City of Angleton Hazard Mitigation Plan 2025

Prepared by: The Houston-Galveston Area Council
Amanda Ashcroft, AICP

Table of Contents

List of Acronyms

ASL	above sea level
ASTDR	Agency for Toxic Substances and Disease Registry
BCA	Benefit Cost Analysis
CDBG-MIT	Community Development Block Grant Mitigation
CDC	Centers for Disease Control and Prevention
COLE	Coefficient of Linear Extent
CPZ	Community Protection Zone
CRF	Community Risk Factor
CRS	Community Rating System
DBIR	Data Breach Investigations Report
DDoS	Distributed Denial of Service
DMA 2000	Disaster Mitigation Act of 2000
EAL	expected annual loss
EDT	Eastern Daylight Time
EID	Emerging Infectious Diseases
EM	Emergency
FDPO	Flood Damage Prevention Ordinance
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Fire Intensity Scale
FMA	Flood Mitigation Assistance
FPF	Federal Policy Fee
FSA	Farm Service Agency
GIS	Geographic Information Systems
GLO	Texas General Land Office
H-GAC	The Houston-Galveston Area Council
HLR	Historic loss ratio
HMA	Hazard Mitigation Assistance
HMC	Hazard Mitigation Committee
HMAP	Hazard Mitigation Action Plan
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
ICC	Increased Cost of Compliance
K	Susceptibility of the soil to water erosion
LEP	Linear Extensibility Percent
LHMP	Local Hazard Mitigation Plan
LS	Combined effects of slope length and steepness
MRLC	Multi-Resolution Land Characteristics
NCC	Network Control Center
NCEI	National Center for Environmental Information
NCHH	National Center for Healthy Housing

NDFD	National Digital Forecast Database
NFIP	National Flood Insurance Program
NHC	National Hurricane Center
NLCD	National Land Cover Database
NLDN	National Lightning Detection Network
nmi	nautical miles
NOAA	National Oceanic and Atmospheric Administration
NRI	National Risk Index
NSSL	NOAA's National Severe Storms Laboratory
NWS	National Weather Service
P	probability
PMT	Plan Maintenance Team
PT	Planning Team
PVI	Pandemic Vulnerability Index
R	Rainfall and runoff factor
RHMP	Regional Hazard Mitigation Plan
RL	repetitive loss
RUSLE	Revised Universal Soil Loss Equation
S	severity
SED	State Executive Director
SFHA	special flood hazard areas
SPC	Storm Prediction Center
SRL	severe repetitive loss
SVI	Social Vulnerability Index
TCEQ	Texas Commission on Environmental Quality
TDEM	Texas Division of Emergency Management
TWRA	Texas Wildfire Risk Assessment
TxWrap	Texas Wildfire Risk Assessment Portal
USDA	United States Department of Agriculture
USDM	United States Drought Monitor
USLE	Universal Soil Loss Equation
VPI	Vulnerable Population Index
WSSI	Winter Storm Severity Index
WUI	wildland urban interface

List of Tables and Figures

List of Appendices

Section 1: Introduction

This section includes the introduction of the plan. This section contains background context, the planning need, purpose, scope, and organization of the plan.

Section 1: Introduction

In 2011, Brazoria County's Hazard Mitigation Plan (HMP) was updated as part of a seven-county Regional Hazard Mitigation Plan (RHMP) led by H-GAC. In 2018, due to new regulations and planning recommendations, Brazoria County prepared a countywide multi-jurisdictional HMP, of which the City of Angleton was a participating jurisdiction. The City of Angleton partnered with the Houston-Galveston Area Council (H-GAC) for a new Local Hazard Mitigation Plan (LHMP) for 2024.

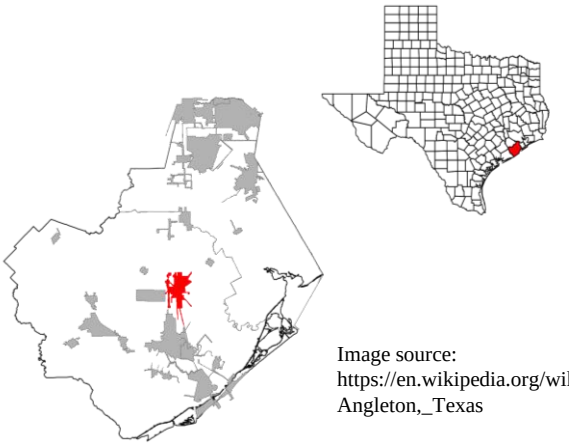


Image source: https://en.wikipedia.org/wiki/Angleton,_Texas

History

On April 28, 2006, the Federal Emergency Management Agency (FEMA) and the Texas Division of Emergency Management (TDEM) approved the first Regional Hazard Mitigation Plan which was later updated in 2011. These RHMPs were a collaboration between 85 local governments to identify regional hazards, vulnerabilities, and 300+ mitigation projects that could be implemented within the region. The 2018, due to new regulation and planning recommendations, Brazoria County, in which the City of Angleton was a participating jurisdiction to the plan, prepared a new countywide multijurisdictional Hazard Mitigation Plan that included a more robust assessment of natural hazards, newly uncovered vulnerabilities, more advanced analysis techniques, and a more effective and informed mitigation strategy. In 2022 The City of Angleton was awarded a LHMP Program grant through H-GAC from the Texas General Land Office (GLO) to develop a new HMP for the city.

Purpose of Plan

The purpose of The City of Angleton's LHMP is to reduce the loss of life and property within the city, lessen the negative impacts of natural disasters, and increase the resiliency of the community to hazards. Vulnerability to several natural hazards has been identified through a risk assessment, public input, research, and analysis. These hazards threaten the safety of residents and have the potential to damage or destroy both public and private property, disrupt the local economy, and impact the overall quality of life of individuals who live, work, and play in the city. While natural hazards cannot be eliminated, the effective reduction of a hazard's impact can be accomplished through thoughtful planning and action.

The concept and practice of reducing risks to people and property from known hazards is generally referred to as hazard mitigation. One of the most effective tools a community can use to reduce hazard vulnerability is developing, adopting, and updating a hazard mitigation plan as needed. A hazard mitigation plan establishes the broad community vision and guiding principles for reducing hazard risk, including the development of specific mitigation actions designed to eliminate or reduce identified vulnerabilities.

Planning Need

HMPs should serve as a living document that outlines the communities' long-term strategies to reducing damage to life, and property, and increasing the resilience to the natural hazards it is affected by. HMPs must be updated every 5 years per the Disaster Mitigation Act of 2000 (DMA 2000). This plan serves as the 2024 LHMP for the City of Angleton. The 2024 City of Angleton HMP adhered to the FEMA updated policy guide (FP-206-21-0002), Released on April 19, 2022. The new policy guide became effective on April 19, 2023. Updates included but were not limited to expanding outreach efforts to

include those from various community lifelines within the in the planning process, extensive mapping updates to critical facilities, community lifelines, and other data to visually highlight vulnerabilities to identified hazards, updating the process for risk and capability assessments, and including new hazards to incorporate based on recent events such as winter storms and the Covid-19 Pandemic of 2020.

Scope of Plan

This HMP includes the following participating jurisdictions:

- City of Angleton

The HMP profiles the following hazards:

- Hurricanes, Tropical Storms & Tropical Depressions
- Flooding
- Winter Weather
- Tornado
- Extreme Heat
- Wildfire
- Drought & Expansive Soils
- Severe Thunderstorm & Lightning
- Hail
- Windstorm
- Erosion
- Emerging Infectious Diseases
- Cybersecurity

Plan Organization

The 2024 City of Angleton HMP contains 8 sections:

Section 1 is the introduction of the plan. This section contains background context, the planning need, purpose, scope, and organization of the HMP.

Section 2 identifies the planning process, which involves a description of the HMP methodology and development process, identifying Planning Team members, Hazard Mitigation Committee members, roles and responsibilities of those members, stakeholder involvement efforts, meeting dates and summaries, and plan development resources.

Section 3 contains the community profile, which provides a history of hazard events, an overview of the planning area, geographic setting, land use and land cover, population demographics, vulnerable population information, housing and household arrangements, loss estimations, critical facilities, repetitive loss, and severe repetitive loss properties, NFIP and CRS participation, and NFIP policies in force information.

Section 4 outlines the risk assessment procedures and identifies hazards ranked by risk that affect the City of Angleton.

Section 5 includes the capability assessment, which includes a summary and description of the existing plans, programs, and regulatory mechanisms that support hazard mitigation within the planning area.

Section 6 is broken down into subsections for each hazard of concern to the city identified during the risk assessment. It contains descriptions of identified hazards, hazard location, extent, history of events, probability of future events, and climate change impacts. Additionally, vulnerability is addressed for all hazards and includes a probable risk level, an estimate of property and crop damages, number of events, fatalities and injuries, average annual events, changes in frequency, and estimated annualized losses, where applicable.

Section 7 covers the mitigation strategy summary, which provides the mitigation goals, objectives, and action items included in the Hazard Mitigation Action Plan in response to identified hazards.

Section 8 provides and overview of plan maintenance procedures which includes information on monitoring, evaluating, and updating the plan, and a description of how this plan will be incorporated into existing programs.

The appendices cover the hazard summary data (Hazus), H-GAC created maps, a comprehensive list of critical facilities, meeting documentation, and plan adoption.

Appendix A- Hazus Results
Appendix B- H-GAC Maps
Appendix C- Critical Facilities
Appendix D- Meeting Documentation
Appendix E- Survey Results
Appendix F- Plan Adoption

Section 2: Planning Process

This section summarizes the planning process, which involves a description of the HMP methodology and development process, identifying Planning Team members, Hazard Mitigation Committee members, roles and responsibilities of those members, stakeholder involvement efforts, meeting dates and summaries, and plan development resources.

Section 2: Planning Process

Overview

Hazard mitigation is any sustained action taken to reduce or eliminate the long-term risk to people and property from hazards and their effects. It includes long-term solutions that reduce the impact of disasters in the future. A core assumption of hazard mitigation is that pre-disaster investments will significantly reduce the demand for post-disaster assistance by alleviating the need for emergency response, repair, recovery, and reconstruction[1].

Hazard mitigation planning is the process of identifying natural hazards, assessing hazard vulnerability and risk, understanding community capabilities and resources, and determining how to minimize or manage those risks. In partnership with the City of Angleton, H-GAC approached the hazard mitigation planning process by establishing a Planning Team (PT) and a Hazard Mitigation Committee (HMC) as outlined in the tables below. The PT included H-GAC staff and the point of contact for the 's Office of Emergency Management. The HMC was comprised of representatives from the City of Angleton and a wide range of stakeholders within the city and surrounding areas. All members identified were asked to participate in the HMC or attend an HMP meeting throughout the planning process via email, website(s), the H-GAC website, and social media. All meetings hosted for this plan update were open to the public.

The PT outlined roles and expectations during the Kickoff meeting, which included the following:

1) *Participate in the process.*
   a) It must be documented in the plan that each participating jurisdiction participates in the process that generated the plan. At each meeting of the Hazard Mitigation Committee for this planning process, we will be documenting attendance, participation, and the collection of any handouts or worksheets provided to you. If you cannot attend the scheduled Hazard Mitigation Committee meeting, attendance can be supplemented with a 1-1 meeting with H-GAC staff.
2) *Consistency Review.*
   a) Review of existing documents pertinent to each jurisdiction
3) *Action Review.*
   a) For plan updates, a review of the strategies from your prior action plan to determine those that have been accomplished and how they were accomplished; and why those that have not been accomplished were not completed.
4) *Update Localized Risk Assessment.*
   a) Each jurisdiction will complete the Risk Identification/Risk Assessment by either working individually and averaging scores among all participating jurisdictions, working together as a group, or a combination of both to remove hazards not associated with the defined jurisdictional area or determining if any hazards need to be added or updated.
5) *Capability assessment.*
   a) Each planning partner must identify and review their individual regulatory, technical, and financial capabilities with regards to the implementation of hazard mitigation actions.
6) *Personalize mitigation recommendations & create an Action Plan.*
   a) Identify and prioritize mitigation recommendations specific to each jurisdiction's defined area.
7) *Incorporate Public Participation.*
   a) Representatives from a broad range of sectors, community lifelines, organizations that support underserved communities, the public and community-based organizations need to be given the opportunity to provide input on, and participate in, the planning process. The Hazard Mitigation Committee will assist with various tasks, when needed, for these types of events.

Planning Team

The City of Angleton and H-GAC established the Planning Team in February 2023 during a pre-kickoff meeting in preparation for the full kickoff meeting held on March 16, 2023. Members were asked to attend

all public meetings either in person or online (if applicable). Online materials, surveys, forms, and documentation are provided in Appendix D. Representatives from the 's Office of Emergency Management served as liaisons between H-GAC and stakeholders, staff, and members of the public who were unable to attend the meetings.

Table 2.1: City of Angleton Planning Team Members

Representative Name & Position/Title	Jurisdiction
Glenn LaMont, Emergency Management Coordinator (retired)	City of Angleton
Jamie Praslicka, Emergency Management Coordinator (current)	City of Angleton
Cheryl Mergo, Senior Manager	H-GAC
Amanda Ashcroft, AICP, Planner	H-GAC

Hazard Mitigation Committee

The City of Angleton and H-GAC established the Hazard Mitigation Committee in February 2023 in preparation for the kickoff meeting held on 3/16/2023. Members were asked to participate in the HMC via email by the 's Emergency Management Coordinator. A concentrated effort was made to include those who oversee, or aid, underserved populations to participate in this planning process. Members of the HMC were asked to attend all public meetings either in person or online (if applicable). Online materials, surveys, forms, and documentation are provided in Appendix D. Representatives from the city's Office of Emergency Management served as liaisons between H-GAC and stakeholders, staff, and members of the public who were unable to attend the meetings.

Table 2.2: City of Angleton Hazard Mitigation Committee Members

Representative Name	Organization	Title
Anthony Norris	City of Angleton	Fire Captain
Beth Reimschissel	UTMB	Administrator, Angleton Danbury Campus Associate Chief Nursing & Patient Care Services Officer
Breah Knape	ActionS, Inc of Brazoria County	Executive Director
Bryan Sidebottom	City of Lake Jackson	Assistant Chief - Emergency Operations | Deputy EOC Coordinator
Chamane M. Barrow	Brazoria County Center for Independent Living	
Chris Whittaker	City of Angleton	Manager
Corey Lukasheay	City of Angleton	Fire Department Lieutenant
Glenn LaMont	City of Angleton	Emergency Management Coordinator
Jamie Praslicka	City of Angleton	Emergency Management Coordinator
Hector Renteria	City of Angleton	Assistant Public Works Director
John Deptuch	City of Angleton	Safety & Facilities Coordinator
John Peterson	HDR	Engineer
Karen Gibson	Angleton Drainage District	Office Manager
KJ Rabe	The Coalition for Barrier Free Living, Inc., Brazoria County Center for Independent Living	Senior Independent Living-Community Integration Specialist (Sr. IL-CIS)
Otis Spriggs	City of Angleton	Director of Development Services/ Planner
Pam Goodson	Brazoria County Center for Independent Living	Independent Living Program Manager
Roberto Muñoz	Angleton ISD	Assistant Superintendent of Student Services
Sara Grether Richards	Country Village Care	Owner

Stephenie Pharr	UTMB	Director, Ambulatory Care Services
Will Blackstock	City of Clute	Director of Parks and Recreation, Deputy Emergency Management Coordinator
Cheryl Mergo	Senior Manager	H-GAC
Amanda Ashcroft	Planner	H-GAC

Meeting Dates & Details

Members of the HMC, as well as stakeholders, met regularly to identify hazards, assess risks, review critical facilities, and assist at workshops or public events/hearings to organize, set up, assist, and answer questions from the public. All members of the HMC had the opportunity to review the draft plan and assist with public outreach efforts and events. Table 2.3 below outlines the participation of each member invited to serve on the HMC for various meetings held throughout the planning process. This does not reflect all planning activities conducted by the PT or HMC. There were various individual meetings between jurisdictions and the PT, phone calls, and other forms of correspondence that are not reflected here. All meeting materials, including agendas, notes, list of attendees, completed worksheets, and outreach notices for public meetings can be found in Appendix A.

Table 2.3: Participation Matrix

Representative Name	Organization	Kickoff Meeting 3/16/23	Risk & Capability Assessment 4/20/23	Public Meeting Planning 8/23/23	Public Meeting #1 9/14/23	Public Meeting, Facebook Live 10/11/23	Plan Draft Review 2/27/24
Anthony Norris	City of Angleton						
Beth Reimschissel	UTMB		X				
Breah Knape	ActionS, Inc of Brazoria County						
Bryan Sidebottom	City of Lake Jackson	X	X				
Chamane M. Barrow	Brazoria County Center for Independent Living						
Chris Whittaker	City of Angleton				X		
Corey Lukasheay	City of Angleton	X	X				
Glenn LaMont	City of Angleton	X	X				
Jamie Praslicka	City of Angleton			X	X	X	X
Hector Renteria	City of Angleton	X	X				
John Deptuch	City of Angleton	X	X		X		
John Peterson	HDR	X	X				
Karen Gibson	Angleton Drainage District						
KJ Rabe	The Coalition for Barrier Free Living, Inc., Brazoria County Center for Independent Living		X				
Otis Spriggs	City of Angleton		X				

Pam Goodson	Brazoria County Center for Independent Living		X				
Roberto Muñoz	Angleton ISD						
Sara Grether Richards	Country Village Care	X					
Stephenie Pharr	UTMB		X				
Will Blackstock	City of Clute	X					
Cheryl Mergo	H-GAC	X	X	X	X		
Amanda Ashcroft	H-GAC	X	X	X	X	X	X

March 16, 2023: Hazard Mitigation Kickoff Meeting

The PT hosted a kickoff meeting of the HMC on March 22, 2023, at the Angleton City Hall located at 121 S Velasco St, Angleton, TX 77515. The purpose of the kickoff meeting was to introduce the hazard mitigation planning process and its importance to all attendees, to gather feedback and input about various hazards and local vulnerabilities, and to discuss the risk assessment for the city. The HMC was given a presentation covering the benefits of hazard mitigation, the planning process and timeline, updates to FEMA policies surrounding hazard mitigation plans that took effect in April 2023, and expectations for those participating in the HMC. The committee discussed the next steps for the planning process and the risk assessment. Before the meeting, community members and stakeholders were invited to attend and learn about the hazard mitigation planning process through meeting notices posted on social media, the H-GAC website, and the Angleton city website.

April 20, 2023: Risk and Capability Assessment Meeting

The PT hosted a meeting to cover the capability assessment worksheet and collected completed risk assessment worksheets from HMC members on April 20, 2023, at the Angleton City Hall located at 121 S Velasco St, Angleton, TX 77515. The purpose of this meeting was to review the capability assessment worksheet and instructions. The HMC then reviewed the various sections of the capability assessment worksheet. The categories discussed were:

1) Prevention- Administrative or regulatory actions that influence how land is developed and buildings are built. Examples include planning & zoning, building codes, open space preservation, and floodplain regulations.
2) Property Protection- Modification or removal of existing buildings to protect them from a hazard. Examples include purchase, relocation, raised elevation, and structural retrofits.
3) Natural Resource Protection- Preservation or restoration of the functions of natural systems while minimizing hazard losses. Examples include floodplain protection, forest management, and slope stabilization.
4) Structural Projects- Modification of the natural conditions for or progression of a hazard. Examples include dams, levees, seawalls, detention/retention basins, channel modification, retaining walls, and storm sewers.
5) Emergency Services- Protection of people and property during and immediately after a hazard event. Examples include warning systems, evacuation planning, emergency response training, and protection of emergency facilities.
6) Public Education and Awareness- Informing of citizens about hazards and the techniques they can use to protect themselves and their property. Examples include outreach, school education, library materials, and demonstration events.

The capability assessment also had areas where participants would be tasked with identifying opportunities to enhance local capabilities to better integrate hazard mitigation into their plans, programs,

and day-to-day operations. The committee completed the capability assessment worksheet together at this meeting.

The committee then discussed the online survey development that would be used to gather input from stakeholders within the city, the next steps for the planning process, discussed public engagement event planning, and what events could look like to gather input. Before the meeting, community members and stakeholders were invited to attend and learn about the hazard mitigation planning process through meeting notices posted on social media, the H-GAC website, and the Angleton city website.

June 17, 2023: Brazoria County Hurricane and Disaster Preparedness Expo

A public event hosted by Brazoria County took place on June 17, 2023, from 8:30 AM - 2:00 PM at the Brazoria County Fairgrounds located at 901 S Downing Rd, Angleton, TX, 77515. This was a heavily attended event that offered community members various information about risks and resources available to them, with free food, emergency vehicle tours, raffle prizes of emergency preparedness items (including generators), and even an HEB mascot appearance for kids. Many children and adults were in attendance and stopped by the H-GAC table which was set up with interactive activities for residents to provide their feedback on hazards of concern for Brazoria County and the City of Angleton. Data collected was sorted out for Brazoria County and City of Angleton residents via color coding respondents. All Brazoria County data was provided to the point of contact in charge of updating the Brazoria County HMP. Feedback activities were organized in a variety of formats from large, printed maps where participants could mark areas of concern within their community or add critical facilities to the map, an input exercise where participants had to assign dollars to mitigation project ideas, feedback worksheets that discussed how emergency notifications were received within the and how these communications could be improved, and a dot exercise where participants had to notate their top three hazards of concern within the using stickers. Public input helps the project team analyze potential hazards affecting residents and recommend possible actions to reduce their impact. H-GAC also provided information about the HMP and its importance, disaster preparedness flyers with preparedness checklists for vulnerable populations on the back (translated in 4 different languages), and flyers with a QR code that linked to the online survey that also gave a brief overview of the HMP.

August 14, 2023: Public Engagement Planning

The PT met briefly via Microsoft Teams to discuss planning a public engagement event to solicit more public feedback, types of activities to include, and timing. The public meeting event was scheduled for September 19th, 2023, from 6:00- 8:00 PM at the First Presbyterian Church located at 130 South Arcola Street, Angleton, TX 77515.

September 19, 2023: Public Meeting Event

A public meeting was hosted on September 19th, 2023, from 6:00- 8:00 PM at the First Presbyterian Church located at 130 South Arcola Street, Angleton, TX 77515. The purpose of this meeting was to provide a hazard mitigation planning project overview from the PT and HMC members in attendance and solicit feedback and information from stakeholders. Feedback activities were organized in a variety of formats from large, printed maps where participants could mark areas of concern within their community or add critical facilities to the map, an input exercise where participants had to assign dollars to mitigation project ideas, feedback worksheets that discussed how emergency notifications were received within the and how these communications could be improved, and a dot exercise where participants had to notate their top three hazards of concern within the using stickers. Public input helps the project team analyze potential hazards affecting residents and recommend possible actions to reduce their impact. Unfortunately, no residents showed up to this meeting.

October 11, 2023: Public Engagement Planning

A public meeting was hosted via Facebook Live on October 11, 2023, from 1:00-2:00 PM. The purpose of this meeting was to provide a hazard mitigation planning project overview from the PT and HMC members in attendance and solicit feedback and information from stakeholders. Community members could provide comments live during the meeting or reach out to PT members after the meeting via email or phone. There were some residents in attendance for this event, but no questions were asked. The survey was also shared and QR code provided during the meeting.

February 27, 2024: Draft Plan Review

The PT held a meeting to discuss and provide feedback on draft sections of the plan that were completed and any changes that needed to occur for plan development to be completed.

Participation & Public Input

Public input and participation are a crucial element of hazard mitigation planning. Public input was solicited and gathered via the following ways for this plan update:

1) Community Events
    a) The PT had the opportunity to set up a table and collect feedback from citizens and residents of Brazoria County at the Hurricane and Disaster Preparedness Expo hosted on Saturday, June 17, 2023. This was a heavily attended event that offered community members various information about risks and resources available to them, with free food, emergency vehicle tours, raffle prizes of emergency preparedness items (including generators), and even the H-E-B mascot. Many children and adults were in attendance and stopped by the H-GAC table setup with interactive activities to offer their feedback on hazards of concern for Angleton. Data collected was sorted out for Brazoria County and City of Angleton residents. All Brazoria County data was provided to the point of contact in charge of updating the Brazoria County HMP.

2) An online survey
    a) The online survey was open from May 8, 2023, to October 31, 2023. In total, there were only 2 responses to the survey. Survey questions asked participants about hazards of concern, vulnerable community assets, how they receive information regarding hazards, and what the city can do to better communicate about hazards.

3) Public Meetings
    a) A public meeting was hosted on September 19th, 2023, from 6:00- 8:00 PM at the First Presbyterian Church located at 130 South Arcola Street, Angleton, TX 77515. Feedback activities were organized in a variety of formats from large, printed maps where participants could mark areas of concern within their community or add critical facilities to the map, an input exercise where participants had to assign dollars to mitigation project ideas, feedback worksheets that discussed how emergency notifications were received within the planning area and how these communications could be improved, and a dot exercise where participants had to notate their top three hazards of concern within the city using stickers. Unfortunately, no residents showed up to this meeting.
    b) A Facebook Live Event was hosted on October 11, 2023, from 1:00-2:00 PM.

4) Draft Plan Public Input Survey
    a) The online survey was opened from March 27th through July 26th, 2024 to gather public comments regarding the finished draft of the City of Angleton HMP. There were no public comments submitted to the online survey. A full list of survey results can be found in Appendix E

Feedback and input from the public were used to identify vulnerabilities within the city, identify valuable assets, identify critical facilities, and further develop the risk assessment. Additionally, H-GAC hosted all HMP-related materials online and advertised meeting information, presentations, and meeting notes for those who were unable to attend through this public-facing website: https://www.h-gac.com/regional-hazard-mitigation-planning.

Plan Development Resources

The City of Angleton HMP was developed using existing plans, studies, reports, and technical information. Materials and historical data were used to inform participants throughout the planning process, evaluate and analyze hazards, and develop the mitigation strategy. For a full list of references, seen endnotes.

Plan Development Resources: Existing Documents and Data	
2023 Texas State Hazard Mitigation Plan	List of Reports and Publications | 2022 Census of Agriculture | USDA/NASS
2023 Data Breach Investigations Report | Verizon	Losing Ground: Flood Data Visualization Tool (nrdc.org)
2023 Texas State Hazard Mitigation Plan	Major Land Resource Area (MLRA) | Natural Resources Conservation Service (usda.gov)
American Community Survey (ACS) (census.gov)	Mayo Clinic
Association of State Dam Safety	MRLC Viewer
Census.gov	National Centers for Environmental Information (NCEI) (noaa.gov)
FEMA 2013 Mitigation Ideas	National Institute of Allergy and Infectious Diseases (NIAID) (nih.gov)
FEMA 2021 Mitigation Action Portfolio	National Institute of Environmental Health Sciences: NIEHS Home page (nih.gov)
FEMA 2022 Local Mitigation Planning Policy Guide	National Oceanic and Atmospheric Administration (noaa.gov)
FEMA 2023 Local Mitigation Planning Handbook	National Weather Service
FEMA Declared Disasters	NOAA National Severe Storms Laboratory
FEMA Flood Map Service Center	NOAA Storm Event Database
FEMA Hazardous Response Capabilities	Office of the Texas State Climatologist (tamu.edu)
Flood Insurance Data and Analytics (floodsmart.gov)	Plan Ahead for Disasters | Ready.gov
HEAT.gov - National Integrated Heat Health Information System	Texas A&M Forest Service Wildfire Risk Assessment Portal
H-GAC 2011 Regional Hazard Mitigation Plan	TSHA (tshaonline.org)
H-GAC 2018 Multijurisdictional Hazard Mitigation Plan	USGS HIFLD Open Data
H-GAC Regional Demographic Snapshot	Vaisala National Lightning Detection Network (NLDN) Flash Data (Restricted) (noaa.gov)
H-GAC Regional Flood Information	Web Soil Survey - Home (usda.gov)

Section 3: Community Profile

This section contains the community profile, which provides a history of hazard events, an overview of the planning area, geographic setting, land use and land cover, population demographics, vulnerable population information, housing and household arrangements, loss estimations, critical facilities, repetitive loss and severe repetitive loss properties, NFIP and CRS participants, and NFIP policies in force.

Section 3: Community Profile

History of Hazard Events

The City of Angleton has persevered through many natural disasters. Table 3.1 below lists the presidentially declared emergency and major disaster declarations that the city has experienced since 1953. Each disaster is costly and challenging. 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. A presidential disaster declaration mobilizes federal recovery programs to assist disaster victims, businesses, and public entities. A review of these presidential disaster declarations helps establish the probability of reoccurrence and assists in identifying targets for risk reduction through potential mitigation actions. Table 3-1 shows FEMA disaster declarations for Brazoria County, in which the City of Angleton is located.[1],[2]

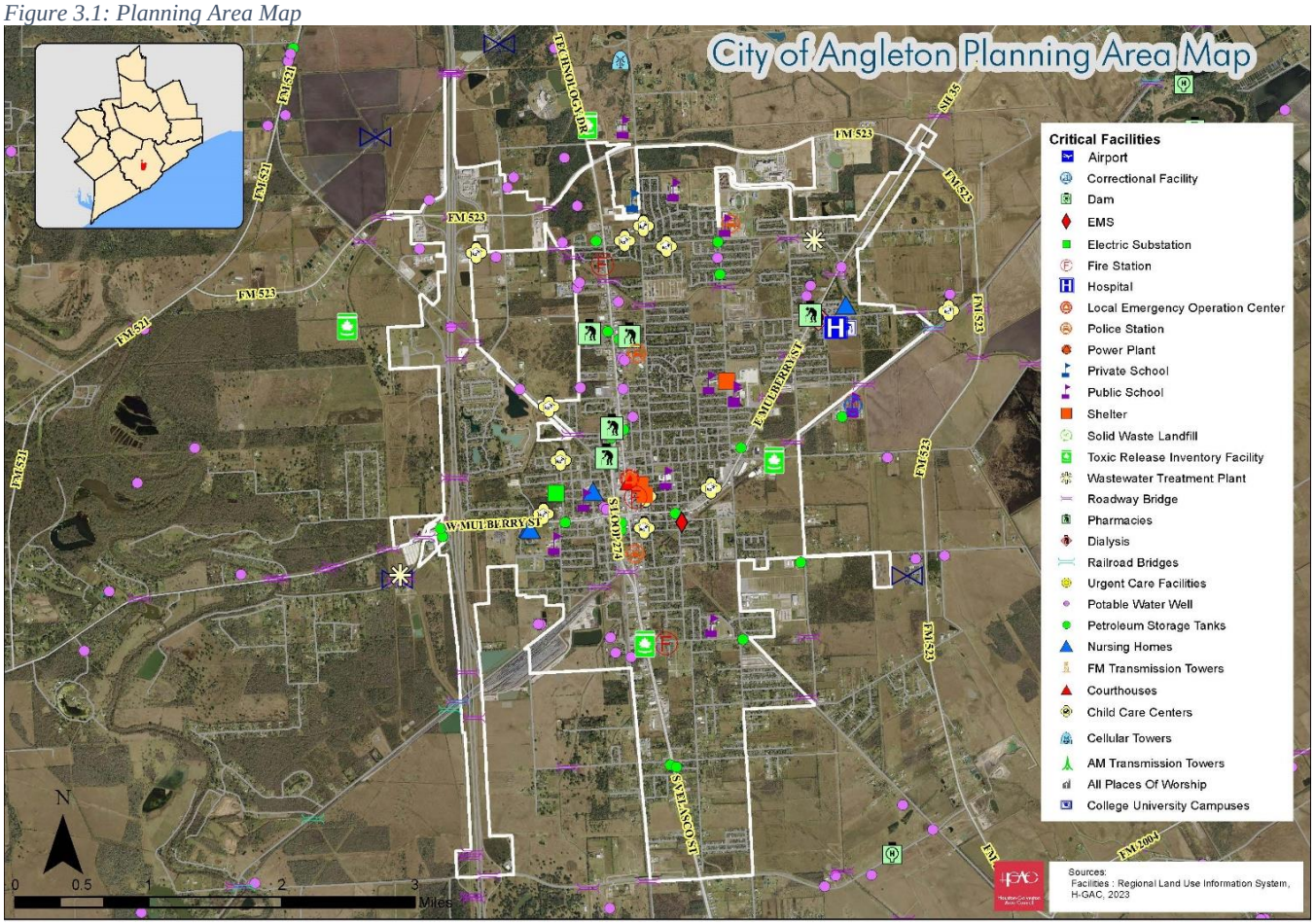
Table 3.1: Presidential Disaster Declarations

Declaration Date	Disaster No.	Declaration Type	Incident Type	Title
7/11/1973	398	Major Disaster Declaration	Flood	Severe Storms and Flooding
7/28/1979	595	Major Disaster Declaration	Flood	Texas Storms, Flash Floods
9/25/1979	603	Major Disaster Declaration	Flood	Texas Severe Storms, Flooding
8/19/1983	689	Major Disaster Declaration	Hurricane	Hurricane Alicia
4/12/1991	900	Major Disaster Declaration	Severe Storm	Texas Flooding, Severe Storm, Tornado
12/26/1991	930	Major Disaster Declaration	Flood	Severe Thunderstorms
9/10/1993	3113	Emergency Declaration	Drought	Extreme Fire Hazard
10/18/1994	1041	Major Disaster Declaration	Flood	Severe Thunderstorms and Flooding
8/26/1998	1239	Major Disaster Declaration	Severe Storm	Tropical Storm Charley
10/21/1998	1257	Major Disaster Declaration	Flood	TX-Flooding 10/18/98
9/1/1999	3142	Emergency Declaration	Fire	Extreme Fire Hazards
9/2/2005	3216	Emergency Declaration	Hurricane	Hurricane Katrina Evacuation
9/21/2005	3261	Emergency Declaration	Hurricane	Hurricane Rita
9/24/2005	1606	Major Disaster Declaration	Hurricane	Hurricane Rita
1/11/2006	1624	Major Disaster Declaration	Fire	Extreme Wildfire Threat
3/14/2008	3284	Emergency Declaration	Fire	Wildfires
8/29/2008	3290	Emergency Declaration	Hurricane	Hurricane Gustav
9/10/2008	3294	Emergency Declaration	Hurricane	Hurricane Ike
9/13/2008	1791	Major Disaster Declaration	Hurricane	Hurricane Ike
5/29/2015	4223	Major Disaster Declaration	Severe Storm	Severe Storms, Tornadoes, Straight-Line Winds and Flooding
4/25/2016	4269	Major Disaster Declaration	Flood	Severe Storms and Flooding
6/11/2016	4272	Major Disaster Declaration	Flood	Severe Storms and Flooding
8/25/2017	4332	Major Disaster Declaration	Hurricane	Texas Hurricane Harvey
3/13/2020	3458	Emergency Declaration	Biological	COVID-19
3/25/2020	4485	Major Disaster Declaration	Biological	COVID-19 Pandemic
2/14/2021	3554	Emergency Declaration	Severe Ice Storm	Severe winter storm
2/19/2021	4586	Major Disaster Declaration	Severe Ice Storm	Severe winter storms
5/17/2024	4781	Major Disaster Declaration	Flood	Severe Storms, Straight-line Winds, Tornadoes, and Flooding
7/9/2024	4798	Major Disaster Declaration	Hurricane	Hurricane Beryl

Planning Area Overview

The following information will showcase data, demographics, and items specific to the City of Angleton. The City of Angleton serves as the county seat for Brazoria County. The largest industries in Brazoria County, TX are Health Care & Social Assistance (23,747 people), Manufacturing (21,998 people), and Construction (18,526 people), and the highest-paying industries are Utilities ($99,892), Mining, Quarrying, & Oil & Gas Extraction ($93,500), and Manufacturing ($86,730). The most common job groups, by number of people living in Brazoria County, TX, are Management Occupations (20,136 people), Office & Administrative Support Occupations (18,113 people), and Sales & Related Occupations (14,011 people). Angleton's median household income is just above the $73,035 median income for the State of Texas. Brazoria County's annual median household income is $91,972 and the City of Angleton's median household income is $77,235. [3] The county's unemployment rate in 2022 was 4.5%, higher than the national average of 3.9%.[4,5]

Figure 3.1: Planning Area Map



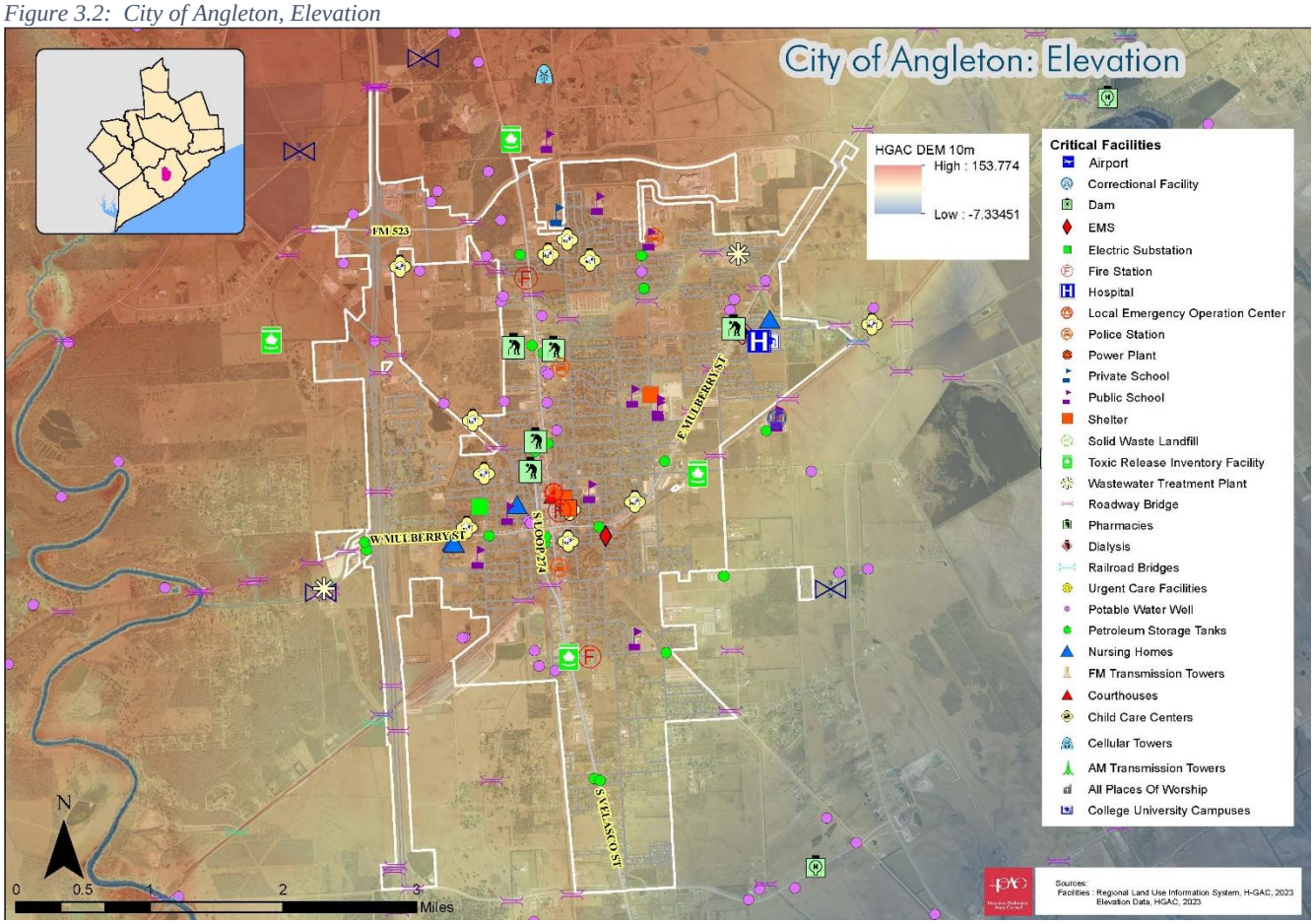
According to the 2020 US Census data, The City of Angleton's population was 19,610.[3] Population, according to the Texas Demographic Center Population Estimates Program, is expected to slowly increase over time. The city saw a 2.4% increase from 2020 to 2023.[6] Population change includes two major components: natural increase (births minus deaths) and net migration (in-migrants minus out-migrants). Net migration includes both international migrants from other countries and domestic migrants (those who moved from other counties in other states or other counties within Texas.) A component of change is determined to be a driver if it comprises more than 50% of the total population change. Between 2010 and 2019, population change in Texas was comprised of 51% net migration and 49% natural increase. From 2021-2022 population change in Texas was comprised of 74% net migration

and 25% natural increase. Drivers of population change within Brazoria County are due primarily to net migration.[7]

Geographic Setting

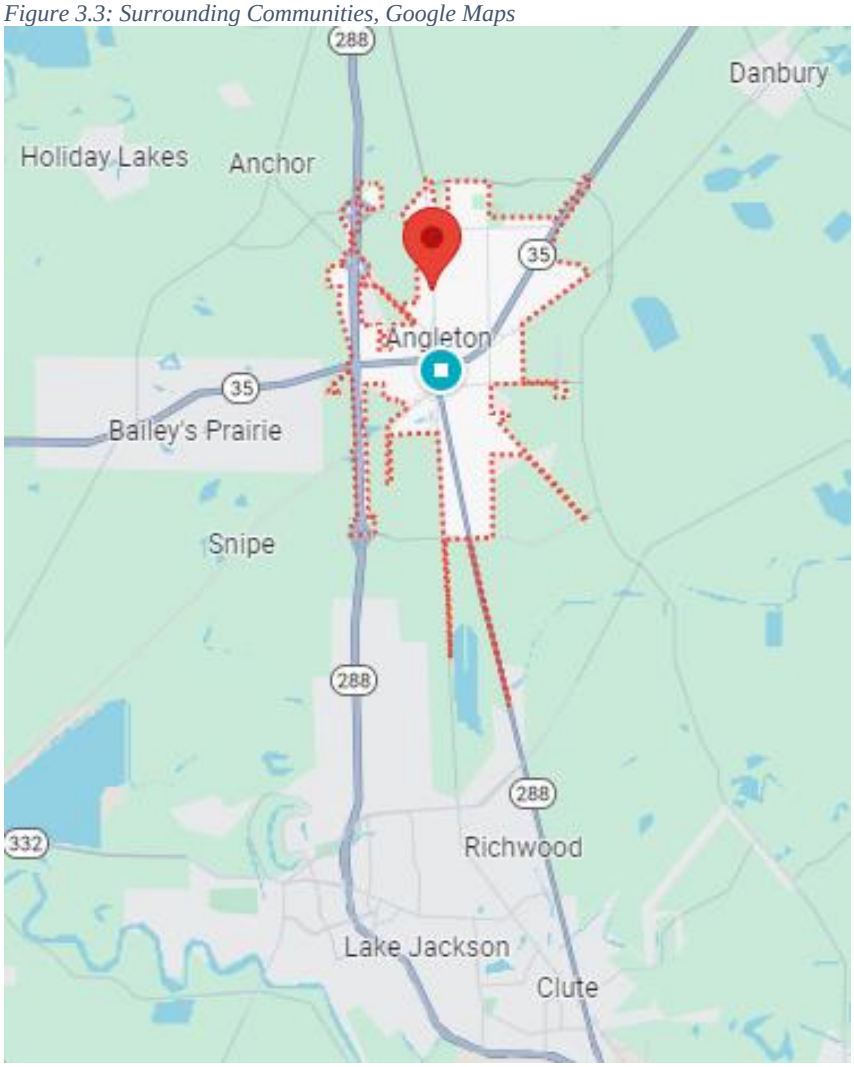
The City of Angleton serves as the county seat for Brazoria County and lies at the intersection of State Highway 288, State Highway 35, and the Union Pacific Railroad. The city is located East of the Brazos River and Oyster Creek and sits approximately 50 miles inland from the Gulf Coast.[8] Elevations within the city are higher in the northwest at range from 108 feet above sea level (ASL), to 2 feet ASL in the southeast. Figure 3.2 shows the elevation of Angleton and surrounding areas.

