Value	Snowfall Thresholds
1	Notable	1–3	<2
2	Significant	3–6	>2
3	Major	6–10	>5
4	Crippling	10–18	>10
5	Extreme	18.0+	>15

Source: NOAA NCEI n.d.
Note: RSI = Regional Snowfall Index

The NWS operates a widespread network of observing systems, such as geostationary satellites, Doppler radars, and automated surface observing systems that feed into the current state-of-the-art numerical computer models to provide a look into what will happen next, ranging from hours to days. The models are then analyzed by NWS meteorologists, who then write and disseminate forecasts (NOAA 2017).

According to the National Weather Service (part of NOAA), the magnitude of winter weather can be qualified into five main categories by event type:

- Heavy Snowstorm – Snowfall accumulating to 4 inches or more in 12 hours or less or snowfall accumulating to 6 inches or more in 24 hours or less.
- Sleet Storm – Significant accumulations of solid pellets that form from the freezing of raindrops or partially melted snowflakes, causing slippery surfaces and posing a hazard to pedestrians and motorists.
- Ice Storm – Significant accumulation of rain or drizzle freezing on objects (trees, power lines, roadways) as it strikes them, causing slippery surfaces and damage from sheer weight of ice accumulations; significant ice accumulations are usually ¼" or greater.
- Blizzard – Sustained winds or frequent gusts of 35 mph or more; considerable blowing snow with visibility frequently below one-quarter mile prevailing over an extended period.
- Severe Blizzard – Wind velocity of 45 mph, temperatures of 10°F or lower, a high density of blowing snow with visibility frequently measured in feet prevailing over an extended period (NWS n.d.).

The NWS uses winter weather watches, warnings, and advisories to ensure that people know what to expect in the coming hours and days.

- Watches
  - Blizzard – Conditions are favorable for blizzard conditions to be met in the next 12 to 48 hours.
  - Winter Weather - Issued when sinter storm conditions, defined above, are possible within 24 to 48 hours.
- Warnings
  - Blizzard – Issued when sustained winds or frequent gusts ≥ 35 mph combined with blowing and or falling snow, reducing visibility below 1/4 mile for 3 hours or more, when imminent or expected within the next 36 hours. Temperatures are assumed below 32°F, and snow should accumulate at least one inch in 12 hours.
  - Winter Weather - Issued when the following conditions, capable of producing high impact and potentially life-threatening conditions, are occurring or expected to occur within the 36 hours: snow - ≥1 inch in 12 hours; sleet - ≥1/2 inch in 12 hours; and or a combination of snow, sleet, ice with snow or sleet meeting warning criteria.

  - Ice Storm – Issued when ≥1/8 inch of ice is expected to accrete on trees, power lines, and bridges/overpasses for the entirety of the event. These conditions are capable of producing high-impact and potentially life-threatening conditions and are either occurring or expected to occur within the next 36 hours.
- Advisories
  - Winter Weather – Issued when the following conditions, capable of producing significant, but not necessarily life-threatening, inconveniences, are occurring or expected to occur within the next 36 hours:
    - Snow: 1/2 to 1 inch in 12 hours
    - Sleet: < 1/2 inch in 12 hours
    - Ice: < 1/8 inch in 12 hours
    - Combination: Snow, sleet, and ice with snow or sleet meeting advisory criteria (NWS n.d.).

Worst-Case Scenario

Overall, the maximum winter weather extent that can be expected in Fort Bend County is an RSI Category 3 snowfall event. Because the County is located in the National Centers for Environmental Information's south climate region, the amount of snow that can fall for this category event is up to 10 inches; however, the area will most likely see lower amounts of snow based on history of occurrence. A winter weather of that magnitude has the potential to cause between $16–$166 billion in property damage countywide.

A worst-case winter weather scenario would be a storm similar to the February 2021 ice storm that brought extreme temperature lows, deaths and injuries, and significant ice buildup on structures and infrastructure, including highway overpasses. A storm like this could lead to downed trees and power lines, power outages, closed roadways, and overall impact to the Planning Area. This would lead to disruption in emergency services and limited access to essentials (e.g., water, heat).

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1953 and 2022, FEMA included the State of Texas in six winter weather-related disaster declarations. Generally, these disasters cover a wide region of the state; therefore, they may have impacted many counties. Fort Bend County was included in two winter weather-related declarations for the same event in February 2021 (FEMA 2022). For events prior to 2017, refer to the 2018 Fort Bend County Hazard Mitigation Plan (HMP).

Table 4.3.11-2. FEMA Disaster Declarations for Winter Weather in Fort Bend County (1954–2022)

Date(s) of Event	Declaration Date	FEMA Declaration Number	Description
February 11-21, 2021	February 19, 2021	4586-DR-TX	Texas Severe Winter Storms
February 11-21, 2021	February 19, 2021	3554-EM-TX	Texas Severe Winter Storm

Source: FEMA 2022

USDA Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in

counties that are contiguous to a designated county. Between 2017 and 2022, there were no USDA disaster declarations related to winter weather events (USDA FSA 2022).

Previous Events

For this 2023 HMP update, known winter weather events that impacted the County between 2017 and 2022 are discussed below.

Table 4.3.11-3. Winter Weather Events in Fort Bend County (2017–2022)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend County included in Declaration?	Description
December 7-8, 2017	Heavy Snow	N/A	N/A	The forcing of an approaching upper trough and jet streak allowed precipitation falling through a deep enough sub-freezing lower layer to turn to snow. The heaviest snow fell across the northwestern CWA on the evening of the 7th, with measurable snow across the central and southern forecast area occurring during the early morning hours of the 8th. 1 to 2 inches of snow was measured across the eastern side of Fort Bend County.
February 11-21, 2021	Ice Storm	4586-DR-TX, 3554-EM-TX	Yes	Very cold air and gusty winds overspread SE Texas behind an Arctic front with wind chill indices from near zero to single digits for much of the period from Sunday night to Tuesday morning. Increased power demand, wind, and ice led to widespread power outages. Bursting pipes caused many to be without water as well. Numerous fatalities resulted from hypothermia, carbon monoxide poisoning, and other effects.
February 3-4, 2022	Winter Weather	N/A	N/A	A period of freezing rain fell over areas mainly north and west of Houston, producing an icy glaze and numerous car accidents. Portions of US90, I69 SH99 and I10 closed due to ice. A 10-car accident was reported near Westpark Tollway and FM1464. A 12-car accident was reported along SH59.
January 20, 2017	Flash Flood	N/A	N/A	Slow-moving showers and thunderstorms produced hail and flash flooding in the afternoon through early evening hours. There were several road closures in and around the Rosenberg area. No damages to property or crops were recorded.

Sources: FEMA 2022; NOAA-NCEI 2022

** Many sources were consulted to provide an update of previous occurrences and losses; event details and loss/impact information may vary and has been summarized in the above table*

Probability of Future Occurrences

For the 2022 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of winter weather events of all types for Fort Bend County. Figure 4.3.11-4 summarizes data regarding the probability of occurrences of winter weather events in the County based on the historic record. The information used to calculate the probability of occurrences is based on NOAA-NCEI storm events and FEMA database results.

Table 4.3.11-4. Probability of Future Occurrence of Severe Winter Weather Events in Fort Bend County

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurrence in Any Given Year
Blizzard	0	0%
Heavy Snow	2	2.74%
Ice Storm	3	4.17%
Sleet	0	0%
Winter weather	3	4.17%

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurrence in Any Given Year
Winter Weather	1	1.39%
Total	**9**	**12.33%**

Source: *NOAA-NCEI 2022, FEMA 2022*

Note: *Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act and selected winter weather events since 1968. Due to limitations in data, not all severe winter weather events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.*

Based on the number of winter weather events, the County averages less than one winter weather event each year. A winter weather event has a 12.33-percent chance of occurring in any given year. Based on the history of events and input from the Planning Partnership, the probability of winter weather events occurring in Fort Bend County is considered "rare". Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

Climate Change Projections

Changes in climate can affect how much snow falls and influence the timing of the winter snow season. Changes in the amount of snow covering the ground and changes in how the snow melts in the spring, will affect the water supplies that people use for things like farming and making electricity (NSIDC 2010). With these projections, the County might not experience an increase in winter weather events, but the lack of snow could impact the water supply.

According to the National Climate Assessment, rising air and water temperatures and changes in precipitation are intensifying droughts, increasing heavy downpours, reducing snowpack, and causing declines in surface water quality, with varying impacts across regions. Future warming will add to the stress on water supplies and adversely impact the availability of water in parts of the United States (USGCRP 2018).

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The entirety of Fort Bend County is exposed and vulnerable to the winter weather hazard; therefore, all assets within the County (population, structures, critical facilities, and lifelines), as described in Section 3 (County Profile), are potentially vulnerable to a winter weather event. The following text evaluates and estimates the potential impact of the winter weather hazard in the County.

Impact on Life, Health, and Safety

For the purposes of this HMP, the entire population of the County (806,497) is exposed to winter weather events (According to the 2021 U.S. Census Population Estimate). Winter weather can immobilize a region and paralyze a community. Additional impacts include stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow can collapse buildings and knock down trees and power lines. The cost of snow removal, repairing damages, and loss of business can have large economic impacts on cities and towns (NOAA NSSL n.d.).

Socially Vulnerable Populations

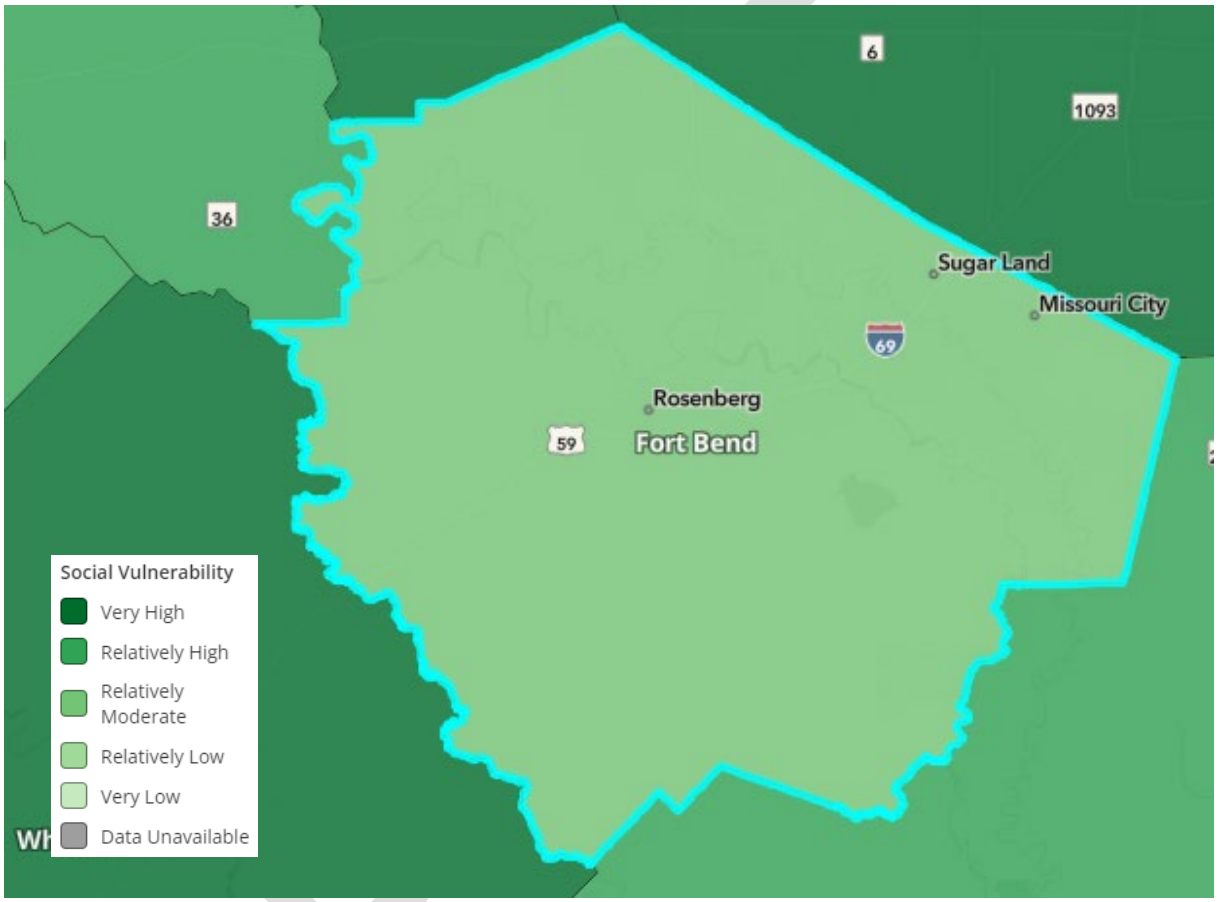
Social vulnerability is defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic,

According to FEMA's National Risk Index, socially vulnerable populations in Fort Bend County have a relatively moderate susceptibility to the adverse impacts of winter weather, when compared to the rest of the United States (FEMA n.d.).

demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards.

The homeless and elderly are considered most susceptible to this hazard; the homeless due to their lack of shelter and the elderly due to their increased risk of injuries and death from falls and overexertion or hypothermia from attempts to clear snow and ice. According to the 2021 U.S. Census Population Estimate, 11.3 percent of the population in Fort Bend County is 65 and over. Winter weather events can reduce the ability of these populations to access emergency services. Refer to Figure 4.3.11-4 for the social vulnerability index for wildfire.

Figure 4.3.11-4. FEMA Social Vulnerability Index for Winter Weather



Source: FEMA NRI

Impact on General Building Stock

The entire general building stock inventory in Fort Bend County (281,285 buildings, replacement cost value of $226.8 billion) is exposed and potentially vulnerable to the winter weather hazard; however, properties in poor condition or in particularly vulnerable locations may be at risk to the most damage. In general, structural impacts include damage to roofs and building frames rather than building content. Current modeling tools are not available to estimate specific losses for this hazard.

Impact on Critical Facilities

Full functionality of critical facilities, such as police, fire, and medical facilities, is essential for response during and after a winter weather event. These critical facility structures are largely constructed of concrete and masonry; therefore, they should only suffer minimal structural damage from winter weather events. Heavy accumulations of ice can bring down trees, electrical wires, telephone poles, utility lines, and communication towers. Communications and power can be disrupted for days while utility companies work to repair the extensive damage. Even small accumulations of ice can cause extreme hazards to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces (NSSL 2006). Winter weather events, such as ice storms, can lead to power outages. Therefore, it is recommended that critical facilities install backup power sources.

Infrastructure at risk for this hazard includes roadways that could be damaged due to salt application and intermittent freezing and warming conditions that can damage roads over time. Severe snowfall requires the clearing roadways and alerting citizens to dangerous conditions; following the winter season, resources for road maintenance and repair might be required.

Impact on Economy

The cost of snow and ice removal and repair of roads from the freeze/thaw process can drain local financial resources. Impacts on the economy also include commuter difficulties into or out of the area for work or school. The loss of power and closure of roads prevent commuters within the County.

Impact on Environment

As snow and ice accumulate, it becomes contaminated with salt, litter, dirt, and other pollutants. During the spring thaw, these pollutants wash away and can contaminate local waterways and ecological systems.

Future Changes That May Impact Vulnerability

Understanding future changes that affect vulnerability in the Planning Area can assist in planning for future development and ensure the establishment of appropriate mitigation, planning, and preparedness measures. The Planning Area considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

Any areas of growth could be potentially impacted by the severe winter weather hazard because the entire County is exposed and vulnerable. The ability of new development to withstand winter weather impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction.

Projected Changes in Population

The County has experienced an increase in population between the 2010 Census (585,375) and the estimated 2016–2020 American Community Survey estimated population of 790,892. The population of the County is expected to increase over the next few years. With an increase in population, more people will be exposed to winter weather events. Additionally, the age of the population, changes in their geography, and how climate

change could alter the winter weather received (rain versus snow) will be important to continue to assess future changes in vulnerability.

Climate Change

Climate is defined not only by average temperature and precipitation but also by type, frequency, and intensity of weather events. Both globally and at the local level, climate change can potentially alter the prevalence and severity of weather extremes, such as winter weather. While predicting changes in winter weather events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment (U.S. EPA 2006). Based on the projections, the County can expect to experience more rain than snow during the winter months. In the immediate future, Fort Bend County can anticipate continuing to experience the impacts of winter weather events.

Change in Vulnerability Since 2018 HMP

Fort Bend County's population increased since the last HMP, increasing the number of people impacted during a winter weather event. Therefore, the entire County remains vulnerable to winter weather events.

SECTION 4. RISK ASSESSMENT

4.4 Hazard Ranking

A comprehensive range of hazards that pose a significant risk to Fort Bend County were selected and considered during the development of this plan; see Section 4.2 (Identification of Hazards of Concern). However, each community has differing levels of exposure and vulnerability to each of these hazards. It is important for each community participating in this plan to recognize those hazards that pose the greatest risk to their community and direct their attention and resources accordingly to most effectively and efficiently manage risk and reduce losses. The hazard ranking for the Planning Area can be found in their jurisdictional annexes in Volume II, Section 9 (Annexes) of this plan.