Figure 3.2: City of Angleton, Elevation



Neighboring communities include the Village of Bonney to the North, the city of Danbury to the Northeast the cities of Richwood, Clute, and Lake Jackson to the South, The Village of Bailey's Prairie to the West, and the Town of Holiday Lakes to the Northwest.

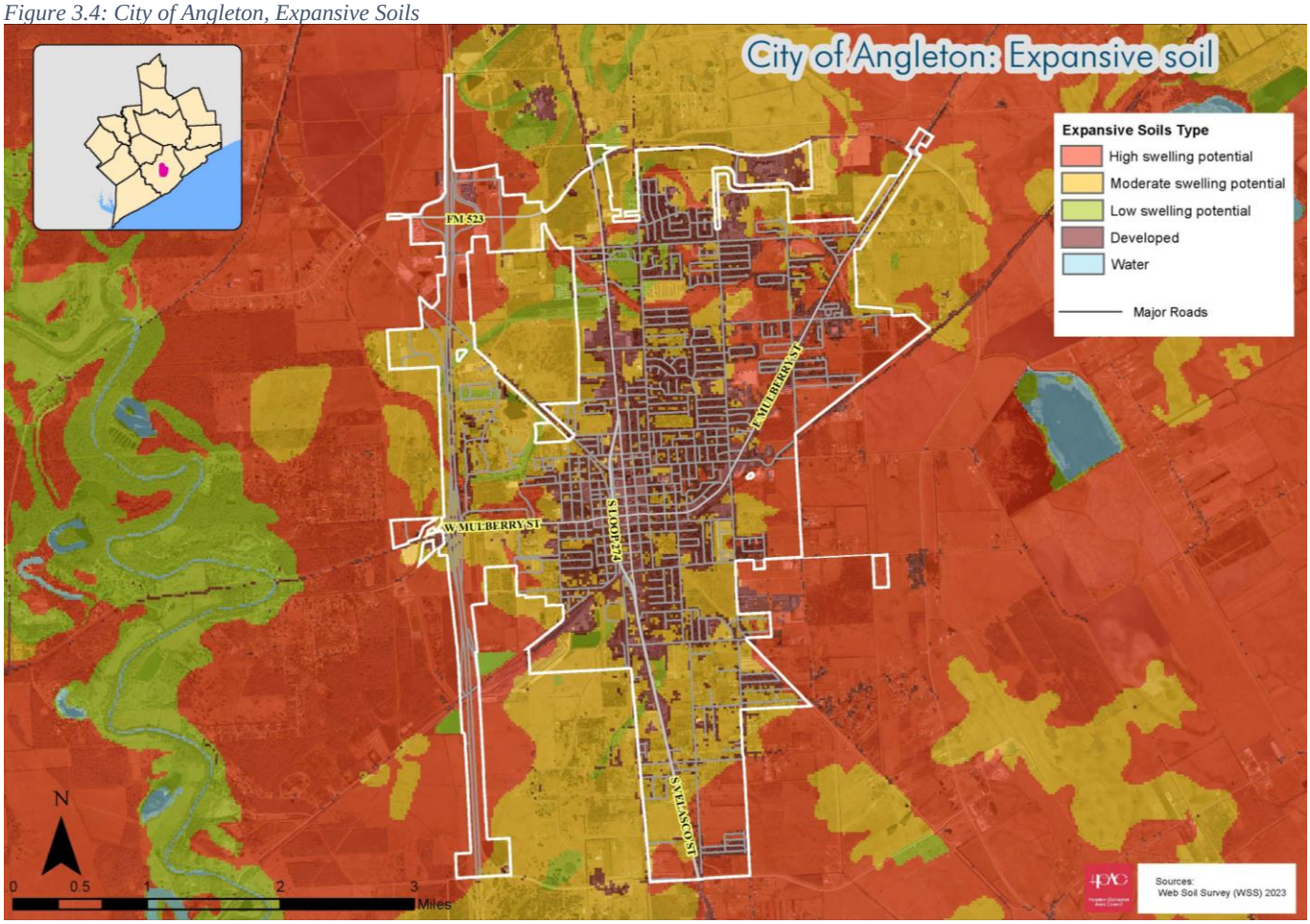
Figure 3.3: Surrounding Communities, Google Maps



Soil Composition

Brazoria County is comprised of soils within the Coast Prairie and Coast Saline Prairie land resource area. Soils within these areas and the city range from deep, dark-colored clays and loams in the south, and deep, dark-gray, neutral to slightly acid clay loams and clays in the north. Soils within the Coast Saline Prairie, in which a majority of the city sits, have very slow surface drainage due to the water table being located at or near the surface and elevation ASL is only a few feet.[9] Expansive soils refer to those that are clay-rich. Due to their clay content, these soils can absorb large quantities of water that cause them to expand, whereas in dry periods the soils will contract and cause the ground to shrink and crack. In areas where development exists, these soils can cause issues with slab-on-grade foundations and infrastructure due to the potential uneven change in volume. This can cause subsidence, cracked foundations, broken pipes, or other detrimental effects on buried infrastructure.[10],[11] The City of Angleton is covered primarily with moderate and high swell potential soils. There are very small pockets of land within the city that have low swelling potential. Figure 3.4 below shows the expansive soils and shrink-swell potential for the city. Full-size maps can be found in Appendix B.

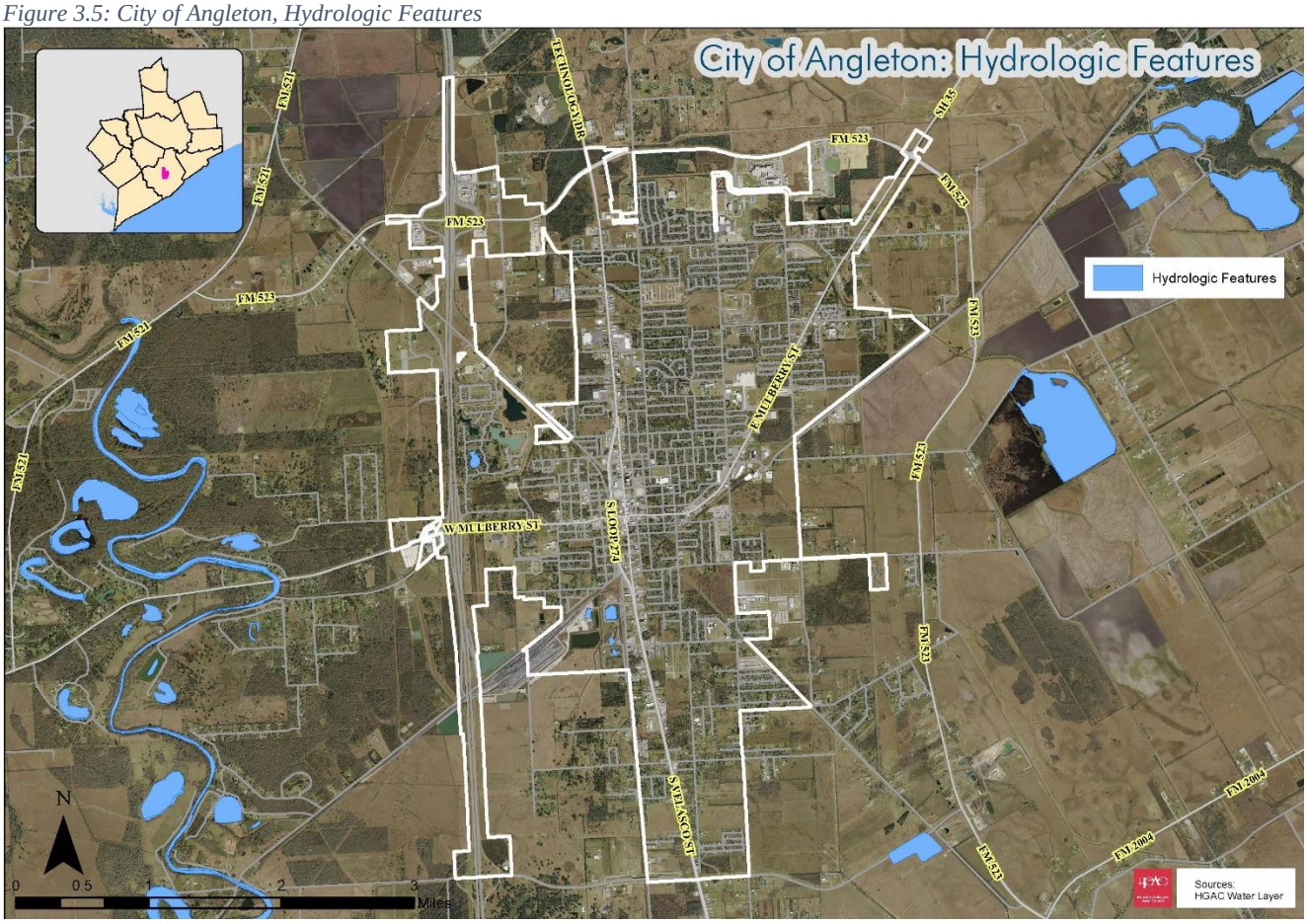
Figure 3.4: City of Angleton, Expansive Soils



Hydrologic Features

There are very few areas of the city that are covered by surface water (found in rivers, creeks, and other hydrologic features). The City of Angleton lies within the drainage basin of the San Jacinto-Brazos Coastal Basin.[12] Figure 3.5 shows hydrologic features located within the city and near the city limits. These include Oyster Creek and various small lakes to the west, and the Tigner-Farrer Reservoir, and small named lakes to the northeast of the city.

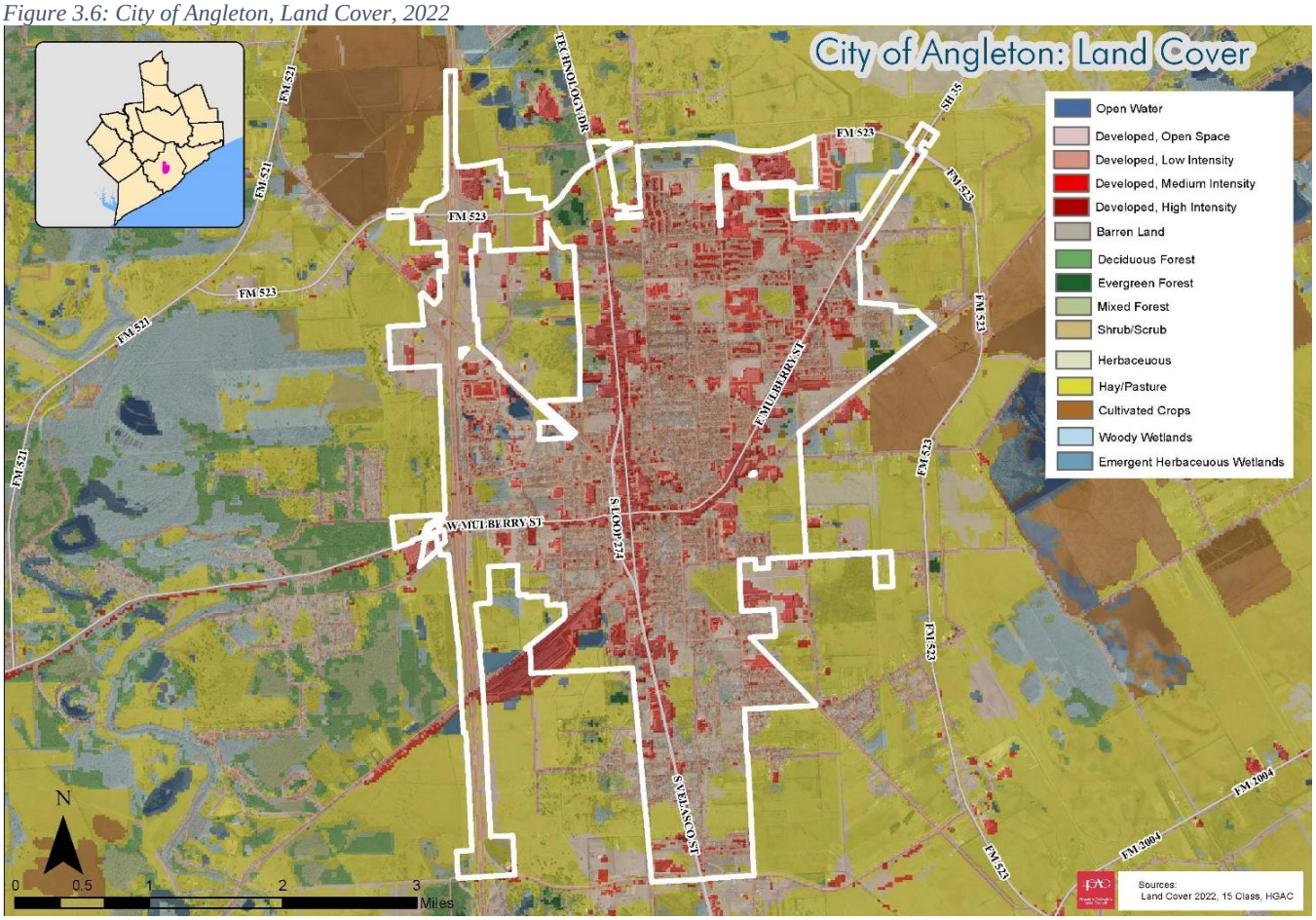
Figure 3.5: City of Angleton, Hydrologic Features



Land Use and Land Cover

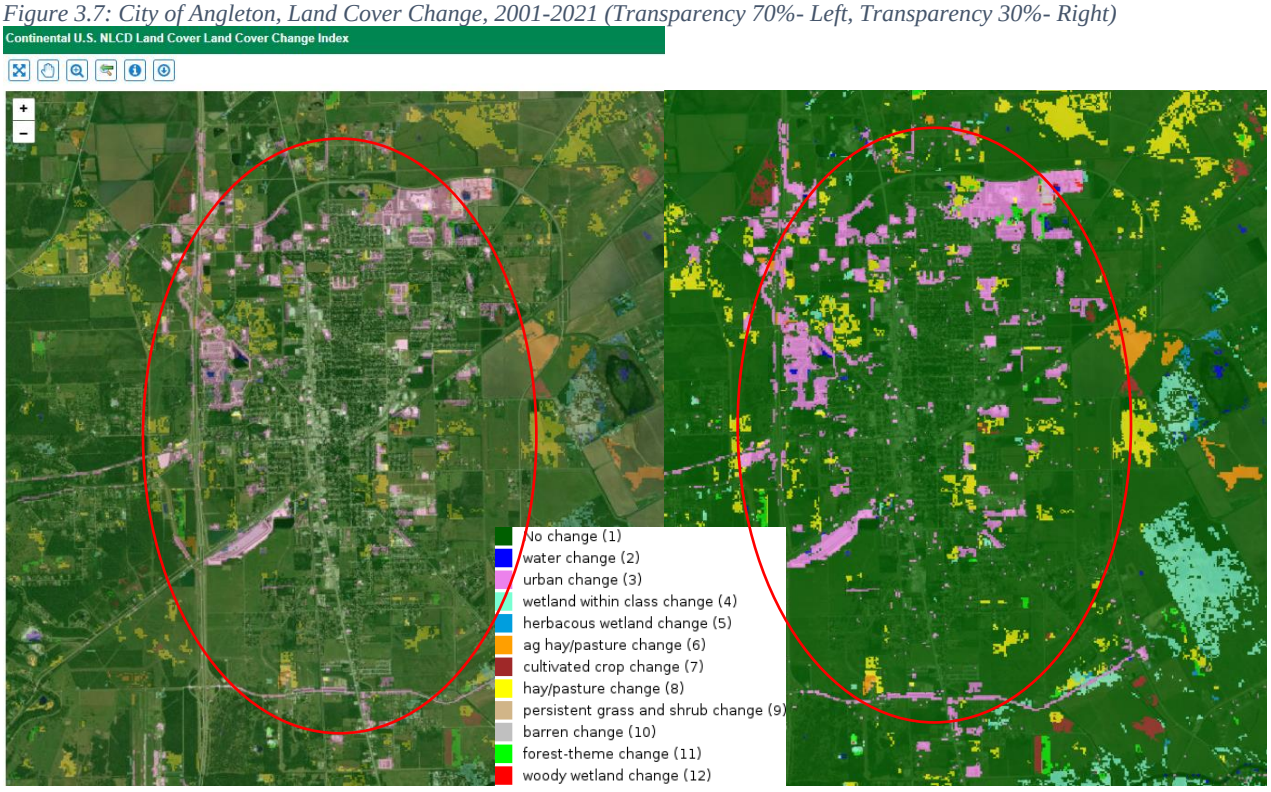
Land cover is primarily developed land of varying intensities within the city limits followed by hay/pasture lands and areas of wetlands and cultivated crops. Figure 3.6 shows the land cover composition of the City of Angleton.

Figure 3.6: City of Angleton, Land Cover, 2022



The Multi-Resolution Land Characteristics (MRLC) consortium is a group of federal agencies that coordinate and generate consistent and relevant land cover information at the national scale for a wide variety of environmental, land management, and modeling applications. The creation of this consortium has resulted in the mapping of the lower 48 United States, Hawaii, Alaska, and Puerto Rico into a comprehensive land cover product termed, the National Land Cover Database (NLCD), from decadal Landsat satellite imagery and other supplementary datasets. The land cover change index, a dataset of the MRLC and NLCD, highlights a simple way to visualize changes in land cover that have occurred over epochs. Within the city, land use changes seen within the last 20 years include hay/pasture change, minimal areas of water, wetland, forest-theme change, and some cultivated crop change. The greatest area of change from 2001-2021 has seen a boom in urban expansion to the north and west of the city, and along major thoroughfares such as State Highway 288 and along the Union Pacific Railroad to the southwest.[13] Figure 3.7 below highlights these land cover changes that have taken place over the last 20 years. The city limits can be found within the red-circled area. Two varying degrees of data transparency are provided to give a better sense of the location of the city and the data/land use change visualizations within city limits.

Figure 3.7: City of Angleton, Land Cover Change, 2001-2021 (Transparency 70%- Left, Transparency 30%- Right)



Building Codes

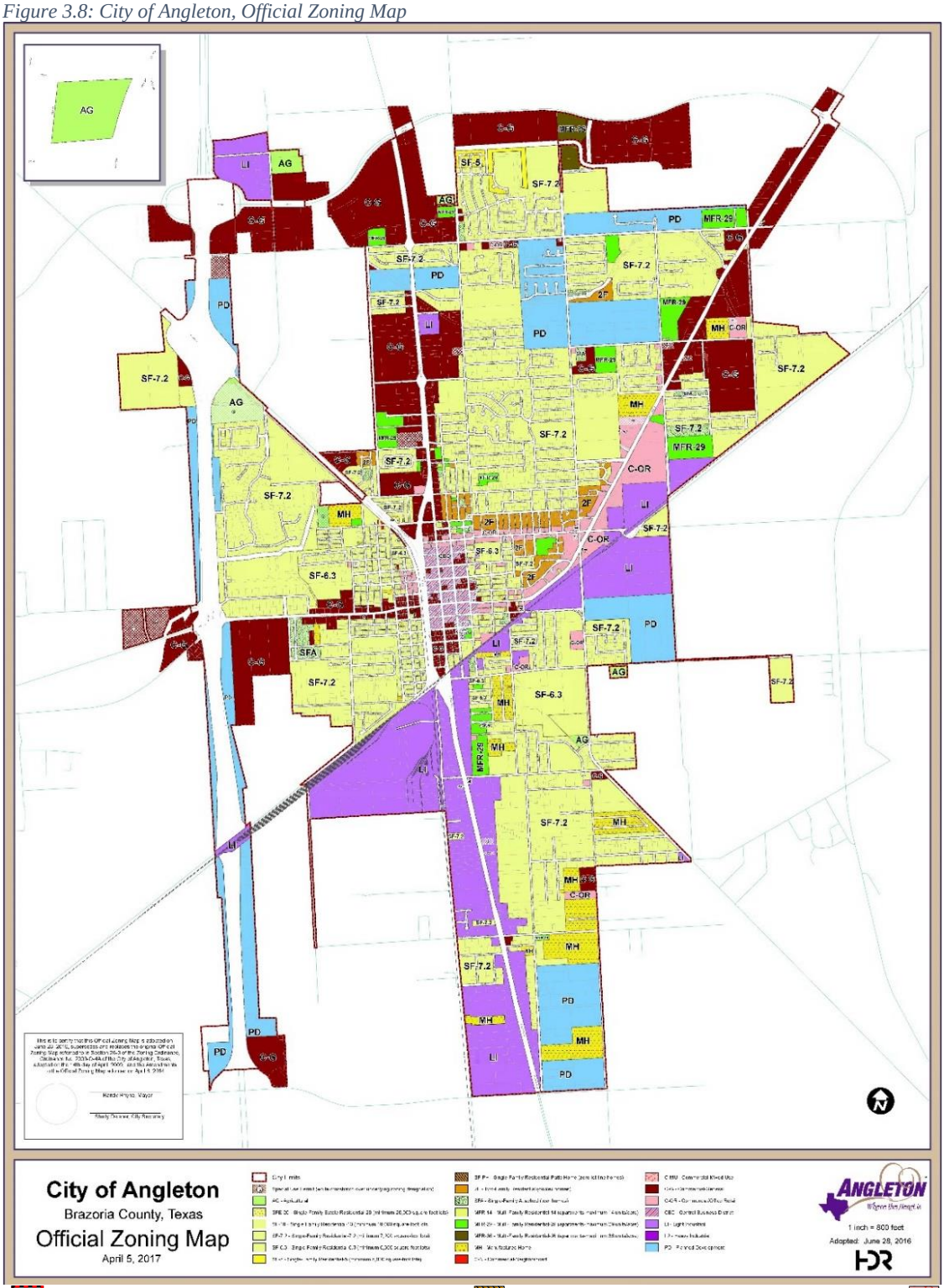
The City of Angleton utilizes its zoning ordinance and building codes to guide development within the city limits and extra-territorial jurisdiction. The City of Angleton has adopted the following Codes:

- 2015 International Energy Code
- 2015 International Fuel Gas Code
- 2015 International Mechanical Code
- 2015 International Plumbing Code
- 2015 International Building Code
- 2015 International Residential Code
- 2014 NFPA 70 National Electric Code
- 2015 International Fire Code
- 2015 Property Maintenance Code
- 2015 Pool and Spa Code

Zoning

Zoning refers to the process by which a municipality divides its geographic area into different zones or districts, each with its own set of regulations governing land use, building heights, density, and other characteristics. Zoning regulations are intended to promote orderly development, protect property values, and ensure that land uses are compatible with their surrounding areas. Zoning regulations can be used to accomplish a variety of goals, such as promoting residential, commercial, or industrial development in certain areas; protecting natural resources or historic landmarks, and separating incompatible land uses such as industrial and residential areas. The authority for Texas municipalities to regulate land use through zoning is found in Chapter 211 of the Texas Local Government Code. Specifically, Section 211.001 provides: "A municipality may regulate the use of land within its boundaries by establishing zoning districts for the municipality and by regulating the location, use, and construction of buildings, structures, and other improvements within those zoning districts." [14] The City of Angleton's most recent zoning map is dated April 5, 2017.[15]

Figure 3.8: City of Angleton, Official Zoning Map

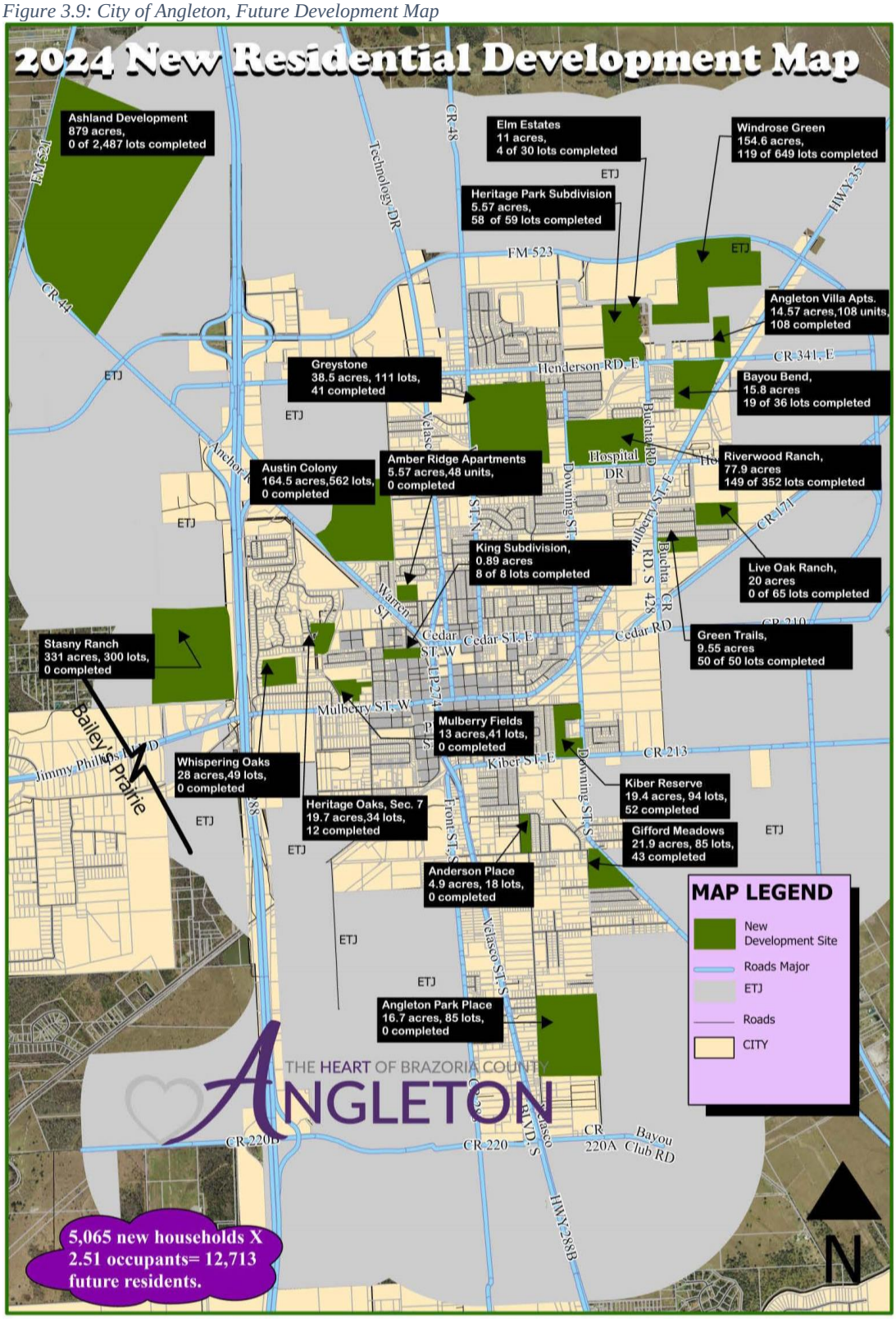


Future Development

The changes in development since the last plan update, and how they have increased or decreased the community's vulnerability are referenced in each hazard profile under "Populations at Risk". The figure below highlights areas of future development for the City of Angleton.

Brazoria County has seen steady population growth since the last plan update, with a 4% increase from 2010 to 2020. As the population continues to increase areas of future development will increase the vulnerability of the City of Angleton to the impacts of certain hazards. For the entire planning area increases in development have increased the vulnerability to flooding from added impervious surface areas. The vulnerability to wildfire continues to grow as new developments expand into wildland urban interface areas. There is also increased vulnerability from impacts due to various types of natural hazards and severe weather that can affect the entire planning area as they have no set geographic boundaries such as thunderstorms, lightning, tornados, hurricanes, tropical storms, tropical depressions, windstorms, hailstorms, extreme heat, and severe winter weather. Additionally, impervious surfaces added over expansive soil areas, like slab-on-grade foundations from new developments, are more vulnerable and at risk for impacts within the planning area.

Figure 3.9: City of Angleton, Future Development Map



Population and Demographics

The City of Angleton has seen its population grow at a slow, but steady pace over time. Between the 2010 and 2020 census population growth was 3%. Brazoria County has seen an average of a 2.5% increase in its population per year since 1971.[16] The projected population for Brazoria County from 2020-2040 is expected to see a 26.3% increase, while population from 2020-2060 is projected to see a 48.3% increase.[6] As the population in the county grows, it can be expected that the population within the City of Angleton will increase as well. Figure 3.10 shows the population distribution per 1000 persons by census tract for the last census in 2020.

Figure 3.10: City of Angleton, Population Distribution Map, 2020 Census

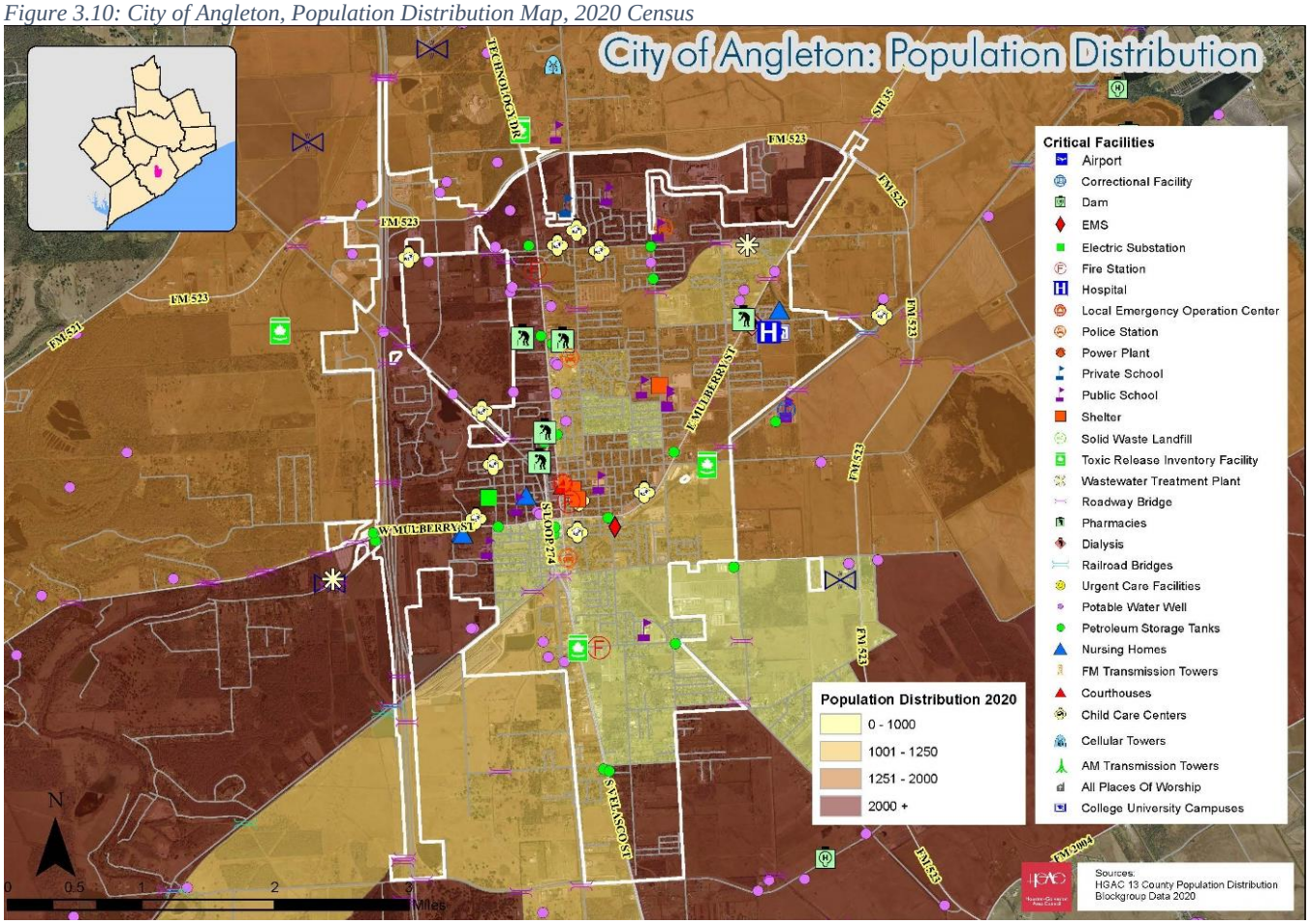


Table 3.2: City of Angleton Population Trends, 1970 to 2020[6,7]

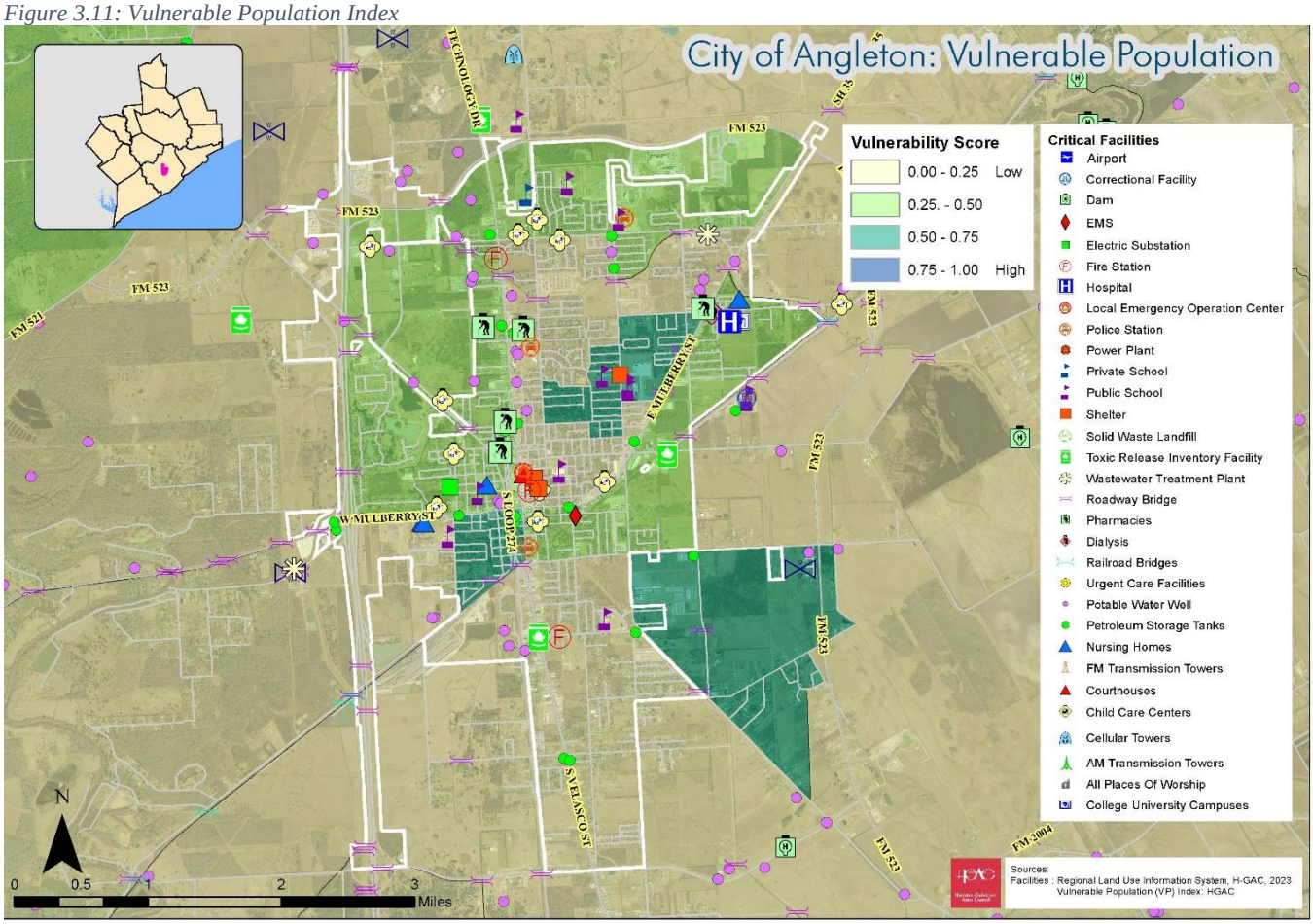
Year	Population Count	Population Change	Percent (%) Change
1970	9,770		
1980	13,929	4,159	42.5%
1990	17,140	3,211	23%
2000	18,130	990	5.8%
2010	18,862	732	4%
2020	19,610	748	4%

The population demographics per the 2020 census consist of 60.7% White population, 25.6% Hispanic or Latino population, 9.8% African American population, 3.1% Asian population, and .8% multiracial. 16% of the population in the city is 65 or older, this is higher than the State average of 13.4%. The poverty rate for the County is 12%, less than the State average of 14%.[17]

Vulnerable Population

The Vulnerable Population Index (VPI), a dataset developed by H-GAC, identifies areas throughout the region that may not have the means or the resources to act when a natural disaster occurs. For this plan, vulnerable populations include any households without a car, single female households with a child or children in the home, individuals living below the poverty line, individuals who are disabled, Hispanic individuals, individuals who are non-Hispanic, and non-white, and individuals who are 65 years and older.[18] The areas in the county with the greatest proportion of these individuals are defined as the most vulnerable areas in Brazoria County, denoted by a higher vulnerability score. Figure 3.11 provides this VPI for the City of Angleton. Defining and mapping vulnerable populations provides the opportunity to demonstrate where the most need is throughout the county.