To this end, a hazard risk ranking process was conducted for the Planning Area using the method described below. This method includes four risk assessment categories: probability of occurrence, impact (population, property, and economy), adaptive capacity, and changing future conditions (i.e., climate change). Each was assigned a weighting factor to calculate an overall ranking value for each hazard of concern. Depending on the calculation, each hazard was assigned a high, medium, or low ranking. Details regarding each of these categories are described below.

4.4.1 Hazard Ranking Methodology

Estimates of hazard risk for Fort Bend were developed using methodologies promoted by the Federal Emergency Management Agency's (FEMA) hazard mitigation planning guidance, generated by FEMA's Hazus risk assessment tool, and with input from Fort Bend County and participating jurisdictions.

As described in Section 4.1 (Methodology and Tools), three different levels of analysis were used to estimate potential impacts: (1) historic loss/qualitative analysis, (2) exposure analysis, and (3) loss estimation. All three levels of analysis are suitable for planning purposes; however, with any risk analysis, there is underlying uncertainty resulting from assumptions used to describe and assess vulnerability and the methodologies available to model impacts. Impacts from any hazard event within the County will vary from the analysis presented here based on the factors described for each hazard of concern, namely location, extent, warning time, and mitigation measures in place at the time of an event.

For some hazards of concern, the hazard ranking methodology is based on a scenario event; for others, the hazard ranking methodology is based on potential risk to the Planning Area as a whole. To account for these differences, the quantitative hazard ranking methodology was adjusted using professional judgment and subject matter input; assumptions are included, as appropriate, in the following subsections. The limitations of this analysis are recognized, given that the scenarios do not have the same likelihood of occurrence; nonetheless, there is value in summarizing and comparing the hazards using a standardized approach to evaluate relative risk. The following categories were considered when evaluating the relative risk of the hazards of concern.

- **Probability of Occurrence**—The probability of occurrence of the scenario evaluated was estimated by examining the historic record and/or calculating the likelihood of annual occurrence. When no scenario was assessed, an examination of the historic record and judgment was used to estimate the probability of occurrence of an event that will impact the County.
- **Impact**—The following three hazard impact subcategories were considered: impact to people; impact to buildings; and impact to the economy. The results of the updated risk assessment and/or professional

judgment were used to assign the numeric values for these three impact subcategories. A factor was applied to each subcategory, giving impact on population the greatest weight.

- Population—Numeric value x 3
- Buildings—Numeric value x 2
- Economy—Numeric value x 1

- **Adaptive Capacity**—Adaptive capacity describes a jurisdiction's current ability to protect from or withstand a hazard event. This includes capabilities and capacity in the following areas: administrative, technical, planning/regulatory, and financial. Mitigation measures already in place increase a jurisdiction's capacity to withstand and rebound from events (e.g., codes/ordinances with higher standards to withstand hazards due to design or location, deployable resources, or plans and procedures in place to respond to an event). In other words, assigning "weak" for adaptive capacity means the jurisdiction does not have the capability to effectively respond, which increases vulnerability, whereas "strong" adaptive capacity means the jurisdiction does have the capability to effectively respond, which decreases vulnerability. These ratings were assigned using the results of the core capability assessment with subject-matter input from each jurisdiction.
- **Climate Change (Changing Future Conditions)**—Current climate change projections were considered as part of the hazard ranking to ensure the potential for an increase in severity/frequency of the hazard was included. This was important to the Planning Area to include because the hazard ranking helps guide and prioritize the mitigation strategy development, which should have a long-term future vision to mitigate the hazards of concern. The potential impacts climate change may have on each hazard of concern is discussed in Sections 4.3.1 through 4.3.11. The benchmark values in the methodology are similar to the confidence levels outlined in the National Climate Assessment 2017.

Hazard Ranking Equation

[Probability of Occurrence x 0.3] + [(Impact on Population x 3) + (Impact on Property x 2) + (Impact on Economy x 1) x 0.3] + [Adaptive Capacity x 0.3] + [Climate Change x 0.1]

Table 4.4-1 summarizes the categories, benchmark values, and weights used to calculate the risk factor for each hazard. Using the weighting applied, the highest possible risk factor value is 6.9. The higher the number, the greater the relative risk. Based on the total for each hazard, a priority ranking is assigned to each hazard of concern (high, medium, or low). The rankings were categorized as follows: Low = Values less than 3.9; Medium = Values between 3.9 and 4.9; High = Values greater than 4.9.

Table 4.4-1. Summary of Hazard Ranking Approach

Category		Level / Category	Degree of Risk / Benchmark Value	Numeric Value	Weighted Value
Probability of Occurrence		Unlikely	A hazard event is not likely to occur or is unlikely to occur with less than a 1% annual chance probability.	0	30%
		Rare	Between 1% and 10% annual probability of a hazard event occurring.	1	
		Occasional	Between 10% and 100% annual probability of a hazard event occurring.	2	
		Frequent	100% annual probability; a hazard event may occur multiple times per year.	3	
Impact (Sum of all 3)	Population (Numeric Value x 3)	Low	14% or less of your population is exposed to a hazard with potential for measurable life safety impact due to its extent and location.	1	30%
		Medium	15% to 29% of your population is exposed to a hazard with potential for measurable life safety impact due to its extent and location.	2	

Category		Level / Category	Degree of Risk / Benchmark Value	Numeric Value	Weighted Value
		High	30% or more of your population is exposed to a hazard with potential for measurable life safety impact due to its extent and location.	3	
	Property (Numeric Value x 2)	Low	Property exposure is 14% or less of the total number of structures for your community.	1	
		Medium	Property exposure is 15% to 29% of the total number of structures for your community.	2	
		High	Property exposure is 30% or more of the total number of structures for your community.	3	
	Economy (Numeric Value x 1)	Low	Loss estimate is 9% or less of the total replacement cost for your community.	1	
		Medium	Loss estimate is 10% to 19% of the total replacement cost for your community.	2	
		High	Loss estimate is 20% or more of the total replacement cost for your community.	3	
Adaptive Capacity		Weak	Weak/outdated/inconsistent plans, policies, codes/ordinances in place; no redundancies; limited to no deployable resources; limited capabilities to respond; long recovery.	1	30%
		Moderate	Plans, policies, codes/ordinances in place and meet minimum requirements; mitigation strategies identified but not implemented on a widespread scale; county/jurisdiction can recover but needs outside resources; moderate county/jurisdiction capabilities.	0	
		Strong	Plans, policies, codes/ordinances in place and exceed minimum requirements; mitigation/protective measures in place; county/jurisdiction has the ability to recover quickly because resources are readily available, and capabilities are high.	-1	
Climate Change		Low	No local data is available; modeling projections are uncertain on whether there is increased future risk; confidence level is low (inconclusive evidence).	1	10%
		Medium	Studies and modeling projections indicate a potential for exacerbated conditions due to climate change; confidence level is medium to high (suggestive to moderate evidence).	2	
		High	Studies and modeling projections indicate exacerbated conditions/increased future risk due to climate change; very high confidence level (strong evidence, well documented and acceptable methods).	3	

Note: A numerical value of zero is assigned if there is no impact.

**For the purposes of this exercise, "impacted" means exposed for population and property and estimated loss for economy. For non-natural hazards, although they may occur anywhere in the Planning Area, an event will not likely cause countywide impacts; therefore, impact to population was scored using an event-specific scenario.*

To summarize the confidence level regarding the input utilized to populate the hazard ranking, a gradient of certainty was developed. A certainty factor of high, medium, or low was selected and assigned to each hazard to provide a level of transparency and increased understanding of the data utilized to support the resulting ranking. The following scale was used to assign a certainty factor to each hazard:

- High—Defined scenario/event to evaluate; probability calculated; evidenced-based/quantitative assessment to estimate potential impacts through hazard modeling.
- Moderate—Defined scenario/event or only a hazard area to evaluate; estimated probability; combination of quantitative (exposure analysis, no hazard modeling) and qualitative data to estimate potential impacts.
- Low—Scenario or hazard area is undefined; there is a degree of uncertainty regarding event probability; majority of potential impacts are qualitative.

4.4.2 Hazard Ranking Results

Using the process described above, the ranking for the identified hazards of concern was determined for the Planning Area (refer to Table 4.4.2-1). The hazard ranking is detailed in the subsequent tables that present the stepwise process for the ranking. The ranking includes the entire Planning Area and may not reflect the highest risk indicated for any of the participating jurisdictions. The resulting ranks of each municipality indicate the differing degrees of risk exposure and vulnerability. The results support the appropriate selection and prioritization of initiatives to reduce the highest levels of risk for each municipality. Both the County and the participating jurisdictions have applied the same methodology to develop the countywide risk and local rankings to ensure consistency in the overall ranking of risk; jurisdictions had the ability to alter rankings based on local knowledge and experience in handling each hazard.

This hazard ranking exercise serves four purposes: (1) to describe the probability of occurrence for each hazard; (2) to describe the impact each would have on the people, property, and economy; (3) to evaluate the capabilities a community has with regard to the hazards of concern; and (4) to consider changing future conditions (i.e., climate change) in Fort Bend County.

Table 4.4-2. Ranking for Hazards of Concern for Fort Bend County

Hazard of Concern	Probability		Impact									Total Impact Value	Adaptive Capacity	Climate Change
			Population			Property			Economy					
	Category	Numeric Value	Impact	Numeric Value	Weighted Value (x3)	Impact	Numeric Value	Weighted Value (x2)	Impact	Numeric Value	Weighted Value (x1)			
Dam/Levee Failure	Occasional	2	Medium	2	2 x 3 = 6	Medium	2	2 x 2 = 4	Medium	2	2 x 1 = 2	12	Moderate	Medium
Drought	Frequent	3	Medium	2	2 x 3 = 6	Low	1	1 x 2 = 2	Medium	2	2 x 1 = 2	10	Moderate	High
Extreme Temperature	Frequent	3	Medium	2	2 x 3 = 6	Low	1	1 x 2 = 2	Medium	2	2 x 1 = 2	10	Moderate	High
Flood	Frequent	3	Low	1	1 x 3 = 3	Low	1	2 x 2 = 2	High	3	3 x 1 = 3	8	Moderate	High
Geologic	Rare	1	High	3	3 x 3 = 9	High	3	6 x 2 = 6	High	3	3 x 1 = 3	18	Moderate	Medium
Hurricane/Tropical Storm	Occasional	2	Medium	2	2 x 3 = 6	Medium	2	4 x 2 = 4	Low	1	1 x 1= 1	11	Moderate	High
Pandemic/Disease Outbreak	Occasional	2	Medium	2	2 x 3 = 6	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	9	Moderate	Medium
Severe Weather	Frequent	3	High	3	3 x 3=9	Medium	2	2 x 2 = 4	Medium	2	2 x 1=2	15	Moderate	High
Tornado	Frequent	3	Medium	2	2 x 3 = 6	Medium	2	2 x 2 = 4	Medium	2	2 x 1 = 2	12	Moderate	High
Wildfire	Occasional	2	Low	1	1 x 3= 3	Low	1	1 x 2= 2	Low	1	1 x 1 = 1	6	Moderate	High
Winter Weather	Rare	1	Medium	2	2 x 3= 6	Low	1	1 x 2= 2	Low	1	1 x 1 = 1	8	Low	Medium

Table 4.4-3 presents the total calculations for each hazard ranking value for the hazards of concern in Fort Bend County.

Table 4.4-3. Total Hazard Ranking Values for the Hazards of Concern for Fort Bend County

Hazard of Concern	Probability x 30%	Total Impact x 30%	Adaptive Capacity x 30%	Changing Future Conditions x 10%	Total Hazard Ranking Value
Dam/Levee Failure	0.6	3.6	0	0.2	4.4
Drought	0.9	3.0	0	0.3	4.2
Extreme Temperature	0.9	3	0	0.3	4.2
Flood	0.9	2.4	0	0.3	3.6
Geologic	0.3	5.4	0	0.2	5.9
Hurricane/Tropical storm	0.6	4.5	0	0.2	5.3
Pandemic/Disease Outbreak	0.3	5.4	0	0.2	5.9
Severe Weather	0.6	3.3	0	0.3	4.2
Tornado	0.6	2.7	0	0.2	3.5
Wildfire	0.9	4.5	0	0.3	5.7
Winter Weather	0.9	3.6	0	0.3	4.8
Dam/Levee Failure	0.6	1.8	0	0.3	2.7
Drought	0.3	2.4	.3	0.2	2.9

Low = Values less than 3.9; Medium = Values between 3.9 and 4.9; High = Values greater than 4.9

SECTION 5. CAPABILITY ASSESSMENT

Existing laws, ordinances, plans, and programs at the federal, state, and local levels can support or impact hazard mitigation actions identified in this plan. Hazard mitigation plans are required to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process (44 CFR, Section 201.6(b)(3)). The following federal and state programs have been identified as programs that may interface with the actions identified in this plan. Each program enhances capabilities to implement mitigation actions or has a nexus with a mitigation action in this plan.

During the 2023 plan update process, all participating jurisdictions were tasked with developing or updating their capability assessment, paying particular attention to evaluating the effectiveness of these capabilities in supporting hazard mitigation and identifying opportunities to enhance local capabilities to integrate hazard mitigation into their plans, programs, and day-to-day operations.

County and municipal capabilities in the areas of planning and regulatory, administrative, technical, and fiscal may be found in the Capability Assessment section of their jurisdictional annexes in Section 9 (Jurisdictional Annexes).

5.1 Update Process Summary

The purpose of the capability assessment is to understand the planning, regulatory, administrative, technical, and financial capabilities present in Fort Bend County. This assessment helps Fort Bend County and its jurisdictions identify strengths and opportunities that can be used to reduce losses from hazard events and reduce risks throughout Fort Bend County.

To complete the capability assessment, the contracted consultant met with both counties and each jurisdiction virtually to review the capability assessment from the 2018 Hazard Mitigation Plan (HMP) and update accordingly. In addition to virtual meetings, the consultant reviewed plans and codes/ordinances to enhance the information provided by the jurisdictions.

A summary of the various federal and state capabilities available to promote and support mitigation and reduce risk in Fort Bend County is presented below. Information provided by the County and municipalities is presented in Volume II, Section 9 (Jurisdictional Annexes) of this plan update.

5.2 Planning and Regulatory Capability

Planning and regulatory capabilities are based on the implementation of ordinances, policies, local laws, state statutes, and plans and programs that relate to guiding and management growth and development. Planning and regulatory capabilities refer not only to the current plans and regulations but also to the jurisdiction's ability to change and improve those plans and regulations as needed. The following provides the planning and regulatory capabilities for Fort Bend County.

5.2.1 Planning and Regulatory Capabilities – Local

Table 5-1 summarizes the planning and regulatory capabilities available to Fort Bend County at the local level.

Table 5-1. Planning and Regulatory Capabilities – Local

Capability	Details	
Building Code, Certificates of Occupancy, and Zoning Ordinances – Verification Letter, January 1, 2022	**Description:**	Fort Bend County Engineering does not issue certificates of occupancy, and the County has not adopted building codes for single-family residential developments. However, Fort Bend County has adopted a County Fire Code, and the Fort Bend County Fire Marshal's office issues certificates of compliance for certain multifamily and nonresidential developments.
	Responsible Agency:	Texas Department of Insurance
	Provides Funding for Mitigation:	No
	Hazard:	All hazards
Fort Bend County Regulations of Subdivision- Rules, Regulations, and Requirements relating to the approval and acceptance of Improvements in Subdivisions or Re-Subdivisions – 07/23/2019	**Description:**	When approving the plat for recording in Fort Bend County, the Commissioners' Court will consider the health, safety, morals, or general welfare of the citizens of Fort Bend County and the safe, orderly, and healthful development of the unincorporated area of the County. This will include all the specific items listed below, plus other considerations that are important to citizens of the area and Fort Bend County. These will include and not be limited to street specifications and widths, traffic patterns and traffic control, drainage and flood protection, sanitary sewers and water systems, recreational facilities, school sites, and any other amenity that applies to the area being considered. The final plat and the construction documents must be reviewed, approved, and signed by the County Engineer, and the drainage plans must be reviewed and approved by the Drainage District Engineer before the final plat is presented to Commissioners' Court for approval. The design and construction of all drainage systems within Fort Bend County shall comply with the established standard principles and practices given in the Fort Bend County Drainage Criteria Manual. Subdivision plats that are filed in Fort Bend County shall contain a community green space dedication at a ratio of ¼ acre of green space for every 100 lots. Green space areas must be no smaller in size than ¼ acre and must be at least 20 feet in width in order to provide access and sufficient useable area.
	Responsible Agency:	Commissioners Court of Fort Bend County, Texas
	Provides Funding for Mitigation:	No
	Hazard:	Flood/Erosion
Stormwater Management Program (SWMP) for the Fort Bend County Stormwater Quality Coalition – January 29, 2019	**Description:**	Each entity in the Coalition is entirely responsible for meeting the applicable SWMP requirements and has agreed to limit the implementation of their best management practices (BMPs) to the boundaries of their municipal separate storm sewer system (MS4) within the urbanized area. The receiving water bodies for the Coalition's storm sewer system include Brazos River Below Navasota River, Upper Oyster Creek, Clear Creek Above Tidal, and Oyster Creek Above Tidal. The Plan requires that All permittees shall develop, implement, and maintain a comprehensive stormwater education and outreach program to educate public employees, businesses, and the general public of hazards associated with the illegal discharges and improper disposal of waste and about the impact that stormwater discharges can have on local waterways, as well as the steps that the public can take to reduce pollutants in stormwater. All permittees shall involve the public and, at minimum, comply with any state and local public notice requirements in the planning and implementation activities related to developing and implementing the SWMP, except that correctional facilities are not required to implement this portion of the MCM.
	Responsible Agency:	County Coalition
	Provides Funding for Mitigation:	No
	Hazard:	Flood, Erosion
	Description:	This Manual was created for the purpose of reclamation and drainage of its overflowed lands and other lands needing drainage. The Fort Bend County Drainage District (FBC DD) will devise plans and construct works to reclaim lands in the