Figure 3.11: Vulnerable Population Index



While age and income have been traditional indicators of vulnerable populations, the Centers for Disease Control and Prevention (CDC) in partnership with the Agency for Toxic Substances and Disease Registry (ASTDR) has developed a Social Vulnerability Index (SVI) that can be generated at the county level. This is a more recent tool used to identify socially vulnerable populations with additional risk factors. The CDC and ASTDR define socially vulnerable populations using factors such as poverty, lack of access to transportation, and crowded housing, to name a few. 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 a total of 16 social factors and groups them into four related themes. Figures 3.12 and 3.13 below depicts the social vulnerability of communities in Brazoria County by census tract.[21] Factoring in these additional aspects of social vulnerability and grouping them by themes gives the county a bigger picture of vulnerable populations. Brazoria's social vulnerability score is 0. 6174 overall. Scores range from 0-1, with 1 being the highest

level of vulnerability within the nation. A score of 0.6174 indicates a medium to high level of vulnerability.[19]

Figure 3.12: Brazoria County Overall CDC/ASTDR Social Vulnerability

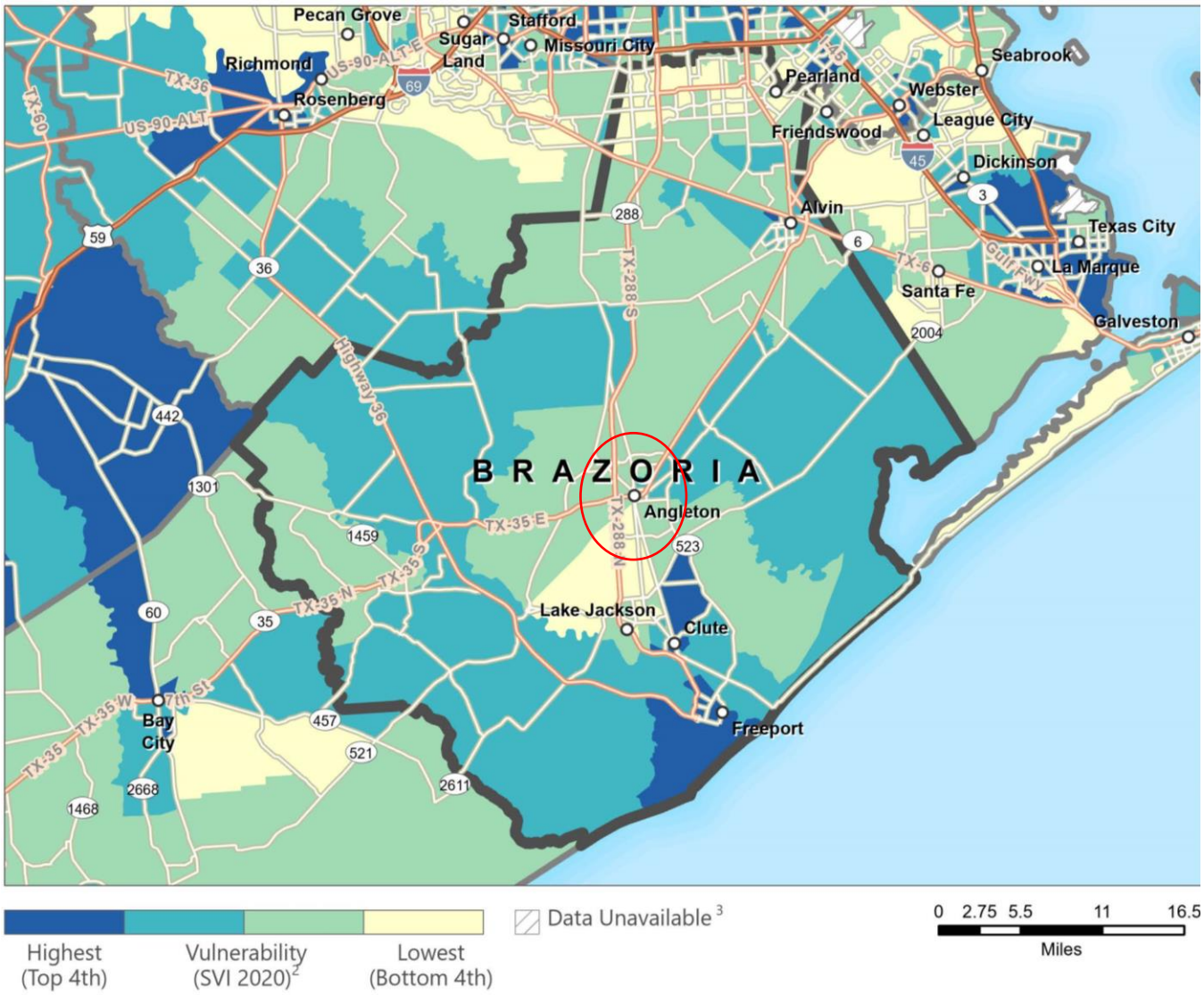
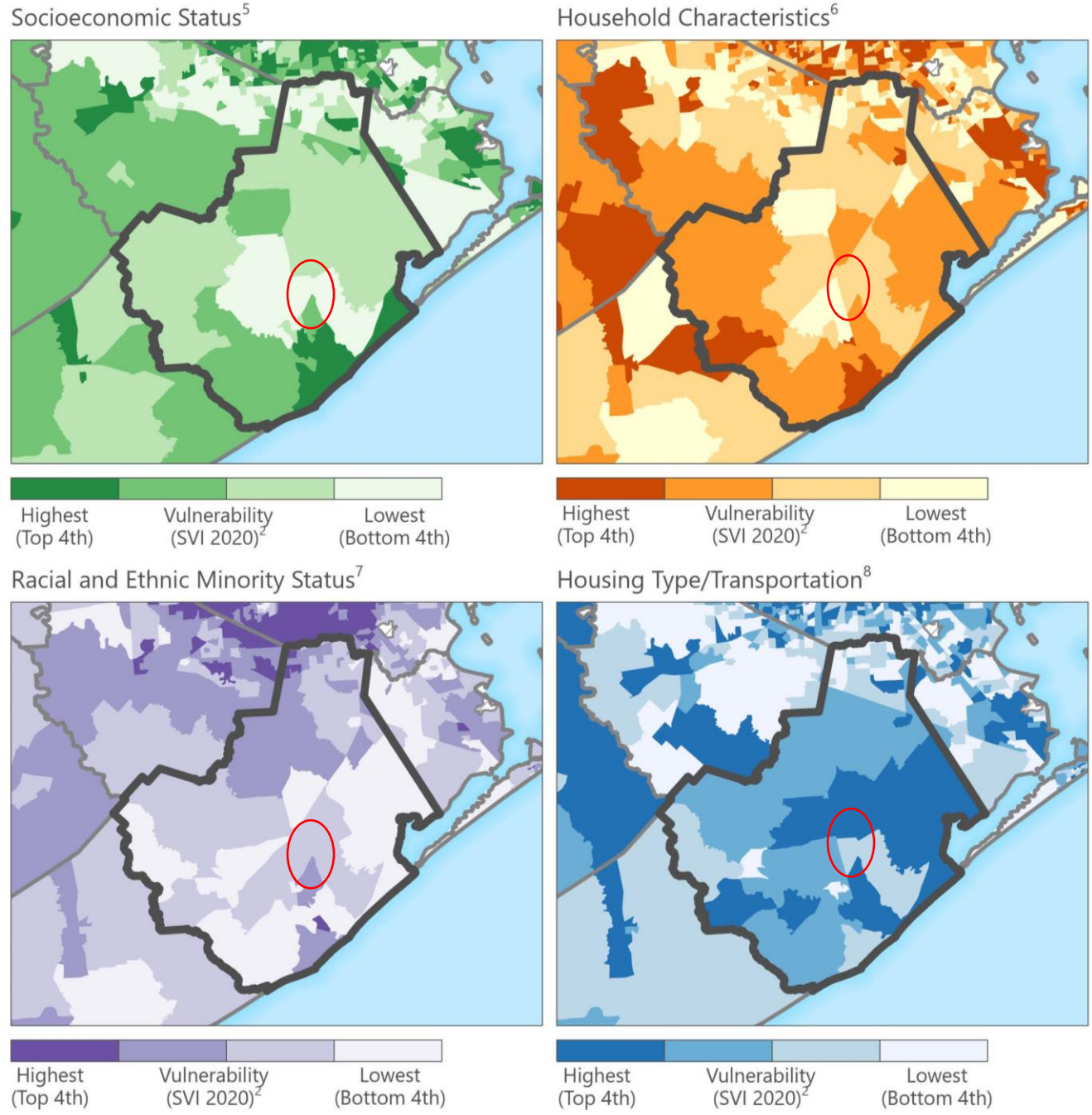


Figure 3.13: Brazoria County Themes for CDC/ASTDR Social Vulnerability



Data Sources: [2]CDC/ATSDR/GRASP, U.S. Census Bureau, Esri® StreetMapTM Premium.
Notes: [1]Overall Social Vulnerability: All 16 variables. [3]Census tracts with 0 population. [4]The CDC/ATSDR SVI combines percentile rankings of US Census American Community Survey (ACS) 2016-2020 variables, for the state, at the census tract level. [5]Socioeconomic Status: Below 150% Poverty, Unemployed, Housing Costs Burden, No High School Diploma, No Health Insurance. [6]Household Characteristics: Aged 65 and Older, Aged 17 and Younger, Civilian with a Disability, Single-Parent Household, English Language Proficiency. [7]Race/Ethnicity: Hispanic or Latino (of any race); Black and African American, Not Hispanic or Latino; American Indian and Alaska Native, Not Hispanic or Latino; Asian, Not Hispanic or Latino; Native Hawaiian and Other Pacific Islander, Not Hispanic or Latino; Two or More Races, Not Hispanic or Latino; Other Races, Not Hispanic or Latino. [8]Housing Type/Transportation: Multi-Unit Structures, Mobile Homes, Crowding, No Vehicle, Group Quarters.
Projection: NAD 1983 Texas Statewide Mapping System.
References: Flanagan, B.E., et al., A Social Vulnerability Index for Disaster Management. *Journal of Homeland Security and Emergency Management*, 2011. 8(1).
CDC/ATSDR SVI web page: https://www.atsdr.cdc.gov/placeandhealth/svi/index.html.

Housing and Living Arrangements

As of July 1, 2022, there were 7,892 housing units within the city, with 7,681 households. A household is defined by the U.S. Census Bureau 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 Angleton was listed at $151,400 in 2021.[20]

Loss Estimations

A Hazus analysis was conducted for 4 scenarios within the city: a 100-year flood scenario, a 500-year flood scenario, a 100-year hurricane scenario, and a 500-year hurricane scenario. Hazus is a regional multi-hazard loss estimation model that was developed by FEMA and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state, and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.[23] For this section, the 100-year flood scenario will be highlighted regarding potential losses of building stock, debris generation, and shelter requirements. The full Hazus analysis for all scenarios can be found in Appendix A. Hazus estimates that about 6,443 buildings will be at least moderately damaged. This is over 24% of the total number of buildings in the scenario. There are an estimated 3,212 buildings that will be completely destroyed.

Table 3.3: Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	$1,496724	52.3%
Commercial	$901,761	31.5%
Industrial	$55,502	1.9%
Agricultural	$7,084	0.2%
Religion	$42,490	1.55%
Government	$51,178	1.8%
Education	$307,167	10.7%
Total	**$2,862,006**	**100%**

Economic Loss

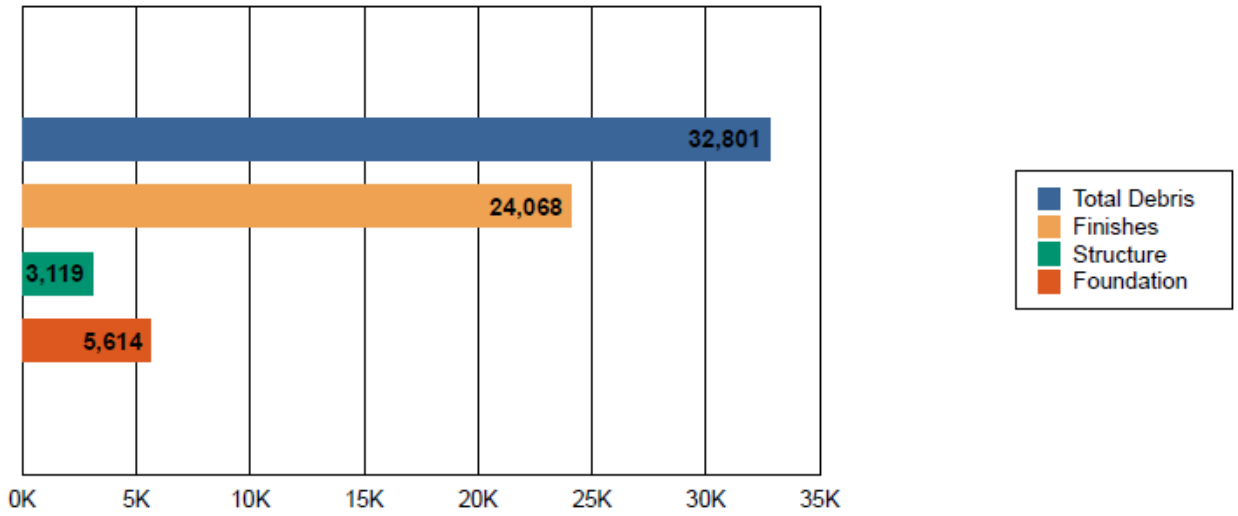
The total economic loss estimated for the flood is 4,708.47 million dollars, which represents 164.52 % of the total replacement value of the scenario buildings. The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with the inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood. The total building-related losses were 2,498.14 million dollars. 47% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 27.55% of the total loss.

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (drywall, insulation, etc.), 2) Structural (wood, brick, etc.), and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris. The model estimates that a total of 32,801 tons of debris will be generated. Finishes comprise 73% of the total, Structure comprises 10% of

the total, and Foundation comprises 17%. If the debris tonnage is converted into an estimated number of truckloads, it will require 1313 truckloads (at 25 tons/truck) to remove the debris generated by a flood.[21]

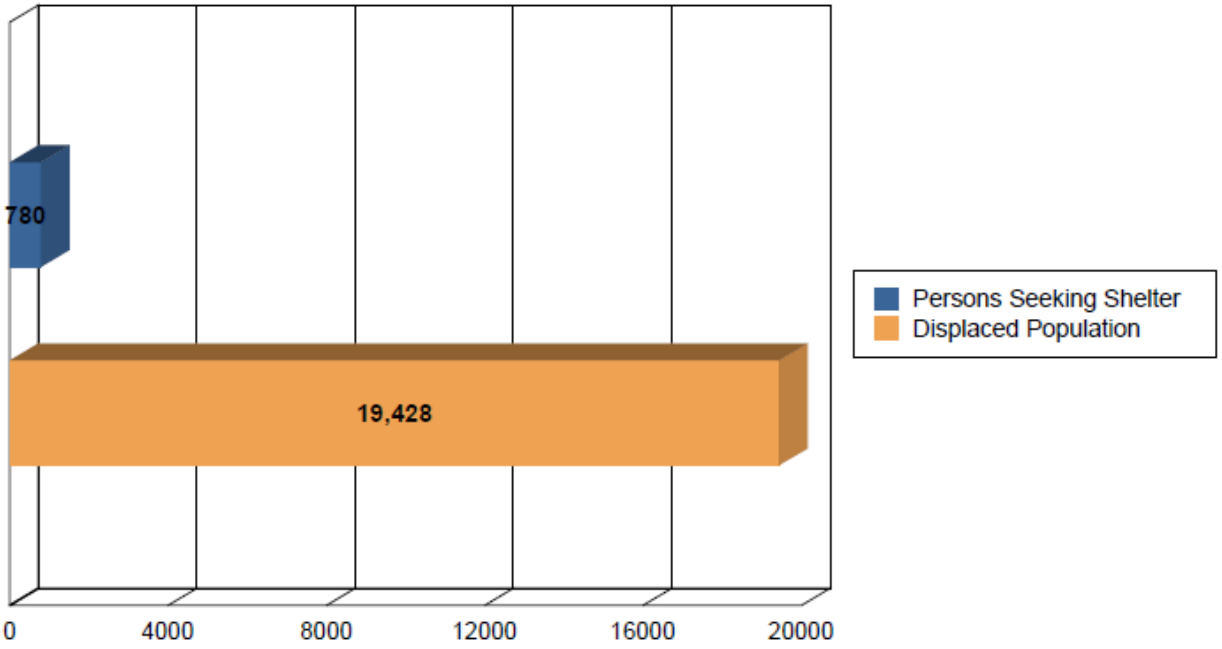
Figure 3.14: Debris Breakdown in Tons



Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 6,476 households (or 19,428 of people) will be displaced due to the flood in this scenario. Displacement includes households evacuated from within or very near to the inundated area. Of these, 780 people (out of a total population of 19,429) will seek temporary shelter in public shelters.[21]

Figure 3.15: Displaced Population/Persons Seeking Short-Term Public Shelter



Critical Facilities and Lifelines

H-GAC maintains a database of critical facilities that was expanded for this plan update based on updated policy guidance from FEMA. The HMC provided additional critical facility data when available at meetings, the PT also collected critical facility information from stakeholders at the public meetings and events. It was determined that there are 179 critical facilities with Angleton. A summary of these facilities is provided below.[22] A full list of critical facilities can be found in Appendix C.

Table 3.4: Critical Facilities & Community Lifelines

Asset Description	Quantity	Amount in a floodplain
AM Transmission Tower	0	0
Cellular Tower	2	0
Childcare Facility	11	0
College/ University Campus	1	0
Correctional Facility	3	0
Courthouse	1	0
Dam	0	0
Dialysis Center	1	0
Elder Care Facility	5	0
Electric Substation	3	0
EMS	1	0
Fire Station	4	0
FM Transmission Tower	0	0
Hospitals/Urgent Care	1	0
Local Emergency Operation Center	1	0
Oil or Gas Well	1	0
Petroleum Storage Tank	26	0
Pharmacy	5	0
Place of Worship	26	0
Police Station	5	0
Potable Water Well	20	2
Power Plant	0	0
Private Schools	1	0
Public Schools	13	0
Railroad Bridge	8	2
Roadway Bridge	26	12
Shelters	3	0
Solid Waste Landfill	2	0
Toxic Release Inventory Facility	6	0
Urgent Care	1	0
Wastewater Outfall	0	0
Wastewater Treatment Plant	2	1
Residential Units	7,673	
Commercial Units	346	

Repetitive Loss and Severe Repetitive Loss Properties

FEMA defines a repetitive loss (RL) structure as "a structure covered under a National Flood Insurance Program (NFIP) flood insurance policy that:

(1) Has incurred flood-related damage on 2 occasions, in which the cost of repair, on average, equaled or exceeded 25% of the value of the structure at the time of each such flood event; and
(2) At the time of the second incidence of flood-related damage, the contract for flood insurance contains increased cost of compliance (ICC) coverage."[23]

A severe repetitive loss (SRL) property is defined as "a structure that is covered under an NFIP flood insurance policy and has incurred flood-related damage:

(1) For which 4 or more separate claims payments have been made under flood insurance coverage under subchapter B of this chapter, with the amount of each claim (including building and contents payments) exceeding $5,000, and with the cumulative amount of such claims payments exceeding $20,000; or
(2) For which at least 2 separate flood insurance claims payments (building payments only) have been made, with a cumulative amount of such claims exceeding the value of the insured structure.[24]

According to available data from 2023, the city has a total of 97 RL properties, of which 18 are designated as SRL properties. This does not include RL or SRL properties that have already been mitigated. Only 23 of these RL and SRL properties are insured through the NFIP. Total SRL property claim payments for the City of Angleton are $2,560,751.56. There is an average of 5.6 NFIP claims per SRL property within the city.[25],[26] Table 3.5 outlines the structure type (residential, commercial, institutional, etc.), and number of records for RL and SRL properties within the city, including the number of those structures that were insured under the NFIP.

Table 3.5: RL and SRL Properties, City of Angleton
(Source: FEMA, Correspondence with the Floodplain Management and Insurance Branch)

Jurisdiction Name	Residential RLPs	Non-Residential RLPs	Total RLPs	SRL Properties	Number of NFIP Insured Properties
Angleton	87	10	97	18	23

FEMA Guidance specifies that NFIP flood insurance claim information is subject to The Privacy Act of 1974, as amended. The Act prohibits public release of policyholder names, or names of financial assistance recipients and the amount of the claim payment or assistance. After flooding events, local officials are responsible for inspecting flood-damaged structures in the special flood hazard areas (SFHA) to determine if they are substantially damaged (50% or more damaged). If so, the property owner is required to bring a non-conforming structure into compliance with the local floodplain ordinance. For the City of Angleton, the Floodplain Administrator for Brazoria County is responsible for handling these NFIP claims.

National Flood Insurance Program Participation

The NFIP is a federal program administered through FEMA that enables property owners in participating communities to purchase insurance as a protection against flood losses. Communities must maintain eligibility in the NFIP by adopting and enforcing floodplain management regulations intended to prevent unsafe development in the floodplain, thus reducing future flood damage. FEMA creates flood maps, or Flood Insurance Rate Maps (FIRM) to support the NFIP.[27],[28] These flood maps are periodically updated and outline SFHA. The SFHA is the area where the NFIP floodplain management regulations must be enforced and the area where the mandatory purchase of flood insurance applies.[29] The NFIP provides affordable flood insurance for property owners, renters, and businesses in participating communities. This reduces the socio-economic impacts of flooding on communities through risk reduction via flood insurance and reduces the physical impacts of flooding through beneficial floodplain regulation. The City of Angleton adopted their Flood Damage Prevention Ordinance in December 2018. The FDPO is located

in the city's Code of Ordinances within Chapter 23, Article V. Environmental Management, Division 1 Flood Damage Prevention and Division 2 Flood Hazard Reduction. The City of Angleton functions under the regulatory umbrella of Brazoria County for floodplain administration. NFIP requirements are handled by the certified floodplain manager (CFM) on staff.

As part of their FDPO, the City of Angleton manages substantial damage or improvements as follows:

Sec. 23-56. - General provisions.

A. *Generally.* This division sets out general and specific standards for flood hazard reduction.

B. *General standards for flood hazard reduction.*

1. *Generally.* The requirements of this subsection apply to all new construction and substantial improvements in areas of special flood hazard.
2. *Resistance to hydrodynamic and hydrostatic loads.* All new construction or substantial improvements shall be designed (or modified) and adequately anchored to prevent flotation, collapse or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy.
3. *Construction to minimize flood damage.* All new construction or substantial improvements shall be constructed by methods and practices that minimize flood damage.
4. *Flood damage resistant materials.* All new construction or substantial improvements shall be constructed with materials resistant to flood damage.
5. *Protection of building service facilities.* All new construction or substantial improvements shall be constructed with electrical, heating, ventilation, plumbing, and air conditioning equipment and other service facilities that are designed and/or located so as to prevent water from entering or accumulating within the components during conditions of flooding.
6. *Protection of water supply systems.* All new and replacement water supply systems shall be designed to minimize, or eliminate, infiltration of floodwaters into the system.
7. *Protection of sanitary sewer systems.* New and replacement sanitary sewage systems, including septic systems, shall be designed to minimize or eliminate infiltration of floodwaters into the system and discharge from the systems into floodwaters.
8. *Location of on-site waste disposal systems.* On-lot sanitary sewage disposal systems shall be located to avoid impairment to them or contamination from them during flooding.
9. *Limitations on fill.*
    a. No fill shall be placed within a special flood hazard area unless the effect of the fill on water storage and water quality is fully mitigated in one or more of the following ways:
        i. Excavation of a volume of soil comparable to the volume that was filled to bring the surface of the land to the base flood elevation. However, excavation is prohibited at depths that would be likely to:
            a. Increase the velocity of stormwater flows;
            b. Cause significant new erosion; or
            c. Expose groundwater to contamination by pollutants which may be present in stormwater runoff.
        ii. A stormwater management system is provided in a manner and location that compensates for the removal of the filled area from the floodplain; or
        iii. If the compensatory storage is provided in the floodplain, the combination of filling, compensatory storage, and detention is intended to lower the flood elevation by increasing channel capacity.
    b. If fill is placed, the applicant shall provide a hydraulics and hydrology study, which shall verify full mitigation, or, alternatively, support a LOMR from FEMA.

The Community Rating System (CRS)

The CRS is a voluntary incentive program that recognizes and encourages community floodplain management practices that exceed the minimum requirements of the NFIP. Participation in the CRS program is voluntary and includes many benefits for a community, such as discounted flood insurance premiums that relate to the community's level of efforts that reduce risk from flooding and strengthen floodplain management. Currently, the City of Angleton does not participate in the CRS Program.[30]

Table 3.6: Community Participation in the NFIP and CRS Program

Jurisdiction	Participating	Date Joined	Current Effective FIRM Date	CRS Participation
Angleton	Y	06/21/74	12/30/20	N

NFIP Policies in Force

The table below summarizes the NFIP policies in force for Brazoria County and the City of Angleton. In total, there are 1,142 NFIP insured properties within the city.[31]

Table 3.7: NFIP Insured Properties

Community Name (Number)	Policies in Force	Total Coverage	Total Written Premium + FPF
BRAZORIA COUNTY (485458)	33,963	$10,621,664,000	$26,637,225
ANGLETON (480064)	1,142	$353,911,000	$762,629

Community Name- The official NFIP name of the community in which the policy resides.
Community Number- The 6-character community ID in which the policy resides.
Total Coverage- The total building and contents coverage for the policies in force.
Total Written Premium + FPF (Federal Policy Fee)- This represents the sum of the premium and FPF for the policies in force.

Section 4: Risk Assessment

This section outlines the risk assessment procedures and identifies hazards ranked by risk that affect the City of Angleton.

Section 4: RISK ASSESSMENT

The 2023 Texas State Hazard Mitigation Plan identified 11 major natural hazards that affect the region. These include hurricanes, floods, wildfires, drought, and tornados. The PT and HMC identified 17 hazards, 12 of which are natural hazards, which could affect the city. Not all hazards were profiled for this plan. Hazards not profiled were drinking water/aging infrastructure, train derailment, and dam/levee failure.

Risk Assessment

The HMC was provided with a Risk Assessment worksheet prepared by H-GAC staff. The worksheet outlined the purpose of the Risk Assessment, important items to keep in mind while completing the worksheet, probability and severity scores, including characteristics for those scores that were relatable, and a guide for how to calculate hazard rankings determined by the probability and severity scores. The Risk Assessment ranked the hazards identified by scoring the probability and severity of each hazard. A risk score was then determined by multiplying the probability (P) by the severity (S). Tables including scores and associated characteristics can be found below. Appendix D includes completed worksheets and a summary of hazard ranking scores from participating members of the HMC.

Probability	Characteristics
4 – Highly Likely	Event is probable within the next calendar year These events have occurred, on average, once every 1-2 years in the past
3 – Likely	Event is probable within the next 10 years Event has a 10-50% chance of occurring in any given year These events have occurred, on average, once every 3-10 years in the past
2 – Possible	Event is probable within the next 50 years Event has a 2-10% chance of occurring in any given year These events have occurred, on average, once every 10-50 years in the past
1 – Unlikely	Event is probable within the next 200 years Event has a 0.5-2% chance of occurring in any given year These events have occurred, on average, once every 50-200 years in the past

Severity	Characteristics
8 – Catastrophic	Multiple deaths Complete shutdown of facilities for 30 or more days More than 50% of property is severely damaged
4 – Critical	Injuries and/or illnesses result in permanent disability Complete shutdown of critical facilities for at least 14 days More than 25% of property is severely damaged
2 – Limited	Injuries and/or illnesses do not result in permanent disability Complete shutdown of critical facilities for more than seven days More than 10% of property is severely damaged.
1 – Negligible	Injuries and/or illnesses are treatable with first aid Minor quality of life lost Shutdown of critical facilities and services for 24 hours or less Less than 10% of property is severely damaged

Hazards Ranked by Risk

Each identified hazard in the table below poses a risk to the City of Angleton. Ranking the hazards from greatest to lowest risk allows the communities to prioritize their resources and focus efforts where they are most needed. Identified hazards were given a risk score as determined by participating jurisdictions and the HMC, those hazards were then categorized with a risk rating of High, Moderate, or Low.

Risk Rating	Ranking	Hazards
High	1	Hurricanes, Tropical Storms, & Depressions
	2	Flooding
	3	Dam/Levee Failure*
Moderate	4	Winter Weather
	5	Tornado
	6	Drinking Water/Aging Infrastructure*
	7	Extreme Heat
	8	Wildfire
	9	Drought & Expansive Soils
	10	Severe Thunderstorms & Lightning
Low	11	Hail
	12	Cybersecurity
	13	Windstorm
	14	Train Derailment*
	15	Erosion
	16	Earthquake*
	17	Emerging Infectious Diseases

* Indicates a hazard that was not profiled but was identified as a hazard of concern by the HMC.

Dam/Levee Failure was not profiled in this plan as there are no dams/levees within Angleton city limits. All dams/levees near the city have been classified as 'Low' in the hazard potential classification. Due to the risk of this hazard being negligible, it will not be profiled in this plan. Drinking water/aging infrastructure and train derailment were not profiled in this plan as they are not natural hazards. Earthquakes, while a natural hazard that affects some areas of Texas, are not considered to be a threat to the City of Angleton. The risk of an earthquake affecting a city as far south as Angleton is minimal. The risk of an earthquake is lowest on the Gulf Coast as the area is not located near any plate boundaries.

Section 5: Capability Assessment

This section includes the capability assessment, which includes a summary and description of the existing plans, programs, and regulatory mechanisms that support hazard mitigation within the planning area.

Section 5: CAPABILITY ASSESSMENT

Capability Assessment

A Capability Assessment is a process of evaluating the existing capabilities, including resources such as staff time, funding, and infrastructure, that the city currently has at its disposal to utilize for hazard risk reduction. The HMC completed local capability and risk assessment surveys for the City of Angleton to collect data on hazards that affect the area, the city's ability to mitigate damages from these hazards, and current plans or programs in place to help mitigate natural hazards. The HMC also identified factors impacting their capabilities to address hazards within the city. The PT used the information to assess the overall risk within the planning area, and to determine a strategy to integrate the HMP into their current planning mechanisms. A condensed version of the information is provided below. The full capability assessment worksheets and responses can be found in Appendix D.

List of Existing Plans & Regulations

CIP: Capital Improvements Plan
COMP: Comprehensive Land Use Plan
COOP: Continuity of Operations Plan
DRP: Disaster Recovery Plan
EDP: Economic Development Plan
EOP: Emergency Operations Plan
FMP: Floodplain Management Plan
FDPO: Flood Damage Prevention Ordinance
FPO: Floodplain Ordinance
HMP: Hazard Mitigation Plan
NHSO: Natural Hazard Specific Ordinance
REP: Radiological Emergency Plan
SMP: Stormwater Management Plan
SO: Subdivision Regulation
TP: Transportation Plan
ZO: Zoning Ordinance

Table 5.1: Existing Plans and Regulations by Participating Jurisdictions

Jurisdiction	CIP	COMP	COOP	DRP	EDP	EOP	FMP	FDPO	FPO	HMP	NHSO	REP	SMP	SO	TP	ZO
Angleton	X	X	X	X		X	X	X	X	X		X	X	X	X	X

The City of Angleton has adopted the following Codes:

- 2015 International Energy Code
- 2015 International Fuel Gas Code
- 2015 International Mechanical Code
- 2015 International Plumbing Code
- 2015 International Building Code
- 2015 International Residential Code
- 2014 NFPA 70 National Electric Code
- 2015 International Fire Code
- 2015 Property Maintenance Code
- 2015 Pool and Spa Code

Capability Limitations and Expansion Opportunities

The city and HMC examined any existing authorities, policies, programs, and resources, then identified ways to improve upon and expand these existing authorities to support the mitigation strategy.

Table 5.2: Capability Limitations and Expansion Opportunities

Jurisdiction	Capability Limitations and Expansion Opportunities
Angleton	Identified an inadequate budget as a factor that decreases their capability to implement mitigation actions and reduce future damages. Angleton will apply for state and federal funding to help fund mitigation actions that reduce the impact of natural hazards. They also plan to expand their mutual aid agreements to address flood emergency response needs.

Section 6: Hazard Identification & Risk Analysis

This section is broken down into subsections for each hazard of concern to the city identified during the risk assessment. It contains descriptions of identified hazards, hazard location, extent, history of events, probability of future events, and climate change impacts. Additionally, vulnerability is addressed for all hazards and includes a probable risk level, an estimate of property and crop damages, number of events, fatalities and injuries, average annual events, changes in frequency, and estimated annualized losses, where applicable.

Section 6: HAZARD IDENTIFICATION & RISK ANALYSIS

Section 6.1: Hurricanes, Tropical Storms, and Tropical Depressions

6.1 Hurricanes, Tropical Storms, and Tropical Depressions

Hurricanes form from the development of thunderstorms that are fueled by warm water and air over the ocean. Tropical waves and disturbances can lead to the formation of tropical cyclones. A tropical cyclone is a rotating, organized system of clouds and thunderstorms that originates over tropical or subtropical waters and has a closed low-level circulation. Tropical cyclones can produce intense rainfall of more than 6 inches, resulting in heavy flooding. Other dangers associated with the formation of these storms include storm surges, damaging winds, rip currents, and tornadoes.[32] Slower moving larger storms can produce more rainfall and more dangerous outcomes. Classifications of tropical cyclones; tropical depressions, tropical storms, hurricanes, and major hurricanes are defined in the table below.[33]

Table 6.1.1: Tropical Cyclone Classifications

Classification	Definition
Tropical Depression	A tropical cyclone with maximum sustained winds of 38 mph (33 knots) or less. Tropical depressions can bring heavy downpours and sustained winds strong enough to generate rough surf and life-threatening rip currents.
Tropical Storm	A tropical cyclone with maximum sustained winds of 39 to 73 mph (34 to 63 knots). These storms are assigned a name and start to become more organized and circular.
Hurricane	A tropical cyclone with maximum sustained winds of 74 mph (64 knots) or higher. Hurricanes have very pronounced circulation of which an area of clear weather, an "eye" forms in the center.
Major Hurricane	A tropical cyclone with maximum sustained winds of 111 mph (96 knots) or higher, corresponding to a Category 3, 4, or 5 on the Saffir-Simpson Hurricane Wind Scale.

Hurricane season for Texas officially begins on June 1 and ends on November 30. The greatest threat of landfall for the Texas coast occurs between the beginning of June and the end of October. The NWS issues hurricane and tropical storm watches and warnings when these hazards are forming. 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 National Weather Service (NWS) allows the National Oceanic and Atmospheric Administration's (NOAA) National Hurricane Center (NHC) to issue advisories during the post-tropical stage. Whenever a tropical cyclone or a subtropical storm has formed in the Atlantic or Eastern North Pacific, the NOAA NHC issues tropical cyclone advisory products at least every 6 hours at 5 AM, 11 AM, 5 PM, and 11 PM Eastern Daylight Time (EDT). When a coastal tropical storm or hurricane watches or warnings are in effect, the NHC issues Tropical Cyclone Public Advisories every 3 hours. The table below provides definitions of these tropical watches and warnings.[34]

Table 6.1.2: Tropical Watches and Warnings

Name	Definition
Advisories	
Tropical Cyclone Public Advisory	Contains a list of all current coastal watches and warnings associated with an ongoing or potential tropical cyclone, a post-tropical cyclone, or a subtropical cyclone. Provides the cyclone position, maximum sustained winds, current motion, and a description of the hazards associated with the storm.
Watches	
Tropical Storm Watch	Tropical storm conditions (sustained winds of 39 to 73 mph) are possible within the specified area within 48 hours.
Storm Surge Watch	There is a possibility of life-threatening inundation from rising water moving inland from the shoreline somewhere within the specified area, generally within 48 hours.
Hurricane Watch	Hurricane conditions (sustained winds of 74 mph or greater) are possible within your area. Because it may not be safe to prepare for a hurricane once winds reach tropical storm force, The NHC issues hurricane watches 48 hours before it anticipates tropical storm-force winds.
Warnings	

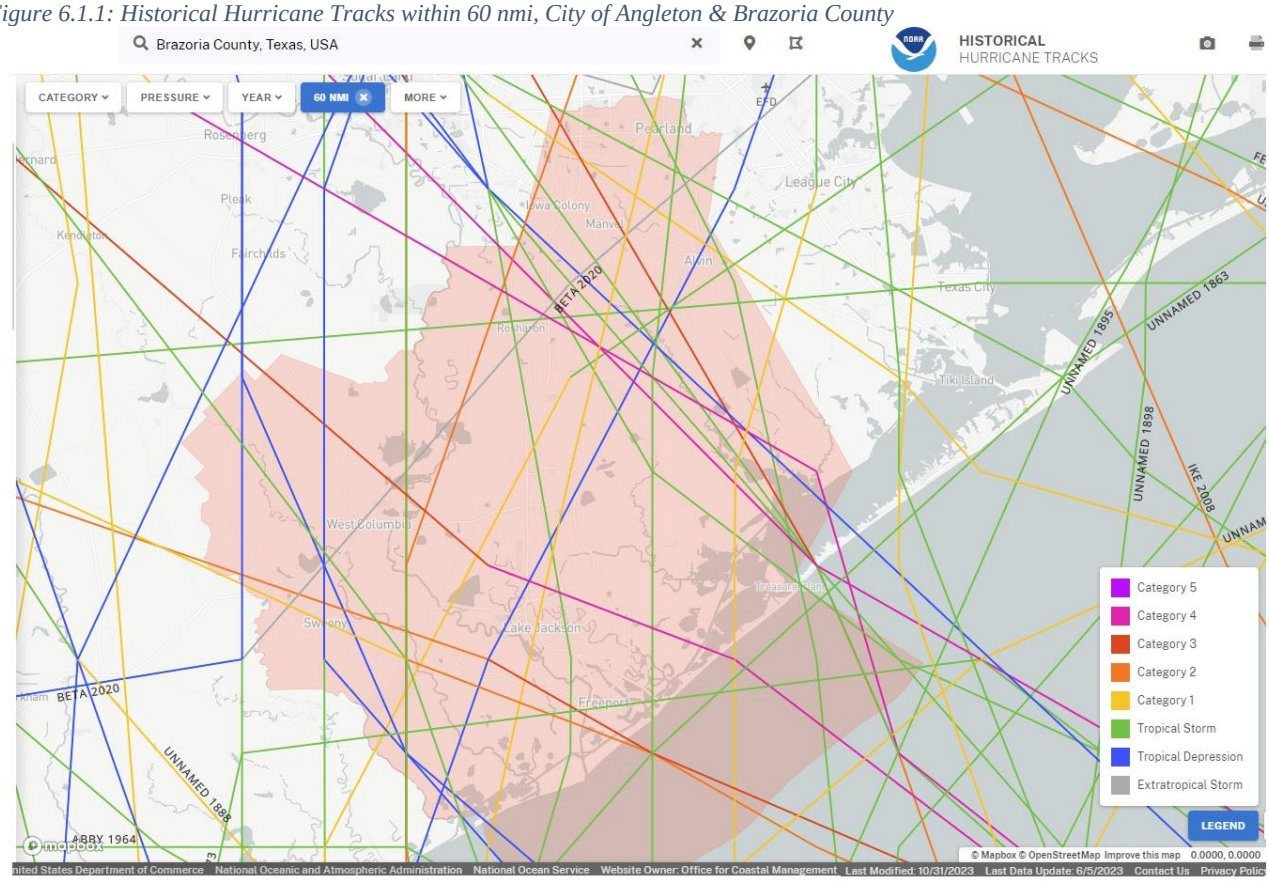
Name	Definition
Tropical Storm Warning	Tropical storm conditions (sustained winds of 39 to 73 mph) are expected within your area within 36 hours.
Storm Surge Warning	There is a danger of life-threatening inundation from rising water moving inland from the shoreline somewhere within the specified area, generally within 36 hours. If you are under a storm surge warning, check for evacuation orders from your local officials.
Extreme Wind Warning	Extreme sustained winds of a major hurricane (115 mph or greater), usually associated with the eyewall, are expected to begin within an hour. Take immediate shelter in the interior portion of a well-built structure.
Hurricane Warning	Hurricane conditions (sustained winds of 74 mph or greater) are expected somewhere within the specified area. NHC issues a hurricane warning 36 hours in advance of tropical storm-force winds to give you time to complete your preparations. All preparations should be complete. Evacuate immediately if so ordered.