Capability	Details	
Drainage Criteria Manual for Fort Bend County Drainage District– last revised February 2011		District; to provide drainage facilities for the reclamation and drainage of the overflowed lands and other lands within the District needing drainage; to acquire or construct properties and facilities beyond the boundaries of the District where in the judgment of the governing body such properties or facilities are necessary to facilitate the drainage and reclamation of lands within the District; and to remove obstructions, natural or artificial, from the streams and water courses, and to clean, straighten, widen and maintain streams, water courses and drainage ditches.
	Responsible Agency:	Commissioner's Court
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood
Fort Bend County Disaster Recovery Voluntary Buyout Program Guidelines – last revised, May 27, 2022	**Description:**	The Fort Bend County Disaster Recovery Voluntary Buyout Program is a program jointly operated through the Fort Bend County Community Development Department and the Fort Bend County Department of Homeland Security and Emergency Management to assist owners whose homes were damaged by the 2016 flooding to relocate outside the threat of flooding. Buyout programs support hazard mitigation and resiliency by removing homeowners from the floodway and floodplain, thus eliminating vulnerability to future flooding situations. After homes are purchased, the structures are demolished or relocated. The land reverts to a natural floodplain, converts into a retention area, or is retained as green space for recreational purposes. The buyout program serves multiple objectives and provides a resiliency option versus rebuilding within a floodplain. Buyouts help prevent repetitive loss and extreme risk to human health and safety. When conducted sooner rather than later, buyouts prevent homeowners from making repairs and investing funds in properties that they then may not want to sell. The objectives of the program are: 1. Acquire properties that have been subject to 2016 floods to use for public space, green space, and/or flood control measures. 2. Assist homeowners in moving to an area with a reduced risk of flooding. 3. Return properties in the floodplain to natural and beneficial function, aiding in the storage of floodwaters. 4. Eliminate future flood damages and health and safety risks for owners and rescuers. 5. Reduce repetitive subsidized flood insurance payments and federal disaster assistance. The program will focus on providing assistance to owners of properties that are located in a floodway and flood plain.
	Responsible Agency:	Fort Bend County Community Development Department and the Fort Bend County Department of Homeland Security and Emergency Management
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood
Historical Rainfall Study - Atlas 14 Implementation – Fort Bend County – January 1, 2020	**Description:**	A historical rainfall study completed by The National Weather Service. Published on September 28, 2018. This study shows that Central Texas is more likely to experience larger storms than previously thought. For example, for Fort Bend County: 100-yr 24-hour rainfall changed from 12.5 inches to 16.5 inches. National Oceanic and Atmospheric Administration (NOAA) Atlas 14 rainfall values are used for infrastructure design and planning activities under federal, state, and local regulations. They also help delineate flood risks and manage development in floodplains for FEMA's National Flood Insurance Program. The study included recommendations for elevating structures above flood elevations and enhanced stormwater guidance.
	Responsible Agency:	County
	Provides Funding for Mitigation:	No
	Hazard:	Flood
	Description:	Due to the accelerated bank erosion along the Brazos River following significant flooding in 2015, 2016, and Hurricane Harvey in 2017, the Fort Bend County Drainage District selected Huitt-Zollars, Inc. to conduct a geomorphologic study

Capability	Details	
Brazos River Erosion Study for the Fort Bend County Drainage District – May 23, 2019		of the bank erosion at selected locations along the 89 miles of the Brazos River in Fort Bend County, Texas. The selected locations were focused on government infrastructure and historic sites, such as roads, levees, bridges, buildings, and park lands along the river. The Brazos River is the 11th longest river in the United States and the longest river in Texas. Its watershed comprises over 44,620 square miles, which begins in New Mexico and extends 1,050 miles through Texas to its outfall to the Gulf of Mexico in Freeport, Texas. **Potential Solutions to Minimize Future Bank Erosion:** For sites near bridge abutments and other structures, structural alternatives to include steel sheet piles, reinforced concrete cut-off walls, timber piles, reinforced concrete drilled shafts, and concrete piles will be required along with anchorage systems, hydrostatic relief, and riprap. Based on the cost of the recent project on the right bank of the river at the Grand Parkway Bridge, a budgetary cost per linear foot for a structural alternative is around $40,000 per linear foot. In other more natural, earthen areas, the clay bank can be sloped at a 1:4 or 1:5 slope with rock riprap and vegetative erosion protection. All potential solutions need to address the highly erodible sand layer at and below the normal water level of the river. Soil borings along the river in Fort Bend County have shown this sand layer to extend 40' below the bottom of the river. These layers need to be protected from erosion in order for the clay layers above them not to shear off into the river during periods of high flows. An alternative for protecting this erosion is sheet piles (embedded in the clay layers below the sand) with anchorage, hydrostatic relief, and rip rap.
	Responsible Agency:	County
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Real Estate Disclosure - Texas Property Code Section § 5.008 - Seller's Disclosure of Property Condition	**Description:**	Real Estate Disclosure ensures that property owners are aware of historical disaster impacts and gives them information necessary to plan for and mitigate future disasters.
	Responsible Agency:	Texas Real Estate Commission
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Regulations for Floodplain Management – January 29, 2021	**Description:**	To accomplish the purposes of these Regulations, the following methods of protecting life and property will be employed: 1. Restrict or prohibit uses that are dangerous to health, safety, or property in times of flood or cause excessive increase in flood heights or velocities. 2. Require that uses vulnerable to floods, including facilities that serve such uses, be protected against flood damage at the time of initial construction. 3. Control the alteration of natural floodplains, stream channels, and natural protective barriers, which are involved in the accommodations of flood waters. 4. Control filling, grading, dredging, and other development which may increase flood damage. 5. Prevent or regulate the construction of flood barriers that will unnaturally divert flood waters or which may increase flood hazards to other lands.
	Responsible Agency:	Commissioners Court – County Judge
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Fort Bend County Major Thoroughfare Plan – Adopted 2015 and amended through July 2022	**Description:**	The Major Thoroughfare Plan is designed to address the mobility needs of Fort Bend County as it continues to become more urbanized. It establishes a hierarchical network of controlled-access highways and toll roads, principal thoroughfares, major thoroughfares, and collectors. The classification of a particular roadway is based on the function of the road relative to mobility and access. Since the adoption of the Major Thoroughfare Plan in 2015, amendments to

Capability	Details	
		modify the plan to address development patterns, unforeseen impediments, and utilization of existing roadways have been approved through Commissioners Court and any applicable city, if within an extraterritorial jurisdiction.
	Responsible Agency:	Commissioners Court/County Engineering
	Provides Funding for Mitigation:	No
	Hazard:	All hazards
Fulshear Transit Feasibility Study Final Report February 2021	**Description:**	The Fulshear Transit Feasibility Study is a comprehensive study conducted to identify existing and future transit opportunities within the city and from the city to the Greater Houston area. The objectives of the study are to: • Develop transit options to connect Fulshear to regional employment centers • Develop transit options to bring employers and visitors to Fulshear • Determine the feasibility of local bus service in Fulshear • Enhance multimodal transportation in Fulshear • Explore transit-oriented development (TOD) and public-private partnership (P3) opportunities The plan serves as a guide for the short- and long-range implementation of transit service within the Fulshear area as well as to and from the area and regional destinations. The recommended routes, service levels, and modes in the plan were developed to meet the following goals: • Provide transit choices for Fulshear residents, employees, and visitors • Provide high-quality commuting services to major activity centers in Houston • Enhance the quality of life in Fulshear • Support traffic and parking congestion mitigation • Improve multimodal connectivity • Build partnerships to share transit costs and benefits • Result in short-range and long-range actionable transit project
	Responsible Agency:	Public Transportation Department
	Provides Funding for Mitigation:	No
	Hazard:	All hazards
The Rules Of Fort Bend County Texas Governing Water and Wastewater Infrastructure, A Supplement To Fort Bend County's Regulations of Subdivisions Adopted August 27, 2002 – Adopted April 6, 2010	**Description:**	These rules are adopted by Fort Bend County, Texas, under the authority of the Local Government Code Chapter 232 and Water Code §16.350. Notwithstanding any provision to the contrary, these rules apply only to a subdivision that creates two or more lots of five acres or less intended for residential purposes. Lots of five acres or less are presumed to be for residential purposes unless the land is restricted to nonresidential uses on the final plat and in all deeds and contracts for deeds. It is the purpose of these rules to promote the public health of the county residents, to ensure the adequate water and wastewater facilities are provided in subdivisions within the jurisdiction of the County, and to apply the minimum State standards for water and wastewater facilities to these subdivisions.
	Responsible Agency:	Commissioners Court/County Engineering
	Provides Funding for Mitigation:	No
	Hazard:	All hazards
Regulations of Subdivisions Section 7 – Green Space Regulations – July 7, 2019	**Description:**	Subdivision Green Space Requirements *Authority for these regulations is given in V.T.C.A., Local Government Code §232.101. Subchapter E (SB873).* A. Subdivision plats that are filed in Fort Bend County shall contain a community green space dedication at a ratio of ¼ acre of green space for every 100 lots. Green space areas must be no smaller in size than ¼ acre and must be at least 20 feet in width in order to provide access and sufficient useable area.

Capability	Details	
		1. Landscape setbacks and ditch rights-of-way along roadways will not be considered green space unless they are wider than required by County or City regulations. 2. Pipeline easements will be accepted as green space if they contain an improved walking trail as defined above. 3. Detention easements, excluding the actual detention pond area, will be accepted as green space if they contain an improved walking trail as defined above. There shall be a credit given toward the tree requirement for the preservation of any existing tree, on the approved planting list, located within the dedicated landscape reserve.
	Responsible Agency:	Commissioners Court
	Provides Funding for Mitigation:	No
	Hazard:	Flood/Erosion
Fort Bend County, Texas FY 2015 Consolidated Plan Draft September 1, 2015 - August 31, 2020	**Description:**	The overall goal of the community planning and development programs covered by the Consolidated Plan is to develop viable urban communities by providing decent housing and a suitable living environment and expanding economic opportunities principally for low- and moderate-income persons. The primary means towards this end is to extend and strengthen partnerships among all levels of government and the private sector, including for-profit and nonprofit organizations, in the production and operation of affordable housing by providing *decent housing, a suitable living environment,* and *expanded economic opportunities.* In addition, the Consolidated Plan discusses how the County will address the goal of ending chronic homelessness. Fort Bend County Community Development Block Grant – Disaster Recovery 2017 was made available by the U.S. Department of Housing and Urban Development (HUD) following the impacts of Hurricane to provide mitigation funding.
	Responsible Agency:	Fort Bend Community Development
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Emergency Management - Texas Government Code Chapter 418	**Description:**	Emergency Management requirements provide for the planning, mitigation, preparedness, response, and recovery activities necessary for a high-impact coastal community.
	Responsible Agency:	Texas Division of Emergency Management
	Provides Funding for Mitigation:	No
	Hazard:	All hazards

5.2.2 Planning and Regulatory Capabilities – Federal and State

Table 5-2 summarizes the federal and state level planning and regulatory capabilities available to Fort Bend County.

Table 5-2. Planning and Regulatory Capabilities – Federal and State

Capability	Details	
Disaster Mitigation Act (DMA)	**Description:**	The DMA is the current federal legislation addressing hazard mitigation planning. It emphasizes planning for disasters before they occur. It specifically addresses planning at the local level, requiring plans to be in place before Hazard Mitigation Assistance grant funds are available to communities. This plan is designed to meet the requirements of DMA, improving eligibility for future hazard mitigation funds.
	Responsible Agency:	FEMA

Capability	Details	
	Provides Funding for Mitigation:	HMPs designed to meet the requirements of DMA will remain eligible for future FEMA Hazard Mitigation Assistance funds
	Hazard:	All natural hazards
State of Texas Community Development Block Grant (CDBG) Mitigation Action Plan - January 24, 2020	**Description:**	The Plan includes the following initiatives: The Texas General Land Office (GLO) is administering $4,297,189,000 in U.S. Department of HUD CDBG-MIT funds. The GLO developed a mitigation needs assessment to determine programs. The GLO will administer state programs focused on infrastructure, housing, and planning. HUD requires that at least 50% of total funds must be used for activities benefiting low- to moderate-income (LMI) persons. All programs will have an LMI priority. These CDBG-MIT funds will be used to build and implement structural and non-structural projects, programs, and partnerships throughout the State of Texas that reduce the risks and impacts of future natural disasters. The State of Texas CDBG Mitigation Action Plan: Building Stronger for a Resilient Future outlines the use of funds, programs, eligible applicants, and eligibility criteria.
	Responsible Agency:	General Land Office
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
National Flood Insurance Program (NFIP)	**Description:**	The NFIP is a federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for state and community floodplain management regulations that reduce future flood damages (FEMA 2023). The Flood Hazard Profile in Section 4.3.6 (Flood) provides information on recent legislation related to reforms to the NFIP. All communities in Fort Bend County participate in the NFIP. As of June 2023, there are 9,669 NFIP policies in the County, with a majority of them in Missouri City, Fulshear, and Sugar Land.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Full compliance and good standing under the NFIP are application prerequisites for all FEMA grant programs for which participating jurisdictions are eligible under this plan.
	Hazard:	Flood
NFIP Community Rating System (CRS)	**Description:**	As an additional component of the NFIP, CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS: (1) reduce flood losses, (2) facilitate accurate insurance rating, and (3) promote the awareness of flood insurance. As of April 2023, the following communities participate in the CRS program: Missouri City (Class 7), Pearland (Class 6), and Sugar Land (Class 6).
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	CRS premium discounts on flood insurance range from 5 percent for Class 9 communities up to 45 percent for Class 1 communities.
	Hazard:	Flood
Local Government Code Title 7. Regulation Of Land Use, Structures, Businesses, and Related Activities Subtitle A. Municipal Regulatory Authority Chapter 211. Municipal Zoning Authority Subchapter A. General Zoning Regulations	**Description:**	The powers granted under this subchapter are for the purpose of promoting the public health, safety, morals, or general welfare and protecting and preserving places and areas of historical, cultural, or architectural importance and significance. The governing body of a municipality may regulate the size of buildings and other structures, lot coverage, size of open spaces, population density, the location and use of buildings and groundwater use. Zoning regulations must be adopted in accordance with a comprehensive plan and must be designed to: (1) lessen congestion in the streets. (2) secure safety from fire, panic, and other dangers. (3) promote health and the general welfare. (4) provide adequate light and air. (5) prevent the overcrowding of land. (6) avoid undue concentration of population; or (7) facilitate the adequate provision of transportation, water, sewers, schools, parks, and other public requirements. The

Capability	Details	
		governing body of a municipality may divide the municipality into districts of a number, shape, and size the governing body considers best for carrying out this subchapter. Within each district, the governing body may regulate the erection, construction, reconstruction, alteration, repair, or use of buildings, other structures, or land. Zoning regulations must be uniform for each class or kind of building in a district, but the regulations may vary from district to district. The regulations shall be adopted with reasonable consideration, among other things, for the character of each district and its peculiar suitability for uses, with a view of conserving the value of buildings and encouraging the most appropriate use of land in the municipality.
	Responsible Agency:	State of Texas
	Provides Funding for Mitigation:	No
	Hazard:	All hazards
Texas Silver Jackets	**Description:**	Silver Jackets is a program under National Flood Risk Management Program to support agency collaboration and coordination with interagency, state-led flood risk and multiple hazard management teams. Provides resources and develops tools to support information sharing and networking and promotes implementation of flood risk management efforts that improve flood risk awareness and result in actions to reduce risk. For more information: http://silverjackets.nfrmp.us/
	Responsible Agency:	US Army Corp of Engineers
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Texas General Land Office (GLO)	**Description:**	The Texas GLO, through the Community Development and Revitalization division, works to rebuild Texas communities by putting Texans back in their homes, restoring critical infrastructure, and mitigating future damage through resilient community planning. The GLO is setting a record pace administering both CDBG-DR and CDBG-MIT funds from the U.S. HUD on behalf of the State of Texas. More than $14 billion have been allocated for recovery and mitigation following Hurricanes Rita, Dolly, and Ike, the 2011 wildfires, the 2015 and 2016 floods, Hurricane Harvey, the 2018 South Texas floods, and the 2019 disasters. These grants can be used for a wide variety of activities, including housing redevelopment, infrastructure repair, and long-term planning, depending on HUD guidance.
	Responsible Agency:	Texas General Land Office
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Hurricane, Wildfire
Coastal Erosion Planning and Response Act (CEPRA)	**Description:**	The average erosion rate for the 367 miles of Texas coast is 4.1 feet per year. Sixty-four percent of the Texas coast is eroding at an average rate of about 6 feet per year, with some locations losing more than 30 feet per year. FEMA estimates that every dollar spent on erosion control and mitigation to preserve wetlands and other natural ecosystems will provide a return on average of $4 in future cost-savings. Since 2000, the GLO's Coastal Erosion Planning and Response Program has received $111.4 million in state-appropriated funding. Project partners (local governments, nonprofits, state, and federal entities) have contributed $52 million in non-federal matching funds and in-kind contributions, along with $165.2 million in federal funds and in-kind contributions that have resulted in more than 355 coastal erosion response projects.
	Responsible Agency:	General Land Office
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Hurricane, Land Subsidence

Capability	Details	
Coastal Management Program (CMP)	**Description:**	Texas receives approximately $2 million annually in grants from NOAA, and 90% of the funds are passed through to local governments and entities to address environmental needs and promote sustainable economic development along the coast. Projects must improve the management of the state's coastal resources and ensure long-term ecological and economic productivity. Section 306 administrative funds can be used for non-construction, coastal planning and education, and research. Section 306A improvement funds can be utilized for construction and land acquisition projects and preservation and restoration. CMP funding categories include Coastal Natural Hazards Response, Critical Areas Enhancement, Public Access, Water/Sediment Quantity and Quality Improvements, Waterfront Revitalization and Ecotourism Development, Permit Streamlining/Assistance, Governmental Coordination and Local Government Planning Assistance.
	Responsible Agency:	Texas General Land Office
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Hurricane
Gulf of Mexico Energy Security Act (GOMESA)	**Description:**	GOMESA significantly enhances oil and gas leasing activities and creates revenue-sharing provisions for the oil- and gas-producing states of Alabama, Louisiana, Mississippi, and Texas and their coastal political subdivisions (CPSs). GOMESA funds are used for coastal conservation, restoration, and hurricane protection. The second phase of GOMESA revenue-sharing began in Fiscal Year 2017 and expands the definition of qualified Outer Continental Shelf revenues to include receipts from Gulf of Mexico leases subject to withdrawal or moratoria restrictions. A revenue-sharing cap of $500 million per year for the four Gulf-producing states, their CPSs, and the Land and Water Conservation Fund applies from fiscal years 2016 through 2055. The $500 million cap does not apply to qualified revenues generated in those areas associated with Phase I of the GOMESA program. From 2009 through 2016, the State of Texas received $3,192,269, and its 18 CPSs received $798,036. The goal of GOMESA funding is to conserve, restore, enhance, and protect the diversity, quality, quantity, functions, and values of the state's coastal natural resources. A primary focus for the GLO will be to protect coastal natural resources while facilitating multiple human uses of coastal resources. The GLO's priority for the expenditures of GOMESA funds include: restoring and enhancing coastal natural resources, providing hurricane protection for coastal public resources, improving water quality, enhancing the balance between the protection of coastal natural resources and public use of those resources, improving environmental management, mitigating coastal erosion, and stabilizing shorelines.
	Responsible Agency:	Texas General Land Office
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Hurricane, Manmade Disasters
U.S. Army Corps of Engineers (USACE) – Dam Safety Program	**Description:**	The U.S. Army Corps of Engineers (USACE) is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. USACE has inventoried dams and has surveyed each state and federal agency's capabilities, practices, and regulations regarding design, construction, operation, and maintenance of the dams. USACE has also developed guidelines for inspection and evaluation of dam safety (USACE 1997).
	Responsible Agency:	USACE
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood
Natural Resources Damage Assessment (NRDA)	**Description:**	The natural resource trustees are the designated federal, state, and tribal agencies that are responsible for the natural resources impacted by an oil spill or hazardous substance release. They have common interests in sharing information,

Capability	Details	
		ideas, and expertise necessary to compensate the public for harm to natural resources because of oil spills and hazardous substance releases.
	Responsible Agency:	Texas Commission on Environmental Quality
	Provides Funding for Mitigation:	Yes
	Hazard:	Manmade Disasters
Coastal and Estuarine Land Conservation Program (CELCP)	**Description:**	Lands being targeted for protection through TCELCP include coastal and estuarine areas with significant ecologic, conservation, recreation, historic, and aesthetic values. Many of these lands are threatened by conversion from their natural state to other uses. This section describes the geographic extent of the TCELCP boundary, outlines the types of lands and values to be protected, and gives an assessment of their status and trends (when known), functions and values, and potential threats. When NOAA provides funding for CELCP, the GLO provides coastal communities an opportunity to apply for up to three projects per year, with federal grants for any single project not to exceed $3 million.
	Responsible Agency:	NOAA, Texas General Land Office
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Hurricane
Texas Division of Emergency Management	**Description:**	TDEM is charged with carrying out a comprehensive, all-hazard emergency management program for the state and assisting cities, counties, and state agencies in implementing their own emergency management programs.
	Responsible Agency:	
	Provides Funding for Mitigation:	No
	Hazard:	All hazards
Community Health and Resource Management (CHARM)	**Description:**	CHARM is directed by the Texas Coastal Watershed Program, a part of Texas A&M AgriLife Extension Service. It is a mapping application that gives local officials, stakeholders, and citizens the power to analyze growth with real-time feedback. Using the tool that transforms an ordinary tabletop into an interactive computer interface, CHARM allows participants to engage the public and gather their input regarding the community's future. The mapping application is supported by a library of data about urbanization, storm surge, conservation, public facilities, and coastal resources. The CHARM application can leverage local knowledge for better long-term planning and is an ideal tool for communities, watersheds, and environmental projects.
	Responsible Agency:	Texas A&M AgriLife Extension Service.
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Home Program	**Description:**	The Texas Department of Housing and Community Affairs (TDHCA) administers the HOME Program on behalf of the state. The purpose of the program is to expand the supply of decent, safe, affordable housing and strengthen public-private housing partnerships between units of local governments, public housing authorities, nonprofits, and for-profit entities. TDHCA has set aside funding for Disaster Relief and Persons with Disabilities, among others.
	Responsible Agency:	TDHCA
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Texas Water Development Board (TWDB) – Flood Insurance Program	**Description:**	TWDB is the state agency charged with collecting and disseminating water-related data, assisting with regional planning, preparing the State Water Plan, which addresses the development of the state's water resources. The agency

Capability	Details	
		also administers cost-effective financial assistance programs for the construction of water supply, wastewater treatment, flood control, and agricultural water conservation projects. The TWDB has made great strides in floodplain management since the last update to the 2013 SHMP. Examples include hiring full-time staff to manage the State's Cooperating Technical Partner floodplain mapping program, developing a State Flood Plan (see below for information on both), and creating a website to assist citizens and first responders during a flood event (www.TexasFloods.org). The following is a list of programs available that may assist with flooding and the mitigation of Repetitive and Severe Repetitive Loss properties. TWDB's National Flood Insurance Program group conducts Community Assistance Visits (CAV), Community Assistance Contacts (CAC), and floodplain management training to assist communities with maintaining NFIP compliance and sound floodplain management practices. The CAV is a scheduled visit to an NFIP community for the purpose of conducting a comprehensive assessment of the community's floodplain management program and evaluating its knowledge and understanding of the requirements of the NFIP. The purpose of the CAV is also to assist the community in understanding NFIP requirements when program deficiencies are discovered. Floodplain Management 101 workshops are offered to local officials and other interested parties, which cover the NFIP and various flood loss reduction techniques and strategies, such as the CRS. The workshops contain training modules on the Texas Water Code, Elevation Certificates, FEMA requirements, community awareness, map reading, permitting, and ordinance comprehension.
	Responsible Agency:	TWDB
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood
Cooperation Technical Partners (CTP)	**Description:**	TWDB also administers the FEMA Cooperating Technical Partners (CTP) Program, which allows communities, tribal nations, universities, and regional and state agencies to be active partners in FEMA's flood hazard mapping program. The CTP program at the state level aims to produce flood risk information through leveraging state and local funds, updated flood risk products, and coordination between statewide cooperating technical partners.
	Responsible Agency:	TWDB
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Fund Development Program	**Description:**	TWDB also administers the Fund Development Program to provide loans for the planning, design, and construction of water supply, wastewater, and flood control projects. Structural flood protection improvements may include construction of storm water retention basins, the enlargement of stream channels, public beach re-nourishment, the control of coastal erosion, and the modification or reconstruction of bridges. Non-structural flood protection improvements may include the acquisition of floodplain properties for use as public open space, the acquisition and removal of buildings and residents located within a floodplain, flood warning systems, and the development of floodplain management plans. The agency conducts an environmental review for all construction projects.
	Responsible Agency:	TWBD
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood
Texas Natural Resources Information System (TNRIS)	**Description:**	The TNRIS is a division of TWDB and is responsible for producing, archiving, and distributing geographic data to agencies, businesses, and the public. TNRIS supports hazard mitigation planning and implementation in three ways: Provides data to organizations for planning or response activities. Develops, locates, and prepares data for specific needs and/or projects. Updates the State Critical Facility Database.
	Responsible Agency:	TWDB

Capability	Details	
	Provides Funding for Mitigation:	No
	Hazard:	All hazards
Texas Flash Flood Coalition	**Description:**	The TFFC is an organization dedicated to decreasing the number of deaths caused by flash flooding in Texas. More than 30 representatives of higher education, media, private industry, local, state, and federal governments participate in the Coalition. Its strategy is to (1) brainstorm and share ideas, data, resources, and best practices; (2) include a diversity of folks from all levels of education, the public, private entities, and academia, an (3) attack the flash flood problem with mitigation, research, technology, education, awareness, warning, and communication.
	Responsible Agency:	Works with the Texas Floodplain Management Association
	Provides Funding for Mitigation:	No
	Hazard:	Flood, Flash Flood
Community Hazard Analysis and Mitigation Planning Support (CHAMPS)	**Description:**	The CHAMPS reports are summarized descriptions of historical hazard events and future hazard risks for each county in Texas. These have been developed by the Texas Geographic Society in a project funded by FEMA and administered by TDEM. CHAMPS reports have been developed to provide local mitigation planners with data, maps, and other information they can use to support the hazard assessment portion of the mitigation planning process. Each report includes information on county populations and built environments, historical losses from multiple hazards, and expected future likelihood of more hazard events. Also included with every hazard is a comparative display showing how the number of hazard events in that county compares with the number of events in other counties for that hazard over the same timeframe.
	Responsible Agency:	Texas Geographic Society
	Provides Funding for Mitigation:	No
	Hazard:	All hazards
Urban Tree Canopy Project – Resilient Landscapes Program	**Description:**	TFS has programs and funding opportunities, such as the Urban Tree Canopy Project, that address mitigation by decreasing impact from summer heat, flooding, and erosion. The Fire-Adapted Communities Program provides cost-share funds to assist in informing and preparing citizens to safely co-exist with wildland fire. The Resilient Landscapes Program provides cost-share reimbursement funds to restore healthy, fire-adapted ecosystems. The Firewise USA Program provides cost-share funds in cooperation with the National Fire Protection Administration to encourage homeowners to take individual responsibility for protecting their homes from the risk of wildfire.
	Responsible Agency:	Texas A&M Forest Service
	Provides Funding for Mitigation:	No
	Hazard:	Wildfires
Texas Department of Licensing and Regulation	**Description:**	Licenses and regulates weather modification programs and hosts the Texas Weather Modification and Advisory Committee meetings. Cloud seeding projects designed to increase rainfall from convective cloud towers are conducted in nearly 31 million acres of Texas. In administering the Texas Weather Modification Act, TDLR's weather modification program issues license and permits for projects using specialized aircraft and sophisticated weather radar systems at sites near Amarillo, San Angelo, and Pleasanton. TDLR also issues permits for hail suppression projects.
	Responsible Agency:	TDLR
	Provides Funding for Mitigation:	No
	Hazard:	Drought

Capability	Details	
Texas Department of Transportation	**Description:**	TxDOT incorporates tornado safe rooms into their Safe Rest Stops program through a federally funded Transportation Enhancement program (See Section 6.3). TxDOT also revises its design manual to include improved guidance on NFIP requirements. The agency supports the effort to certify floodplain managers by encouraging all their personnel to become certified. All engineers in TxDOT's central hydraulics branch are certified.
	Responsible Agency:	TxDOT
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Texas Residential Safe Room Rebate Program	**Description:**	TDEM, through the Hazard Mitigation Assistance (HMA) grants, began offering a rebate incentive for builders and homeowners to build or install residential safe rooms. This program is implemented by local units of government that choose to administer the program through a grant provided through the HMGP or Pre-Disaster Mitigation (PDM) program. TDEM has also published a residential safe room handbook to assist local jurisdictions with the implementation of the program. This program has raised the viability and the visibility of safe rooms in high tornado/windstorm regions of Texas.
	Responsible Agency:	TDEM
	Provides Funding for Mitigation:	Yes
	Hazard:	Tornado, Windstorm

5.3 Administrative and Technical Capabilities

Table 5-3 below summarizes the administrative and technical capabilities in Fort Bend County. Detailed information regarding administrative and technical capabilities in Fort Bend County and the municipalities can be found in each jurisdictional annex found in Volume II, Section 9 (Annexes).

Table 5-3. Administrative and Technical Capability

Capability	Details	
Fort Bend County Stormwater Quality Coalition	**Description:**	The Fort Bend County Stormwater Quality Coalition consists of Fort Bend County and Fort Bend County Drainage District. The Coalition was formed in February 2008 as an effort by the members to assist one another in complying with stormwater quality regulations established by the Texas Commission on Environmental Quality.
	Responsible Agency:	County
	Provides Funding for Mitigation:	No
	Hazard:	Flood, Drought, Severe Storms
Fort Bend Transit	**Description:**	In 2005, the Fort Bend County Commissioners Court approved the creation of the Fort Bend County Public Transportation Department (PBC PTD) to serve the general public in Fort Bend County. The purpose of the FBC PTD was to provide seamless service between urban and rural communities, access rural transit funding, and increase services to residents in Fort Bend County without increasing the financial burden to the taxpayers. Today, the Fort Bend County Public Transportation Department is known as Fort Bend Transit (FBT). Fort Bend Transit's mission is to provide safe and efficient public transportation services while maintaining service quality and customer satisfaction. FBT provides

Capability	Details	
		approximately 392,000 annual passenger trips (data from October 2018 – September 2019) to destinations in Fort Bend and Harris Counties. The services provided are Demand Response and Commuter Park and Ride Services. FBT is located in Rosenberg and has a core inventory of vehicles as well as a fleet provided through a contracted service provider.
	Responsible Agency:	County
	Provides Funding for Mitigation:	No
	Hazard:	All
Fort Bend Texas Agri-Life Extension Service	**Description:**	The Fort Bend County Office of the Texas A&M AgriLife Extension Service and Cooperative Extension Program (CEP) educates Texans in all areas of agriculture, youth & adult life skills, human capital & leadership, and community economic development. Extension offers the knowledge resources of both Texas A&M and Prairie View A&M Universities to educate Texans for self-improvement, individual action, and community problem-solving. We are part of a statewide educational network and a member of the Texas A&M University System linked in a unique partnership with the nationwide Cooperative Extension System and Fort Bend County Commissioners' Court. Agricultural planning reduces the risk to the animals and community during times of disaster. This includes a Texas Extension Disaster Education Network.
	Responsible Agency:	Commissioners Court
	Provides Funding for Mitigation:	No
	Hazard:	Flood, Hurricane, Severe Winter Storm
Fort Bend County Community Development Department	**Description:**	The Fort Bend County Community Development Department was created in 1992 by the Fort Bend County Commissioners Court to administer the CDBG Program and other federal housing programs for the County. Since that time, the Community Development Department's scope has been expanded to include the administration of several other programs. In 1994, Fort Bend County was designated a participating jurisdiction (PJ) and therefore became eligible to receive a grant directly from the HUD through the HOME Investment Partnerships Program. In 1995, Fort Bend County became eligible to receive a grant through the Emergency Shelter Grant (ESG) Program, which is now Emergency Solutions Grant (ESG) Program. Fort Bend County is part of the Houston Eligible Metropolitan Area (EMA) for the Housing Opportunities for Persons With AIDS Program (HOPWA). HUD requires a Consolidated Plan, a single submission for the planning and application aspects of the CDBG, HOME, ESG, and HOPWA formula programs. The consolidated submission also consolidates the reporting requirements for HUD programs, replacing five general performance reports with one performance report, the Consolidated Annual Performance and Evaluation Report (CAPER).
	Responsible Agency:	County
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Fort Bend Parks and Recreation Department	**Description:**	Fort Bend County has 12 active parks, three leased parks, five community centers, and three parks under development. Our parks feature walking trails, playgrounds, basketball courts, baseball fields, soccer fields, football fields, cricket fields, splash pads, fishing holes, and other outdoor recreation. We also offer pavilions, community centers, and building rentals for banquets, weddings, and other private events. The Parks and Recreation Department also includes the Fort Bend County Fairgrounds.
	Responsible Agency:	County
	Provides Funding for Mitigation:	No
	Hazard:	All hazards