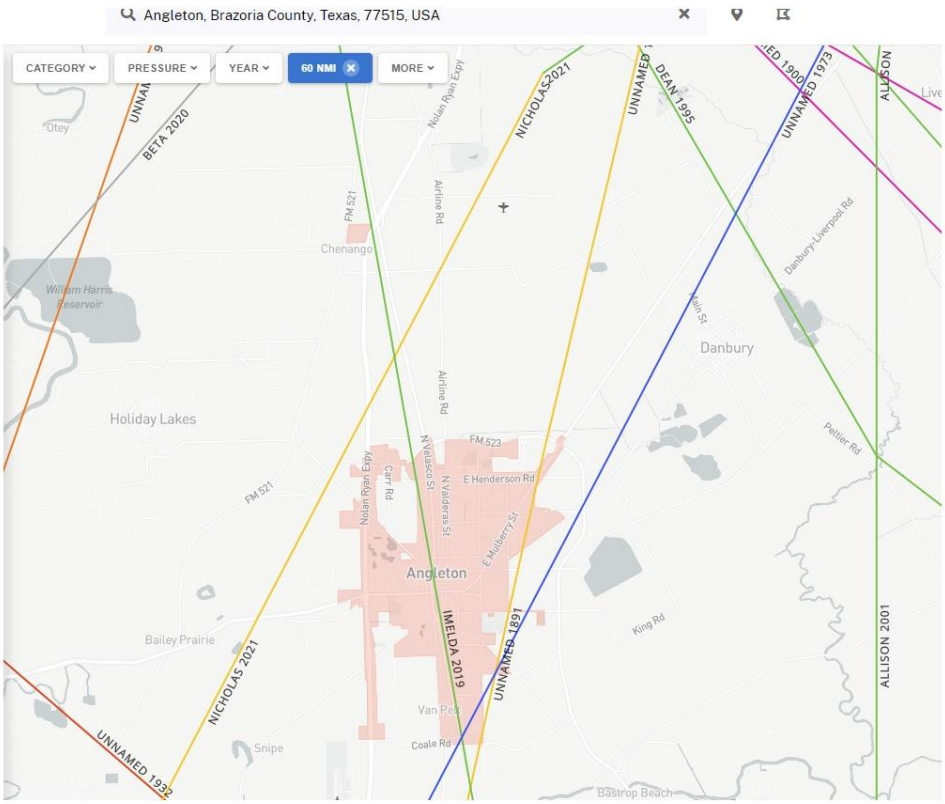
Location

The city of Angleton is located approximately 18 miles inland from the Gulf of Mexico. Wind and rains generated by hurricanes, tropical storms, and depressions do have a significant impact on flooding and windstorm-related damages within the city. The entire City of Angleton is at risk from this hazard as it has no set geographic boundary.

Flooding is profiled in Section 6.2 of this HMP, while the Windstorm profile can be found in Section 6.10. The figures below, based on NOAA's Historical Hurricane Tracks interactive map, show the historical hurricane, tropical storms, and tropical depression tracks that have crossed into the City of Angleton and Brazoria County. It is important to remember that these storms, named or unnamed, do not have to cross the county or city boundaries for the planning area to be at risk from their impacts. There has been a total of 88 of these storms that have occurred within 60 nmi of Brazoria County, while 30 storms have crossed through the county directly and 3 storms have crossed through the Angleton City limits.[35] Not shown on the figures below, Hurricane Beryl made landfall as a category 1 storm just 45 miles east in Matagorda County.

Figure 6.1.1: Historical Hurricane Tracks within 60 nmi, City of Angleton & Brazoria County





Extent

Hurricane intensity is measured through the Saffir-Simpson Hurricane Wind Scale. The scale was originally developed by wind engineer Herb Saffir and meteorologist Bob Simpson. It has been an excellent tool for alerting the public about the possible impacts of various intensity hurricanes. The scale does not address the potential for other hurricane-related impacts, such as storm surges, rainfall-induced floods, and tornadoes. This wind caused damage general descriptions of the scale are to an extent dependent upon the local building codes in effect and how well and how long they have been enforced.[36] The scale gives a 1 to 5 rating based only on a hurricane's maximum sustained wind speed and estimates potential property damage at each scale. Hurricanes of Category 3 and higher are known as major hurricanes. These hurricanes can cause devastating to catastrophic wind damage and significant loss of life due to the strength of their winds. Hurricanes of all categories can produce deadly storm surges, rain-induced floods, and tornadoes. These hazards require people to take protective action, including evacuating from areas vulnerable to storm surges.[37]

Table 6.1.3: The Saffir-Simpson Hurricane Wind Scale

Category	Sustained Wind Speeds	Types of Damage Due to Hurricane Winds
1	74-95 mph	**Very dangerous winds will produce some damage**: People, livestock, and pets struck by flying or falling debris could be injured or killed. 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 mph	**Extremely dangerous winds will cause extensive damage**: There is a substantial risk of injury or death to people, livestock, and pets due to flying and falling debris. Older (mainly pre-1994 construction) manufactured homes have a very high chance of being destroyed and the flying debris generated can shred nearby manufactured homes. Newer manufactured homes can also be destroyed. 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	111-129 mph	**Devastating damage will occur**: There is a high risk of injury or death to people, livestock, and pets due to flying and falling debris. Nearly all older (pre-1994) manufactured homes will be destroyed. Newer manufactured homes will sustain severe damage with the potential for complete roof failure and wall collapse. 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. Electric and water will be unavailable for several days to weeks after the storm passes.
4	130-156 mph	**Catastrophic damage will occur**: There is a very high risk of injury or death to people, livestock, and pets due to flying and falling debris. Nearly all older (pre-1994) manufactured homes will be destroyed. A high percentage of newer manufactured homes also will be destroyed. Poorly constructed homes can sustain complete collapse of all walls as well as the loss of the roof structure. Well-built homes also 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.

Category	Sustained Wind Speeds	Types of Damage Due to Hurricane Winds
5	157 mph or higher	**Catastrophic damage will occur**: People, livestock, and pets are at very high risk of injury or death from flying or falling debris, even if indoors in manufactured homes or framed homes. Almost complete destruction of all manufactured homes will occur, regardless of age or construction. A high percentage of frame homes will be destroyed, with total roof failure and wall collapse. Extensive damage to roof covers, windows, and doors will occur. 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.

A worst-case scenario for this hazard would be a category 5 hurricane making landfall directly over the City of Angleton, near Matagorda County, or near Galveston County. This could lead to catastrophic damage for the city and create an environment favorable for severe thunderstorm development, heavy rains, tornadoes, and hail. Widespread flooding, dangerous winds, and other secondary hazards like power outages, loss of life, and extensive damage to buildings, critical facilities, and infrastructure could occur. Additionally, this hazard could damage critical infrastructure that leads to a prolonged power outage, and even result in a loss of communication within the city or county if a radio or cell tower is destroyed. If the hazard event occurs during a period of extreme heat or drought and disrupts power supply in the area for a prolonged amount of time, secondary hazards will pose increased risks to citizens due to the inability to keep homes and buildings cool and power medical equipment. This scenario is similar to what occurred within the region during the 2024 derecho and Hurricane Beryl. Power lines and poles were destroyed by debris and falling trees due to the severe thunderstorms and winds that Hurricane Beryl swept in when the region was under an excessive heat advisory. Power line restoration and necessary infrastructure repairs took longer to address than anticipated, leading to the activation of cooling centers for residents.

Historic Occurrences

NOAA collects historic climate data for the entire nation. NOAA's storm event data can be accessed on the National Center for Environmental Information (NCEI) storm events database. These events are shown at the county level with some referencing a specific location, city, or zone. The database currently contains data from January 1950 to February 2024, as entered by NOAA's NWS. Due to changes in the data collection and processing procedures over time, there are unique periods of record available depending on the event type. The table below highlights events for this hazard that have occurred within Brazoria County from 1950-2023.[38] The table below does not include data for Hurricane Beryl, which occurred in July 2024.

Table 6.1.4: Hurricane, Tropical Storms, and Tropical Depressions (1950-2023), Brazoria County

Date	Area Impacted	Event Type	Injuries/ Deaths	Property Damage	Crop Damage
8/21/1998	BRAZORIA (ZONE)	Tropical Storm	0/0	$5,000	$0.00
9/7/1998	BRAZORIA (ZONE)	Tropical Storm	0/1	$28,700,000	$0.00
6/5/2001	BRAZORIA (ZONE)	Tropical Storm	0/0	$22,200,000	$0.00
9/5/2002	BRAZORIA (ZONE)	Tropical Storm	0/0	$0.00	$0.00
7/14/2003	BRAZORIA (ZONE)	Hurricane	0/0	$1,270,000	$0.00
8/30/2003	BRAZORIA (ZONE)	Tropical Storm	0/0	$30,000	$0.00
9/1/2003	BRAZORIA (ZONE)	Tropical Storm	0/0	$8,000	$0.00
9/23/2005	BRAZORIA (ZONE)	Hurricane	0/0	$500,000	$0.00
9/12/2008	BRAZORIA (ZONE)	Hurricane	0/0	$700,000,000	$0.00
6/15/2015	BRAZORIA (ZONE)	Tropical Storm	0/0	$0.00	$0.00
6/21/2017	BRAZORIA (ZONE)	Tropical Storm	0/0	$0.00	$0.00
8/25/2017	BRAZORIA (ZONE)	Tropical Storm	0/0	$0.00	$0.00

Date	Area Impacted	Event Type	Injuries/ Deaths	Property Damage	Crop Damage
7/25/2020	BRAZORIA ISLANDS (ZONE)	Tropical Storm	0/0	$0.00	$0.00
7/25/2020	COASTAL BRAZORIA (ZONE)	Tropical Storm	0/0	$0.00	$0.00
9/13/2021	BRAZORIA ISLANDS (ZONE)	Tropical Storm	0/0	$0.00	$0.00
9/13/2021	INLAND BRAZORIA (ZONE)	Tropical Storm	0/0	$500,000*	$0.00
		TOTALS:	**0/1**	**$752,713,000**	**$0.00**

*Source: Angleton Emergency Management Department

Presidential Disaster Declarations

There have been 16 federally declared hurricane, tropical storms, or tropical depression related disasters in Brazoria County since 1950. There were also 2 severe storm disasters and 2 coastal storms that mentioned a hurricane or tropical storm in their declaration title and were included in the table below.

Table 6.1.5: Federal Disaster Declarations for Hurricanes, Tropical Storms, and Tropical Depressions

Date	Disaster Number	Declaration Types	Incident Type	Declaration Title
8/19/1983	689	Major Disaster Declaration	Hurricane	HURRICANE ALICIA
8/26/1998	1239	Major Disaster Declaration	Severe Storm	TROPICAL STORM CHARLEY
9/23/1998	1245	Major Disaster Declaration	Severe Storm	HURRICANE GEORGES - TEXAS
6/9/2001	1379	Major Disaster Declaration	Coastal Storm	TROPICAL STORM ALLISON
9/26/2002	1434	Major Disaster Declaration	Coastal Storm	TROPICAL STORM FAY
7/17/2003	1479	Major Disaster Declaration	Hurricane	HURRICANE CLAUDETTE
9/2/2005	3216	Emergency Declaration	Hurricane	HURRICANE KATRINA EVACUATION
9/21/2005	3261	Emergency Declaration	Hurricane	HURRICANE RITA
9/24/2005	1606	Major Disaster Declaration	Hurricane	HURRICANE RITA
8/18/2007	3277	Emergency Declaration	Hurricane	HURRICANE DEAN
8/29/2008	3290	Emergency Declaration	Hurricane	HURRICANE GUSTAV
9/10/2008	3294	Emergency Declaration	Hurricane	HURRICANE IKE
9/13/2008	1791	Major Disaster Declaration	Hurricane	HURRICANE IKE
7/26/2020	3530	Emergency Declaration	Hurricane	HURRICANE HANNA
8/25/2017	4332	Major Disaster Declaration	Hurricane	HURRICANE HARVEY
8/24/2020	3540	Emergency Declaration	Hurricane	TROPICAL STORMS MARCO AND LAURA
7/9/2024	4798	Major Disaster Declaration	Hurricane	HURRICANE BERYL

U.S. Department of Agriculture (USDA) Disaster Declarations

The Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency (EM) loans available to producers suffering losses in those counties and in counties that are contiguous to a designated county. In addition to EM loan eligibility, other emergency assistance programs, such as USDA Farm Service Agency (FSA) disaster assistance programs, have historically used disaster designations as an eligibility trigger. USDA Secretarial disaster designations must be requested of the Secretary of Agriculture by a governor or the governor's authorized representative, by an Indian Tribal Council leader, or by an FSA State Executive Director (SED). The Secretarial disaster designation is the most widely used. When there is a presidential disaster declaration, FEMA immediately notifies the USDA FSA of the primary counties named in the presidential declaration. USDA disaster declarations for the City of Angleton since 2018 are listed in the table below.[39]

Table 6.1.6: USDA Declared Disasters (2018-2023), Hurricane, Tropical Storms, and Tropical Depressions

Crop Disaster Year	Disaster Description	Designation Number
2021	Hurricane Nicholas	S5115

Probability of Future Occurrences

The State of Texas HMP estimates the occurrence of hurricanes, tropical storms, and tropical depressions is trending upward, with a 400% increase in the 5-year planning cycle between 2017-2021.[40] According to FEMA's National Risk Index (NRI) for hurricanes within Brazoria County, annualized frequency values are 0.2 events per year over 73 years of record (1949-2021), with 43 events on record for this timeframe.[41]

Populations at Risk

Populations at risk for hurricanes, tropical storms, and tropical depressions include the entire county and the City of Angleton as this hazard has no geographic boundaries. Hurricanes can cause property damage, flooding, lack of access to critical facilities that provide food, water, medications, or other forms of medical assistance, and lack of utilities such as electricity and clean water, which can increase the risk of illness. The National Center for Healthy Housing (NCHH) includes at-risk populations for several hazards. For hurricanes, these include older adults, children, people experiencing homelessness, people with disabilities, and people with chronic health conditions. Older adults, in addition to the dangers listed above, can also face social isolation, lack of electricity needed to run medical equipment, and lack of access to other critical supplies. In younger populations, such as children, hurricanes can disrupt schooling and the normal day-to-day routines they thrive on. This can not only jeopardize their academic success, it can also cause mental and emotional stress. Children are more at risk and vulnerable to certain medical conditions like asthma, lead poisoning, allergies, and bacterial infections which can be caused by the resulting flood damage and increased moisture of hurricanes. For people experiencing homelessness, housing and adequate shelter are critical in keeping populations safe during these types of hazard events so hurricanes can be life-threatening for this population if adequate shelter is not located and utilized. People with disabilities may require additional assistance to stay safe and prepare for these hazards such as creating a support network, finding accessible transportation to evacuate or get medical attention, and loss of power for needed medical equipment. Likewise, those with chronic health conditions may need similar assistance as those with disabilities. People with chronic health conditions also face exposure to diseases or illnesses from standing water and increased exposure to these illnesses when utilizing a shelter or evacuation center.[42] People living in mobile homes are also at greater risk of injury and death from these hazards. Despite mobile homes providing shelter, tornadoes and dangerous strong winds produced by hurricanes, tropical storms, and tropical depressions can cause mobile homes, even those that utilize anchoring, to be seriously damaged or destroyed when winds gust over 80 mph.[43]

All areas of future growth and development within the city will increase the risk to this hazard as it has no set geographic boundaries and a wide area of impact, often with many secondary hazards. As the population within the city continues to increase, so will the vulnerability to this hazard. An increase in population will place more strain on critical facilities and resources after an event.

National Risk Index

FEMA's NRI utilizes data from multiple sources including historical hazard events, hazard intensity, exposure of people and property to hazards, socioeconomic factors, and community resilience indicators. The NRI also incorporates hazard data to determine the frequency and intensity of various natural hazards. This information helps assess the likelihood of specific hazards occurring in different regions.[44]

The NRI considers the exposure of communities to hazards and incorporates factors such as population density, infrastructure systems, and critical facilities that may be at risk during a hazard event. The NRI also generates risk scores for communities across the U.S. that provide a relative ranking of areas based on their overall risk level. This helps to identify areas that may require additional resources and attention for mitigation and planning efforts. The NRI risk equation includes 3 components. Expected annual loss (EAL) represents the average economic loss in dollars resulting from natural hazards each year, the Community Risk Factor is a scaling factor that incorporates social vulnerability (the susceptibility of social groups to the adverse impacts of natural hazards), and community resilience (the ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions). The outcome, the risk index, represents the potential negative impacts of natural hazards on the county level or individually by census tracts. The NRI EAL score and rating, represent a community's relative level of expected loss each year when compared to all other communities at the same level.[44]

EAL for the City of Angleton was derived by creating a report that used census tract information for tracts that included the Angleton city limits. These were census tracts 48039662100, 48039662200, 48039662400, 48039662300, 48039662500, 48039663100, and 48039664100.[45]

EAL according to the FEMA NRI for hurricane events for these census tracts is listed as very high, with one tract rating relatively high. EAL values, risk index ratings, risk index scores, social vulnerability, and community resilience for each census tract can be found in the figures below. Additionally, the FEMA NRI lists the historic loss ratio (HLR), a hazard- and county-specific estimate of the percentage of the exposed consequence type (building value, population, or agriculture value) expected to be lost due to a hazard occurrence, for hurricanes within Brazoria County as relatively high.[46] Tropical storms and tropical depressions are not included in the FEMA NRI and were omitted here.

Figure 6.1.2: Risk Index by Census Tract, City of Angleton, Hurricane

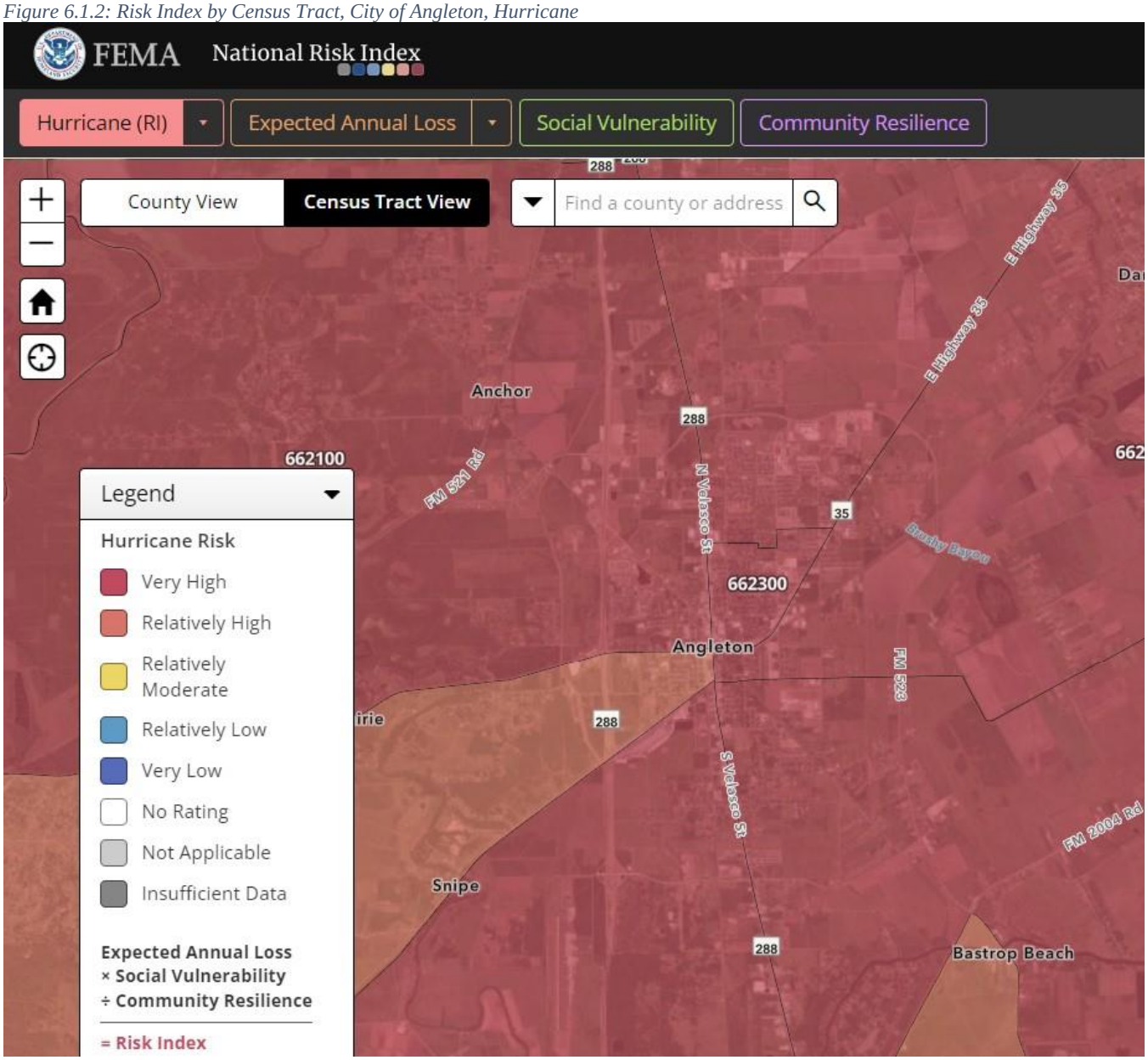


Figure 6.1.3: Expected Annual Loss by Census Tract, City of Angleton, Hurricane

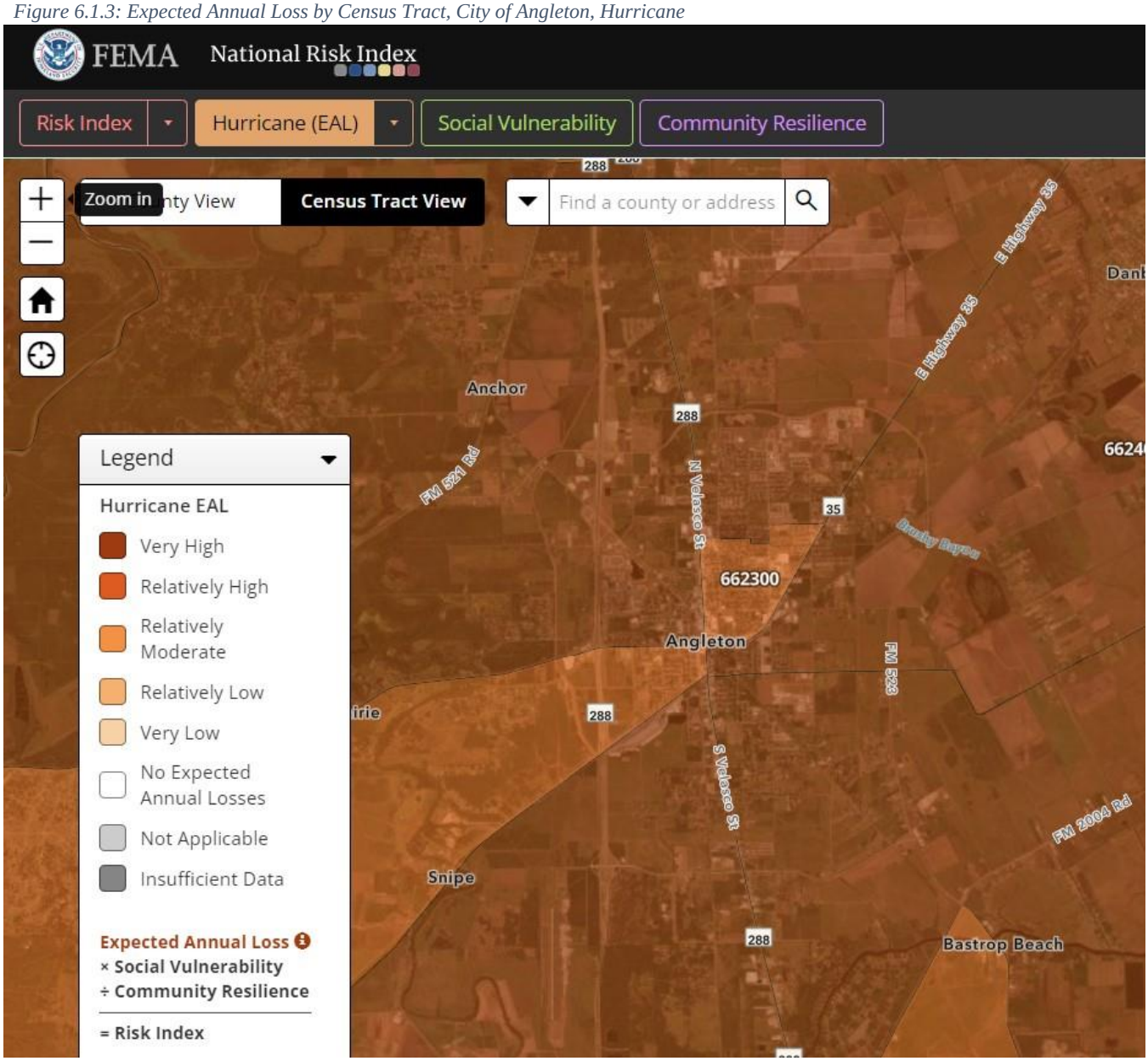


Figure 6.1.4: Social Vulnerability by Census Tract, City of Angleton

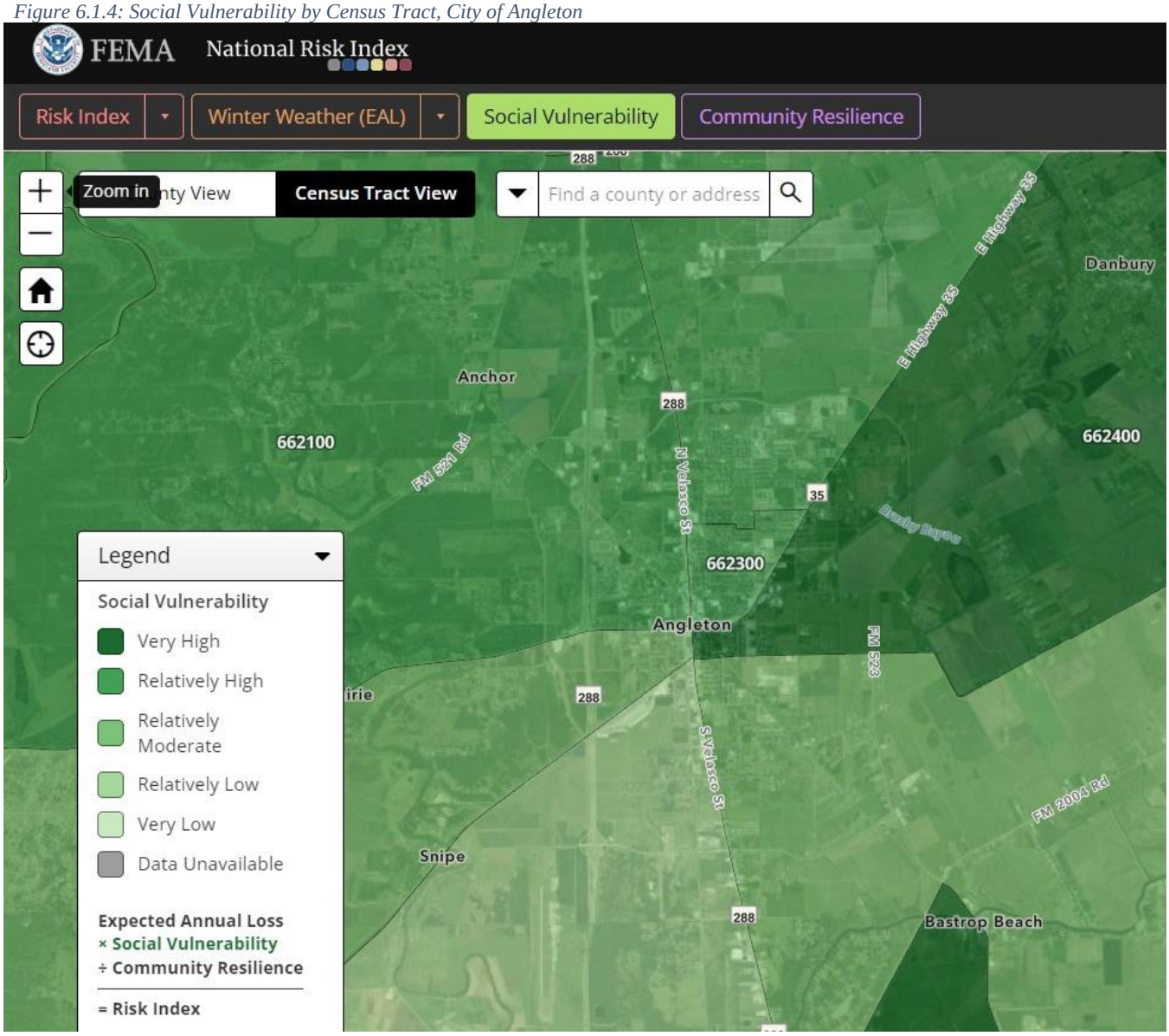


Figure 6.1.5: Community Resilience by Census Tract, City of Angleton

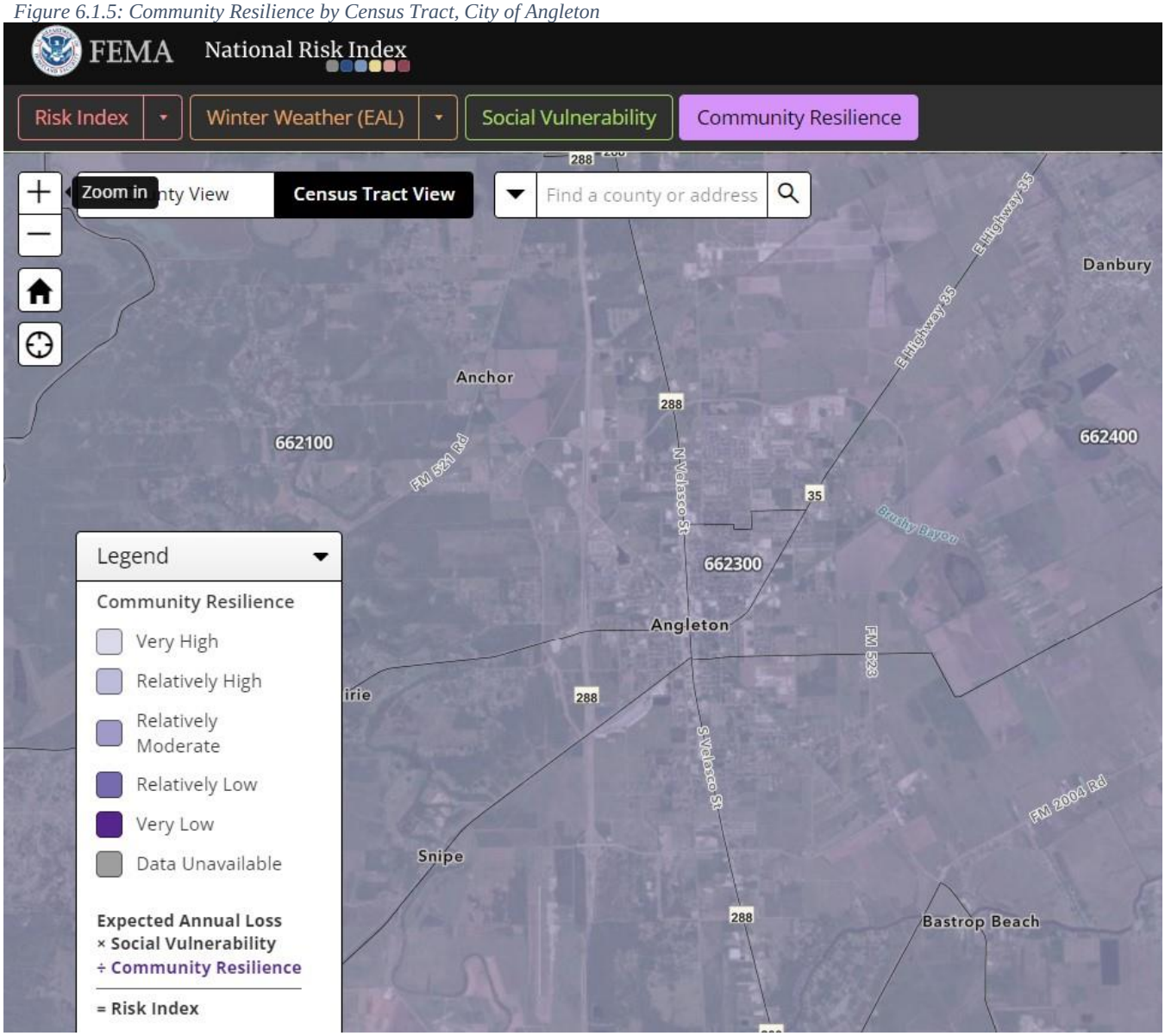


Figure 6.1.6: FEMA NRI Summary by Census Tract, City of Angleton, Hurricane

Rank	Community	State	Risk Index Rating	Risk Index Score	National Percentile
1	Census tract 48039662400	TX	Very High	98.33	0 100
2	Census tract 48039662200	TX	Very High	97.88	0 100
3	Census tract 48039663100	TX	Very High	97.78	0 100
4	Census tract 48039662100	TX	Very High	97.49	0 100
5	Census tract 48039664100	TX	Very High	96.77	0 100
6	Census tract 48039662300	TX	Very High	96.04	0 100
7	Census tract 48039662500	TX	Relatively High	91.91	0 100

Rank	Community	State	EAL Value	Social Vulnerability	Community Resilience	CRF	Risk Value	Risk Index Score
1	Census tract 48039662400	TX	$2,610,634	Very High	Relatively Moderate	1.43	$3,745,913	98.33
2	Census tract 48039662200	TX	$2,490,831	Relatively High	Relatively Moderate	1.34	$3,331,662	97.88
3	Census tract 48039663100	TX	$3,262,887	Relatively Low	Relatively Moderate	1	$3,265,585	97.78
4	Census tract 48039662100	TX	$2,524,451	Relatively High	Relatively Moderate	1.22	$3,088,959	97.49
5	Census tract 48039664100	TX	$2,561,745	Relatively Moderate	Relatively Moderate	1.05	$2,684,512	96.77
6	Census tract 48039662300	TX	$1,736,324	Relatively High	Relatively Moderate	1.38	$2,393,047	96.04
7	Census tract 48039662500	TX	$1,278,006	Relatively Moderate	Relatively Moderate	1.12	$1,427,229	91.91

Climate Change Impacts

According to the Office of the Texas State Climatologist, hurricanes, tropical storms, and tropical depressions, though unpredictable in quantity between 5-year planning cycles, will continue to intensify due to other climate-related factors such as the environmental conditions for thunderstorm intensity rising, warmer temperatures, and increasing ocean temperatures. As temperatures increase, the amount of energy available to fuel these storms, especially those that form over warm tropical waters of the Atlantic Ocean and Gulf of Mexico is expected to increase.[43]

Table 6.1.7: Climate Change Impacts Summary, Hurricane, Tropical Storms, and Tropical Depressions

Location	The location of hurricanes, tropical storms, and tropical depressions is not expected to change.
Extent/Intensity	The extent and intensity of hurricanes, tropical storms, and tropical depressions are not expected to change.
Frequency	There are no clear trends in hurricanes, tropical storms, and tropical depression frequency. This is due to considerable variability in conditions that lead to these hazards occurring. However, these hazards occur most frequently in warmer months. For the Texas coast, hurricane season officially begins on June 1 and ends on November 30. The greatest threat of landfall for these hazards occurs between the beginning of June through October.
Duration	The duration of hurricanes, tropical storms, and tropical depressions is not likely to change, however, their intensity is expected to increase due to rising temperatures and the proximity of the county and city to the Gulf of Mexico, which aids in fueling thunderstorms and tropical cyclone formation when waters are warm and thunderstorm development is more likely.