Capability	Details	
Fort Bend County Drainage District	**Description:**	The primary mission of the Fort Bend County Drainage District is to maintain the drainage channels, where the District has easements, in their existing flow conditions. This is accomplished through appropriate structural repairs and vegetation control. Secondarily, the District provides a review of plats and drainage plans of new development to be approved by Commissioners Court to ensure the elimination of an adverse drainage impact on current and future residents.
	Responsible Agency:	County
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Fort Bend Engineering Department	**Description:**	The Engineering Department provides comprehensive planning, design, mapping, and management services to facilitate quality construction of private development, public roads, and public infrastructure to enhance public safety and quality of life in the County.
	Responsible Agency:	County
	Provides Funding for Mitigation:	No
	Hazard:	All hazards
Fort Bend County Drainage District	**Description:**	The primary mission of the Fort Bend County Drainage District is to maintain the drainage channels, where the District has easements, in their existing flow conditions. This is accomplished through appropriate structural repairs and vegetation control. Secondarily, the District provides a review of plats and drainage plans of new development to be approved by Commissioners Court to ensure the elimination of an adverse drainage impact on current and future residents.
	Responsible Agency:	Commissioners Court
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Fort Bend County Environmental Enforcement Program	**Description:**	The goal of this program is to investigate environmental health crimes and violations on public and private properties within the unincorporated areas of Fort Bend County. This includes violations of the Texas Health & Safety Code, Texas Water Code, Texas Penal Code, and Texas Transportation Code. In addition to responding to complaints received, investigators proactively patrol the County looking for environmental crimes and violations. The Program also provides Disaster Resource Information for all disasters.
	Responsible Agency:	Commissioners Court/Health and Human Services
	Provides Funding for Mitigation:	No
	Hazard:	All hazards
Fort Bend County Health and Human Services Department	**Description:**	Fort Bend County Health & Human Services is the principal agency for protecting the health of County residents and providing essential human services, especially for those who are least able to help themselves. The mission of Fort Bend County Health & Human Services (FBHHS) is to promote and protect the health and well-being of the residents of Fort Bend County through disease prevention and intervention, public health emergency preparedness and response, community engagement, and helping to ensure the equitable provision of basic human needs.
	Responsible Agency:	County
	Provides Funding for Mitigation:	No
	Hazard:	All hazards

Capability	Details	
Fort Bend County Homeland Security & Emergency Management	**Description:**	It is the mission of the Fort Bend County Department of Homeland Security and Emergency Management to create an environment of readiness for the whole-community through a comprehensive program of prevention, protection, mitigation, response, and disaster recovery. It is the Department's vision to provide effective coordination and collaboration to create a culture of preparedness that builds and sustains a disaster-resilient community in Fort Bend County. The Department administers the Emergency Alerts & Warnings Program (Fort Bend County Alert). The system enables the Department to provide the participating public with critical information quickly in a variety of situations, such as severe weather, unexpected road closures, missing persons and evacuations of buildings or neighborhoods.
	Responsible Agency:	Commissioners Court
	Provides Funding for Mitigation:	No
	Hazard:	All hazards
Fort Bend County Information Technology Department	**Description:**	The Director of Information Technology is an Executive Manager reporting directly to Commissioners Court. The Director works with Commissioners Court, other elected officials, and department heads to provide information technology components for strategic planning and the implementation of information technology components within approved strategic plans. The Director also provides central Information Technology (IT.) policy direction for all County departments and supervises and directs the I.T. Department personnel. Under the direction of Commissioners Court, the Director is responsible for managing and coordinating the development, operation, and maintenance of the County's I.T. systems. The Department's duties include but are not limited to: Recommends countywide policies and standards for privacy, security, and protection of data integrity in technology infrastructure, electronic commerce, and technology vendor relationships as part of the County's strategic planning process as well as oversees the implementation of adopted policies and standards. Participates in activities and duties related to emergency management during a local state of disaster as directed by appropriate county managers.
	Responsible Agency:	Commissioners Court
	Provides Funding for Mitigation:	No
	Hazard:	All hazards
Fort Bend County Road & Bridge Department	**Description:**	In January 1996, the Road & Bridge Department was formed. This organization began beating its heart to a very public audience. Citizens groups were formed to monitor the development and effectiveness of the department. To date, this department has proven to be an asset and has also provided extreme savings to the taxpayers of Fort Bend County. The Road & Bridge Department is committed to providing the most efficient, most responsive, and most courteous services possible. The fleet of vehicles and equipment is kept in top shape and are replaced only when the cost of repair exceeds the value of the equipment. An updated, mechanically sound fleet provides a safe and productive environment. Services provided by this department include: Road Construction, Maintenance and Repair, County Road Drainage, Herbicide Treatment, Right-of-Way Mowing, Residential Driveway Installation, Repair, Replacement Installation, Maintenance & Repair of Street Signs & Barricades, and Road Striping.
	Responsible Agency:	Commissioners Court
	Provides Funding for Mitigation:	No
	Hazard:	All hazards
Fort Bend County Sheriff's Office	**Description:**	The Fort Bend County Sheriff's Office (FBCSO) was founded in 1837 and is the largest law enforcement agency in Fort Bend County—the most diverse county in Texas. The FBCSO has over 800 employees, including 565 sworn peace officers and 25 reserve deputies dedicated to protecting and serving nearly 900,000 Fort Bend County residents. Among the ten fastest-growing counties in the nation, Fort Bend covers 885 square miles and includes 21 unincorporated communities.

Capability	Details	
		Fort Bend County also includes 16 incorporated municipalities, including Sugar Land, Katy, Missouri City, Richmond, Rosenberg, and Stafford.
	Responsible Agency:	Commissioners Court
	Provides Funding for Mitigation:	No
	Hazard:	All hazards

5.4 Fiscal Capabilities

Fiscal capabilities are the resources that a jurisdiction has access to or is eligible to use to fund mitigation actions. Table 5-4 provides a list of programs, descriptions, and links for those jurisdictions seeking funding sources. This table is not intended to be a comprehensive list but rather a tool to help begin identifying potential sources of funding.

Table 5-4. Fiscal Capabilities

Capability	Details	
Federal		
Hazard Mitigation Grant Program (HMGP)	**Description:**	The HMGP is a post-disaster mitigation program. It is made available to states by FEMA after each federal disaster declaration. The HMGP can provide up to 75% funding for hazard mitigation measures. The HMGP can be used to fund cost-effective projects that will protect public or private property in an area covered by a federal disaster declaration or that will reduce the likely damage from future disasters. Examples of projects include acquisition and demolition of structures in hazard-prone areas, flood-proofing or elevation to reduce future damage, minor structural improvements, and development of state or local standards. Projects must fit into an overall mitigation strategy for the area identified as part of a local planning effort. All applicants must have a FEMA-approved HMP (this plan). Applicants who are eligible for the HMGP are state and local governments, certain nonprofit organizations or institutions that perform essential government services, and Indian tribes and authorized tribal organizations. Individuals or homeowners cannot apply directly for the HMGP; a local government must apply on their behalf. Applications are submitted to TDEM, placed in rank order for available funding, and submitted to FEMA for final approval. Eligible projects not selected for funding are placed in an inactive status and may be considered as additional HMGP funding becomes available. For additional information regarding HMGP, please refer to: https://www.fema.gov/hazard-mitigation-grant-program
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Flood Mitigation Assistance (FMA) Program	**Description:**	The FMA program combines the previous Repetitive Flood Claims and Severe Repetitive Loss Grants into one grant program. The FMA provides funding to assist states and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the NFIP. The FMA is funded annually; no federal disaster declaration is required. Only NFIP-insured homes and businesses are eligible for mitigation in this program. Funding for FMA is very limited, and, as with the HMGP, individuals cannot apply directly for the program. Applications must come from local governments or other eligible organizations. The federal

Capability	Details	
		cost-share for an FMA project is at least 75 percent. For the nom-federal share, at most 25 percent of the total eligible costs must be provided by a non-federal source; of this 25 percent, no more than half can be provided as in-kind contributions from third parties. At minimum, a FEMA-approved local flood mitigation plan is required before a project can be approved. The FMA funds are distributed from FEMA to the state. TDEM serves as the grantee and program administrator for the FMA program. The FMA program is detailed on the FEMA website: https://www.fema.gov/flood-mitigation-assistance-grant-program.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Severe Weather
Building Resilient Infrastructure and Communities (BRIC) Program	**Description:**	BRIC will support states, local communities, tribes, and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards. BRIC is a new FEMA pre-disaster hazard mitigation program that replaces the existing PDM program. The BRIC program guiding principles are supporting communities through capability- and capacity-building; encouraging and enabling innovation; promoting partnerships; enabling large projects; maintaining flexibility; and providing consistency. For additional information regarding the BRIC program, please refer to: https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Extraordinary Circumstances	**Description:**	For PDM and FMA project subawards, the (FEMA) Region may apply extraordinary circumstances when justification is provided and with concurrence from FEMA Headquarters (Risk Reduction and Risk Analysis Divisions) prior to granting an exception. If this exception is granted, a local mitigation plan must be approved by FEMA within 12 months of the award of the project subaward to that community. For HMGP, PDM, and FMA, extraordinary circumstances exist when a determination is made by the Applicant and FEMA that the proposed project is consistent with the priorities and strategies identified in the State (Standard or Enhanced) Mitigation Plan and that the jurisdiction meets at least one of the criteria below. If the jurisdiction does not meet at least one of these criteria, the Region must coordinate with FEMA Headquarters (Risk Reduction and Risk Analysis Divisions) for HMGP; however, for PDM and FMA the Region must coordinate and seek concurrence prior to granting an exception: The jurisdiction meets the small, impoverished community criteria (see Part VIII, B.2). The jurisdiction has been determined to have had insufficient capacity due to lack of available funding, staffing, or other necessary expertise to satisfy the mitigation planning requirement prior to the current disaster or application deadline. The jurisdiction has been determined to have been at low risk from hazards because of low frequency of occurrence or minimal damage from previous occurrences because of sparse development. The jurisdiction experienced significant disruption from a declared disaster or another event that impacts its ability to complete the mitigation planning process prior to award or final approval of a project award. The jurisdiction does not have a mitigation plan for reasons beyond the control of the State, federally recognized tribe, or local community, such as Disaster Relief Fund restrictions that delay FEMA from granting a subaward prior to the expiration of the local or Tribal Mitigation Plan. For HMGP, PDM, and FMA, the Applicant must provide written justification that identifies the specific criteria or circumstance listed above, explains why there is no longer an impediment to satisfying the mitigation planning requirement, and identifies the specific actions or circumstances that eliminated the deficiency. When an HMGP project funding is awarded under extraordinary circumstances, the Recipient shall acknowledge in writing to the Regional Administrator that a plan will be completed within 12 months of the subaward. The Recipient must provide a work plan for completing the local or Tribal Mitigation Plan, including milestones and a timetable, to ensure that the jurisdiction will complete the plan in the required time. This

Capability	Details	
		requirement shall be incorporated into the award (both the planning and project subaward agreements, if a planning subaward is also awarded).
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Individual Assistance (IA)	**Description:**	IA provides help for homeowners, renters, businesses, and some nonprofit entities after disasters occur. This program is largely funded by the U.S. Small Business Administration. For homeowners and renters, those who suffered uninsured or underinsured losses could be eligible for a Home Disaster Loan to repair or replace damaged real estate or personal property. Renters are eligible for loans to cover personal property losses. Individuals are allowed to borrow up to $200,000 to repair or replace real estate, $40,000 to cover losses to personal property, and an additional 20 percent for mitigation. For businesses, loans could be made to repair or replace disaster damages to property owned by the business, including real estate, machinery and equipment, inventory, and supplies. Businesses of any size are eligible. Nonprofit organizations, such as charities, churches, and private universities are eligible. An Economic Injury Disaster Loan provides necessary working capital until normal operations resume after a physical disaster but are restricted by law to small businesses only. IA is detailed on the FEMA website: https://www.fema.gov/individual-disaster-assistance.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Public Assistance (PA)	**Description:**	PA provides cost reimbursement aid to local governments (state, county, local, municipal authorities, and school districts) and certain nonprofit agencies that were involved in disaster response and recovery programs or that suffered loss or damage to facilities or property used to deliver government-like services. This program is largely funded by FEMA with both local and state matching contributions required. PA is detailed on the FEMA website: https://www.fema.gov/public-assistance-local-state-tribal-and-nonprofit.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Department of Homeland Security Grant Program (HSGP)	**Description:**	The HSGP plays an important role in the implementation of the National Preparedness System by supporting the building, sustainment, and delivery of core capabilities essential to achieving the National Preparedness Goal of a secure and resilient nation. In FY 2019, the total amount of funds available under HSGP was $1.095 billion. HSGP is composed of three interconnected grant programs, including the State Homeland Security Program, Urban Areas Security Initiative (UASI), and the Operation Stonegarden. Together, these grant programs fund a range of preparedness activities, including planning, organization, equipment purchase, training, exercises, and management and administration. Additional information regarding HSGP is available on the website: https://www.fema.gov/homeland-security-grant-program.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Fire Management Assistance Grant Program	**Description:**	Assistance for the mitigation, management, and control of fires on publicly or privately-owned forests or grasslands that threaten such destruction as would constitute a major disaster. Provides a 75% federal cost-share, and the state

Capability	Details	
		pays the remaining 25% for actual cost. Information on this program is available on the website: https://www.fema.gov/fire-management-assistance-grant-program.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	Wildfire
Assistance to Firefighters Grant Program	**Description:**	The primary goal of the Assistance to Firefighters Grants is to enhance the safety of the public and firefighters with respect to fire-related hazards by providing direct financial assistance to eligible fire departments, nonaffiliated Emergency Medical Services organizations, and State Fire Training Academies. This funding is for critically needed resources to equip and train emergency personnel to recognized standards, enhance operations efficiencies, foster interoperability, and support community resilience. Information regarding this grant program is available on the website: https://www.fema.gov/welcome-assistance-firefighters-grant-program.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	Wildfire
High Hazard Potential Dams (HHPD) Grant Program	**Description:**	The Rehabilitation of HHPD Grant Program provides technical, planning, design, and construction assistance in the form of grants to non-federal governmental organizations or nonprofit organizations for rehabilitation of eligible high hazard potential dams. Information regarding this program is available on the website: https://www.grants.gov/web/grants/view-opportunity.html?oppId=316238.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood
Small Business Administration (SBA) Loan	**Description:**	The SBA provides low-interest disaster loans to homeowners, renters, businesses of all sizes, and most private nonprofit organizations. SBA disaster loans can be used to repair or replace the following items damaged or destroyed in a declared disaster: real estate, personal property, machinery and equipment, and inventory and business assets. Homeowners could apply for up to $200,000 to replace or repair their primary residence. Renters and homeowners could borrow up to $40,000 to replace or repair personal property-such as clothing, furniture, cars, and appliances that were damaged or destroyed in a disaster. Physical disaster loans of up to $2 million are available to qualified businesses or most private nonprofit organizations. Additional information regarding SBA loans is available on the SBA website: https://www.sba.gov/managing-business/running-business/emergency-preparedness/disaster-assistance.
	Responsible Agency:	SBA
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Community Development Block (CDBG) Grant Program	**Description:**	CDBG are federal funds intended to provide low and moderate-income households with viable communities, including decent housing, a suitable living environment, and expanded economic opportunities. Eligible activities include community facilities and improvements, roads and infrastructure, housing rehabilitation and preservation, development activities, public services, economic development, and planning and administration. Public improvements could include flood and drainage improvements. In limited instances and during times of “urgent need” (e.g., post-disaster) as defined by the CDBG National Objectives, CDBG funding could be used to acquire a property located in a floodplain that was severely damaged by a recent flood, demolish a structure severely damaged by an

Capability	Details	
		earthquake, or repair a public facility severely damaged by a hazard event. Additional information regarding CDBG is available on the website: https://www.hudexchange.info/programs/cdbg-entitlement/.
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Federal Highway Administration (FHWA) -Emergency Relief	**Description:**	The FHWA Emergency Relief is a grant program through the U.S. Department of Transportation (DOT) that can be used for repair or reconstruction of federal-aid highways and roads on federal lands that have suffered serious damage as a result of a disaster. The Texas Department of Transportation serves as the liaison between local municipalities and FHWA. Additional information regarding the FHWA Emergency Relief Program is available on the website: https://www.fhwa.dot.gov/programadmin/erelief.cfm.
	Responsible Agency:	U.S. DOT
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Federal Transit Administration - Emergency Relief	**Description:**	The Federal Transit Authority (FTA) Emergency Relief is a grant program that funds capital projects to protect, repair, reconstruct, or replace equipment and facilities of public transportation systems. Administered by the Federal Transit Authority at the U.S. DOT and directly allocated to Metropolitan Transit Authority (MTA) and Port Authority, this transportation-specific fund was created as an alternative to FEMA PA. Currently, a total of $5.2 billion has been allocated to New Jersey-related entities. Additional information regarding the FTA Emergency Relief Program is available on the website: https://www.transit.dot.gov/funding/grant-programs/emergency-relief-program/emergency-relief-program.
	Responsible Agency:	U.S. DOT
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Disaster Housing Program	**Description:**	Emergency assistance for housing, including minor repair of home to establish livable conditions, mortgage, and rental assistance available through the U.S. Department of Housing and Urban Development (HUD). Information on this program is available on the website: https://www.hud.gov/program_offices/public_indian_housing/publications/dhap.
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
HOME Investment Partnerships Program	**Description:**	Grants to local and state government and consortia for permanent and transitional housing (including financial support for property acquisition and rehabilitation for low-income persons). Information on this program is available on the website: https://www.hud.gov/program_offices/comm_planning/affordablehousing/programs/home/.
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
HUD Disaster Recovery Assistance	**Description:**	Grants to fund gaps in available recovery assistance after disasters (including mitigation). Information on this program is available on the website: https://www.hud.gov/info/disasterresources.
	Responsible Agency:	HUD

Capability	Details	
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Section 108 Loan Guarantee	**Description:**	Enables states and local governments participating in the CDBG program to obtain federally guaranteed loans for disaster-distressed areas. Information on this program is available on the website: https://www.hudexchange.info/programs/section-108/.
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Smart Growth Implementation Assistance Program	**Description:**	The Smart Growth Implementation Assistance (SGIA) program through the U.S. Environmental Protection Agency (EPA) focuses on complex or cutting-edge issues, such as stormwater management, code revision, transit-oriented development, affordable housing, infill development, corridor planning, green building, and climate change. Applicants can submit proposals under 4 categories: community resilience to disasters, job creation, the role of manufactured homes in sustainable neighborhood design, or medical and social service facilities siting. Information on this program is available on the website: https://www.epa.gov/smartgrowth.
	Responsible Agency:	EPA
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Partners for Fish and Wildlife	**Description:**	Financial and technical assistance to private landowners interested in pursuing restoration projects affecting wetlands and riparian habitats. Information on this program is available on the website: https://www.fws.gov/partners/.
	Responsible Agency:	U.S. Fish and Wildlife Service
	Provides Funding for Mitigation:	Yes
	Hazard:	All natural hazards
Transportation Investment Generating Economic Recovery (TIGER)	**Description:**	Investing in critical road, rail, transit, and port projects across the nation. Information on this program is available on the website: https://www.transportation.gov/tags/tiger-grants.
	Responsible Agency:	U.S. DOT
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Community Facilities Direct Loan & Grant Program	**Description:**	This program provides affordable funding to develop essential community facilities in rural areas. An essential community facility is defined as a facility that provides an essential service to the local community for the orderly development of the community in a primarily rural area and does not include private, commercial, or business undertakings. Information on this program is available on the website: https://www.rd.usda.gov/programs-services/community-facilities-direct-loan-grant-program.
	Responsible Agency:	USDA
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Emergency Loan Program	**Description:**	USDA's Farm Service Agency provides emergency loans to help producers recover from production and physical losses due to drought, flooding, other natural disasters, or quarantine. Information on this program is available on the website: https://www.fsa.usda.gov/programs-and-services/farm-loan-programs/emergency-farm-loans/index.