Section 6.2: Flooding

6.2 Flooding

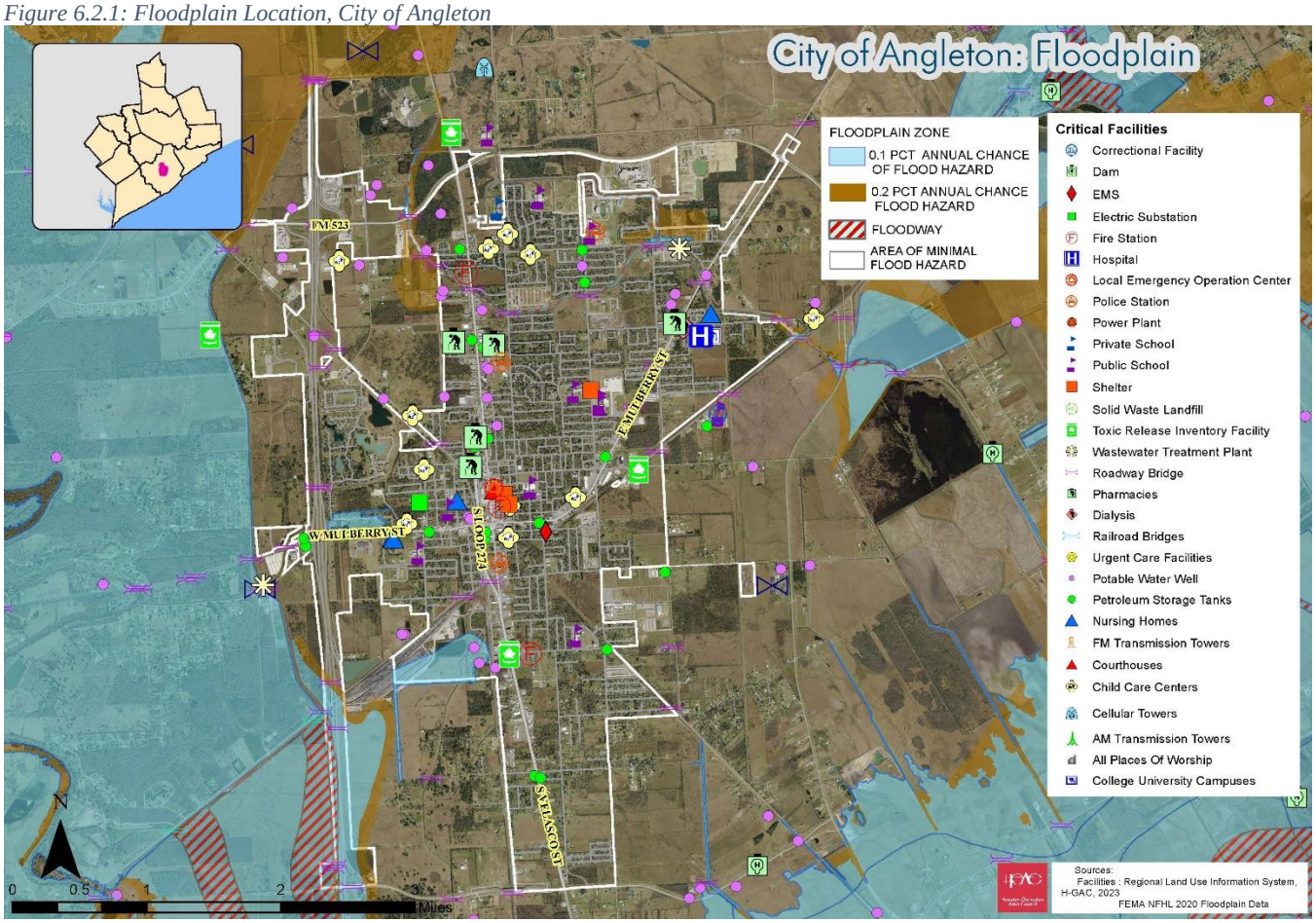
Floodplains are the primary tool used by FEMA to determine areas at risk of flooding. The periodic flooding of lands adjacent to rivers, streams, and shorelines is a natural and inevitable occurrence that can be expected based on established recurrence intervals. The recurrence interval of a flood is the average time interval, in years, that can be anticipated between flood events of a certain magnitude. Using the recurrence interval with land and precipitation modeling, forecasters can estimate the probability and likely location of flooding. These are expressed as floodplains. The most used floodplain measurements are the 100-year floodplain and the 500-year floodplain. The 100-year floodplain is an SFHA that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. The 1-percent (1 in 100) annual chance flood is also referred to as the base flood.[47] The 500-year floodplain, or the 0.2% annual chance flood, is a flooding event that has a 0.2 percent (1 in 500) chance of occurring in any given year at any given location.

Four different types of flooding can affect an area: coastal, riverine, flash flooding, and groundwater flooding. For this HMP the flooding section focuses on coastal, riverine, and flash flooding as those are historically the types of floods that have occurred within the area. Riverine 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.[48] Riverine flooding can occur during heavy periods of rain that cause rivers and streams to crest their banks and can take days, weeks, to months to subside back to normal levels. Coastal Flooding is when water inundates or covers normally dry coastal land as a result of high or rising tides or storm surges.[49] Flash Flooding is defined by the NWS as "A rapid and extreme flow of high water into a normally dry area or a rapid water level rise in a stream or creek above a predetermined flood level. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters. Commonly it occurs within six hours of a heavy rain event. However, flash floods can also occur within hours or even minutes if a dam or levee fails or rapid ponding of water caused by torrential rainfall."[50]

Location

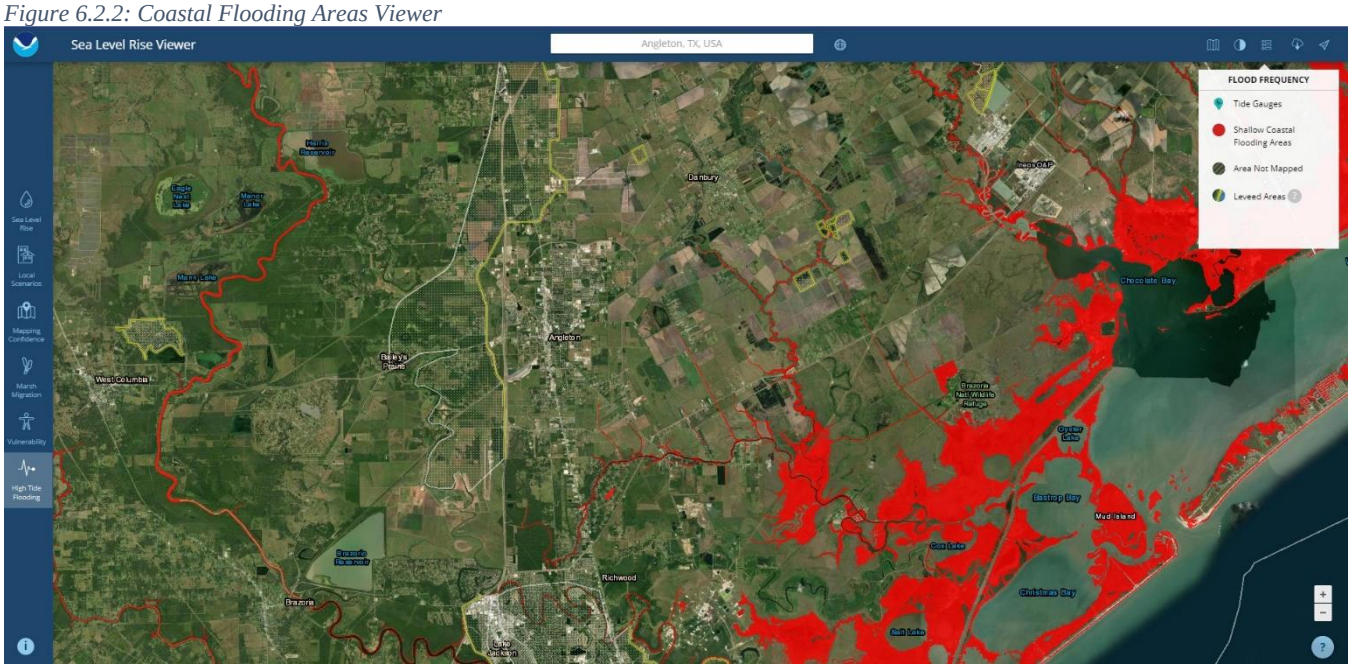
Figure 6.2.1 below shows the location of floodplains within the City of Angleton. Areas depicted by differentiating colors on the map show the locations of the 100-year and 500-year floodplains, as well as the floodway.

Figure 6.2.1: Floodplain Location, City of Angleton



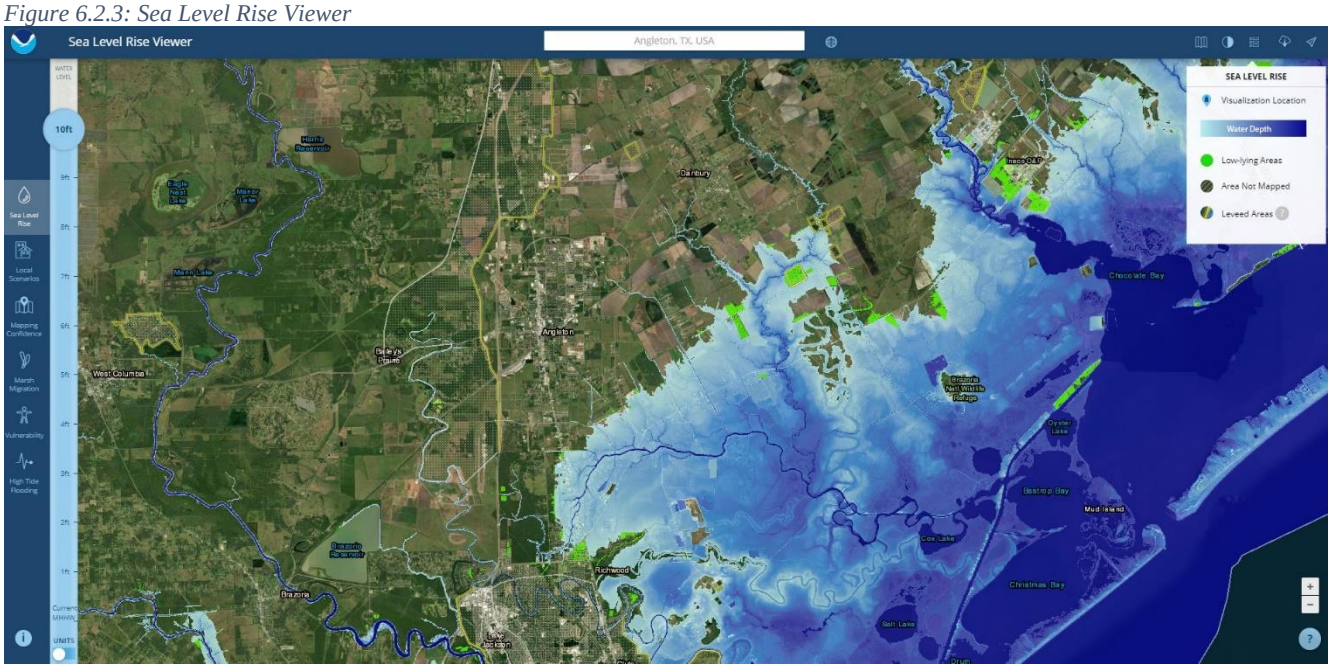
Coastal flooding is a result of rising tides or storm surges. As sea levels continue to rise due to various factors such as warming oceans, melting glaciers, and melting ice sheets raising global sea levels, the risk of coastal flooding for the city will increase. Using data based on the Surging Seas Risk Finder, there is a 95% risk of at least one flood over 5 ft taking place between today and 2050 in the Angleton area.[51] This would minimally impact the city as it is further inland than other coastal areas. Including impacts from other hazards, such as rising sea levels and storm surges from a hurricane, the city would be at a greater risk of flooding. Per NOAA, annual occurrences of tidal flooding have increased 5 to 10-fold since the 1960s. The changes in high tide flooding over time are greatest where elevation is lower. "Today's flood will become tomorrow's high tide, as sea level rise will cause flooding to occur more frequently and last for longer durations of time." Figure 6.2.2 below highlights areas that are currently considered shallow coastal flooding areas by NOAA, or areas currently subject to tidal flooding/recurrent or nuisance flooding.[52]

Figure 6.2.2: Coastal Flooding Areas Viewer



A sea level rise of 10 ft shows the inundation footprint entering city limits to the south and northeast. Areas that are hydrologically connected to the ocean are shown in shades of blue (darker blue means a greater depth of water).

Figure 6.2.3: Sea Level Rise Viewer



Extent

The NWS categorizes riverine flooding levels into four categories, minor, moderate, major, and record flooding. Table 6.1.1 below outlines these categories and their descriptions. Once a river reaches flood stage, an established gage height for a given location in which a rise in surface water begins to create a hazard to lives, property, or businesses, the NWS utilizes these categories to describe flood severity.

Table 6.2.1: NWS Flood Categories

Flood Category	Description
Minor Flooding	Minimal or no property damage is expected, but the flooding could possibly cause some public threat or inconvenience.
Moderate Flooding	Some inundation of structures and roads near streams is expected. Some evacuations of people and or a transfer of property to higher elevations are necessary.
Major Flooding	Extensive inundation of structures and roads in addition to the possible significant evacuations of people and/or transfer of property to higher elevations.
Record Flooding	Flooding which equals or exceeds the highest stage or discharge observed at a given site during the period of record.

Flash Floods can be caused by several things, but they are most often caused due to extremely heavy rainfall from thunderstorms. The intensity of the rainfall, the location and distribution of the rainfall, the land use and topography, vegetation types and growth/density, soil type, and soil water content all determine how quickly flooding may occur, and influence where it may occur.[53]

Coastal flooding is characterized by the NWS using the following threat levels, map colors, and descriptions for specified areas within the vicinity of the coast based on the adverse effects of surf conditions as saltwater is deposited onto the beach.[54]

Table 6.2.2: NWS Coastal Flood Categories

Threat Level	Description
Extreme	**"An Extreme Threat to Life and Property within the Coastal Zone from Saltwater Flooding."** Persistent battering surf conditions (lasting more than 36 hours), or major extra-tropical storm surge event. The potential for widespread breaching of dunes and seawalls. Near-shore roads may become weakened or washed out affecting local escape routes. Shoreline structures may experience significant damage resulting in local evacuations. Significant damage to marinas and piers may occur.
High	**"A High Threat to Life and Property within the Coastal Zone from Saltwater Flooding."** Battering surf conditions (lasting less than 36 hours), or moderate extra-tropical storm surge event. The potential for surf to breach dunes and seawalls in scattered locations which may begin to affect sections of near-shore roads and shoreline structures. Some damage to marinas and piers may occur.
Moderate	**"A Moderate Threat to Life and Property within the Coastal Zone from Saltwater Flooding."** High (very heavy) surf conditions which may cause major beach erosion. The potential for surf to breach dunes and seawalls in isolated locations, mainly in historically vulnerable spots.
Low	**"A Low Threat to Life and Property within the Coastal Zone from Saltwater Flooding."** High (heavy) surf conditions which may cause moderate beach erosion.
Very Low	**"A Very Low Threat to Life and Property within the Coastal Zone from Saltwater Flooding."** Rough surf conditions which may cause minor beach erosion.
Non-Threatening	**"No Threat to Life and Property within the Coastal Zone from Saltwater Flooding."** Surf conditions are non-threatening.

Flooding causes widespread and varying degrees of damage. The magnitude or extent of flood damage is expressed by using the maximum depth of flood water during a specific flood event. Structures inundated by 4 feet or more of flood water are considered an absolute loss. Other forms of loss include damage to roads and bridges, agriculture damages, loss of services, injury, or death. "In addition to property damage, flooding can also cut off access to utilities, emergency services, and transportation, and may impact the overall economic well-being of an area.

Previous occurrences within the city have seen historic flooding, roads made inaccessible by flood waters, property damage, and the destruction of critical facilities and infrastructure. During Hurricane Harvey in 2017, some residents saw up to 14" of water in homes and mandatory evacuations were called for residents along the Brazos River due to the river reaching major flood stage. A worst-case scenario for this hazard would include a heavy rain event that results in dangerous and life-threatening flooding, inundated roadways cutting off access to neighborhoods and critical facilities, roads and bridges being washed out, nearby rivers cresting, and flood waters receding slowly exacerbating recovery efforts. This would be similar to what occurred during Hurricane Harvey. Additionally, this hazard could damage critical infrastructure that leads to a prolonged power outage. If such an event were to occur during a heat event or drought, and disrupts power supply in the area for a prolonged amount of time, secondary hazards will pose increased risks to citizens. This scenario is similar to what occurred within the region during the 2024 derecho and Hurricane Beryl. Power lines were destroyed by winds and falling trees as Beryl made landfall when the region was under an excessive heat advisory. Power line restoration and repairs took longer to address than anticipated. This led to the activation of cooling centers and a scarcity of resources, like fuel to run cars or generators, across the region.

Historic Occurrences

NOAA collects historic climate data for the entire nation. NOAA's storm event data can be accessed on the NCEI Storm Events Database. These events are shown at the county level with some referencing a specific location, city, or zone. The database currently contains data from January 1950 to December 2023, as entered by NOAA's NWS. Due to changes in the data collection and processing procedures over time, there are unique periods of record available depending on the event type. The table below highlights events for this hazard that have occurred within Brazoria County from 1950-2023. Events that occurred within the City of Angleton are highlighted in purple.[38]

Table 6.2.3: City of Angleton Flood Events (1950-2023)

Event Date	Event Type	Injuries	Fatalities	Property Damage ($)	Crop Damage ($)
1/27/1997	Flash Flood	0	0	$5,000	$-
4/11/1997	Flash Flood	0	0	$5,000	$-
4/25/1997	Flash Flood	0	0	$10,000	$-
6/18/1997	Flash Flood	0	0	$5,000	$-
10/13/1997	Flash Flood	0	0	$20,000	$-
1/4/1998	Flash Flood	0	0	$7,000	$-
1/6/1998	Flash Flood	0	0	$2,000	$-
3/16/1998	Flash Flood	0	0	$3,000	$-
9/10/1998	Flash Flood	0	0	$-	$-
9/11/1998	Flash Flood	0	0	$-	$-
10/17/1998	Flood	0	0	$-	$-
10/18/1998	Flash Flood	0	0	$3,000	$-
11/12/1998	Flood	0	0	$-	$-
9/13/2000	Flash Flood	0	0	$150,000	$-
6/5/2001	Flash Flood	0	0	$-	$-
6/7/2001	Flash Flood	0	0	$-	$-
6/8/2001	Flash Flood	0	0	$-	$-
6/8/2001	Flash Flood	0	0	$-	$-
6/9/2001	Flash Flood	0	0	$-	$-
6/9/2001	Flash Flood	0	0	$-	$-
8/30/2001	Flash Flood	0	0	$30,000	$-

Event Date	Event Type	Injuries	Fatalities	Property Damage ($)	Crop Damage ($)
8/31/2001	Flash Flood	0	0	$500,000	$-
9/2/2001	Flash Flood	0	0	$80,000	$-
4/8/2002	Flash Flood	0	0	$5,000	$-
5/17/2002	Flash Flood	0	0	$1,000	$-
8/15/2002	Flash Flood	0	0	$50,000	$-
8/15/2002	Flash Flood	0	0	$90,000	$-
9/6/2002	Flash Flood	0	0	$25,000	$-
9/7/2002	Flash Flood	0	0	$250,000	$-
9/9/2002	Flash Flood	0	0	$30,000	$-
9/10/2002	Flash Flood	0	0	$30,000	$-
10/24/2002	Flash Flood	0	0	$75,000	$-
11/5/2002	Flash Flood	0	0	$35,000	$-
12/4/2002	Flash Flood	0	0	$2,000	$-
9/4/2003	Flash Flood	0	0	$10,000	$-
10/9/2003	Flash Flood	0	0	$15,000	$-
11/17/2003	Flash Flood	0	0	$5,000	$-
6/23/2004	Flash Flood	0	0	$5,000	$-
10/16/2006	Flash Flood	0	0	$500,000	$-
4/25/2007	Flash Flood	0	0	$15,000	$-
5/28/2007	Flash Flood	0	0	$110,000	$-
5/28/2007	Flash Flood	0	0	$-	$-
4/24/2009	Flash Flood	0	0	$1,000	$-
7/1/2010	Flash Flood	0	0	$-	$-
7/1/2010	Flash Flood	0	0	$500,000	$-
7/1/2010	Flash Flood	0	0	$1,250,000	$-
1/22/2015	Flash Flood	0	0	$1,000	$-
4/14/2015	Flash Flood	0	0	$-	$-
4/17/2015	Flash Flood	0	0	$5,000	$-
4/17/2015	Flash Flood	0	0	$8,000	$-
5/12/2015	Flash Flood	0	0	$75,000	$-
8/20/2015	Flash Flood	0	0	$-	$-
8/28/2016	Flash Flood	0	0	$12,000	$-
3/29/2017	Flash Flood	0	0	$-	$-
4/18/2017	Flash Flood	0	0	$450,000	$-
4/18/2017	Flash Flood	0	0	$-	$-
8/26/2017	Flash Flood	0	0	$2,000,000,000	$100,000
8/26/2017	Flash Flood	0	0	$-	$-
8/28/2017	Flash Flood	0	0	$-	$-
8/28/2017	Flash Flood	0	0	$-	$-
8/28/2017	Flash Flood	0	0	$-	$-
9/18/2019	Flash Flood	0	0	$-	$-
5/1/2021	Flash Flood	0	0	$5,000	$-
			Brazoria County Totals:	**$2,004,380,000**	**$100,000**
			City of Angleton Totals:	**$418,000**	**$-**

Rows highlighted in purple are events that reference the City of Angleton within the event narrative or event location (beginning or end).
$- No dollar amount ($0.00).

Presidential Disaster Declarations

There have been seven federally declared flood disasters in the City of Angleton since 1950. Additionally, four disaster declaration events mention flooding in their title but are categorized as severe storms for incident type. These are also included in the table below.[1,2]

Table 6.2.4: Federally Declared Disasters, Flood

Declaration Year	Incident Type	Incident Title	Disaster Number	Declaration Type
1973	Flood	SEVERE STORMS & FLOODING	398	Major Disaster Declaration
1979	Flood	STORMS & FLASH FLOODS	595	Major Disaster Declaration
1979	Flood	SEVERE STORMS & FLOODING	603	Major Disaster Declaration
1992	Flood	SEVERE THUNDERSTORMS	930	Major Disaster Declaration
1995	Flood	SEVERE THUNDERSTORMS AND FLOODING	1041	Major Disaster Declaration
1999	Flood	TX-FLOODING 10/18/98	1257	Major Disaster Declaration
2016	Flood	SEVERE STORMS AND FLOODING	4272	Major Disaster Declaration
1991	Severe Storm	SEVERE STORMS, TORNADOES & FLOODING	900	Major Disaster Declaration
2003	Severe Storm	SEVERE STORMS, TORNADOES AND FLOODING	1439	Major Disaster Declaration
2015	Severe Storm	SEVERE STORMS, TORNADOES, STRAIGHT-LINE WINDS AND FLOODING	4223	Major Disaster Declaration
2016	Severe Storm	SEVERE STORMS, TORNADOES, STRAIGHT-LINE WINDS, AND FLOODING	4245	Major Disaster Declaration
2024	Severe Storm	SEVERE STORMS, STRAIGHT-LINE WINDS, TORNADOES, AND FLOODING	4781	Major Disaster Declaration

USDA Disaster Declarations

The USDA authorizes the Secretary of Agriculture to designate counties as disaster areas to make EM loans available to producers suffering losses in those counties and in counties that are contiguous to a designated county. In addition to EM loan eligibility, other emergency assistance programs, such as FSA disaster assistance programs, have historically used disaster designations as an eligibility trigger. USDA Secretarial disaster designations must be requested of the Secretary of Agriculture by a governor or the governor's authorized representative, by an Indian Tribal Council leader or by an FSA SED. The Secretarial disaster designation is the most widely used. When there is a presidential disaster declaration, FEMA immediately notifies FSA of the primary counties named in a Presidential declaration. USDA Disaster Declarations for the City of Angleton since the last HMP are listed in the table below.[39]

Table 6.2.5: USDA Declared Disasters (2018-2023), Flood

Crop Disaster Year	Disaster Description	Designation Number
2019	Excessive moisture and flooding	S4534

National Flood Insurance Program

The NFIP is a federal program administered through FEMA that enables property owners in participating communities to purchase insurance as a protection against flood losses. Communities must maintain eligibility in the NFIP by adopting and enforcing floodplain management regulations intended to prevent unsafe development in the floodplain, thus reducing future flood damage. FEMA creates flood maps, or FIRMs to support the NFIP.[27,28] These flood maps are periodically updated and outline SFHA. The SFHA is the area where the NFIP floodplain management regulations must be enforced and the area where the mandatory purchase of flood insurance applies.[29] The NFIP provides affordable flood insurance for

property owners, renters, and businesses in participating communities. This reduces the socio-economic impacts of flooding on communities through risk reduction via flood insurance and reduces the physical impacts of flooding through beneficial floodplain regulation. For more information regarding NFIP participation for the city, see Section 3, National Flood Insurance Program Participation.

The Community Rating System

The CRS is a voluntary incentive program that recognizes and encourages community floodplain management practices that exceed the minimum requirements of the NFIP. Participation in the CRS program is voluntary and includes many benefits for a community, such as discounted flood insurance premiums that relate to the community's level of efforts that reduce risk from flooding and strengthen floodplain management. Currently, the City of Angleton does not participate in the CRS Program.[30]

As seen in Section 3- Table 3.6: Community Participation in the NFIP and CRS Program

Jurisdiction	Participating	Date Joined	Current Effective FIRM Date	CRS Participation
Angleton	Y	06/21/74	12/30/20	N

Repetitive Loss and Severe Repetitive Loss Properties

FEMA defines a RL structure as "a structure covered under an NFIP flood insurance policy that:

(3) Has incurred flood-related damage on 2 occasions, in which the cost of repair, on average, equaled or exceeded 25% of the value of the structure at the time of each such flood event; and

(4) At the time of the second incidence of flood-related damage, the contract for flood insurance contains ICC coverage."[23]

A SRL property is defined as "a structure that is covered under an NFIP flood insurance policy and has incurred flood-related damage:

(3) For which 4 or more separate claims payments have been made under flood insurance coverage under subchapter B of this chapter, with the amount of each claim (including building and contents payments) exceeding $5,000, and with the cumulative amount of such claims payments exceeding $20,000; or

(4) For which at least 2 separate flood insurance claims payments (building payments only) have been made, with a cumulative amount of such claims exceeding the value of the insured structure.[24]

According to available data from 2023, the city has a total of 97 RL properties, of which 18 are designated as SRL properties. This does not include RL or SRL properties that have already been mitigated. Only 23 of these RL and SRL properties are insured through the NFIP. Total SRL property claim payments for the City of Angleton are $2,560,751.56. There is an average of 5.6 NFIP claims per SRL property within the city.[25,26] Table 3.5 outlines the structure type (residential, commercial, institutional, etc.), and number of records for RL and SRL properties within the city, including the number of those structures that were insured under the NFIP.

As seen in Section 3- Table 3.5: RL and SRL Properties, City of Angleton
(Source: FEMA, Correspondence with the Floodplain Management and Insurance Branch)

Jurisdiction Name	Residential RLPs	Non-Residential RLPs	Total RLPs	SRL Properties	Number of NFIP Insured Properties
Angleton	87	10	97	18	23

FEMA Guidance specifies that NFIP flood insurance claim information is subject to The Privacy Act of 1974, as amended. The Act prohibits public release of policyholder names, or names of financial assistance recipients and the amount of the claim payment or assistance. After flooding events, local officials are responsible for inspecting flood-damaged structures in the SFHA to determine if they are substantially damaged (50% or more damaged). If so, the property owner is required to bring a non-conforming structure into compliance with the local floodplain ordinance. For the City of Angleton, the Floodplain Administrator for Brazoria County is responsible for handling these NFIP claims.

Flood Mitigation Assistance Repetitive Loss and Severe Repetitive Loss Properties

FEMA supports a handful of Hazard Mitigation Assistance (HMA) programs that support mitigation activities by providing funding that helps support mitigation projects. One such program is Flood Mitigation Assistance (FMA), this competitive program provides funding to states, local communities, federally recognized tribes, and territories that can be used for projects that reduce or eliminate the risk of repetitive flood damage to structures insured by the NFIP. While individual homeowners are not eligible to apply for FMA grant funds, a community in good standing (those that have a FEMA-approved HMP and are in good standing with the NFIP) can apply on their behalf. Homeowners who do receive FMA grant funds are required to have active NFIP flood insurance policies, and the NFIP flood insurance policy must be maintained for the life of the structure.[55] Table 3.6 outlines the jurisdiction, structure type (residential, commercial, institutional, etc.), and number of records for RL and SRL properties under the FMA program within the city.

Table 6.2.6: FMA RL and SRL Properties, City of Angleton (Source: FEMA, Floodplain Management and Insurance Branch)

Jurisdiction Name	Residential FMA RLPs	Non-Residential FMA RLPs	Total FMA RLPs	FMA SRL Properties
City of Angleton	3	0	10	18

NFIP Policies in Force

The table below summarizes the NFIP policies in force for Brazoria County and the City of Angleton. In total, there are 1,142 NFIP-insured properties within the city.[31]

As seen in Section 3- Table 3.7: NFIP Insured Properties, City of Angleton

Community Name (Number)	Policies in Force	Total Coverage	Total Written Premium + FPF
BRAZORIA COUNTY (485458)	33,963	$10,621,664,000	$26,637,225
ANGLETON (480064)	1,142	$353,911,000	$762,629

Community Name- The official NFIP name of the community in which the policy resides.
Community Number- The 6-character community ID in which the policy resides.
Total Coverage- The total building and contents coverage for the policies in force.
Total Written Premium + FPF (Federal Policy Fee)- This represents the sum of the premium and FPF for the policies in force.

Probability of Future Occurrences

According to RiskFactor, a site that publishes climate risk data to quantify and communicate risk for properties with the U.S., the City of Angleton has a moderate risk of flooding over the next 30 years. This means flooding is likely to impact day-to-day life within the community. This is based on the level of risk the properties face rather than the proportion of properties with risk."[56] Flooding and flash floods will continue to occur within the City of Angleton. The FEMA NRI utilizes data from multiple

sources including historical hazard events, hazard intensity, exposure of people and property to hazards, socioeconomic factors, and community resilience indicators. The NRI also incorporates hazard data to determine the frequency and intensity of various natural hazards. This information helps assess the likelihood of specific hazards occurring in different regions. According to the FEMA NRI for coastal flooding annualized frequency values are 3.7 events per year. For riverine flooding, annualized frequency values are 2.1 events per year over 24 years of record 1996-2019, with 51 events on record.[41]

Populations at Risk

Populations at risk for flooding are similar to that noted in Section 6.1 for hurricanes, tropical storms, and tropical depressions. Populations at risk include the entire county and the City of Angleton as this hazard has no geographic boundaries. Those living within or near 100 or 500-year floodplains as well as floodways are at a higher risk for impacts from this hazard. Flooding can cause property damage, displacement, lack of access to critical facilities that provide food, water, medications, or other forms of medical assistance, and lack of utilities such as electricity and clean water which can increase the risk of illness. The NCHH summarizes at-risk and vulnerable populations for several hazards. For flooding these include older adults, children, people experiencing homelessness, people with disabilities, and people with chronic health conditions. In addition to the dangers listed above, older adults can face social isolation, lack of electricity needed to run medical equipment, lack of access to a vehicle for evacuation, and lack of access to other critical supplies. In younger populations, such as children, flood events can disrupt schooling and the normal day-to-day routines they thrive on. This can not only jeopardize their academic success but can also cause mental and emotional stress. Children are more at risk and vulnerable to certain medical conditions like asthma, lead poisoning, allergies, and bacterial infections which can be caused by the resulting flood damage and increased moisture. For people experiencing homelessness, adequate shelter is critical in keeping populations safe during flood events. People with disabilities may require additional assistance to stay safe and prepare for these hazards such as creating a support network, finding accessible transportation to evacuate or get medical attention, and loss of power for needed medical equipment. Likewise, those with chronic health conditions may need similar assistance as those with disabilities. People with chronic health conditions also face exposure to diseases or illnesses from standing water and increased exposure to these illnesses when utilizing a shelter or evacuation center to escape the flood. Additionally, flooding of homes and businesses can cause mold to thrive if not treated promptly. This can exacerbate illness among the general population but especially among those with chronic health conditions.

The vulnerability to this hazard increases as new developments and future construction increase the impervious surface area in a given location, especially if the location is within or near the SFHA, creeks, rivers, or bodies of water. Flooding can also occur outside of the floodplain due to drainage issues within the city. The city has seen a steady increase in population over time, and has even served as an inland shelter for more coastal areas during previous named storm events. This can put a strain on critical resources for residents and evacuees. As the population continues to increase so will the vulnerability of residents to this hazard.

National Risk Index

FEMA's NRI utilizes data from multiple sources including historical hazard events, hazard intensity, exposure of people and property to hazards, socioeconomic factors, and community resilience indicators. The NRI also incorporates hazard data to determine the frequency and intensity of various natural hazards. This information helps assess the likelihood of specific hazards occurring in different regions.[44]

The NRI considers the exposure of communities to hazards and incorporates factors such as population density, infrastructure systems, and critical facilities that may be at risk during a hazard event. The NRI also generates risk scores for communities across the U.S. that provide a relative ranking of areas based

on their overall risk level. This helps to identify areas that may require additional resources and attention for mitigation and planning efforts. The NRI risk equation includes 3 components. EAL represents the average economic loss in dollars resulting from natural hazards each year, the Community Risk Factor is a scaling factor that incorporates social vulnerability (the susceptibility of social groups to the adverse impacts of natural hazards), and community resilience (the ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions). The outcome, the risk index, represents the potential negative impacts of natural hazards on the county level or individually by census tracts. The NRI EAL score and rating, represent a community's relative level of expected loss each year when compared to all other communities at the same level.[44]

EAL for the City of Angleton was derived by creating a report that used census tract information for tracts that included the Angleton city limits. These were census tracts 48039662100, 48039662200, 48039662400, 48039662300, 48039662500, 48039663100, and 48039664100.[45]

EAL according to the FEMA NRI for coastal flood events, a majority of these census tracts are listed as relatively low, with one tract rating relatively moderate and another with no rating. For riverine flood events, a majority of these census tracts are listed as very high, with one tract having no rating. EAL values, risk index ratings, risk index scores, social vulnerability, and community resilience for each census tract can be found in the figures below. Additionally, the FEMA NRI lists the HLR, a hazard- and county-specific estimate of the percentage of the exposed consequence type (building value, population, or agriculture value) expected to be lost due to a hazard occurrence, for coastal and riverine floods within Brazoria County as very low and relatively low, respectively.[46]

Figure 6.2.4: Risk Index by Census Tract, City of Angleton, Coastal Flooding

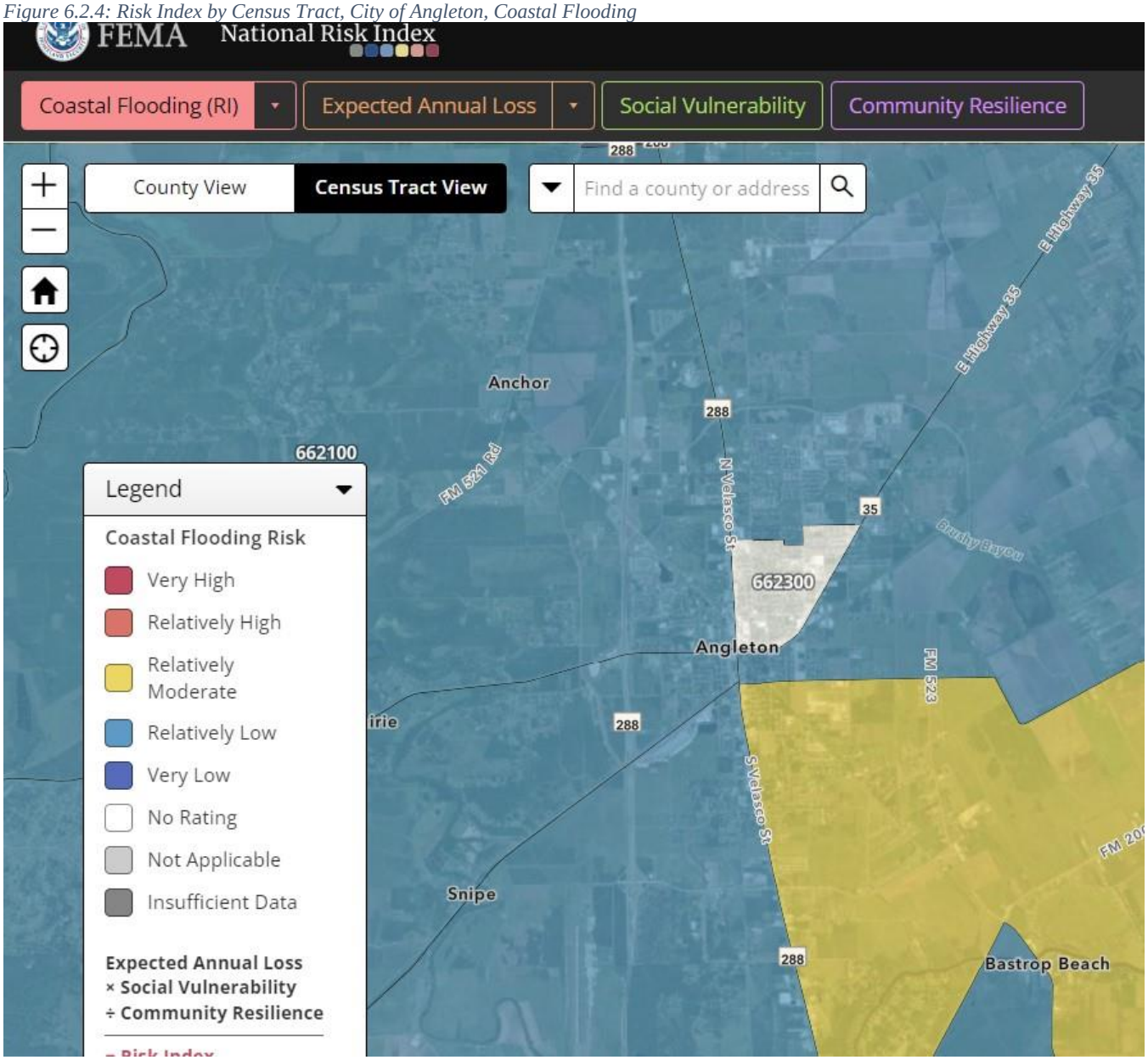


Figure 6.2.5: Risk Index by Census Tract, City of Angleton, Riverine Flooding

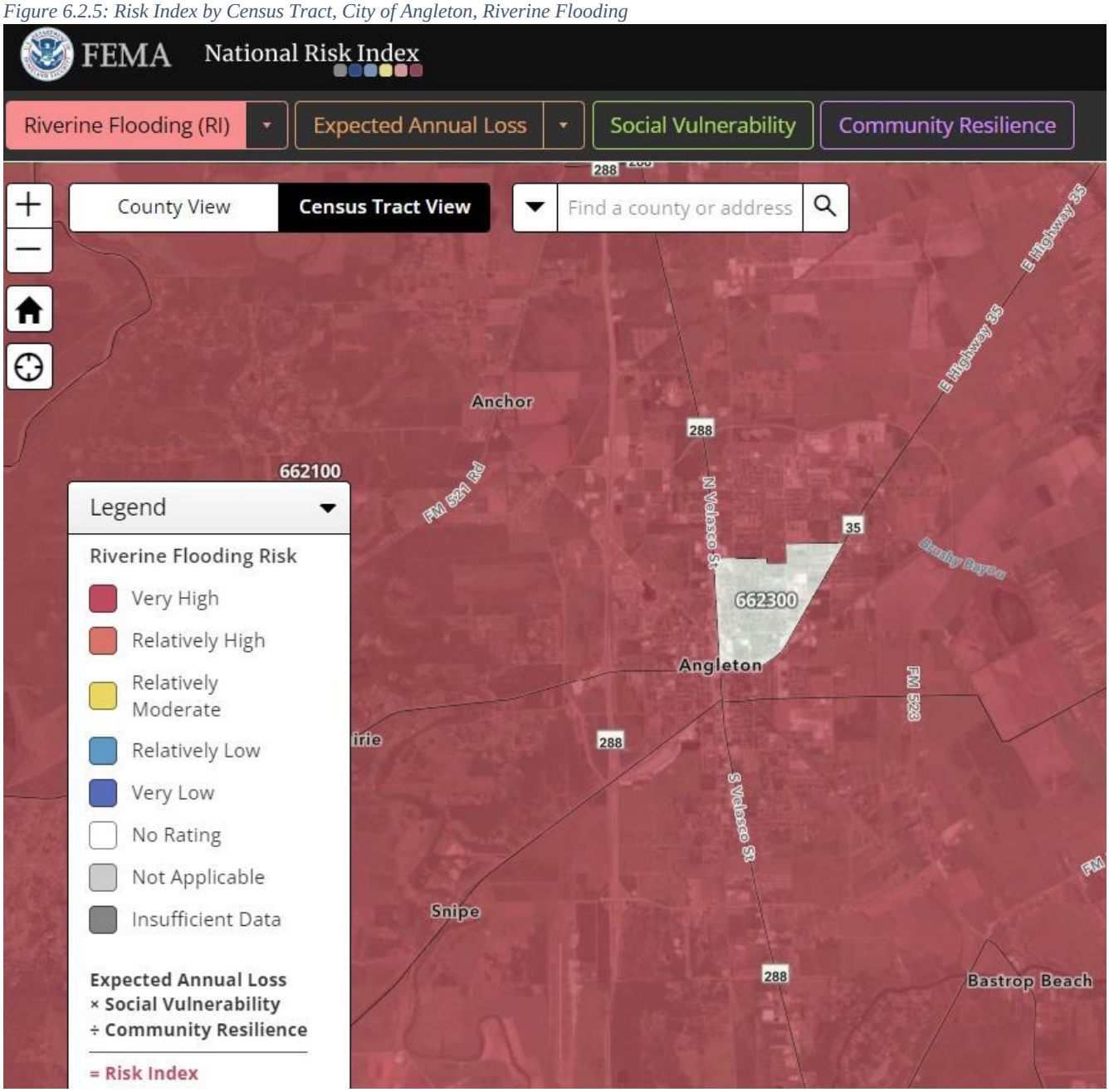


Figure 6.2.6: Expected Annual Loss by Census Tract, City of Angleton, Coastal Flooding