Capability	Details	
	Responsible Agency:	USDA
	Provides Funding for Mitigation:	Yes
	Hazard:	All natural hazards
Emergency Watershed Protection Program	**Description:**	The Emergency Watershed Protection (EWP) program provides assistance to relieve imminent hazards to life and property caused by floods, fires, drought, windstorms, and other natural occurrences through the Natural Resources Conservation Service. Information on this program is available on the website: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/.
	Responsible Agency:	USDA
	Provides Funding for Mitigation:	Yes
	Hazard:	All natural hazards
Financial Assistance	**Description:**	Financial assistance to help plan and implement conservation practices that address natural resource concerns or opportunities to help save energy and improve soil, water, plant, air, animal and related resources on agricultural lands and non-industrial private forest land. Information on this program is available on the website: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/.
	Responsible Agency:	NRCS
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Emergency Management Performance Grants (EMPG) Program	**Description:**	Assist local, tribal, territorial, and state governments in enhancing and sustaining all-hazards emergency management capabilities. Information on this program is available on the website: https://www.fema.gov/emergency-management-performance-grant-program.
	Responsible Agency:	U.S. DHS
	Provides Funding for Mitigation:	Yes
	Hazard:	All hazards
Reimbursement for Firefighting on Federal Property	**Description:**	Provides reimbursement only for direct costs and losses over and above normal operating costs. Information on this program is available on the website: https://www.usfa.fema.gov/grants/firefighting_federal_property.html.
	Responsible Agency:	U.S. DHS
	Provides Funding for Mitigation:	Yes
	Hazard:	Wildfire
Land & Water Conservation Fund	**Description:**	Matching grants to states and local governments for the acquisition and development of public outdoor recreation areas and facilities (as well as funding for shared federal land acquisition and conservation strategies). Information on this program is available on the website: https://www.nps.gov/subjects/lwcf/index.htm.
	Responsible Agency:	National Park Service
	Provides Funding for Mitigation:	Yes
	Hazard:	All natural hazards
State		
Texas Water Development Board Flood Funding	**Description:**	The TWDB offers a variety of cost-effective loan and grant programs that provide for the planning, acquisition, design, and construction of water-related infrastructure and other water quality improvements.

Capability	Details	
	Responsible Agency:	Texas Water Development Board
	Provides Funding for Mitigation:	Yes
	Hazard:	Flooding
Texas A&M Forest Service Prescribed Burn Grants	**Description:**	Texas A&M Forest Service offers grants to landowners to complete prescribed fires on private land. Each grant targets landowners in different priority areas across the state.
	Responsible Agency:	Texas A&M Forest Service
	Provides Funding for Mitigation:	Yes
	Hazard:	Wildfire
Flood Control Dam Infrastructure Projects - Supplemental Funding	**Description:**	Projects to repair and rehabilitate flood control structures across Texas will now be funded due to a $150 million appropriations bill legislators passed this session.
	Responsible Agency:	Texas State Soil and Water Conservation Board
	Provides Funding for Mitigation:	Yes
	Hazard:	Flooding, Dam Failure
Flood Infrastructure Fund (FIF)	**Description:**	FIF program provides financial assistance in the form of loans and grants for flood control, flood mitigation, and drainage projects.
	Responsible Agency:	Texas Water Development Board
	Provides Funding for Mitigation:	Yes
	Hazard:	Flooding
Texas Coastal Management Program Grant	**Description:**	Funding for projects that address environmental concerns and promote economic development within the Texas coastal zone.
	Responsible Agency:	Texas General Land Office
	Provides Funding for Mitigation:	Yes
	Hazard:	Erosion and Flooding
Texas Farm and Ranch Lands Conservation Program (TFRLCP)	**Description:**	Funding conserves natural resources by protecting working lands from fragmentation and development. TFRLCP maintains and enhances the ecological and agricultural productivity of these lands through Agricultural Conservation Easements.
	Responsible Agency:	Texas Parks and Wildlife
	Provides Funding for Mitigation:	Yes
	Hazard:	Flooding

5.5 Plan Integration

Described earlier in this section and within each annex, participating jurisdictions identified integration of hazard risk management into their existing planning, regulatory, and operational/administrative framework ("integration capabilities") and intended integration promotion (integration actions). Volume II, Section 9 (Jurisdictional Annexes) provides details on how each jurisdiction integrates hazard mitigation into their existing capabilities.

5.5.1 Integration Process

Hazard mitigation is a sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards. Integrating hazard mitigation into a community's existing plans, policies, codes, and programs leads to development patterns that do not increase risk from known hazards or leads to redevelopment that reduces risk from known hazards. The Fort Bend County Planning Partnership was tasked with identifying how hazard mitigation is integrated into existing planning mechanisms. Section 9 (Jurisdictional Annexes) details how this is done for each participating municipality and each County. During this process, many municipalities recognized the importance and benefits of incorporating hazard mitigation into future municipal planning and regulatory processes and have added new mitigation actions to support this effort. The Planning Partnership representatives will continue to incorporate mitigation planning as an integral component of daily government operations.

Planning Partnership representatives will continue to work with local government officials to integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. Further, the sample adoption resolution presented in Appendix A (Plan Adoption) includes a resolution item stating the intent of the local governing body to incorporate mitigation planning as an integral component of government and partner operations. By doing so, the Planning Partnership anticipates that:

1. Hazard mitigation planning will be formally recognized as an integral part of overall planning and emergency management efforts.
2. The Hazard Mitigation Plan, Master Plans, Emergency Management Plans, and other relevant planning mechanisms will become mutually supportive documents that work in concert to meet the goals and needs of County residents.

Section 7 (Plan Maintenance) provides for additional information on the implementation of the mitigation plan through existing programs.

SECTION 6. MITIGATION STRATEGY

6.1 Introduction

This section presents mitigation actions for Fort Bend County (the Planning Area) to reduce potential exposure and losses identified as concerns in the Risk Assessment (Section 5). The Planning Partnership reviewed the risk assessment to identify and develop these mitigation actions, which are presented herein.

This section includes:

- Background and Past Mitigation Accomplishments
- General Mitigation Planning Approach
- Strengths, Weaknesses, Obstacles, and Opportunities
- Review and Update of Mitigation Goals and Objectives
- Mitigation Strategy Development and Update

Hazard mitigation reduces the potential impacts of, and costs associated with, emergency and disaster-related events. Mitigation actions address a range of impacts, including impacts on the population, property, the economy, and the environment.

Mitigation actions can include activities such as: revisions to land-use planning, training and education, and structural and nonstructural safety measures.

6.2 Background and Past Mitigation Accomplishments

In accordance with DMA 2000 requirements, a discussion regarding past mitigation activities and an overview of past efforts is provided as a foundation for understanding the mitigation goals, objectives, and activities outlined in this Hazard Mitigation Plan (HMP). The Planning Area, through previous and ongoing hazard mitigation activities, has demonstrated that it is proactive in protecting its physical assets and citizens against losses from natural and human-caused hazards. Examples of previous and ongoing actions, projects, and capabilities include the following:

- Fort Bend County participated in the development of a 2018 Hazard Mitigation Plan (HMP) and facilitated the 2023 HMP update, which included the participation of all municipal governments in the Planning Area. The current planning process represents the regulatory five-year local plan update process.
- All municipalities in Fort Bend County participate in the National Flood Insurance Program (NFIP), which requires the adoption of Federal Emergency Management Agency (FEMA) floodplain mapping and certain minimum construction standards for building within the floodplain.
- Currently, three Fort Bend municipalities are participating in the NFIP Community Rating System (CRS) program.
- Municipalities have participated on a limited basis in available mitigation grant funding opportunities to implement mitigation projects, including the following:
  - Safe rooms for tornadoes and severe wind events
  - Generators
  - Infrastructure protection measures for roadways and bridges
  - Property acquisitions
  - Retrofitting public structures

  - Warning systems
  - Shoreline stabilization
  - Mitigation planning
- The County and its municipalities have implemented mitigation actions to protect critical facilities and infrastructure throughout the Planning Area. These actions and others were identified in the County's Participation in their 2018 HMP.
- TDEM supports Fort Bend County communities reducing their risk and increasing their resilience. TDEM provides a comprehensive program to support local jurisdictions as they assess the risks they face, plan to mitigate them, and fund those plans to implement mitigation projects that reduce risk across the Planning Area.
- In 2020, the County and local municipalities responded to and worked to mitigate the impacts of the coronavirus pandemic through education of the public, enforcement of local and state social distancing and masking measures, and establishment of best practices to slow the spread of COVID-19.

These past and ongoing activities have contributed to the Planning Area's understanding of its hazard preparedness and future mitigation activity needs, costs, and benefits. These efforts provide an ongoing foundation for the Planning Partnership to use in developing this HMP update.

6.3 General Mitigation Planning Approach

The overall approach used to update the County and local hazard mitigation strategies are based on FEMA and State of Texas regulations and guidance regarding local mitigation plan development, including:

- DMA 2000 regulations, specifically 44 CFR 201.6 (local mitigation planning)
- FEMA Local Mitigation Planning Policy Guide, April 19, 2023
- FEMA Local Mitigation Planning Handbook, March 2013
- FEMA Local Mitigation Plan Review Guide, October 1, 2011
- FEMA Integrating Hazard Mitigation into Local Planning, March 1, 2013
- FEMA Plan Integration: Linking Local Planning Efforts, July 2015
- FEMA Mitigation Planning How-To Guide #3, Identifying Mitigation Actions and Implementing Strategies (FEMA 386-3), February 2013
- FEMA Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards, January 2013

The mitigation strategy update approach includes the following steps that are further detailed in later subsections of this section:

- Section 6.4 – Problem and solutions exercise
- Section 6.5 – Review and update mitigation goals and objectives
- Section 6.6 - Develop and prepare a mitigation strategy, including:
  - Review of the 2018 HMP mitigation actions
  - Identification of progress on the previous Fort Bend County and local mitigation strategies
  - 2023 HMP Mitigation Action Plan
  - Mitigation best practices
  - Mitigation strategy evaluation and prioritization
  - Benefit/cost review

6.4 Problem and Solutions Identification

A problem and solutions identification exercise was completed via online survey by the participating jurisdictions. Participants were asked to fill out at least one problem and solution for each of the hazards of concern for the 2023 HMP update. The Planning Partnership was asked to begin the exercise by identifying a problem caused by one of the hazards. Next, potential solutions to that problem were identified. To conclude the discussion of each ranked hazard, participants were asked about anticipated costs, benefits, funding sources, and project feasibility. The results were compiled and presented to the Planning Partnership. The results were also used by the participants to help identify capabilities and potential mitigation actions.

6.5 Review and Update of Mitigation Goals and Objectives

FEMA defines ***Goals*** as general guidelines that explain what should be achieved. Goals are usually broad, long-term, policy statements, and represent a global vision.

FEMA defines ***Objectives*** as strategies or implementation steps to attain mitigation goals. Unlike goals, objectives are specific and measurable, where feasible.

FEMA defines ***Mitigation Actions*** as specific actions that help to achieve the mitigation goals and objectives.

This section documents the efforts to update the guiding principles and hazard mitigation goals and objectives established to reduce or avoid long-term vulnerabilities to the identified hazards.

6.5.1 Goals and Objectives

According to CFR 201.6(c)(3)(i): "The hazard mitigation strategy shall include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards." Further, FEMA mitigation planning guidance recommends establishing objectives to better tie mitigation goals to specific mitigation strategies (e.g., projects, activities, and initiatives).

The goals established in the 2018 Fort Bend County Hazard Mitigation Plan were presented to the Steering Committee and Planning Partnership for review and amendment throughout the planning process. This review was made with consideration of the hazard events and losses since the 2018 plan, the updated hazard profiles and vulnerability assessment, and the goals and objectives established in the updated 2018 State HMP.

The Steering Committee met on February 9, 2023, to review the 2018 goals and objectives and provided input on updated goals and objectives. These updates were presented to the Planning Partnership during the March 2023 Mitigation Strategy Workshop. As a result of these efforts, Table 6-1 presents the Planning Area's updated goals and objectives for the 2023 HMP update.

Table 6-1. Fort Bend County 2023 Hazard Mitigation Plan Goals and Objectives

2023 HMP Update Goals	
1	Educate and inform citizens regarding potential emergency situations related to hazards.
2	Decrease the risk to life and property from hazards through planning, preparing, and mitigating.
3	Performing projects that reduce the impact of natural hazards in order to increase resiliency and enhance the ability to recover.
4	Enhance coordination between local, county, state, and federal agencies by understanding the impact of hazards in Fort Bend County and developing policies and strategies to effectively manage and reduce risk.
5	Support continuity of operations pre-, during, and post-hazard events, including the support of community lifelines and critical facilities.

	2023 HMP Update Objectives
1	Evaluate and improve safety & loss reduction codes/standards for hazards that affect Fort Bend County and its municipalities.
2	Develop and strengthen public/private partnerships between the County, non-profits, and the business community.
3	Identify funding sources and increase awareness of funding sources to obtain funding for mitigation projects from a variety of federal, state, regional, and local entities.
4	Promote sustainable communities and hazard-resilient development.
5	Promote the use of emergency notification systems and weather alert systems for all hazards.
6	Develop publications and information on all hazards that could potentially impact Fort Bend County.
7	Incorporate hazard mitigation into community planning mechanisms, codes/ordinances, day-to-day operations, and projects.
8	Identify, protect, and assist socially vulnerable populations recover from hazard impacts.
9	Ensure continuity of operations of government, non-government, commerce, private sector, non-profit, and infrastructure.
10	Implement mitigation measures that promote the reliability of community lifeline systems.

6.6 Mitigation Strategy Development and Update

As required by FEMA, the County and participating municipalities completed a comprehensive evaluation of the mitigation strategies and actions from the 2018 HMP and reported on the status of each. Their update may be found in each jurisdictional annex (Section 9). In addition, the County and participating municipalities were provided the opportunity to include new strategies or actions to include in the 2023 HMP Update. New actions were prioritized to ensure they are cost-effective, environmentally sound, and technically feasible using the methodology outlined below.

6.6.1 Review of the 2018 HMP Mitigation Action Plans

To evaluate progress on local mitigation actions, the planning consultant met with each participant to discuss the status of the mitigation actions identified in the 2018 plan. For each action, jurisdictions were asked to provide the status of each action (*No Progress, In Progress, Ongoing Capability, Discontinue, or Completed*) and provide review comments on each. Jurisdictions were requested to quantify the extent of progress and provide reasons for the level of progress or why actions were being discontinued. Each jurisdictional annex in Section 9 (Jurisdictional Annexes) provides a table identifying the jurisdiction's prior mitigation strategy, the status of those actions and initiatives, and their disposition within their updated strategy.

Local mitigation actions identified as *Complete*, and those actions identified as *Discontinued*, were removed from the updated strategies. Local mitigation actions identified as an *Ongoing Capability* were incorporated into the capability assessment of each jurisdictional annex. Those actions identified as *No Progress* or *In Progress* that remain a priority for the jurisdiction have been carried forward into the updated mitigation strategy. Actions identified as *Ongoing Capabilities,* which are fully integrated into the normal operational and administrative framework of the community have been identified within the capabilities section of each annex and removed from the updated mitigation strategy.

At the November 2022 kick-off meeting and during subsequent local-level planning meetings (phone, email), all participating jurisdictions were requested to identify mitigation activities completed, ongoing, and potential/proposed. As new potential

Throughout the planning process, the planning consultant worked directly with each community (phone, email) to assist with the development and update of their annex and include mitigation strategies, focusing on identifying well-defined, implementable projects with a careful consideration of benefits (risk reduction, losses avoided), costs, and possible funding sources (including mitigation grant programs).

mitigation actions, projects, or initiatives became evident during the plan update process, including as part of the risk assessment update and as identified through the public and stakeholder outreach process detailed in Section 2 (Planning Process), jurisdictions were made aware of these either through direct communication (local meetings, email, phone), at Steering and Planning Committee meetings, or via their draft jurisdictional annexes.

6.6.2 Identification and Analysis of Mitigation Techniques

Concerted efforts were made to ensure that municipalities develop updated mitigation strategies that included activities and initiatives covering the range of mitigation action types described in recent FEMA planning guidance (FEMA "Local Mitigation Planning Handbook" March 2013), specifically:

- **Local Plans and Regulations** - These actions include government authorities, policies, or codes that influence the way land and buildings are being developed and built.
- **Structure and Infrastructure Projects** - These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct manmade structures to reduce the impact of hazards.
- **Natural Systems Protection** - These are actions that minimize damage and losses and preserve or restore the functions of natural systems.
- **Education and Awareness Programs** - These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. These actions may also include participation in national programs, such as the NFIP and CRS, StormReady (NOAA), and Firewise (NFPA) Communities.

6.6.3 2023 HMP Mitigation Action Plan

To help support the selection of an appropriate, risk-based mitigation strategy, each annex provides a summary of hazard vulnerabilities identified during the plan update process, either directly by municipal representatives, through a review of the available Fort Bend County and local plans and reports, and through the hazard profiling and vulnerability assessment process.

In March 2023, the Planning Partnership participated in a mitigation strategy development workshop, supplemented by emails and phone calls between jurisdictions and the contract consultant, for all participating jurisdictions to support the development of focused problem statements based on the impacts of natural hazards in the County and their communities. These problem statements were intended to provide a detailed description of the problem area, including its impacts to the municipality/jurisdiction, past damages, loss of service; etc. An effort was made to include the street address of the property/project location, adjacent streets, water bodies, and well-known structures as well as a brief description of existing conditions (topography, terrain, hydrology) of the site. These problem statements formed a bridge between the hazard risk assessment, which quantifies impacts to each community with the development of actionable mitigation strategies.

As discussed within the hazard profiles in Section 4.3 (Risk Assessment), the long-term effects of climate change are anticipated to exacerbate the impacts of weather-related hazards, including flood, hurricanes and tropical storm, severe weather, severe winter weather, and wildfire. By way of addressing these climate change-sensitive hazards within their local mitigation strategies and integration actions, communities are working to evaluate and recognize these long-term implications and potential impacts and to incorporate them in planning and capital improvement updates.

A strong effort has been made to better focus local mitigation strategies to clearly defined, readily implementable projects and initiatives that meet the definition or characteristics of mitigation. Broadly defined mitigation actions were eliminated from the updated strategy unless accompanied by discrete actions, projects, or initiatives. Certain continuous or ongoing strategies that represent programs that are fully integrated into the normal operational and administrative framework of the community have been identified within the capabilities section of each annex and removed from the updated mitigation strategy.

To assist with the development of mitigation actions, municipalities were provided with the following:

- 2023 HMP goals and objectives
- 2018 HMP mitigation strategies
- Risk assessment results
- Outcome of the problem and solutions exercise
- Mitigation catalog
- Stakeholder and public input (e.g. resident and stakeholder survey results)
- FEMA resources

Overall, a comprehensive range of specific mitigation initiatives were considered by each plan participant to pursue in the future to reduce the effects of hazards. Some of these initiatives may be previous actions carried forward for this plan update. These initiatives are dependent upon available funding (grants and local match availability) and may be modified or omitted at any time based on the occurrence of new hazard events and changes in municipal priorities.

Throughout the course of the plan update process, additional regional and county-level mitigation actions were identified by the following processes:

- Review of the results and findings of the updated risk assessment
- Review of available regional and County plans reports and studies
- Direct input from County departments and other County and regional agencies
- Input received through the public and stakeholder outreach process

6.6.4 Mitigation Best Practices

Catalogs of hazard mitigation best practices were developed that present a broad range of alternatives to be considered for use in the Planning Area, in compliance with 44 CFR Section 201.6(c)(3)(ii). One catalog was developed for each natural hazard of concern evaluated in this plan, referred to as Appendix F (Mitigation Strategy Supplementary Data). The catalogs present alternatives that are categorized in two ways:

- By whom would have responsibility for implementation:
  - Individuals – personal scale
  - Businesses – corporate scale
  - Government – government scale
- By what each of the alternatives would do:
  - Manipulate the hazard
  - Reduce exposure to the hazard
  - Reduce vulnerability to the hazard
  - Build local capacity to respond to or be prepared for the hazard

The alternatives presented include actions that will mitigate current risk from hazards and actions that will help reduce risk from changes in the impacts of these hazards resulting from climate change. Hazard mitigation actions recommended in this plan were selected from among the alternatives presented in the catalog as well as other resources made available to all jurisdictions (i.e., FEMA's Mitigation Ideas). The catalog provides a baseline of mitigation alternatives that are backed by a planning process, are consistent with the established goals and objectives, and are within the capabilities of the planning partners to implement. Some of these

actions may not be feasible based on the selection criteria identified for this plan. The purpose of the catalog was to provide a list of what could be considered to reduce risk from natural hazards within the Planning Area. Actions in the catalog that are not included for the partnership's action plan were not selected for one or more of the following reasons:

- The action is not feasible;
- The action is already being implemented;
- There is an apparently more cost-effective alternative; and/or
- The action does not have public or political support.

6.6.5 Mitigation Strategy Evaluation and Prioritization

Section 201.c.3.iii of 44 CFR requires an action plan describing how the actions identified will be prioritized. Recent FEMA planning guidance (March 2013) identifies a modified STAPLEE (Social, Technical, Administrative, Political, Legal, Economic, and Environmental) mitigation action evaluation methodology that uses a set of 10 evaluation criteria suited to the purposes of hazard mitigation strategy evaluation. This method provides a systematic approach that considers the opportunities and constraints of implementing a particular mitigation action.

Based on this guidance, the Steering Committee has adopted and applied an action evaluation and prioritization methodology, which includes an expanded set of 14 criteria to include the consideration of cost-effectiveness, availability of funding, anticipated timeline, and if the action addresses multiple hazards.

The 14 evaluation/prioritization criteria used in the 2023 update process are:

1) **Life Safety** – How effective will the action be at protecting lives and preventing injuries?
2) **Property Protection** – How significant will the action be at eliminating or reducing damage to structures and infrastructure?
3) **Cost-Effectiveness** – Are the costs to implement the project or initiative commensurate with the benefits achieved?
4) **Technical** – Is the mitigation action technically feasible? Is it a long-term solution? Eliminate actions that, from a technical standpoint, will not meet the goals.
5) **Political** – Is there overall public support for the mitigation action? Is there the political will to support it?
6) **Legal** – Does the municipality have the authority to implement the action?
7) **Fiscal** – Can the project be funded under existing program budgets (i.e., is this initiative currently budgeted for)? Or would it require a new budget authorization or funding from another source such as grants?
8) **Environmental** – What are the potential environmental impacts of the action? Will it comply with environmental regulations?
9) **Social** – Will the proposed action adversely affect one segment of the population? Will the action disrupt established neighborhoods, break up voting districts, or cause the relocation of lower-income people?
10) **Administrative** – Does the jurisdiction have the personnel and administrative capabilities to implement the action and maintain it, or will outside help be necessary?
11) **Multi-hazard** – Does the action reduce the risk to multiple hazards?
12) **Timeline** – Can the action be completed in less than 5 years (within our planning horizon)?

13) **Local Champion** – Is there a strong advocate for the action or project among the jurisdiction's staff, governing body, or committees that will support the action's implementation?
14) **Other Local Objectives** – Does the action advance other local objectives, such as capital improvements, economic development, environmental quality, or open space preservation? Does it support the policies of other plans and programs?

Specifically, for each mitigation action, the jurisdictions were asked to assign a numeric rank (-1, 0, or 1) for each of the 14 evaluation criteria, defined as follows:

- 1 = Highly effective or feasible
- 0 = Neutral
- -1 = Ineffective or not feasible

Further, jurisdictions were asked to provide a summary of the rationale behind the numeric rankings assigned, as applicable. The numerical results were totaled to assist each jurisdiction in selecting mitigation actions for the updated plan.

As step 1 in the prioritization process, actions that had a numerical value between 0 and 4 were initially prioritized as low; actions with numerical values between 5 and 9 were initially categorized as medium; and actions with numerical values between 10 and 14 were initially categorized as high.

As step 2, jurisdictions were asked to consider the benefits and costs as well as the desired timeline for implementation and project completion timeline when finalizing each action's priority as high/medium/low. These attributes are included in the mitigation strategy table and for FEMA-eligible projects in the mitigation worksheets (Section 9 – Annexes).

For the plan update, there has been an effort to develop more clearly defined and action-oriented mitigation strategies. These local strategies include projects and initiatives that are seen by the community as the most effective approaches to advance their local mitigation goals and objectives within their capabilities. In addition, each jurisdiction was asked to develop problem statements. With this process, participating jurisdictions were able to develop action-oriented and achievable mitigation strategies.

6.6.6 Benefit/Cost Review

Section 201.6.c.3iii of 44CFR requires the prioritization of the action plan to emphasize the extent to which benefits are maximized according to a cost/benefit review of the proposed projects and their associated costs. Stated otherwise, cost-effectiveness is one of the criteria that must be applied during the evaluation and prioritization of all actions comprising the overall mitigation strategy.

The benefit/cost review applied in the evaluation and prioritization of projects and initiatives in this HMP update process was qualitative; that is, it does not include the level of detail required by FEMA for project grant eligibility under the Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA) and Pre-Disaster Mitigation (PDM) grant programs. For all actions identified in the local strategies, jurisdictions have identified both the costs and benefits associated with project, action, or initiative.

Costs are the total cost for the action or project and may include administrative costs, construction costs (including engineering, design, and permitting), and maintenance costs.

Benefits are the savings from losses avoided attributed to the implementation of the project and may include life safety, structure and infrastructure damages, loss of service or function, and economic and environmental damage and losses.

When possible, jurisdictions were asked to identify the actual or estimated dollar value for project costs and associated benefits. Having defined costs and benefits allows a direct comparison of benefits versus costs and a quantitative evaluation of project cost-effectiveness. Often, however, numerical costs and/or benefits have not been identified or may be impossible to quantitatively assess.

For the purposes of this planning process, jurisdictions were tasked with evaluating project cost-effectiveness with both costs and benefits assigned to "High", "Medium", and "Low" ratings. Where quantitative estimates of costs and benefits were available, ratings/ranges were defined as:

- Low = < $10,000
- Medium = $10,000 to $100,000
- High = > $100,000

Where quantitative estimates of costs and/or benefits were not available, qualitative ratings using the following definitions were used:

Table 6-2. Qualitative Cost and Benefit Ratings

Costs	
High	Existing funding levels are not adequate to cover the costs of the proposed project, and implementation would require an increase in revenue through an alternative source (e.g., bonds, grants, and fee increases).
Medium	The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
Low	The project could be funded under the existing budget. The project is part of or can be part of an existing, ongoing program.
Benefits	
High	Project will have an immediate impact on the reduction of risk exposure to life and property.
Medium	Project will have a long-term impact on the reduction of risk exposure to life and property or will provide an immediate reduction in the risk exposure to property.
Low	Long-term benefits of the project are difficult to quantify in the short term.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly. For some of the Fort Bend County initiatives identified, the Planning Partnership may seek financial assistance under FEMA's HMGP or Hazard Mitigation Assistance (HMA) programs. These programs require detailed benefit/cost analysis as part of the application process. These analyses will be performed when funding applications are prepared, using the FEMA BCA model process. The Planning Partnership is committed to implementing mitigation strategies with benefits that exceed costs. For projects not seeking financial assistance from grant programs that require this sort of analysis, the Planning Partnership reserves the right to define "benefits" according to parameters that meet its needs and the goals and objectives of this HMP.

SECTION 7. PLAN MAINTENANCE

This section details the formal process that will ensure that the Hazard Mitigation Plan (HMP) remains an active and relevant document and that the Planning Partnership maintains its eligibility for applicable funding sources. The plan maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan every five years. In addition, this section describes how public participation will be integrated throughout the plan maintenance and implementation process. It explains how the mitigation strategies outlined in this plan update will be incorporated into existing planning mechanisms and programs, such as comprehensive land use planning processes, capital improvement planning, and building code enforcement and implementation. The plan's format allows sections to be reviewed and updated when new data becomes available, resulting in a plan that will remain current and relevant.

The plan maintenance matrix shown in Table 7-1 provides a synopsis of responsibilities for plan monitoring, evaluation, and update, which are discussed in further detail in the sections below.

Table 7-1. Plan Maintenance Matrix

Task	Approach	Timeline	Lead Responsibility	Support Responsibility
Monitoring	Preparation of status updates and action implementation tracking as part of submission for Annual Progress Report.	Meet annually or upon major update to comprehensive plan or major disaster declaration	Jurisdictional points-of-contact identified in Section 8 (Planning Partnership) and Section 9 (Annexes)	Jurisdictional implementation lead identified in Section 8 (Planning Partnership) and Section 9 (Annexes)
Integration	For integration of mitigation principles action to become an organic part of the ongoing County and municipal activities, the County will incorporate the distribution of the safe growth worksheet for annual review and update by all participating jurisdictions.	September each year with interim email reminders to address integration in County and municipal activities	HMP Coordinator and jurisdictional points-of-contact identified in Section 8 (Planning Partnership) and Section 9 (Annexes)	HMP Coordinator
Evaluation	Review the status of previous actions as submitted by the monitoring task lead and support to assess the effectiveness of the plan; compile and finalize the Annual Progress Report.	Finalized progress report completed by October 14 of each year	Planning Partnership; Plan Maintenance element	Jurisdictional points-of-contact identified in Section 9 (Annexes)
Update	Reconvene the planning partners, at a minimum, every five years to guide a comprehensive update to review and revise the plan.	Every five years or upon major update to Master Plan or major disaster	HMP Coordinator	Jurisdictional points-of-contact identified in Section 9 (Annexes)

7.1 Monitoring, Evaluating, and Updating the Plan

The procedures for monitoring, evaluating, and updating the plan are provided below.

The Fort Bend County HMP Coordinator is assigned to manage the maintenance and update of the plan during its performance period. The Fort Bend County HMP Coordinator will chair the Planning Partnership and be the prime point

of contact for questions regarding the plan and its implementation as well as to coordinate incorporation of additional information into the plan.

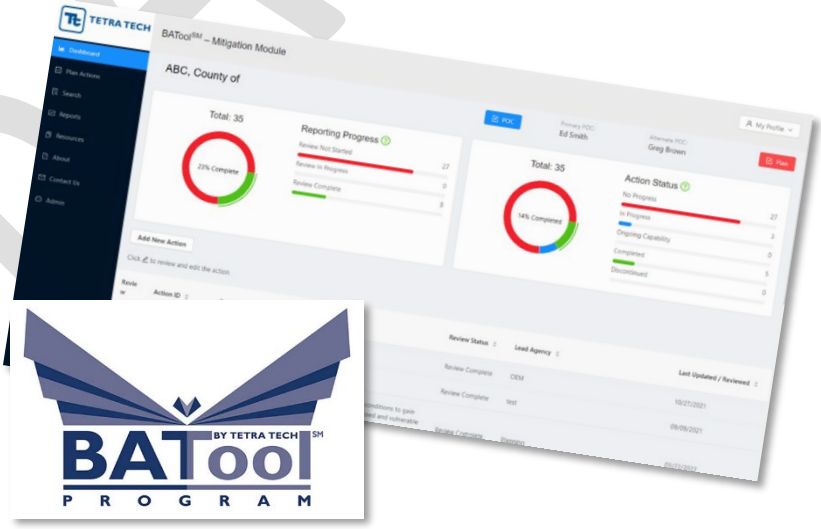
The Planning Partnership, which is composed of a representative from each participating jurisdiction, shall fulfill the monitoring, evaluation, and updating responsibilities identified in this section. Each jurisdiction is expected to maintain a representative on the Planning Partnership throughout the plan performance period (five years from the date of plan adoption). As of the date of this plan, primary and secondary mitigation planning representatives (points-of-contact) are identified in each jurisdictional annex in Section 9 (Annexes).