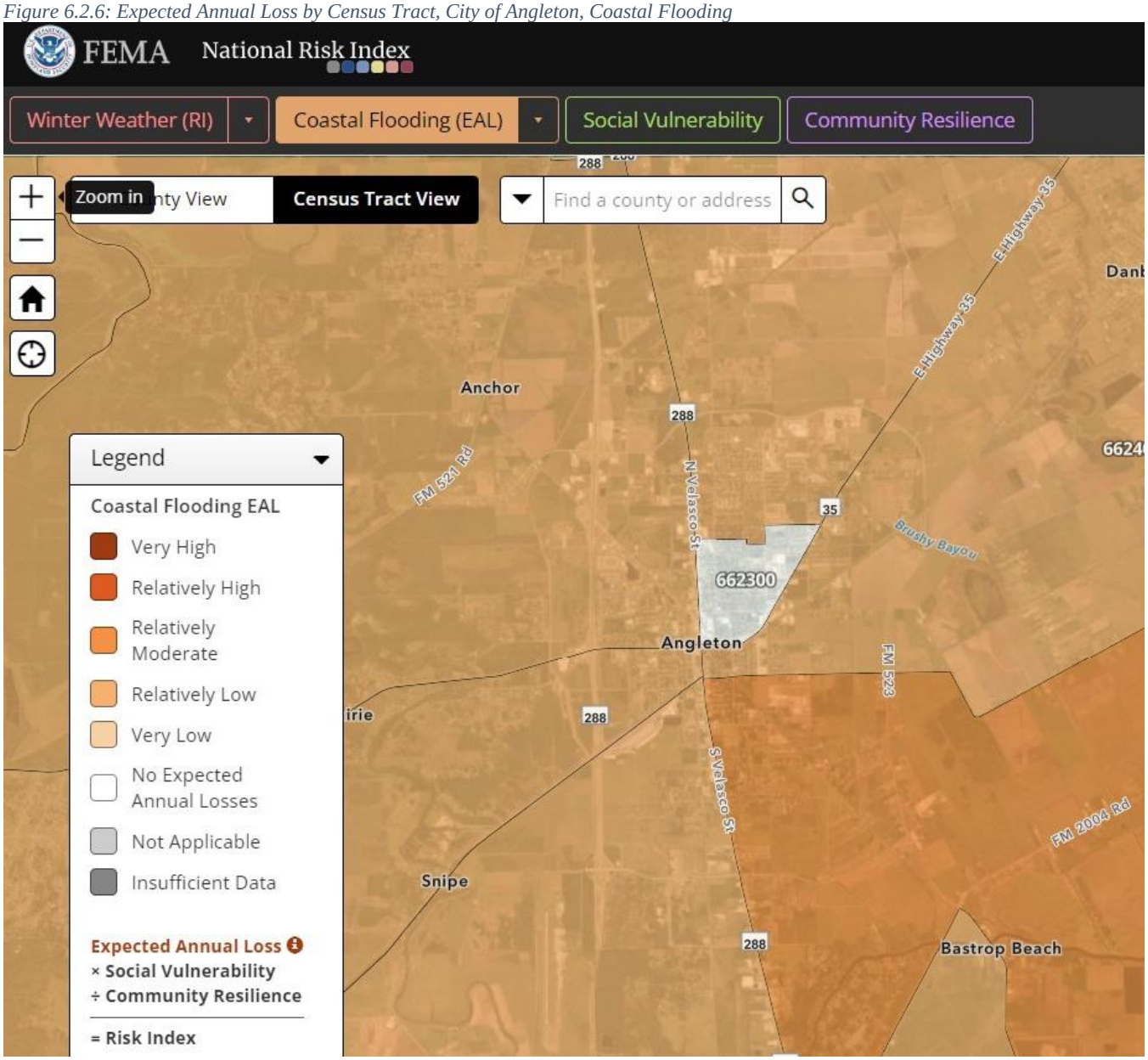


Figure 6.2.7: Expected Annual Loss by Census Tract, City of Angleton, Riverine Flooding

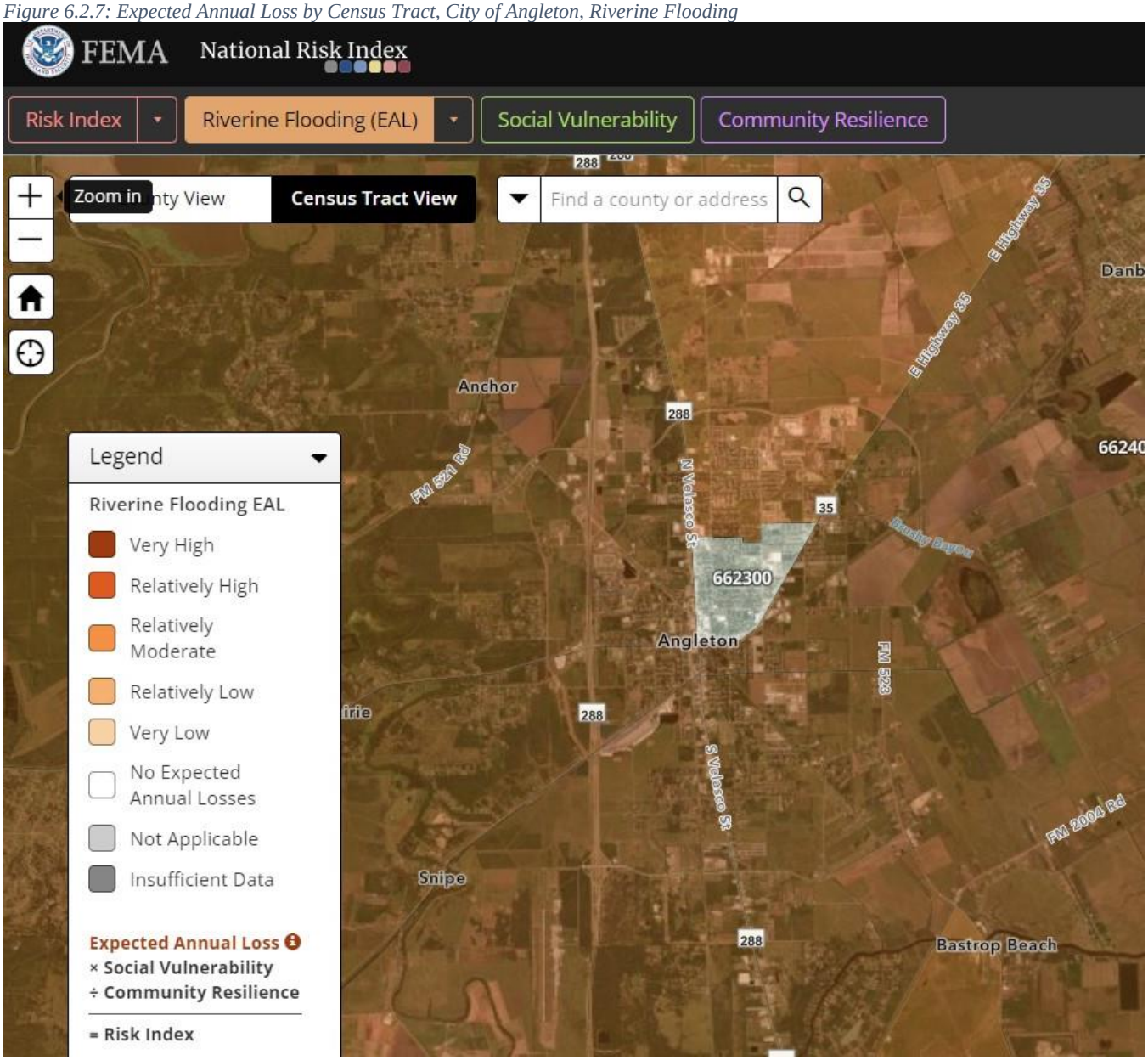


Figure 6.2.8: Social Vulnerability by Census Tract, City of Angleton

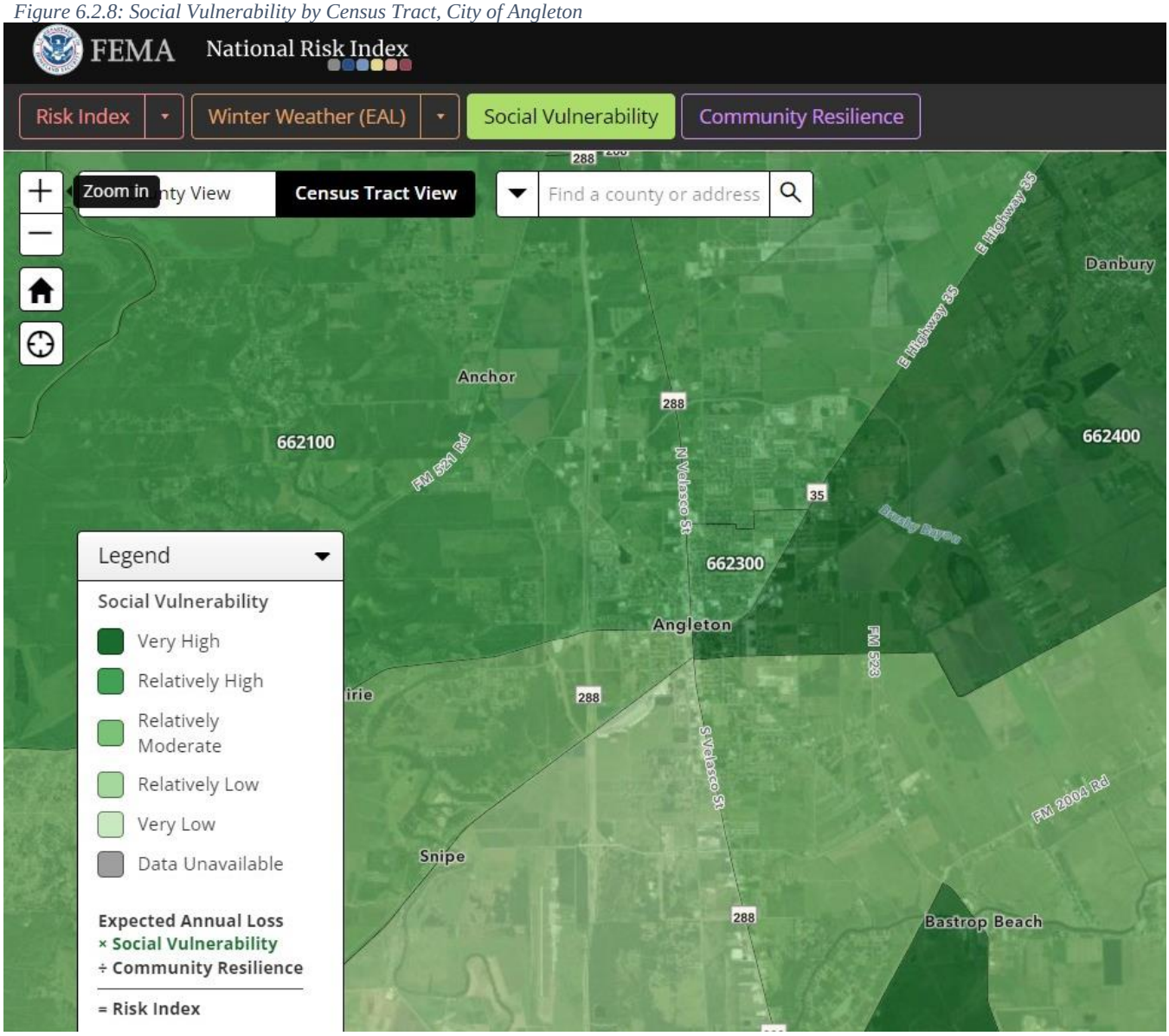


Figure 6.2.9: Community Resilience by Census Tract, City of Angleton

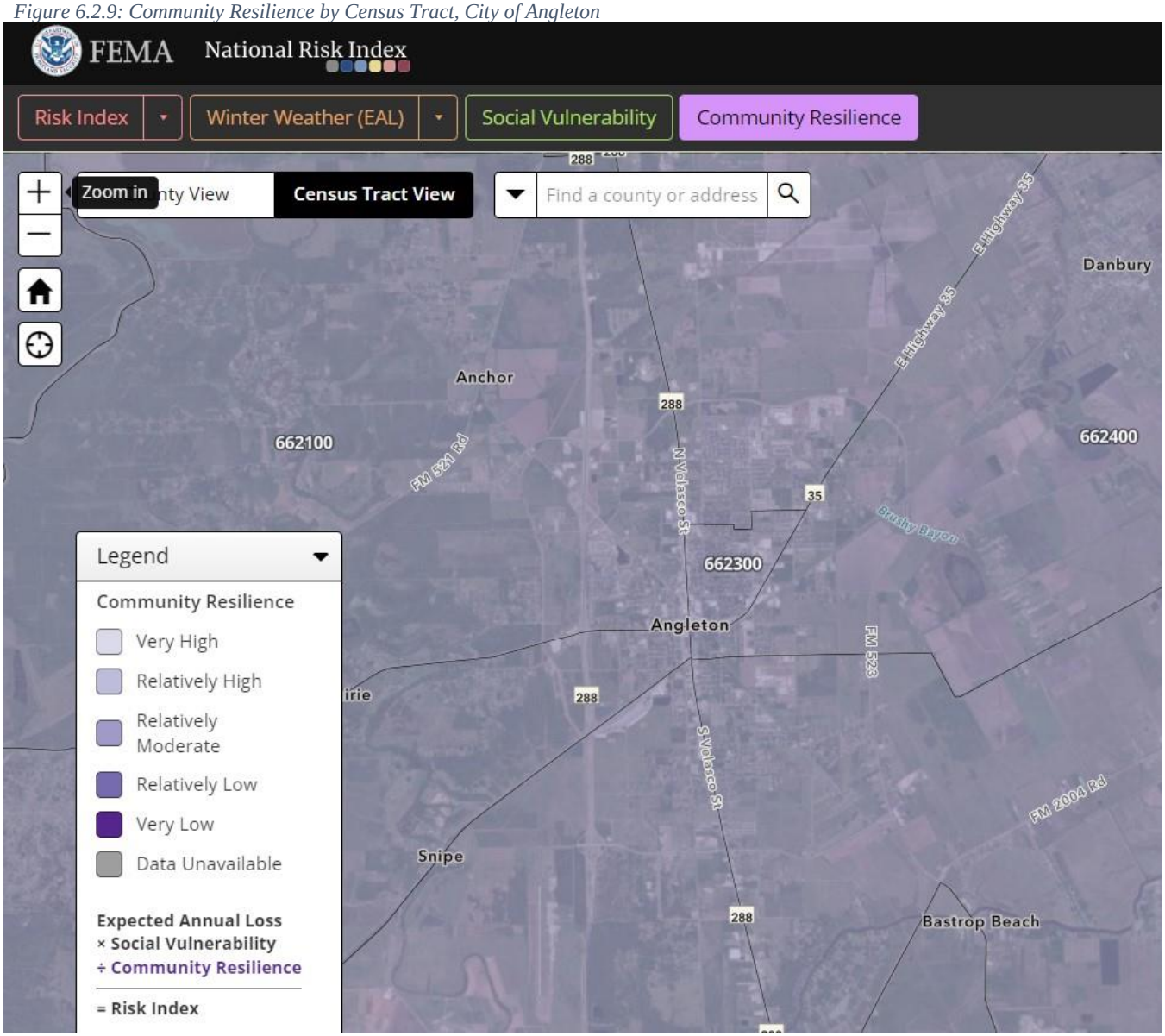


Figure 6.2.10: FEMA NRI Summary by Census Tract, City of Angleton, Coastal Flooding

Rank	Community	State	Risk Index Rating	Risk Index Score	National Percentile
1	Census tract 48039664100	TX	Relatively Moderate	96.73	0 100
2	Census tract 48039663100	TX	Relatively Low	92.42	0 100
3	Census tract 48039662500	TX	Relatively Low	89	0 100
4	Census tract 48039662100	TX	Relatively Low	88.72	0 100
5	Census tract 48039662400	TX	Relatively Low	85.13	0 100
6	Census tract 48039662200	TX	Relatively Low	84.15	0 100
	Census tract 48039662300	TX	No Rating	0	0 100

Rank	Community	State	EAL Value	Social Vulnerability	Community Resilience	CRF	Risk Value	Risk Index Score
1	Census tract 48039664100	TX	$111,846	Relatively Moderate	Relatively Moderate	1.05	$117,206	96.73
2	Census tract 48039663100	TX	$22,853	Relatively Low	Relatively Moderate	1	$22,872	92.42
3	Census tract 48039662500	TX	$7,576	Relatively Moderate	Relatively Moderate	1.12	$8,460	89
4	Census tract 48039662100	TX	$6,482	Relatively High	Relatively Moderate	1.22	$7,932	88.72
5	Census tract 48039662400	TX	$2,077	Very High	Relatively Moderate	1.43	$2,981	85.13
6	Census tract 48039662200	TX	$1,731	Relatively High	Relatively Moderate	1.34	$2,316	84.15
	Census tract 48039662300	TX	$0	Relatively High	Relatively Moderate	1.38	$0	0

Figure 6.2.11: FEMA NRI Summary by Census Tract, City of Angleton, Riverine Flooding

Rank	Community	State	Risk Index Rating	Risk Index Score	National Percentile
1	Census tract 48039663100	TX	Very High	99.97	0 100
2	Census tract 48039664100	TX	Very High	99.89	0 100
3	Census tract 48039662100	TX	Very High	99.89	0 100
4	Census tract 48039662500	TX	Very High	99.84	0 100
5	Census tract 48039662400	TX	Very High	98.86	0 100
6	Census tract 48039662200	TX	Very High	98.6	0 100
	Census tract 48039662300	TX	No Rating	0	0 100

Rank	Community	State	EAL Value	Social Vulnerability	Community Resilience	CRF	Risk Value	Risk Index Score
1	Census tract 48039663100	TX	$10,593,051	Relatively Low	Relatively Moderate	1	$10,601,810	99.97
2	Census tract 48039664100	TX	$5,775,706	Relatively Moderate	Relatively Moderate	1.05	$6,052,497	99.89
3	Census tract 48039662100	TX	$4,935,902	Relatively High	Relatively Moderate	1.22	$6,039,649	99.89
4	Census tract 48039662500	TX	$4,520,531	Relatively Moderate	Relatively Moderate	1.12	$5,048,358	99.84
5	Census tract 48039662400	TX	$958,338	Very High	Relatively Moderate	1.43	$1,375,088	98.86
6	Census tract 48039662200	TX	$861,407	Relatively High	Relatively Moderate	1.34	$1,152,193	98.6
	Census tract 48039662300	TX	$0	Relatively High	Relatively Moderate	1.38	$0	0

Climate Change Impacts

Factors such as climate-driven changes like increasing precipitation and warmer sea surface temperatures may also affect the probability of future floods within Brazoria County and the City of Angleton. Precipitation changes within the next 15 to 30 years are expected to be 10%-15% heavier due to increased surface temperatures. These increased temperatures cause more evaporation, making more water available in the atmosphere for rain events. Increased sea surface temperatures can cause a greater intensity of hurricanes and precipitation. Storms are also likely to be more severe.[57] According to the Office of the Texas State Climatologist, riverine flooding in Texas is projected to have no substantial change through 2036. This is due to the construction of dams and reservoirs for flood management that occurred and continues to occur within the 20th century. There is a mixture of historical trends categorized by season, but there is no one clear trend to project future flood probabilities. In addition, meteorological drivers of riverine flooding (increased rainfall intensity and decreased soil moisture) are projected to have competing influences. If there is an increasing trend present in riverine flooding, it will be at the most extreme flood events or in the wettest parts of the state where there is so much rainfall that a decrease in soil moisture would have little mitigating impact.[58] The table below summarizes the expected climate change impacts of flooding.

Table 6.2.7: Climate Change Impacts, Flooding

Location	The location of floods is not expected to change
Extent/Intensity	The extent and intensity of flooding within the County may change due to increased precipitation, stronger storms, and rising surface temperatures.
Frequency	There are no clear trends in flood frequency due to considerable variability, flood management measures, and competing meteorological drivers.
Duration	The duration of flood events is not likely to change.

Section 6.3: Winter Weather

6.3 Winter Weather

Winter weather is defined by NWS as "a winter weather phenomenon (such as snow, sleet, ice, wind chill) that impacts public safety, transportation, and/or commerce. It typically occurs during the climatological winter season between October 15 and April 15."[59]

Location

Winter weather occurs on a regional scale, with no specific geographic boundary, and can happen anywhere within the state, the region, the county, or city.

Extent

The Winter Storm Severity Index (WSSI) is a new product (released in 2022) of the NWS that forecasts the potential impacts of winter storms. NWS has implemented the WSSI to provide the public with a tool that attempts to convey the complexities and hazards associated with winter storms as they relate to potential societal impacts. The WSSI is created using Geographic Information Systems (GIS) by screening the official NWS gridded forecasts from the National Digital Forecast Database (NDFD) for winter weather elements and combining those data with non-meteorological or static information datasets such as land use, climatology, urban areas, etc. The outcome is a graphical depiction of anticipated overall impacts on society due to winter weather. There are numerous datasets used or derived as part of calculating the WSSI.

Table 6.3.1: Winter Storm Severity Index Datasets

Data Source	Dataset
Official NWS Forecast datasets from NDFD	• 6-hour snow accumulation • 6-hour ice accumulation • 6-hour precipitation accumulation (Quantitative Precipitation Forecasts) • Wind speed (hourly time steps) • Temperature (hourly time steps)
Additional derived forecast parameters from other official NWS NDFD	• Total snowfall • Total ice accumulation • Maximum wind speed within each 6-hour period • 6-hourly snowfall accumulation rate • 6-hourly snow-liquid ratio • Average snow-liquid ratio
Daily National Snow Analyses are obtained from the NWS National Operational Hydrologic Remote Sensing Center	• Snow depth • Snowpack temperature • Snow water equivalent
Non-forecast datasets	• Urban area designation • Land-use designations • NOAA/NCEI gridded annual snowfall climatology

The WSSI consists of a series of component algorithms, each of which uses meteorological and non-meteorological data to model the predicted severity of specific characteristics of winter weather. Each of the components produces a 0 to 5 output scale value that equates to the potential severity based on the winter weather hazards. The final WSSI value is the maximum value from all the sub-components. The 4 impact levels are given the following descriptors: Minor, Moderate, Major, and Extreme. In addition to the impact levels, a Winter Weather Area is also shown to depict the extent of the winter weather conditions. The WSSI output provides colors, impact classifications, and definitions of the overall expected severity of winter weather, as depicted in the table below.

Table 6.3.2: Winter Storm Severity Index Impact Classifications and Definitions

Map Color	Associated Impacts	WSSI Definition
	No Impacts	N/A
	Limited Impacts, Winter Weather Area	**Expect winter weather.** Winter driving conditions: **Drive carefully.**
	Minor Impacts	**Expect a few inconveniences to daily life.** Winter driving conditions: **Use caution while driving.**
	Moderate Impacts	**Expect disruptions to daily life.** Winter driving conditions: Hazardous driving conditions. **Use extra caution while driving**. Closures and disruptions to infrastructure may occur.
	Major Impacts	**Expect considerable disruptions to daily life.** Winter driving conditions: Dangerous or impossible driving conditions. **Avoid travel if possible.** Widespread closures and disruptions to infrastructure may occur.
	Extreme Impacts	**Expect substantial disruptions to daily life.** Winter driving conditions: Extremely dangerous or impossible driving conditions. **Travel is not advised.** Extensive and widespread closures and disruptions to infrastructure may occur. Life-saving actions may be needed.

The specific sub-components of the WSSI are:

- Snow Load Index- Indicates potential infrastructure impacts due to the weight of the snow. This index accounts for the land cover type. This component is significant because the weight of the snow creates a threat to the structural integrity of residential and commercial buildings, as well as tree and powerline damage.
- Snow Amount Index- Indicates potential impacts due to the total amount of snow or the snow accumulation rate. This index also normalizes for climatology, such that regions of the country that experience, on average, less snowfall will show a higher level of severity for the same amount of snow that is forecast across a region that experiences more snowfall on average. Designated urban areas are also weighted a little more than non-urban areas.
- Ice Accumulation- Indicates potential infrastructure impacts (e.g., roads/bridges) due to combined effects and severity of ice and wind. Designated urban areas are also weighted a little more than non-urban areas.
- Blowing Snow Index- Indicates the potential disruption due to blowing and drifting snow. This index accounts for land use type. The impacts created by this component of winter weather are visibility and drifting snow issues. It is highly dependent on the type of land cover; an open field is more susceptible to blowing snow than a heavily forested area.
- Flash Freeze Index- Indicates the potential impacts of flash freezing (temperatures starting above freezing and quickly dropping below freezing) during or after precipitation events. The main hazard for this component is black ice on surfaces.
- Ground Blizzard- Indicates the potential travel-related impacts of strong winds interacting with pre-existing snow cover. This is the only sub-component that does not require snow to be forecast for calculations to be made. The impacts created by this component of winter weather are visibility and drifting snow issues. It is highly dependent on the type of land cover; an open field is more susceptible to blowing snow than a heavily forested area.[60]

Not all sub-components above are included for every planning area due to different locations, climates, and geographies. For the City of Angleton, anticipated intensities for the WSSI sub-components mentioned above per the American Society of Civil Engineers are highlighted and explained in more detail below. These values given are used for determining loads for structures with a risk category of 4 (those that have the greatest impact on life, health, and welfare).[61] [62]

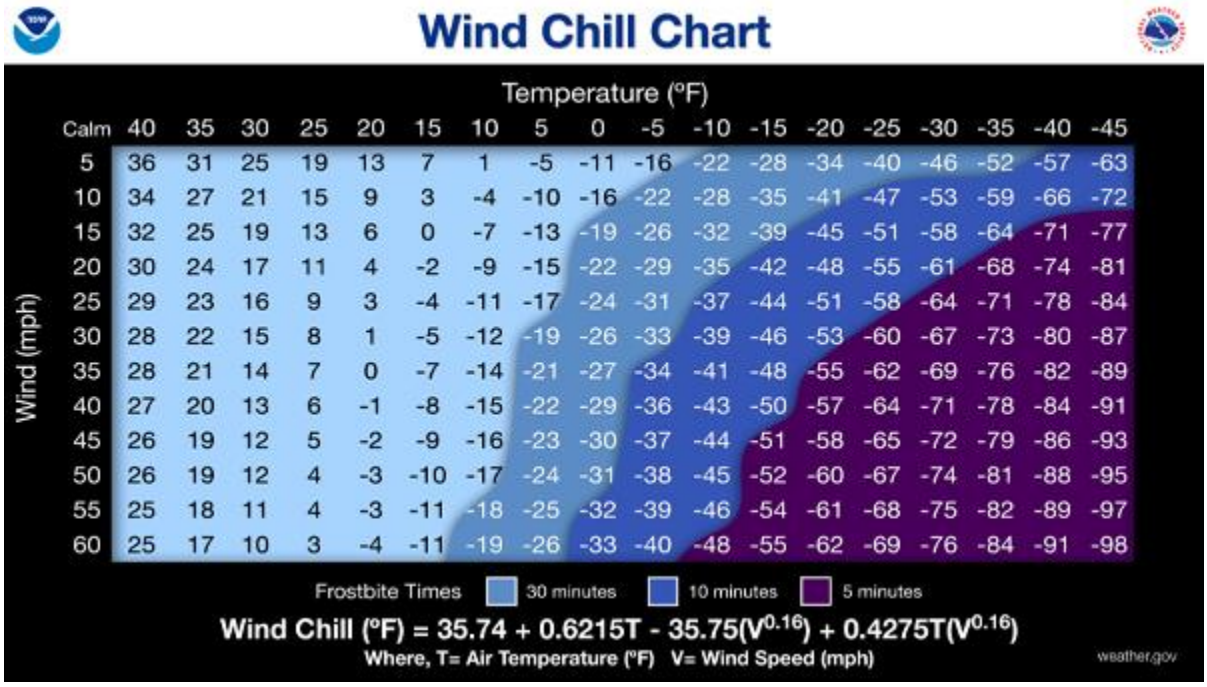
For the City of Angleton, these include:

- Snow Load Index-

    - Ground Snow Load, pg: 10 lb./ft2
        - This is the maximum amount of snow that's expected to accumulate on the ground in a specific location. Light snow ranges from 5–20 lb/ft^2.
    - 20-year Mean Return Interval Value: 1.11 lb./ft2
        - This represents the snow load that is statistically likely to occur once every 20 years at a given location, used primarily in structural engineering calculations to design buildings against snow loads.
    - Winter Wind Parameter: 0.35
        - The percentage of time the wind speed is above 10 mph during October through April. Used to calculate snow drifting.
    - Mapped Elevation: 26.2 ft
- Ice Accumulation- Ice thickness on structures in exposed locations at elevations higher than the surrounding terrain and in valleys and gorges may exceed the mapped values. Values provided are equivalent radial ice thicknesses due to freezing rain for 250, 500, 1,000, and 1,400-year mean recurrence intervals along with concurrent 3-s gust speeds and concurrent air temperatures.
    - Ice Thickness: 0.97 in.
        - This refers to the total depth or layer of ice that builds up on a structure due to freezing rain or other icing conditions, which engineers must consider when designing buildings and infrastructure in areas prone to ice storms
    - Concurrent Temperature: 15 F
    - 3-s Gust Speed 31 mph

A worst-case scenario for this hazard within the planning area would be similar to that of Winter Storm Uri in 2021 which brought snow, sleet, freezing rain, and extreme cold temperatures that lasted for several days. The city saw ice accumulations of .25", temperatures of 10°F with windchill, and snow/sleet accumulations up to 1”. This resulted in multiday road closures (3+ days within Brazoria County) as roads and bridges throughout the county and through the city were covered with snow and ice from the previous night’s freezing rain, sleet, and plummeting temperatures. The increased demand for electricity across the state at this time led to extensive power outages, loss of heat, broken pipes, and other societal impacts for the region. Winter Storm Uri was the largest and most costly winter weather event in Brazoria County’s history, causing $880,000 in reported property damage. Another winter storm event of this magnitude could, again, result in risks to life and property as well as secondary hazards from prolonged power outages, closure of roads, and the inability of residents to access critical facilities or resources. On January 21, 2025, Winter Storm Enzo brought .25 inches of ice and 2 inches of snow across the Gulf Coast. Enzo brought plummeting temperatures, freezing rain, sleet, and dangerous travel conditions. The city was better prepared for Enzo having already endured Uri and was able to de-ice and re-open major roads within 1 day.

Figure 6.3.1: NWS Wind Chill Chart



The NWS Wind Chill Temperature uses advances in science, technology, and computer modeling to provide an accurate, understandable, and useful formula for calculating the dangers from winter winds and freezing temperatures. The wind chill temperature is how cold people and animals feel when outside. Wind chill is based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature. Therefore, the wind makes it feel much colder. If the temperature is 0°F and the wind is blowing at 15 mph, the wind chill is -19°F. At this wind chill temperature, exposed skin can freeze in 30 minutes. Average temperatures for Brazoria County during the months of November- February typically range from highs in the mid-60's to low 70's during the day and lows in the 40's at night, with the coldest month generally being January. Wind speeds during the months of November to January average 8-10 mph.[63] According to the NWS Wind Chill Chart above, this puts the planning area, on average, slightly above freezing. Winter weather events, like cold waves or Winter Storm Uri, within the planning area occur rarely (once every 10 years)

A worst-case scenario for wind chill within Brazoria County would be similar to that of Winter Storm Uri which occurred in February 2021. Every county across Texas was under a Winter Storm Warning and wind chill values were below zero as far south as the Rio Grande River and into northeastern Mexico. This historic winter storm brought snow, sleet, freezing rain and prolonged extreme temperature lows that brought significant buildup of ice on roads and highway overpasses.[64] Impacts were extreme according to the NWS WSSI impact classifications seen above. Travel was dangerous and not advised, there was extensive damage to public infrastructure by means of frozen, cracking pipes and water line breaks. Ice accumulations led to downed trees and power lines, which in turn led to prolonged power outages, closed roadways, and cut-off access to critical facilities and services due to dangerous travel conditions. This storm was the largest and most costly winter weather event in the county's history, causing over $880,000 in property damage in the County. Additionally, a hazard of this severity occurring again and damaging critical infrastructure that leads to a prolonged power outage raises secondary hazards for residents due to the cold and inability to keep homes and buildings warm.

NOAA and the NWS have a variety of watches, warnings, and advisories for freeze, frost, wind, and ice events. A watch is generally issued in the 24 to 72-hour forecast time frame when the risk of a hazardous winter weather event has increased (50 to 80% certainty that warning thresholds will be met). It is intended to provide enough lead time so those who need to set their plans in motion can do so. Warnings are issued when a hazardous winter weather event is occurring, is imminent, or has a very high probability of occurrence (generally greater than 80%). A warning is used for conditions posing a threat to life or property. Advisories are issued when a hazardous winter weather event is occurring, is imminent, or has a very high probability of occurrence (generally greater than 80%). An advisory is for less serious conditions that cause significant inconvenience and, if caution is not exercised, could lead to situations that may threaten life and/or property. The table below describes the various winter weather warnings, watches, and advisories below.[65]

Table 6.3.3: Winter Weather-Related Warnings, Watches, and Advisories

Watch/ Warning/ Advisory	Description
Winter Storm Watch	Issued when conditions are favorable for a significant winter storm event (heavy sleet, heavy snow, ice storm, heavy snow and blowing snow, or a combination of events.)
Extreme Cold Watch (Previously Wind Chill Watch)	Issued when there is the potential for dangerously cold air with or without wind.
Freeze Watch	Issued when there is a potential for significant, widespread freezing temperatures within the next 24-36 hours.
Winter Storm Warning	Issued when dangerously cold air, with or without wind, is expected. Conditions could lead to frostbite or hypothermia. Limit time outside.
Extreme Cold Warning (Previously Wind Chill Warning)	Issued for a combination of very cold air and strong winds that will create dangerously low wind chill values. This level of wind chill will result in frostbite and lead to hypothermia if precautions are not taken. Avoid going outdoors and wear warm protective clothing if you must venture outside.
Freeze Warning	Issued when significant, widespread freezing temperatures are expected.
Ice Storm Warning	Are usually issued for ice accumulation of around 1/4 inch or more. This amount of ice accumulation will make travel dangerous or impossible and likely lead to snapped power lines and falling tree branches. Travel is strongly discouraged.
Blizzard Warning	Issued for frequent gusts greater than or equal to 35 mph accompanied by falling and/or blowing snow, frequently reducing visibility to less than 1/4 mile for three hours or more. A Blizzard Warning means severe winter weather conditions are expected or occurring. Falling and blowing snow with strong winds and poor visibilities are likely, leading to whiteout conditions making travel extremely difficult. Do not travel.
Winter Weather Advisory	Issued for any amount of freezing rain, or when 2 to 4 inches of snow (alone or in combination with sleet and freezing rain) is expected to cause a significant inconvenience, but not serious enough to warrant a warning.
Cold Weather Advisory (Previously Wind Chill Advisory)	Issued when seasonably cold air temperatures or wind chill values, but not extremely cold values, are expected or occurring.
Frost Advisory	Issued when the minimum temperature is forecast to be 33 to 36 degrees on clear and calm nights during the growing season.

2021 Winter Storm Uri resulted in a total of 8 days, 23 hours, and 23 minutes of winter highlights between the first Winter Weather Advisory issued on Thursday, February 11th, 2021, at 9:37 am, to when the last Freeze Warning expired at 9 am on Saturday, February 20th, 2021. While a winter weather hazard event of Uri's magnitude in southeast Texas is uncommon, winter weather is expected to affect the planning area yearly and annualized frequency for this hazard is expected to remain the same in the future.

Historic Occurrences

NOAA collects historic climate data for the entire nation. NOAA's storm event data can be accessed on the NCEI Storm Events Database. These events are shown at the county level with some referencing a specific location, city, or zone. The database currently contains data from January 1950 to December 2023, as entered by NOAA's NWS. Due to changes in the data collection and processing procedures over time, there are unique periods of record available depending on the event type. The table below highlights events for this hazard that have occurred within Brazoria County from 1950-2023.[38]

Table 6.3.4: Historic Occurrences, Winter Weather

Event Date	Event Type	Injuries	Fatalities	Property Damage ($)	Crop Damage ($)
1/12/1997	Ice Storm	0	0	$-	$-
12/4/2009	Winter Storm	0	0	$-	$-
2/3/2011	Ice Storm	0	0	$-	$-
1/28/2014	Winter Weather	0	0	$-	$-
12/8/2017	Heavy Snow	0	0	$-	$-
2/15/2021	Cold/Wind Chill	0	1	$880,000	$-
2/15/2021	Cold/Wind Chill	0	0	$-	$-
2/15/2021	Cold/Wind Chill	0	0	$-	$-
Totals:		0	1	$880,000	$-

Rows highlighted in purple are events that reference the City of Angleton within the event narrative or event location (beginning or end).
$- No dollar amount ($0.00).