Regarding the composition of the committee, it is recognized that individual commitments change over time, and it shall be the responsibility of each jurisdiction and its representatives to inform the Fort Bend County HMP Coordinator of any changes in representation. The Fort Bend County HMP Coordinator will strive to keep the committee makeup as a uniform representation of planning partners and stakeholders within the planning area. Currently, the Fort Bend County HMP Coordinator is designated as:

Greg Babst, Fort Bend County Emergency Management Coordinator
(281) 238-3428 | Gregory.Babst@fortbendcountytx.gov

7.1.1 Monitoring

The Planning Partnership will be responsible for monitoring progress, evaluating the effectiveness of the plan, and documenting annual progress. Each year, beginning one year after plan development, Fort Bend County and local Planning Partnership representatives will collect and process information from the departments, agencies, and organizations involved in implementing mitigation projects or activities identified in their jurisdictional annexes (Section 9) of this plan, by contacting persons responsible for initiating and/or overseeing the mitigation projects.



In the first year of the performance period, this will be accomplished by utilizing an online performance progress reporting system, the Baseline Assessment Tool (BATool[SM]), which will enable municipal and County representatives to directly access mitigation initiatives to easily update the status of each project, document successes or obstacles to implementation, add or delete projects to maintain mitigation project implementation. It is anticipated that all participating partners will be prompted by the tool to update progress annually, providing an incentive for participants to refresh their mitigation strategies and to continue implementation of projects. It is expected that this reporting system will support the submittal of an increased number of project grant fund applications due to the functionality of the system which facilitates the sorting and prioritization of projects.

In addition to progress on the implementation of mitigation actions, including efforts to obtain outside funding and obstacles or impediments to implementation of actions, the information that Planning Partnership representatives shall be expected to document, as needed and appropriate, includes:

- Any grant applications filed on behalf of the participating jurisdictions
- Hazard events and losses occurring in their jurisdiction
- Additional mitigation actions believed to be appropriate and feasible
- Public and stakeholder input

Plan monitoring for years 2 through 4 of the plan performance period will be similarly addressed via the BATool[SM] or manually.

7.1.2 Integration Process of the HMP into Municipal Planning Mechanisms

Hazard mitigation is sustained action taken to reduce or eliminate the long-term risk to human life and property from natural hazards. Integrating hazard mitigation into a community's existing plans, policies, codes, and programs leads to development patterns that do not increase risk from known hazards or leads to redevelopment that reduces risk from known hazards. The Fort Bend County HMP Planning Partnership was tasked with identifying how hazard mitigation is integrated into existing planning mechanisms. Refer to Section 9 (Annexes) for how this is done for each participating municipality. During this process, many municipalities recognized the importance and benefits of incorporating hazard mitigation into future municipal planning and regulatory processes.

The Planning Partnership representatives will incorporate mitigation planning as an integral component of daily government operations. They will work with local government officials to integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. Further, the sample adoption resolution (Appendix A) includes a resolution item stating the intent of the local governing body to incorporate mitigation planning as an integral component of government and partner operations. By doing so, the Planning Partnership anticipates that:

- Hazard mitigation planning will be formally recognized as an integral part of overall planning and emergency management efforts.
- The HMP, Comprehensive Plans, Emergency Management/Operations Plans and other relevant planning mechanisms will become mutually supportive documents that work in concert to meet the goals and needs of County residents.

During the HMP annual review process, each participating municipality will be asked to document how they are utilizing and incorporating the Fort Bend County HMP 2023 update into their day-to-day operations and planning and regulatory processes. Additionally, the County will identify additional policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions and include these findings and recommendations in the Annual HMP Progress Report. The following checklist presented in Table 7-2 was adapted from FEMA's Local Mitigation Handbook (2013), Appendix A, Worksheet 4.2. This checklist will help a community analyze how hazard mitigation is integrated into local plans, ordinances, regulations, ordinances, and policies. Completing the checklist will help the County identify areas that integrate hazard mitigation currently and where to make improvements and reduce vulnerability to future development. In this manner, the integration of mitigation into jurisdictional activities will evolve into an ongoing culture within the County.

Table 7-2. Safe Growth Check List

Planning Mechanisms	Do you do this? Yes	Do you do this? No	Notes: How is it being done or how will this be utilized in the future?
Operating, Municipal, and Capital Improvement Program Budgets			
▪ When constructing upcoming budgets, hazard mitigation actions will be funded as budget allows. Construction			

Planning Mechanisms	Do you do this? Yes	Do you do this? No	Notes: How is it being done or how will this be utilized in the future?
projects will be evaluated to see if they meet the hazard mitigation goals.			
▪ Annually, during adoption process, the municipality will review mitigation actions when allocating funding.			
▪ Do budgets limit expenditures on projects that would encourage development in areas vulnerable to natural hazards?			
▪ Do infrastructure policies limit extension of existing facilities and services that would encourage development in areas vulnerable to natural hazards?			
▪ Do budgets provide funding for hazard mitigation projects identified in the County HMP?			
Human Resource Manual			
▪ Do any job descriptions specifically include identifying and/or implementing mitigation projects/actions or other efforts to reduce natural hazard risk?			
Building and Zoning Ordinances			
▪ Prior to zoning changes or development permitting, does the municipality will review the HMP and other hazard analyses to ensure consistent and compatible land use?			
▪ Does the zoning ordinance discourage development or redevelopment within natural areas, including wetlands, floodways, and floodplains?			
▪ Does it contain natural overlay zones that set conditions?			
▪ Does the ordinance require developers to take additional actions to mitigate natural hazard risk?			
▪ Do rezoning procedures recognize natural hazard areas as limits on zoning changes that allow greater intensity or density of use?			
▪ Do the ordinances prohibit development within or filling of wetlands, floodways, and floodplains?			
Subdivision Regulations			
▪ Do the subdivision regulations restrict the subdivision of land within or adjacent to natural hazard areas?			
▪ Do the subdivision regulations restrict the subdivision of land within or adjacent to natural hazard areas?			
▪ Do the regulations provide for conservation subdivisions or cluster subdivisions in order to conserve environmental resources?			
▪ Do the regulations allow density transfers where hazard areas exist?			
Comprehensive Plan			
▪ Are the goals and policies of the plan related to those of the County HMP?			
▪ Does the future land use map clearly identify natural hazard areas?			
▪ Do the land use policies discourage development or redevelopment with natural hazard areas?			
▪ Does the plan provide adequate space for expected future growth in areas located outside natural hazard areas?			
Land Use			
▪ Does the future land use map clearly identify natural hazard areas?			
▪ Do the land use policies discourage development or redevelopment with natural hazard areas?			
▪ Does the plan provide adequate space for expected future growth in areas located outside natural hazard areas?			
Transportation Plan			

Planning Mechanisms	Do you do this? Yes	Do you do this? No	Notes: How is it being done or how will this be utilized in the future?
▪ Does the transportation plan limit access to hazard areas?			
▪ Is transportation policy used to guide growth to safe locations?			
▪ Are transportation systems designed to function under disaster conditions (e.g., evacuation)?			
Environmental Management			
▪ Are environmental systems that protect development from hazards identified and mapped?			
▪ Do environmental policies maintain and restore protective ecosystems?			
▪ Do environmental policies provide incentives to development that is located outside protective ecosystems?			
Grant Applications			
▪ Data and maps will be used as supporting documentation in grant applications.			
Municipal Ordinances			
▪ When updating municipal ordinances, hazard mitigation will be a priority.			
Economic Development			
▪ Local economic development group will take into account information regarding identified hazard areas when assisting new businesses in finding a location.			
Public Education and Outreach			
▪ Does the municipality have any public outreach mechanisms/programs in place to inform citizens on natural hazards, risk, and ways to protect themselves during such events?			

7.1.3 Evaluating

The evaluation of the mitigation plan is an assessment of whether the planning process and actions have been effective, if the HMP goals are being achieved, and whether changes are needed. The HMP will be evaluated on an annual basis to determine the effectiveness of the programs and to reflect changes that could affect mitigation priorities or available funding.

The status of the HMP will be discussed and documented at an annual plan review meeting of the Planning Partnership, to be held either in person or via teleconference approximately one year from the date of local adoption of this update and successively thereafter. At least two weeks before the annual plan review meeting, the Fort Bend County HMP Coordinator will advise Planning Partnership members of the meeting date, agenda, and expectations of the members.

The Fort Bend County HMP Coordinator will be responsible for calling and coordinating the annual plan review meeting and soliciting input regarding progress toward meeting plan goals and objectives. These evaluations will assess whether:

- Goals and objectives address current and expected conditions
- The nature or magnitude of the risks has changed
- Current resources are appropriate for implementing the HMP and whether different or additional resources are now available
- Actions were cost-effective
- Schedules and budgets are feasible
- Implementation problems, such as technical, political, legal, or coordination issues with other agencies, are present
- Outcomes have occurred as expected

- Changes in Planning Area resources impacted plan implementation (e.g., funding, personnel, and equipment)
- New agencies/departments/staff should be included, including other local governments, as defined under 44 CFR 201.6.

Specifically, the Planning Partnership will review the mitigation goals, objectives, and activities using performance-based indicators, including:

- New agencies/departments
- Project completion
- Underspending/overspending
- Achievement of the goals and objectives
- Resource allocation
- Timeframes
- Budgets
- Lead/support agency commitment
- Resources
- Feasibility

Finally, the Planning Partnership will evaluate how other programs and policies have conflicted or augmented planned or implemented measures and shall identify policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions ("Implementation of Mitigation Plan through Existing Programs" subsection later in this section discusses this process). Other programs and policies can include those that address:

- Economic development
- Environmental preservation
- Historic preservation
- Redevelopment
- Health and/or safety
- Recreation
- Land use/zoning
- Public education and outreach
- Transportation

The Planning Partnership should refer to the evaluation forms, Worksheets #2 and #4, in the FEMA 386-4 guidance document, to assist in the evaluation process (see Appendix F – Maintenance). Further, the Planning Partnership should refer to any process and plan review deliverables developed by the County as a part of the plan review processes established for prior or existing local HMPs within the County.

The Fort Bend County HMP Coordinator shall be responsible for preparing an Annual HMP Progress Report for each year of the performance period, based on the information provided by the local Planning Partnership members, information presented at the annual Planning Partnership meeting, and other information as appropriate and relevant. These annual reports will provide data for the five-year update of this HMP and will assist in pinpointing any implementation challenges. By monitoring the implementation of the HMP on an annual basis, the Planning Partnership will be able to assess which projects are completed, which are no longer feasible, and what projects should require additional funding.

The Annual HMP Progress Report shall be posted on Fort Bend County's website to keep the public appraised of the plan's implementation (located at https://www.fortbendcountytxhmp.com/). Additionally, the website provides details on the HMP update planning process.

The HMP will also be evaluated and revised following any major disasters to determine if the recommended actions remain relevant and appropriate. The risk assessment will also be revisited to see if any changes are necessary based on the pattern of disaster damages or if data listed in Section 4.3 (Hazard Profiles) of this plan has been collected to facilitate the risk assessment. This is an opportunity to increase the community's disaster resistance and build a better and stronger community.

7.1.4 Updating

To facilitate the update process, the Fort Bend County HMP Coordinator, with support of the Planning Partnership, shall use the second annual meeting to develop and commence the implementation of a detailed plan update program. The Fort Bend County HMP Coordinator shall invite representatives from the Texas Division of Emergency Management (TDEM) to this meeting to provide guidance on plan update procedures. This program shall, at a minimum, establish who shall be responsible for managing and completing the plan update effort, what needs to be included in the updated plan, and a detailed timeline with milestones to ensure that the update is completed according to regulatory requirements.

At this meeting, the Planning Partnership shall determine what resources will be needed to complete the update. The Fort Bend County HMP Coordinator shall be responsible for assuring that needed resources are secured.

Following each five-year update of the mitigation plan, the updated plan will be distributed for public comment. After all comments are addressed, the HMP will be revised and distributed to all planning group members and the State of Texas State Hazard Mitigation Officer.

7.1.5 Grant Monitoring and Coordination

Fort Bend County recognizes the importance of having an annual coordination period that helps each planning partner become aware of upcoming mitigation grant opportunities and identifies multi-jurisdiction projects to pursue. Grant monitoring will be the responsibility of each municipal partner as part of their annual progress reporting. The Fort Bend County HMP Coordinator will keep the planning partners apprised of FEMA Hazard Mitigation Assistance grant openings and assist in developing letters of intent for grant opportunities when practicable.

Fort Bend County intends to be a resource to the Planning Partnership in the support of project grant writing and development. The degree of this support will depend on the level of assistance requested by the partnership during open windows for grant applications. As part of grant monitoring and coordination, Fort Bend County intends to provide the following:

- Notification to planning partners about impending grant opportunities
- A current list of eligible, jurisdiction-specific projects for funding pursuit consideration
- Notification about mitigation priorities for the fiscal year to assist the planning partners in the selection of appropriate projects

Grant monitoring and coordination will be integrated into the annual progress report or as needed based on the availability of non-HMA or post-disaster funding opportunities.

7.2 Implementation of Mitigation Plan Through Existing Programs

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies become an integral part of public activities and decision-making. Within the County, there are many existing plans and programs that support hazard risk management, and thus, it is critical that this HMP integrate and coordinate with and complement those existing plans and programs.

Section 5 (Capability Assessment) provides a summary and description of the existing plans, programs, and regulatory mechanisms at all levels of government (federal, state, county, and local) that support hazard mitigation within the County. Within each jurisdictional annex in Section 9 (Annexes), the County and each participating jurisdiction identified how each capability reduces risk and how they are integrating hazard risk management into their existing planning, regulatory, and operational/administrative framework. If they are currently not showing this, they indicate how they intend to promote this integration.

It is the intention of Planning Partnership representatives to continue to incorporate mitigation planning as an integral component of daily government operations. The Planning Partnership representatives will work with local government officials to integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. Further, the sample adoption resolution (Appendix A [Adoption Resolutions]) includes a resolution item stating the intent of the local governing body to incorporate mitigation planning as an integral component of government and partner operations. By doing so, the Steering Committee anticipates that:

- Hazard mitigation planning will be formally recognized as an integral part of overall emergency management efforts.
- The HMP, Master Plans, Emergency Operations Plans, and other relevant planning mechanisms will become mutually supportive documents that work in concert to meet the goals and needs of County residents.

Other planning processes and programs to be coordinated with the recommendations of the HMP include the following:

- Emergency operations and response plans
- Training and exercise of emergency response plans
- Debris management plans
- Recovery plans
- Capital improvement programs
- Municipal codes
- Community design guidelines
- Water-efficient landscape design guidelines
- Stormwater management programs
- Water system vulnerability assessments
- Community wildfire protection plans
- Comprehensive flood hazard management plans
- Resiliency plans
- Community Development Block Grant-Disaster Recovery action plans
- Public information/education plans.

Some action items do not need to be implemented through regulation. Instead, these items can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation.

During the annual plan evaluation process, the Planning Partnership representatives will identify additional policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions and include these findings and recommendations in the Annual HMP Progress Report.

7.3 Continued Public Involvement

Fort Bend County and participating jurisdictions are committed to the continued involvement of the public in the hazard mitigation process. This HMP update will continue to be posted online: https://www.fortbendcountytxhmp.com/.

In addition, public outreach and dissemination of the HMP will include:

- Links to the plan on municipal websites of each jurisdiction with capability.
- Continued utilization of existing social media outlets (Facebook, Twitter) to inform the public of natural hazard events, such as floods and severe storms. Educate the public via the jurisdictional websites on how these applications can be used in an emergency.
- Development of annual articles or workshops on flood hazards to educate the public and keep them aware of the dangers of flooding.

The Steering Committee representatives and the Fort Bend County HMP Coordinator will be responsible for receiving, tracking, and filing public comments regarding this HMP. The public will have an opportunity to comment on the plan via the hazard mitigation website at any time. The HMP Coordinator will maintain this website, posting new information and maintaining an active link to collect public comments.

The public can also provide input at the annual review meeting for the HMP and during the next five-year plan update. The Fort Bend County HMP Coordinator is responsible for coordinating the plan evaluation portion of the meeting, soliciting feedback, collecting, and reviewing the comments, and ensuring their incorporation in the five-year plan update as appropriate. Additional meetings might also be held as deemed necessary by the planning group. The purpose of these meeting would be to provide the public an opportunity to express concerns, opinions, and ideas about the mitigation plan.

The Steering Committee representatives shall be responsible to ensure that:

- Public comment and input on the plan, and hazard mitigation in general, are recorded and addressed, as appropriate.
- Copies of the latest approved plan (or draft in the case that the five-year update effort is underway) are available for review, along with instructions to facilitate public input and comment on the HMP.
- Appropriate links to the Fort Bend County HMP webpage are included on municipal websites.
- Public notices are made as appropriate to inform the public of the availability of the plan, particularly during HMP update cycles.

The Fort Bend County HMP Coordinator shall be responsible to ensure that:

- Public and stakeholder comment and input on the plan, and hazard mitigation in general, are recorded and addressed, as appropriate.
- Copies of the latest approved plan are available for review at appropriate County facilities along with instructions to facilitate public input and comment on the plan.
- Public notices, including media releases, are made as appropriate to inform the public of the availability of the plan, particularly during plan update cycles.