Presidential Disaster Declarations

There have been 2 disaster declarations for winter weather within the City of Angleton since 1953.[1,2]

Table 6.3.5: Federal Disaster Declarations, Winter Weather

Declaration Date	Incident Type	Title	Disaster Number	Declaration Type
2/14/2021	Severe Ice Storm	Severe Winter Storm	3554	Emergency Declaration
2/19/2021	Severe Ice Storms	Severe Winer Storms	4586	Major Disaster Declaration

USDA Disaster Declarations

The Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency EM loans available to producers suffering losses in those counties and in counties that are contiguous to a designated county. In addition to EM loan eligibility, other emergency assistance programs, such as FSA disaster assistance programs, have historically used disaster designations as an eligibility trigger. USDA Secretarial disaster designations must be requested of the Secretary of Agriculture by a governor or the governor's authorized representative, by an Indian Tribal Council leader, or by an FSA SED. The Secretarial disaster designation is the most widely used. When there is a presidential disaster declaration, FEMA immediately notifies FSA of the primary counties named in a Presidential declaration. USDA Disaster Declarations for the City of Angleton since 2018 are listed in the table below.[39]

Table 6.3.6: USDA Disaster Declarations (2018-2023), Winter Weather

Crop Disaster Year	Disaster Description	Designation Number
None		

Probability of Future Occurrences

The table below shows FEMA NRI annualized frequency values for winter weather and related hazards.[44]

Table 6.3.7: Annualized Frequency Values, Cold Wave, Ice Storm, and Winter Weather

Hazard Type	Annualized Frequency	Events on Record	Period of Record
Cold Wave	0.2 events per year	3	2005-2021 (16 years)
Ice Storm	0.7 events per year	43	1949-2021 (73 years)
Winter Weather	0.5 events per year	7	2005-2021 (16 years)

Populations at Risk

The Gulf Coast and Southeast Texas region are generally not used to snow, ice, and freezing temperatures. When cold air penetrates south across Texas and Florida, into the Gulf of Mexico, temperatures fall below freezing. This can kill vulnerable vegetation, such as flowering plants and the citrus fruit crop. Wet snow and ice rapidly accumulate on trees with leaves, causing the branches to snap under the load. Motorists are generally unaccustomed to driving on slick roads and traffic accidents increase. Some buildings are poorly insulated or lack heat altogether. Local towns may not have snow removal equipment or treatments available, such as sand or salt for icy roads.[66] Populations at risk include adults over 65 years of age and children, who according to the CDC are the most vulnerable populations to winter weather-related illnesses. Winter weather and ice storms can cause dangerous driving conditions, falling trees, and power outages in homes. The most notable vulnerabilities throughout the county to this hazard are the dangerous driving conditions and power outages.

The NCHH summarizes at-risk populations for several hazards. These include older adults, children, people experiencing homelessness, people with disabilities, and people with chronic health conditions. In addition to the dangers listed above, older adults can face social isolation, lack of electricity needed to run medical equipment, lack of access to a vehicle for evacuation, and lack of access to other critical supplies. In younger populations, such as children, winter weather and related hazard events can disrupt schooling and the normal day-to-day routines they thrive on. This can not only jeopardize their academic success but can also cause mental and emotional stress. Children are more at risk when their exposure to these extreme temperatures is prolonged. For people experiencing homelessness, adequate shelter is critical in keeping populations safe during winter weather and related events. People with disabilities may require additional assistance to stay safe and prepare for these hazards such as creating a support network, finding accessible transportation to evacuate or get medical attention, and loss of power for needed medical equipment. Likewise, those with chronic health conditions may need similar assistance as those with disabilities. People with chronic health conditions also face exposure to diseases or illnesses from prolonged exposure to extreme temperatures and increased exposure to these illnesses when utilizing a shelter, warming center, or evacuation center. Additionally, freezing temperatures can cause damage to homes and businesses in the form of burst pipes, which can cause mold to thrive if not treated promptly. This can exacerbate illness among the general population but especially among those with chronic health conditions. When heating systems or power outages can't adequately maintain a safe temperature households may turn to using space heaters, fireplaces, or appliances that aren't meant for heating (such as ovens or stoves) for warmth. This increases the risk of fires and negatively impacts indoor air quality. Additionally, carbon monoxide poisoning can be a risk for those who utilize generators too close to the home or indoors. These issues disproportionately affect low-income communities and families who may lack the resources to pay for safe heating in their homes.[42]

Any areas of growth within the city could be potentially impacted by this hazard as it has no set geographic boundary. As future developments are completed the risk to this hazard increases as more structures are

being added. Similarly, as the population within the county increases, more people will be at risk of the impacts from these hazards, with vulnerable populations experiencing the most risk.

National Risk Index

FEMA's NRI utilizes data from multiple sources including historical hazard events, hazard intensity, exposure of people and property to hazards, socioeconomic factors, and community resilience indicators. The NRI also incorporates hazard data to determine the frequency and intensity of various natural hazards. This information helps assess the likelihood of specific hazards occurring in different regions.[44]

The NRI considers the exposure of communities to hazards and incorporates factors such as population density, infrastructure systems, and critical facilities that may be at risk during a hazard event. The NRI also generates risk scores for communities across the U.S. that provide a relative ranking of areas based on their overall risk level. This helps to identify areas that may require additional resources and attention for mitigation and planning efforts. The NRI risk equation includes 3 components. EAL represents the average economic loss in dollars resulting from natural hazards each year, the Community Risk Factor is a scaling factor that incorporates social vulnerability (the susceptibility of social groups to the adverse impacts of natural hazards), and community resilience (the ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions). The outcome, the risk index, represents the potential negative impacts of natural hazards on the county level or individually by census tracts. The NRI EAL score and rating, represent a community's relative level of expected loss each year when compared to all other communities at the same level.[44]

The FEMA NRI accounts for winter weather in various formats, these are cold waves, ice storms, and winter weather. EAL Exposure Values for Brazoria County, which includes the City of Angleton, each year according to the FEMA NRI for these hazards are listed as relatively low.[46] EAL Exposure Values and EAL Values can be found in the tables and figures below.

Table 6.3.8: Expected Annual Loss Exposure Values, Cold Wave, Ice Storm, and Winter Weather

Hazard Type	Building Value ($)	Population Equivalence ($)/ Population (#)	Agricultural Value ($)	EAL Total ($)
Cold Wave, Ice Storm, and Winter Weather	$57,433,464,365	$4,309,091,556,009/ 371,473.41	$91,232,428	$4,364,260,048,386

Table 6.3.9: Expected Annual Loss Values, Cold Wave, Ice Storm, and Winter Weather

Hazard Type	Building Value ($)	Population Equivalence ($)/ Population (#)	Agriculture Value
Cold Wave	$12,102	$1,220,169/ 0.11	$45,826
Ice Storm	$4,492	$85,003/ 0.01	N/A
Winter Weather	$10,586	$462,229/ 0.04	$1,198

N/A- Not Applicable

EAL for the City of Angleton was derived by creating a report that used census tract information for tracts that included the Angleton city limits. These were census tracts 48039662100, 48039662200, 48039662400, 48039662300, 48039662500, 48039663100, and 48039664100.[45]

EAL values, risk index ratings, risk index scores, social vulnerability, and community resilience for each census tract can be found in the figures below. Additionally, the FEMA NRI lists the HLR, a hazard- and county-specific estimate of the percentage of the exposed consequence type (building value, population, or agriculture value) expected to be lost due to a hazard occurrence, for cold waves and ice storms within the county as very low. Winter weather HLR is listed as relatively moderate.[46]

Figure 6.3.2: Risk Index by Census Tract, Cold Wave

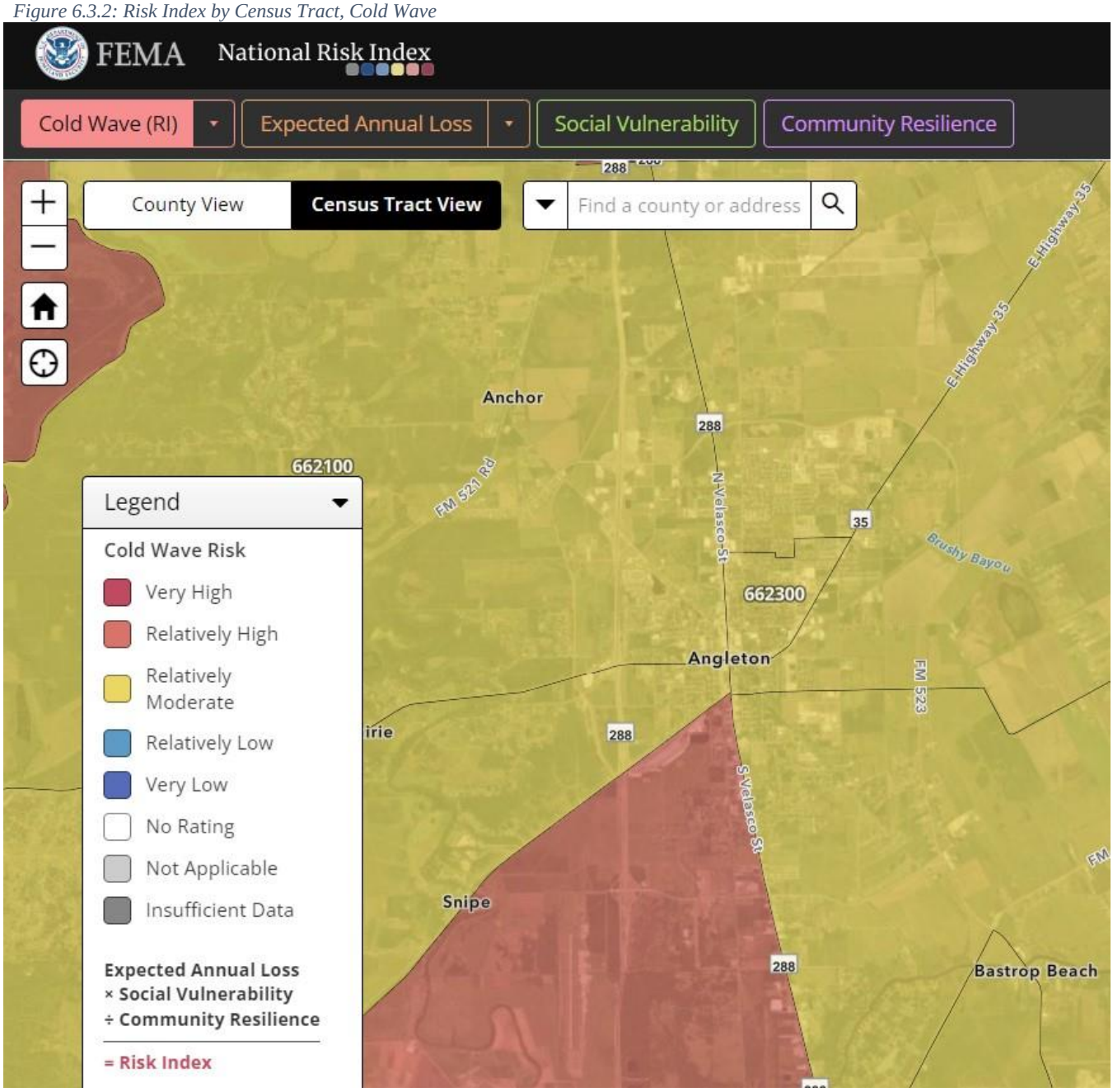


Figure 6.3.3: Risk Index by Census Tract, Ice Storm

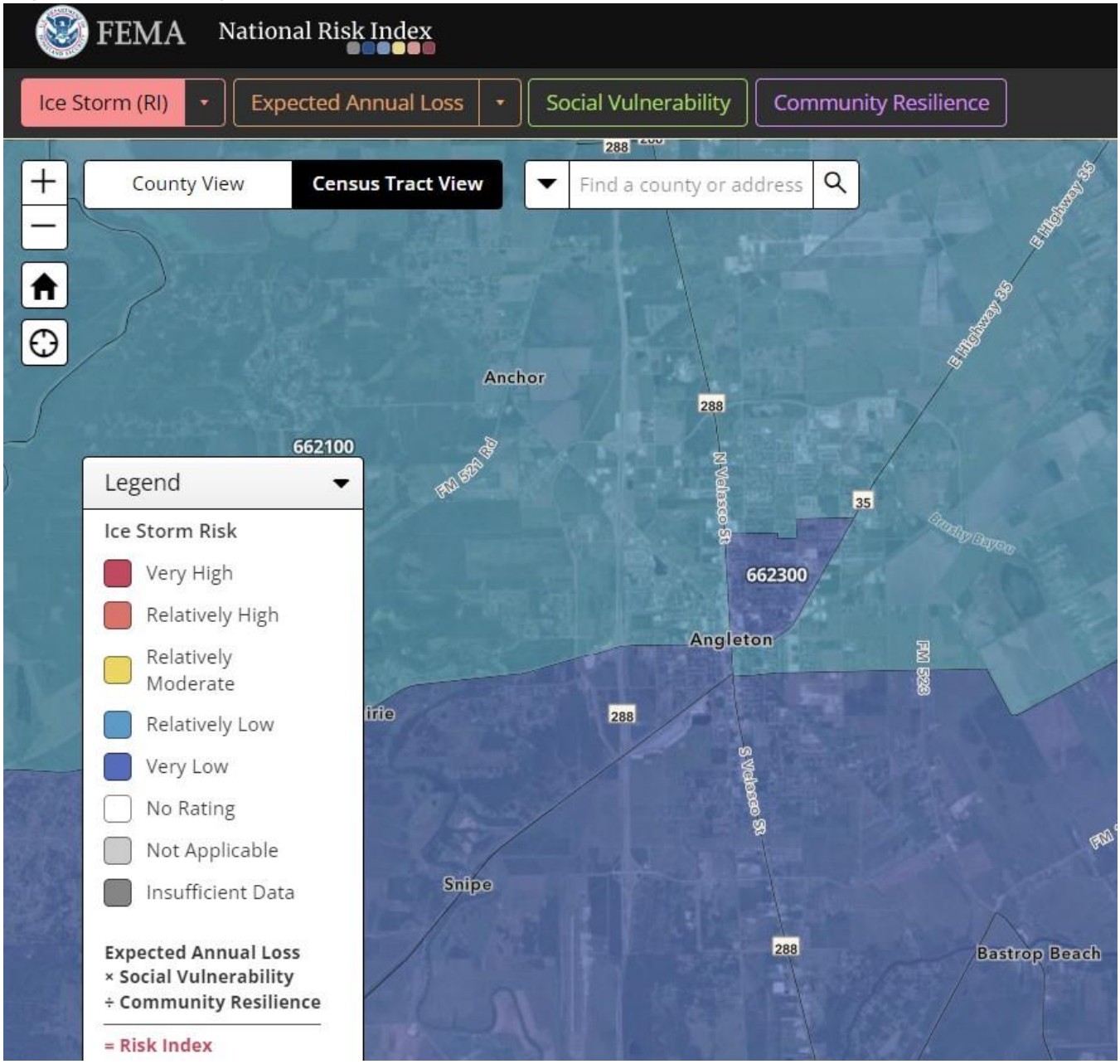


Figure 6.3.4: Risk Index by Census Tract, Winter Weather

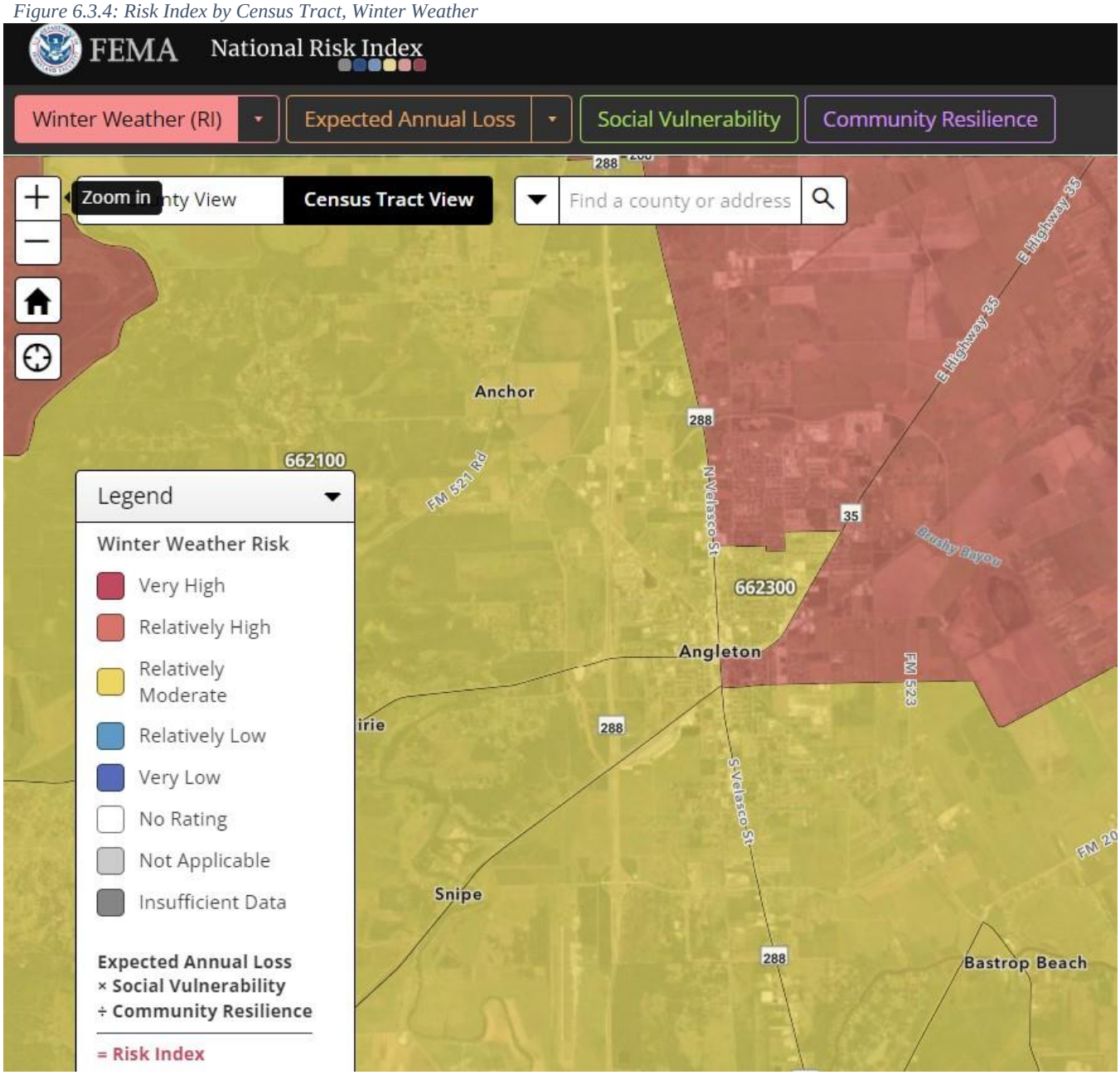


Figure 6.3.5: Social Vulnerability by Census Tract, City of Angleton

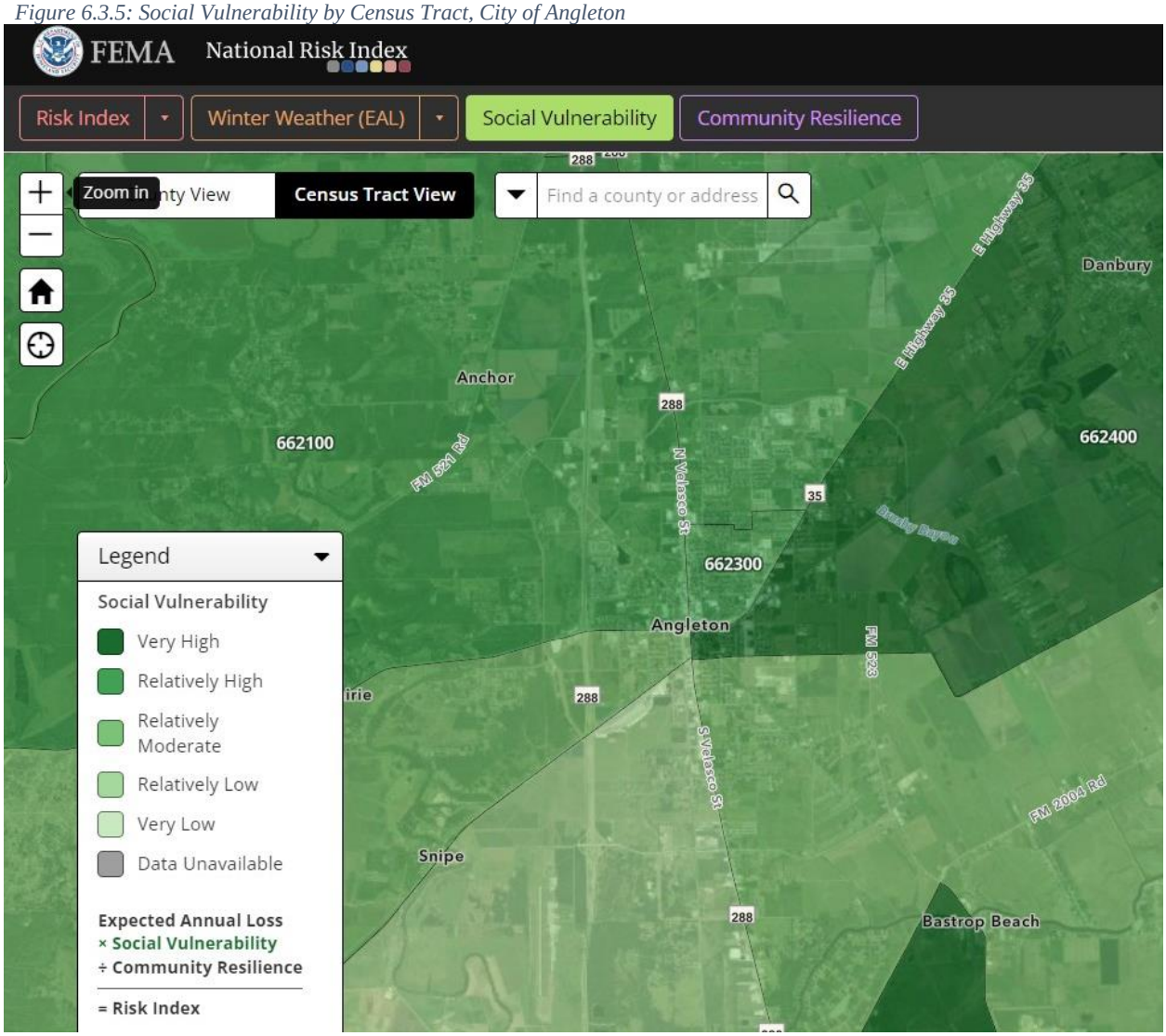


Figure 6.3.6: Community Resilience by Census Tract, City of Angleton

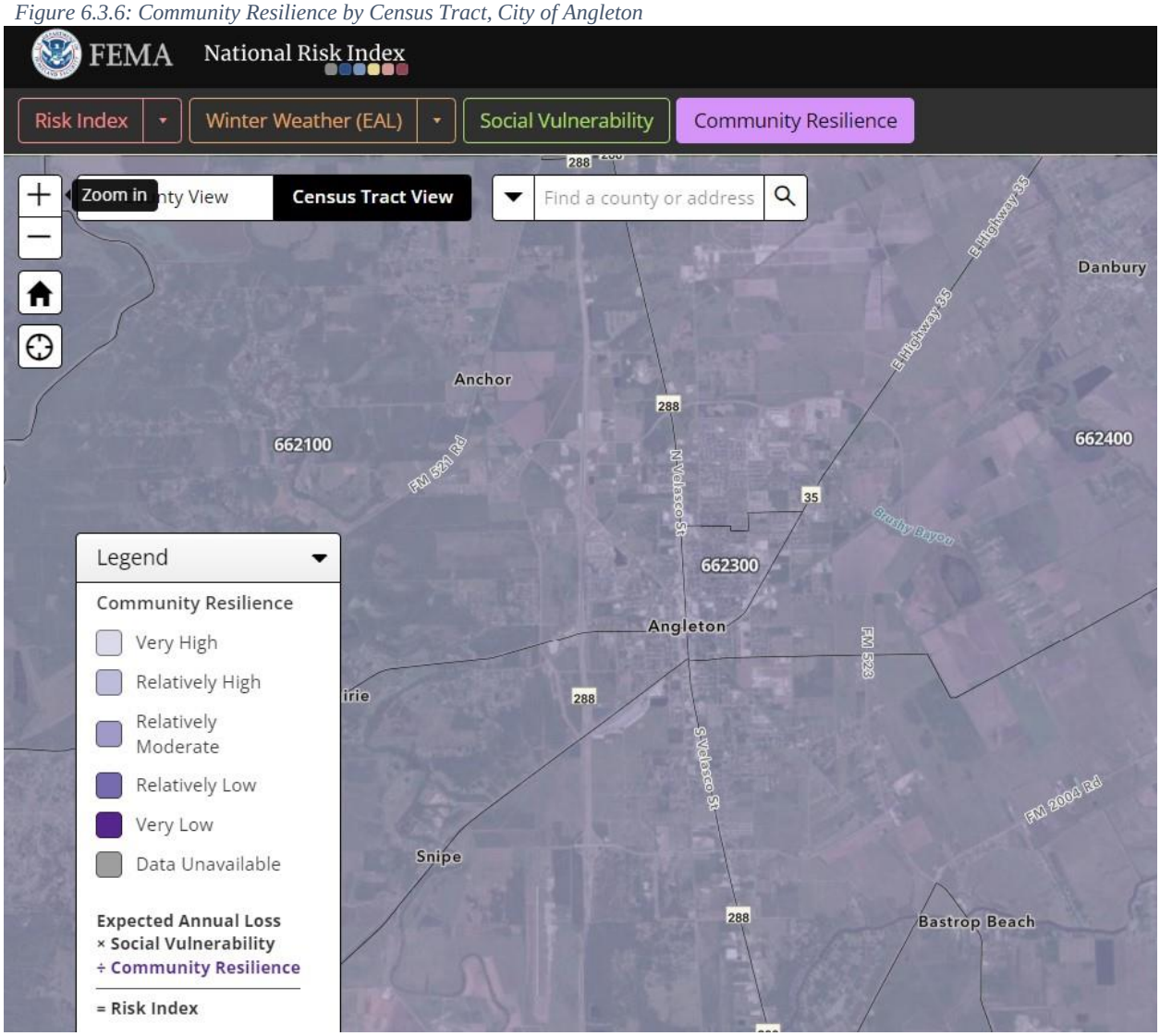


Figure 6.3.7: FEMA NRI Summary, Cold Wave

Rank	Community	State	Risk Index Rating	Risk Index Score	National Percentile
1	Census tract 48039663100	TX	Relatively High	91.33	0 100
2	Census tract 48039662200	TX	Relatively Moderate	89.49	0 100
3	Census tract 48039662400	TX	Relatively Moderate	89.42	0 100
4	Census tract 48039664100	TX	Relatively Moderate	88.89	0 100
5	Census tract 48039662100	TX	Relatively Moderate	87.67	0 100
6	Census tract 48039662300	TX	Relatively Moderate	84.32	0 100
7	Census tract 48039662500	TX	Relatively Moderate	77.74	0 100

Rank	Community	State	EAL Value	Social Vulnerability	Community Resilience	CRF	Risk Value	Risk Index Score
1	Census tract 48039663100	TX	$33,873	Relatively Low	Relatively Moderate	1	$33,901	91.33
2	Census tract 48039662200	TX	$21,068	Relatively High	Relatively Moderate	1.34	$28,180	89.49
3	Census tract 48039662400	TX	$19,509	Very High	Relatively Moderate	1.43	$27,993	89.42
4	Census tract 48039664100	TX	$25,346	Relatively Moderate	Relatively Moderate	1.05	$26,561	88.89
5	Census tract 48039662100	TX	$19,375	Relatively High	Relatively Moderate	1.22	$23,707	87.67
6	Census tract 48039662300	TX	$13,009	Relatively High	Relatively Moderate	1.38	$17,929	84.32
7	Census tract 48039662500	TX	$9,728	Relatively Moderate	Relatively Moderate	1.12	$10,864	77.74

Figure 6.3.8: FEMA NRI Summary, Ice Storm

Rank	Community	State	Risk Index Rating	Risk Index Score	National Percentile
1	Census tract 48039662200	TX	Relatively Low	38.68	0 100
2	Census tract 48039662400	TX	Relatively Low	35.11	0 100
3	Census tract 48039662100	TX	Relatively Low	34.75	0 100
4	Census tract 48039663100	TX	Very Low	31.86	0 100
5	Census tract 48039662300	TX	Very Low	29.28	0 100
6	Census tract 48039664100	TX	Very Low	29.15	0 100
7	Census tract 48039662500	TX	Very Low	19.22	0 100

Rank	Community	State	EAL Value	Social Vulnerability	Community Resilience	CRF	Risk Value	Risk Index Score
1	Census tract 48039662200	TX	$1,259	Relatively High	Relatively Moderate	1.34	$1,684	38.68
2	Census tract 48039662400	TX	$1,019	Very High	Relatively Moderate	1.43	$1,462	35.11
3	Census tract 48039662100	TX	$1,180	Relatively High	Relatively Moderate	1.22	$1,443	34.75
4	Census tract 48039663100	TX	$1,273	Relatively Low	Relatively Moderate	1	$1,275	31.86
5	Census tract 48039662300	TX	$821	Relatively High	Relatively Moderate	1.38	$1,132	29.28
6	Census tract 48039664100	TX	$1,072	Relatively Moderate	Relatively Moderate	1.05	$1,124	29.15
7	Census tract 48039662500	TX	$570	Relatively Moderate	Relatively Moderate	1.12	$636	19.22

Figure 6.3.9: FEMA NRI Summary, Winter Weather

Rank	Community	State	Risk Index Rating	Risk Index Score	National Percentile
1	Census tract 48039662200	TX	Relatively High	87.13	0 100
2	Census tract 48039662400	TX	Relatively High	85.92	0 100
3	Census tract 48039662100	TX	Relatively Moderate	85.5	0 100
4	Census tract 48039663100	TX	Relatively Moderate	85.15	0 100
5	Census tract 48039664100	TX	Relatively Moderate	83.1	0 100
6	Census tract 48039662300	TX	Relatively Moderate	82.29	0 100
7	Census tract 48039662500	TX	Relatively Moderate	71.67	0 100

Rank	Community	State	EAL Value	Social Vulnerability	Community Resilience	CRF	Risk Value	Risk Index Score
1	Census tract 48039662200	TX	$8,474	Relatively High	Relatively Moderate	1.34	$11,335	87.13
2	Census tract 48039662400	TX	$7,190	Very High	Relatively Moderate	1.43	$10,316	85.92
3	Census tract 48039662100	TX	$8,165	Relatively High	Relatively Moderate	1.22	$9,991	85.5
4	Census tract 48039663100	TX	$9,718	Relatively Low	Relatively Moderate	1	$9,726	85.15
5	Census tract 48039664100	TX	$8,036	Relatively Moderate	Relatively Moderate	1.05	$8,421	83.1
6	Census tract 48039662300	TX	$5,790	Relatively High	Relatively Moderate	1.38	$7,980	82.29
7	Census tract 48039662500	TX	$3,928	Relatively Moderate	Relatively Moderate	1.12	$4,387	71.67

Climate Change Impacts

As stated above, the Gulf Coast and Southeast Texas region are generally not used to snow, ice, and freezing temperatures. According to the Office of the Texas State Climatologist, in the southern part of the state and in coastal regions, snow is rare, but nonetheless, large accumulations of snow are possible. Climate model projections have shown the risk of snowfall consistently decreases in climates like that of Texas.[58]

Table 6.3.10: Climate Change Impacts, Winter Weather

Location	The location of winter weather is not expected to change.
Extent/Intensity	The extent of winter weather is not expected to change.
Frequency	The frequency of winter weather is expected to decrease.
Duration	The duration of winter weather is expected to decrease.

Section 6.4: Tornado

6.4 Tornado

A Tornado is defined by the NWS as "a violently rotating column of air touching the ground, usually attached to the base of a thunderstorm."[67] Tornados are one of the most violent storms, with the strongest tornados being capable of massive destruction. In extreme cases, winds from a tornado may approach 300 miles per hour, with damage paths that can be more than one mile wide and 50 miles long. These catastrophic tornados are often produced by supercell thunderstorms.[68]

Location

Tornadoes do not have any specific geographic boundary and can occur anywhere if the right conditions are present. From 1951-2011, nearly 62.7 percent of all Texas tornadoes occurred within the three months of April, May, and June, with almost one-third of the total tornadoes occurring in May.[69] The State of Texas has the highest average annual number of tornadoes per state, with an average of 136 tornadoes per year over 30 years, as seen in Figure 6.4.1.[70] Figure 6.4.2 depicts Brazoria County's total number of tornadoes per year between 61-80 instances.[71]

Figure 6.4.1: Annual Tornadoes per State, 1993-2022

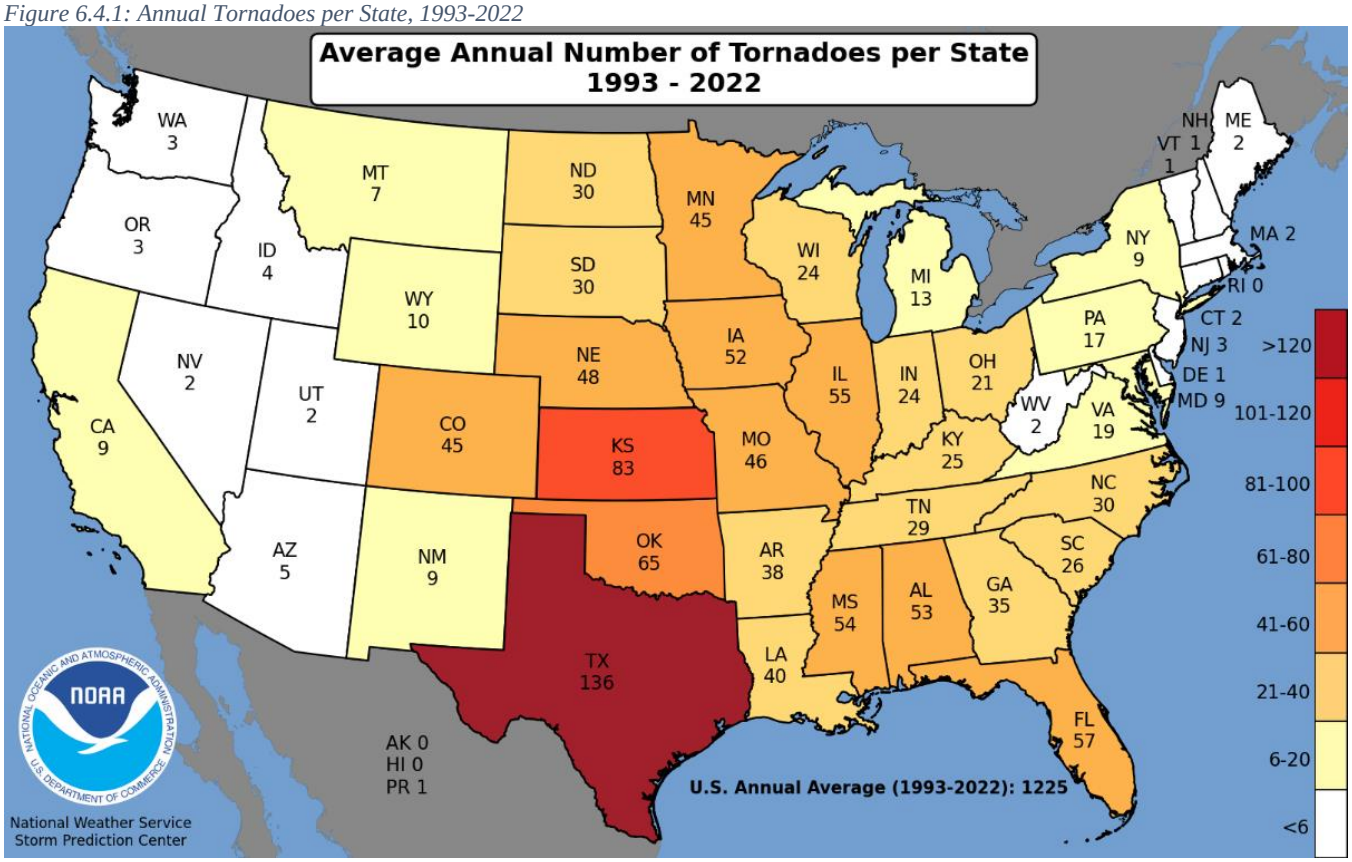
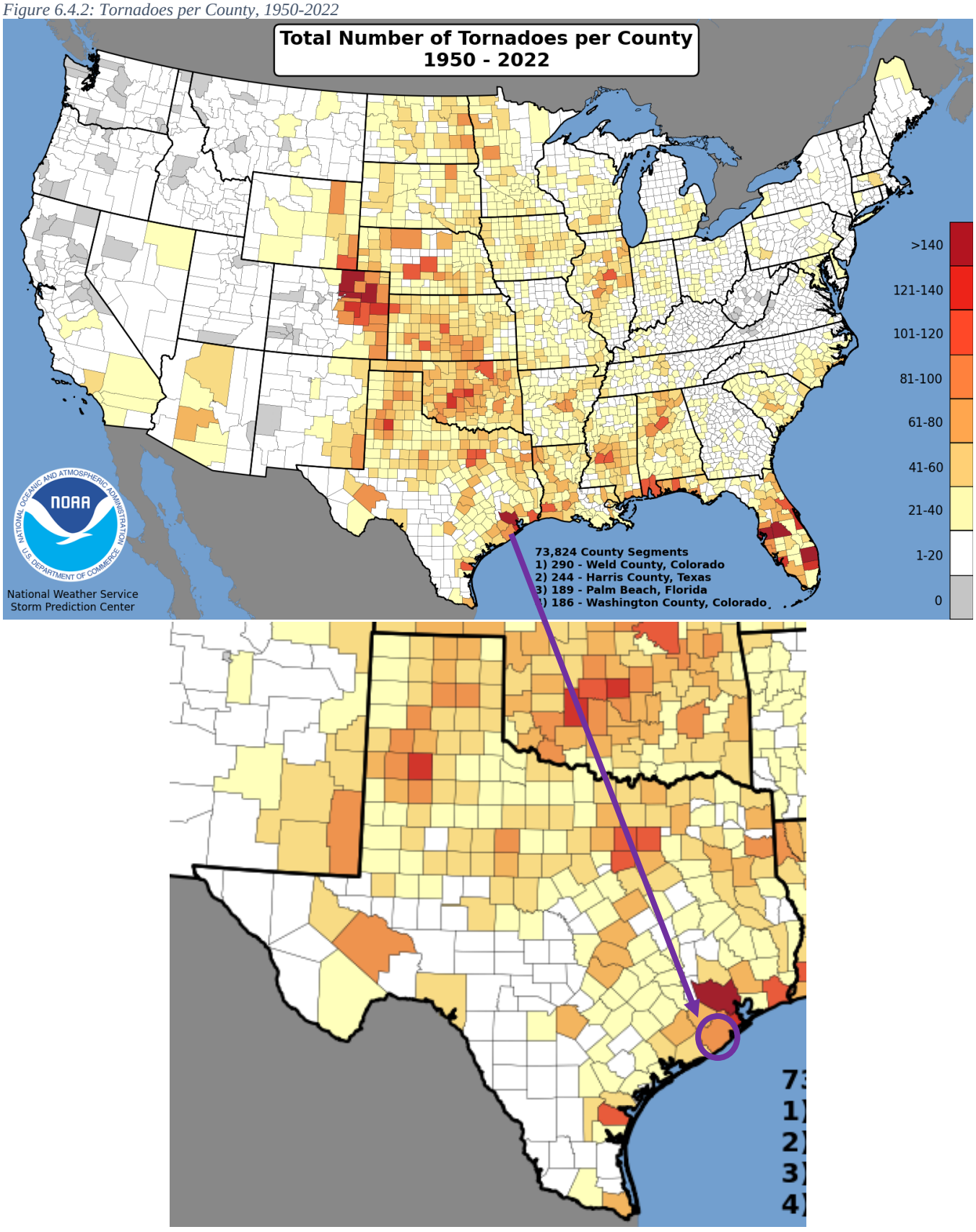


Figure 6.4.2: Tornadoes per County, 1950-2022



Extent

Tornado intensity is ranked using the Enhanced Fujita Scale (EF- Scale), a rating of how strong a tornado was. It is calculated by surveying the damage and comparing it with damage to similar objects at certain wind speeds. The EF-Scale is not meant to be used as a measure of how strong a tornado currently on the ground is. The EF-Scale incorporates 28 damage indicators such as building type, structures, and trees. For each damage indicator, there are 8 degrees of damage ranging from the beginning of visible damage to complete destruction of the damage indicator.[72]

Table 6.4.1: Enhanced Fujita Scale Descriptions

EF Rating	Wind Speed	Typical Damage
0	65-85	Light damage. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
1	86-110	Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
2	111-135	Considerable damage. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
3	136-165	Severe damage. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
4	166-200	Devastating damage. Whole frame houses Well-constructed houses and whole frame houses completely leveled; cars thrown, and small missiles generated.
5	>200	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly more than 109 yards; high-rise buildings have significant structural deformation; incredible phenomena will occur.

Table 6.4.2: EF-Scale Damage Indicators

Number (Details Linked)	Damage indicator	Abbreviation
1	Small barns, farm outbuildings	SBO
2	One- or two-family residences	FR12
3	Single-wide mobile home (MHSW)	MHSW
4	Double-wide mobile home	MHDW
5	Apt, condo, townhouse (3 stories or less)	ACT
6	Motel	M
7	Masonry apt. or motel	MAM
8	Small retail bldg. (fast food)	SRB
9	Small professional (doctor office, branch bank)	SPB
10	Strip mall	SM
11	Large shopping mall	LSM
12	Large, isolated ("big box") retail bldg.	LIRB
13	Automobile showroom	ASR
14	Automotive service building	ASB
15	School - 1-story elementary (interior or exterior halls)	ES
16	School - jr. or sr. high school	JHSH
17	Low-rise (1-4 story) bldg.	LRB
18	Mid-rise (5-20 story) bldg.	MRB
19	High-rise (over 20 stories)	HRB
20	Institutional bldg. (hospital, govt. or university)	IB
21	Metal building system	MBS
22	Service station canopy	SSC

23	Warehouse (tilt-up walls or heavy timber)	WHB
24	Transmission line tower	TLT
25	Free-standing tower	FST
26	Free standing pole (light, flag, luminary)	FSP
27	Tree - hardwood	TH
28	Tree - softwood	TS

For this hazard, a worst-case scenario within the city would be an EF-3 or stronger tornado crossing through the county. This would be a severe event with buildings and homes damaged, vehicles becoming airborne, downed trees and power lines, debris on roadways, and critical facilities damaged or experiencing a service disruption to residents due to damages or lack of power. This scenario is based on previous occurrences of tornadoes and high winds that have occurred within Brazoria County and the City of Angleton, with the strongest tornado occurrence being an EF-2 that crossed through southern areas of the city (see Figure 6.4.3 below). Additionally, this hazard could damage critical infrastructure that leads to a prolonged power outage, and even result in a loss of communication within the county if a radio or cell tower is destroyed. If the tornado occurs during a heat event or drought and disrupts power supply in the area for a prolonged amount of time, secondary hazards will pose increased risks to citizens due to the heat and inability to keep homes and buildings cool. This scenario is similar to what occurred within the region during the 2024 derecho and Hurricane Beryl. Power lines were destroyed by debris and falling trees due to the severe thunderstorms, tornadoes, and high winds when the region was under an excessive heat advisory. Power line restoration/repairs took longer to address than anticipated leading to the activation of cooling centers for residents.

Historic Occurrences

NOAA collects historic climate data for the entire nation. NOAA's storm event data can be accessed on the NCEI Storm Events Database. The database currently contains data from January 1950 to December 2023, as entered by NOAA's NWS. Due to changes in the data collection and processing procedures over time, there are unique periods of record available depending on the event type. These events are shown at the county level with some referencing a specific location, city, or zone. There have been 129 tornadoes within Brazoria County since 1950. The City of Angleton has been listed in 13 of these events as recorded by the NCEI, either within the location (beginning or ending) or the event narrative.

There have been 11 new tornado or funnel cloud events in Brazoria County since 2018. Figure 6.4.3 below depicts historic tornado occurrences and their tracks within the City of Angleton, while the table below highlights events for this hazard that have occurred within Brazoria County since 2018. Events that occurred within the City of Angleton are highlighted in purple.[38]

Figure 6.4.3: Tornado Paths, City of Angleton

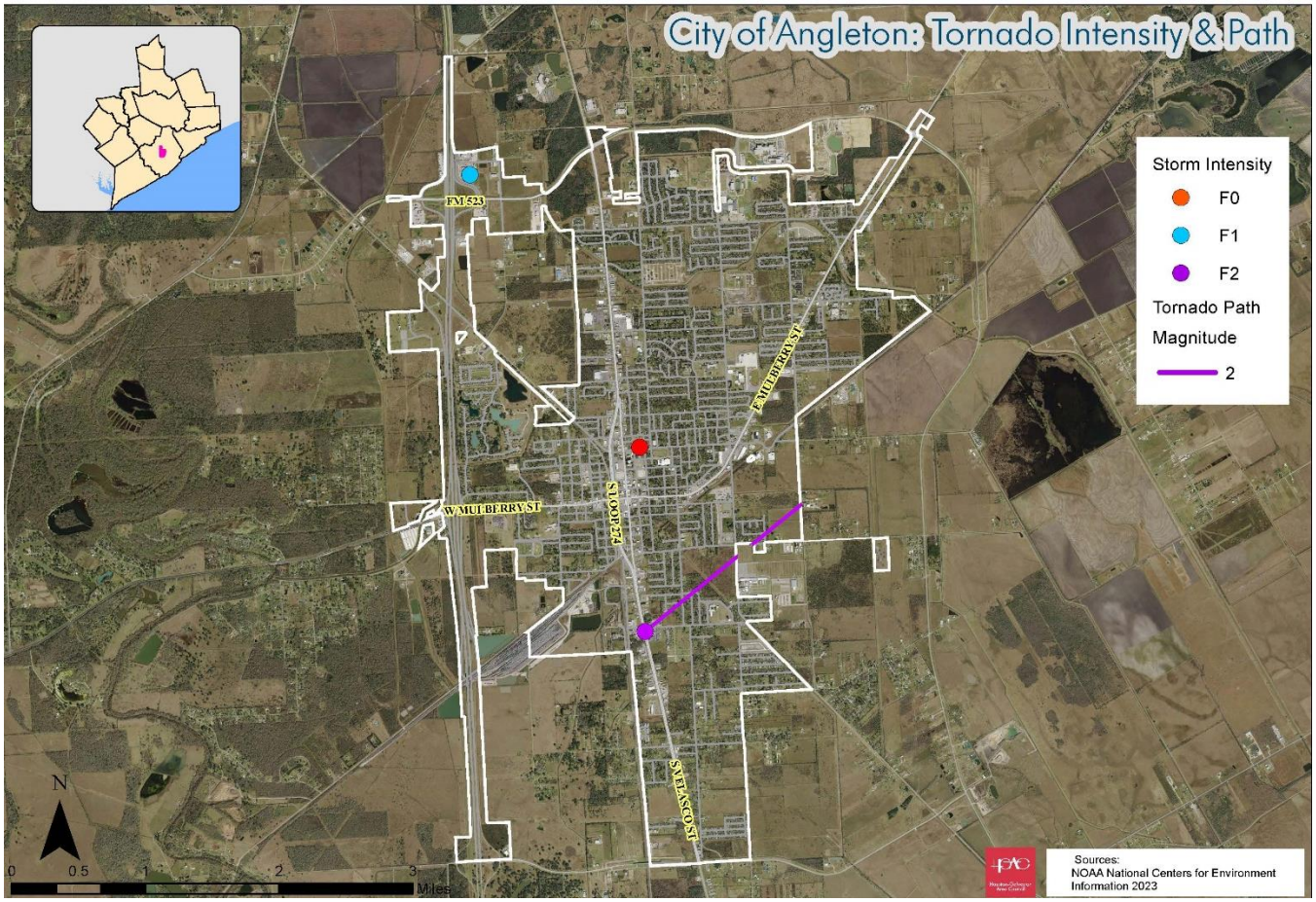


Table 6.4.3:Tornado Occurrences, City of Angleton

Date	Event Type/ Rating	Location	Injuries	Fatalities	Property Damage ($)	Crop Damage ($)
3/29/2018	Tornado/ EF0	Manvel Coyle ARPT	0	0	$1,000	$-
5/23/2018	Funnel Cloud	Rosharon	0	0	$-	$-
5/23/2018	Funnel Cloud	Alvin	0	0	$-	$-
9/9/2018	Funnel Cloud	Freeport	0	0	$-	$-
10/15/2018	Funnel Cloud	Chenango	0	0	$-	$-
10/31/2018	Tornado/ EF0	Angleton	0	0	$30,000	$-
3/30/2019	Funnel Cloud	Brazoria	0	0	$-	$-
7/14/2019	Funnel Cloud	Hinkles Ferry	0	0	$-	$-
8/14/2021	Funnel Cloud	Angleton Bailes ARPT	0	0	$-	$-
3/22/2022	Tornado/ EF0	Danbury	0	0	$1,000	$-
1/24/2023	Tornado/ EF0	Manvel	0	0	$-	$-

Rows highlighted in purple are events that reference the City of Angleton within the event narrative or event location (beginning or end).
$- No dollar amount ($0.00).

Presidential Disaster Declarations

There have been 0 disaster declarations for tornado, however 4 disaster designations have included tornado in the declaration title for Brazoria County. The declaration incident type for these events is listed as a "severe storm".[1,2]

Table 6.4.4: Federal Disaster Declarations, Tornado

Declaration Year	Incident Type	Incident Title	Disaster Number	Declaration Type
1991	Severe Storm	SEVERE STORMS, TORNADOES & FLOODING	900	Major Disaster Declaration
2003	Severe Storm	SEVERE STORMS, TORNADOES AND FLOODING	1439	Major Disaster Declaration
2015	Severe Storm	SEVERE STORMS, TORNADOES, STRAIGHT-LINE WINDS AND FLOODING	4223	Major Disaster Declaration
2016	Severe Storm	SEVERE STORMS, TORNADOES, STRAIGHT-LINE WINDS, AND FLOODING	4245	Major Disaster Declaration

USDA Disaster Declarations

The Secretary of Agriculture is authorized to designate counties as disaster areas to make EM loans available to producers suffering losses in those counties and in counties that are contiguous to a designated county. In addition to EM loan eligibility, other emergency assistance programs, such as FSA disaster assistance programs, have historically used disaster designations as an eligibility trigger. USDA Secretarial disaster designations must be requested of the Secretary of Agriculture by a governor or the governor's authorized representative, by an Indian Tribal Council leader or by an FSA SED. The Secretarial disaster designation is the most widely used. When there is a presidential disaster declaration, FEMA immediately notifies FSA of the primary counties named in a Presidential declaration. USDA Disaster Declarations for the City of Angleton since the last HMP are listed in the table below.[39]

Table 6.4.5: USDA Declared Disasters (2018-2023), Tornado

Crop Disaster Year	Disaster Description	Designation Number
None		

Probability of Future Occurrences

Tornado season usually refers to the time of year the U.S. sees the most tornadoes. The peak "tornado season" for the southern Plains (e.g., Texas, Oklahoma, and Kansas) is from May into early June. On the Gulf Coast, it is earlier in the spring.[66] According to the FEMA NRI for tornadoes within Brazoria County, annualized frequency values are 1.1 events per year over 72 years of record (1950-2021), with 63 events on record for this timeframe.[42]

Populations at Risk

The NCHH summarizes at-risk populations for several hazards. These include older adults, people experiencing homelessness, people with disabilities, and people with chronic health conditions. In addition to the dangers listed above, older adults can face social isolation, lack of electricity needed to run medical equipment, lack of access to a vehicle for evacuation, and lack of access to other critical supplies. Evacuation for these events is fast-paced, and older adults may not be able to seek adequate shelter before a tornado impacts their area. For people experiencing homelessness, adequate shelter is critical in keeping populations safe during a tornado. People with disabilities may require additional assistance to stay safe and prepare for these hazards and their after-effects such as creating a support network, finding accessible transportation to evacuate or get medical attention, and loss of power for needed medical equipment. Likewise, those with chronic health conditions may need similar assistance as those with disabilities. Residents impacted 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 further injury or loss of life. Socially vulnerable populations are most susceptible based on several factors, including their physical and financial ability to react or respond during or directly following a hazard event. These issues disproportionately affect low-income communities and families who may lack the resources to pay for damages to their homes, lack insurance, or lack the resources to replace home contents or personal

belongings.[43] Those living in mobile/manufactured housing are also at greater risk from this hazard as even anchored mobile homes can be seriously damaged or destroyed when winds gust over 80 mph.[43]

All areas and residents within the city are exposed to this hazard. As the city continues to expand in both population and development, areas of future growth could increase the vulnerability of the city and its residents to this hazard. The impacts of a tornado on the life, health, and safety of City of Angleton residents depend on several factors, including the severity of the event and adequate warning time being provided to residents to take shelter. Tornadoes can lead to a disruption in emergency response services, shelters, electricity, clean water, and other forms of necessary medical assistance while repairs are made to critical facilities or power is being restored.

National Risk Index

FEMA's NRI utilizes data from multiple sources including historical hazard events, hazard intensity, exposure of people and property to hazards, socioeconomic factors, and community resilience indicators. The NRI also incorporates hazard data to determine the frequency and intensity of various natural hazards. This information helps assess the likelihood of specific hazards occurring in different regions.[44]

The NRI considers the exposure of communities to hazards and incorporates factors such as population density, infrastructure systems, and critical facilities that may be at risk during a hazard event. The NRI also generates risk scores for communities across the U.S. that provide a relative ranking of areas based on their overall risk level. This helps to identify areas that may require additional resources and attention for mitigation and planning efforts. The NRI risk equation includes 3 components. EAL represents the average economic loss in dollars resulting from natural hazards each year, the Community Risk Factor is a scaling factor that incorporates social vulnerability (the susceptibility of social groups to the adverse impacts of natural hazards), and community resilience (the ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions). The outcome, the risk index, represents the potential negative impacts of natural hazards on the county level or individually by census tracts. The NRI EAL score and rating, represent a community's relative level of expected loss each year when compared to all other communities at the same level.[44]

EAL Exposure Values and EAL Values for Brazoria County can be found in the tables below.

Table 6.4.6: Expected Annual Loss Exposure Values, Tornado

Hazard Type	Building Value ($)	Population Equivalence ($)/ Population (#)	Agricultural Value ($)	EAL Total ($)
Tornado	$57,514,822,174	$4,309,098,400,000/ 371,474	$91,232,428	$4,366,704,454,602

Table 6.4.7: Expected Annual Loss Values, Tornado

Hazard Type	Building Value ($)	Population Equivalence ($)/ Population (#)	Agriculture Value
Tornado	$3,081,036	$15,053,946/ 1.30	$1,815

N/A- Not Applicable

EAL for the City of Angleton was derived by creating a report that used census tract information for tracts that included the Angleton city limits. These were census tracts 48039662100, 48039662200, 48039662400, 48039662300, 48039662500, 48039663100, and 48039664100. EAL according to the FEMA NRI for tornado events for these census tracts is listed as relatively high, with one tract rating relatively moderate. EAL values, risk index ratings, risk index scores, social vulnerability, and community resilience for each census tract can be found in the figures below.[45] Additionally, the FEMA NRI lists the HLR, a hazard- and county-specific estimate of the percentage of the exposed consequence

type (building value, population, or agriculture value) expected to be lost due to a hazard occurrence, for tornado within Brazoria County as very low.[46]

Figure 6.4.4: Risk Index by Census Tract, Tornado

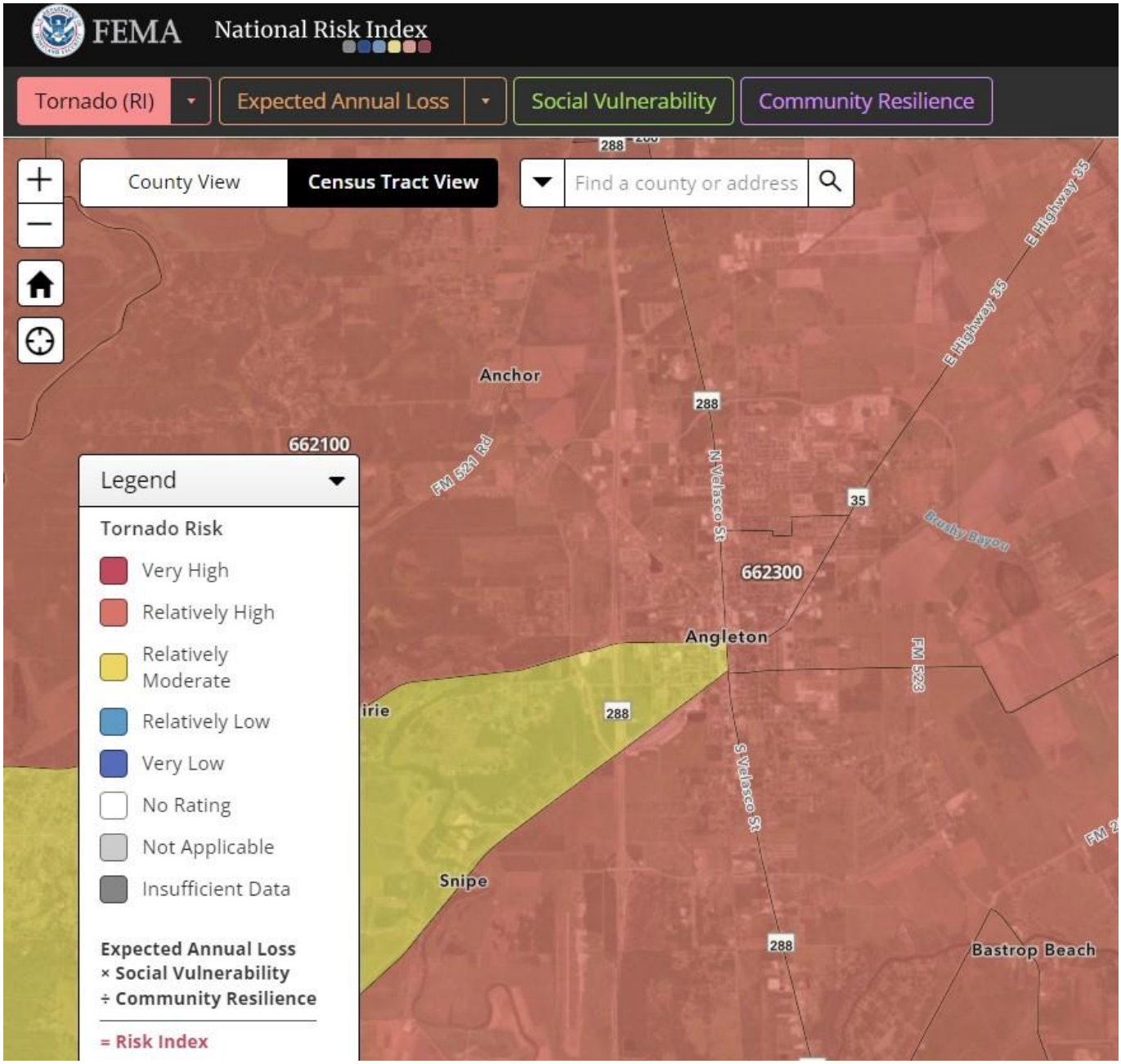


Figure 6.4.5: Social Vulnerability by Census Tract, City of Angleton

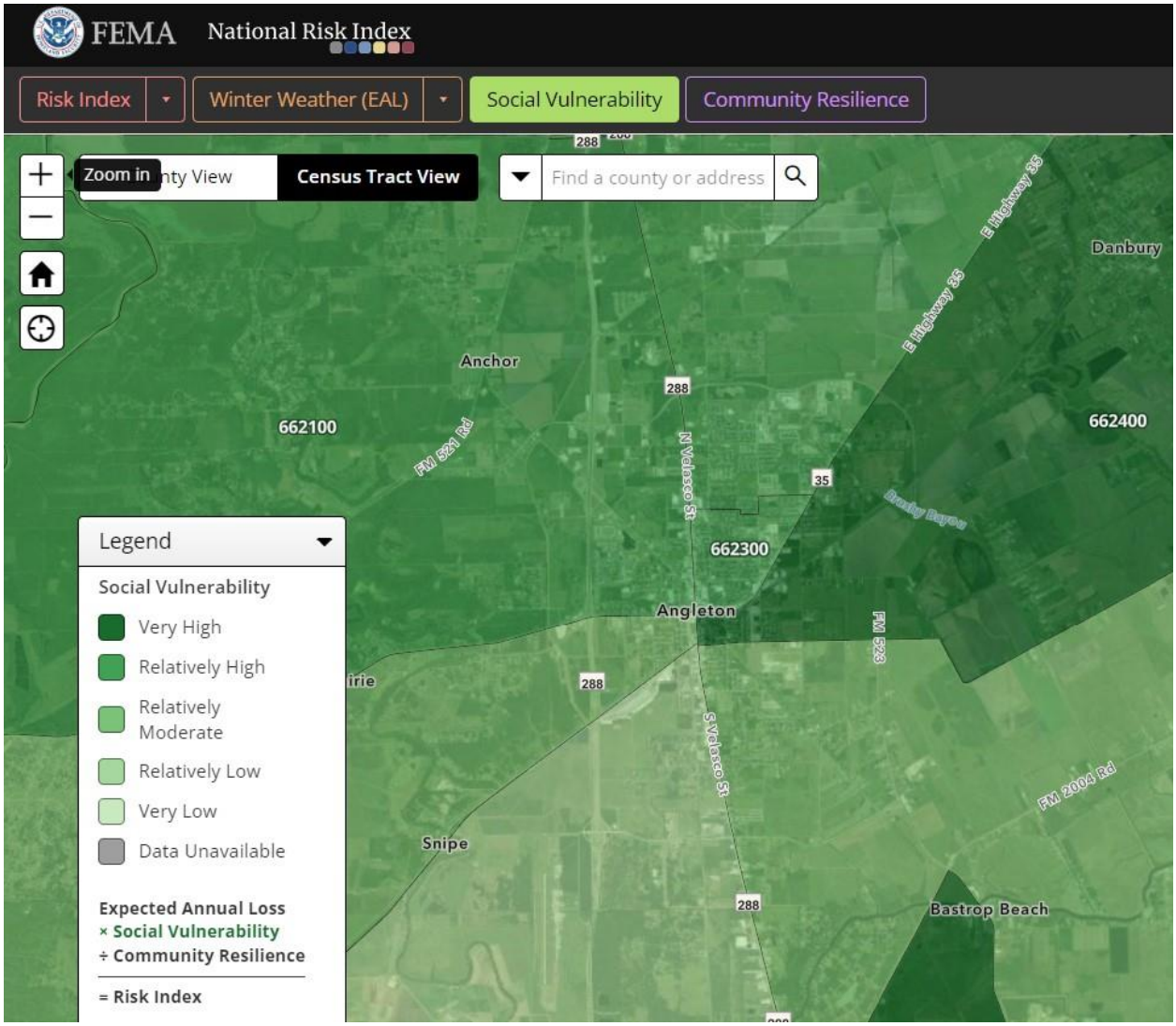


Figure 6.4.6: Community Resilience by Census Tract, City of Angleton

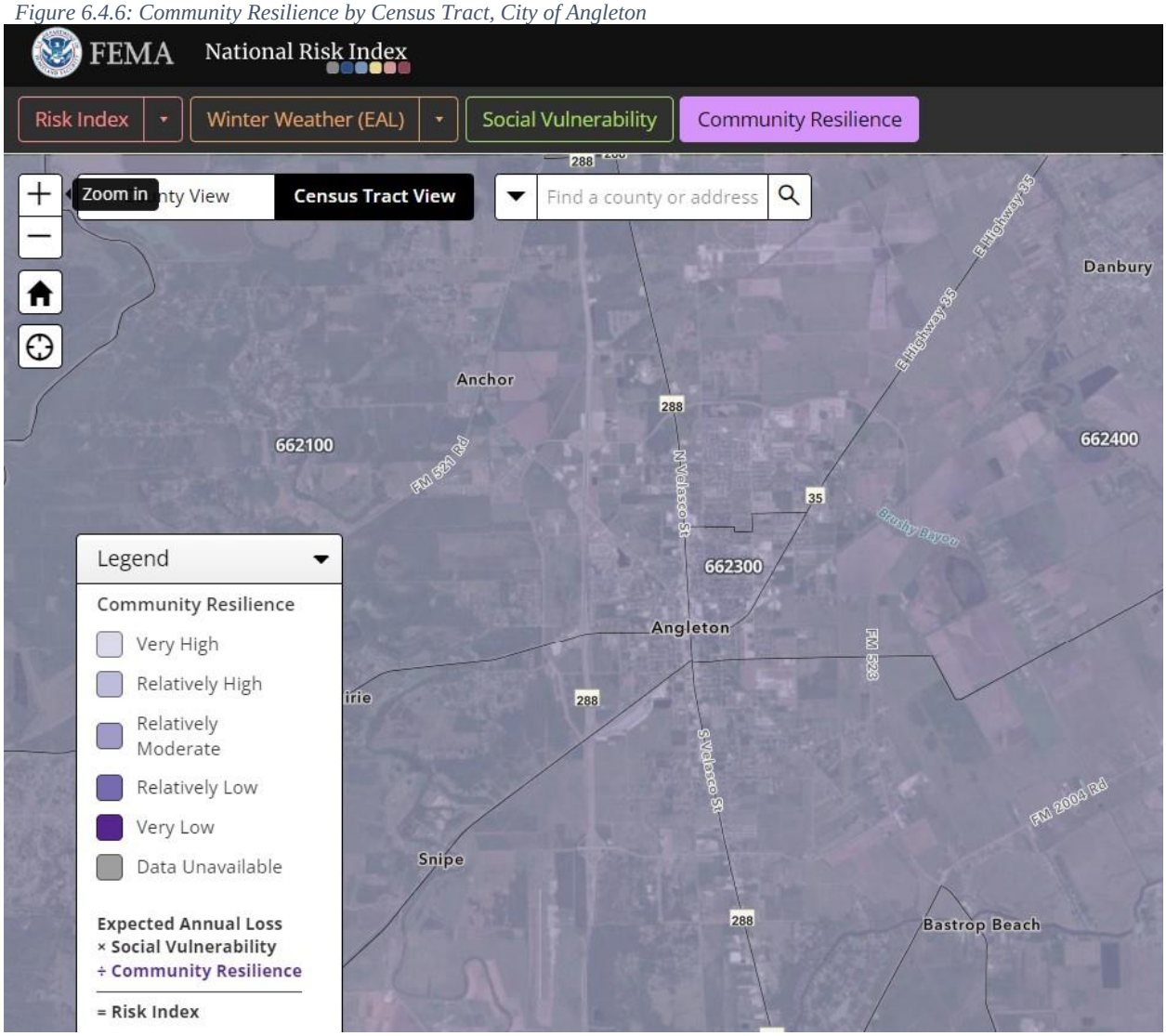


Figure 6.4.7: FEMA NRI Summary, Tornado

Rank	Community	State	Risk Index Rating	Risk Index Score	National Percentile
1	Census tract 48039662200	TX	Relatively High	90.46	0 100
2	Census tract 48039662400	TX	Relatively High	88.45	0 100
3	Census tract 48039662100	TX	Relatively High	87.86	0 100
4	Census tract 48039663100	TX	Relatively High	85.62	0 100
5	Census tract 48039664100	TX	Relatively High	82.1	0 100
6	Census tract 48039662300	TX	Relatively High	81.79	0 100
7	Census tract 48039662500	TX	Relatively Moderate	68.07	0 100

Rank	Community	State	EAL Value	Social Vulnerability	Community Resilience	CRF	Risk Value	Risk Index Score
1	Census tract 48039662200	TX	$277,476	Relatively High	Relatively Moderate	1.34	$371,144	90.46
2	Census tract 48039662400	TX	$234,585	Very High	Relatively Moderate	1.43	$336,599	88.45
3	Census tract 48039662100	TX	$267,801	Relatively High	Relatively Moderate	1.22	$327,686	87.86
4	Census tract 48039663100	TX	$296,693	Relatively Low	Relatively Moderate	1	$296,939	85.62
5	Census tract 48039664100	TX	$245,675	Relatively Moderate	Relatively Moderate	1.05	$257,449	82.1
6	Census tract 48039662300	TX	$184,461	Relatively High	Relatively Moderate	1.38	$254,228	81.79
7	Census tract 48039662500	TX	$131,736	Relatively Moderate	Relatively Moderate	1.12	$147,118	68.07

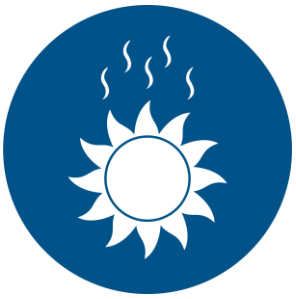
Climate Change Impacts

According to the Office of the Texas State Climatologist, "The most robust trend in tornado activity is a tendency of more tornadoes in large outbreaks, but the factors apparently driving that trend are not projected to continue."[58] Severe thunderstorms and lightning are more likely to occur in summer months when temperatures are higher and moisture from the gulf helps to fuel thunderstorm development, which could lead to the development of tornadoes along the front of the storm if the right conditions exist.

Table 6.4.8: Climate Change Impacts, Tornado

Location	The location of tornadoes is not expected to change.
Extent/Intensity	The extent and intensity of tornadoes within the county may change (increase) due to increased temperatures and energy available to fuel severe thunderstorms from the warm air within the Gulf of Mexico.
Frequency	Tornado frequency is not expected to change. 62.7 percent of all Texas tornadoes occurred within the three-month period of April, May, and June, with almost one-third of the total tornadoes occurring in May
Duration	The duration of tornado events is not likely to change, however the intensity of them, or outbreaks is expected to increase.

Section 6.5: Extreme Heat



6.5 Extreme Heat

Heat events, or extreme heat, is defined by the CDC as summertime temperatures that are much hotter and/or humid than average.[73] The US Department of Homeland Security's Ready.gov website takes this definition a step further by defining extreme heat as "a period of high heat and humidity with temperatures above 90°F for at least two to three days." Among all weather-related hazards, extreme heat is responsible for the highest number of annual deaths as the body must work extra hard to maintain a normal temperature.[74] Heat-related illnesses, like heat exhaustion or heat stroke, happen when the body is not able to properly cool itself. While the body normally cools itself by sweating, during extreme heat, this might not be enough. In these cases, a person's body temperature rises faster than it can cool itself down. This can cause damage to the brain and other vital organs. The table below provides classifications of various heat-related NWS warnings and watches for extreme heat.[75]

Table 6.5.1: NWS Heat-Related Watches and Warnings

Name	Definition
Excessive Heat Outlook	**Be Aware!** The outlooks are issued when the potential exists for an excessive heat event in the next 3-7 days. An Outlook provides information to those who need considerable lead-time to prepare for the event.
Excessive Heat Watch	**Be Prepared!** Heat watches are issued when conditions are favorable for an excessive heat event in the next 24 to 72 hours. A Watch is used when the risk of a heat wave has increased but its occurrence and timing is still uncertain.
Excessive Heat Warning	**Take Action!** An Excessive Heat Warning is issued within 12 hours of the onset of extremely dangerous heat conditions. The general rule of thumb for this Warning is when the maximum heat index temperature is expected to be 105°F or higher for at least 2 days and nighttime air temperatures will not drop below 75°F; however, these criteria vary across the country, especially for areas not used to extreme heat conditions. If you don't take precautions immediately when conditions are extreme, you may become seriously ill or even die.
Heat Advisory	**Take Action!** A Heat Advisory is issued within 12 hours of the onset of extremely dangerous heat conditions. The general rule of thumb for this Advisory is when the maximum heat index temperature is expected to be 100°F or higher for at least 2 days, and nighttime air temperatures will not drop below 75°F; however, these criteria vary across the country, especially for areas that are not used to dangerous heat conditions. Take precautions to avoid heat illness. If you don't take precautions, you may become seriously ill or even die.

Location

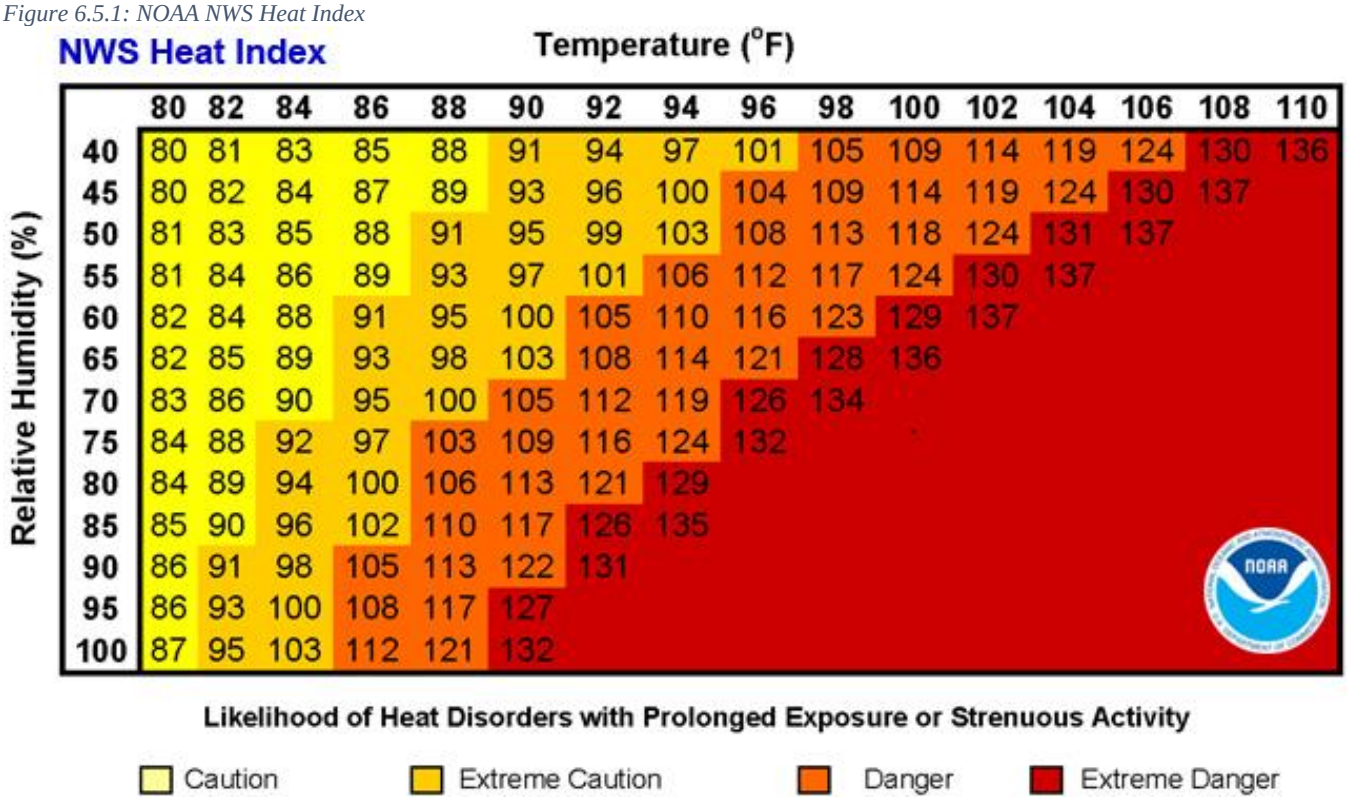
The risk of an extreme heat event occurring applies the same to the entire county. The City of Angleton experiences the highest temperatures in the months of June to August, with average temperatures between 90°F and 100°F degrees. In more developed areas, the "urban heat island" effect (increased air temperatures in urban areas in contrast to cooler surrounding rural areas.) can occur due to higher concentrations of buildings and impervious surface/pavement. These materials absorb more heat during the day and radiate it at night, prohibiting temperatures from cooling as much compared to undeveloped and rural areas.[76] A map of the land cover within the City of Angleton can be found in Section 3: County Profile, Figure 3.16.

Extent

The intensity of heat and extreme heat events are measured by temperature and humidity. NOAA's heat index or the "Apparent Temperature" is an accurate measure of how hot it feels when the relative humidity is added to the actual air temperature. The figure below outlines the NOAA NWS heat index for shaded areas. In direct sunlight, these heat index values can be increased by up to 15°F. At

temperatures over 103°F dangerous heat disorders can begin with prolonged exposure to the heat or increased physical activity in the heat.[77]

Figure 6.5.1: NOAA NWS Heat Index



The table below outlines various effects on the body in relation to the heat index and associated temperature from the figure above.

Table 6.5.2: Heat Index

Color	Heat Index	Classification	Effect on the body
	Caution	80°F - 90°F	Fatigue possible with prolonged exposure and/or physical activity
	Extreme Caution	90°F - 103°F	Heat stroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity
	Danger	103°F - 124°F	Heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity
	Extreme Danger	125°F +	Heat stroke highly likely

A worst-case scenario for this hazard would include prolonged periods of increased temperatures and humidity resulting in a heat index rating of danger or extreme danger, and excessive heat warnings being issued (maximum heat index values of 113°F or above or maximum temperatures of 105°F or above). In the event of a prolonged power outage during a heat event or drought, secondary hazards will pose increased risks to citizens life, health, and welfare due to the heat and inability to keep homes and buildings cool. This scenario is similar to what occurred within the region during the 2024 derecho and Hurricane Beryl. Power lines were destroyed by debris and falling trees due to the severe thunderstorms, tornadoes, and high winds when the region was under an excessive heat advisory. Power line restoration/repairs took longer to address than anticipated, leading to the activation of cooling centers for residents due to dangerous and life threatening.

Historic Occurrences

NOAA collects historic climate data for the entire nation. NOAA's storm event data can be accessed on the NCEI Storm Events Database. These events are shown at the county level with some referencing a specific location, city, or zone. The database currently contains data from January 1950 to December 2023, as entered by NOAA's NWS. Due to changes in the data collection and processing procedures over time, there are unique periods of record available depending on the event type. The table below highlights events for this hazard that have occurred within Brazoria County from 1950-2023.[38] The previous *13* occurrences of heat or excessive heat all occurred within the last year, 2023.

Table 6.5.3: Heat Events (1950-2023)

Event Date	Event Type	Injuries	Fatalities	Property Damage ($)	Crop Damage ($)
6/26/1999	Heat	0	0	$-	$-
8/1/1999	Heat	0	0	$-	$-
7/6/2000	Heat	0	0	$-	$-
8/29/2000	Heat	0	0	$-	$-
9/1/2000	Heat	0	0	$-	$-
6/24/2009	Heat	0	0	$-	$-
6/9/2019	Heat	0	0	$-	$-
6/9/2019	Heat	0	0	$-	$-
6/16/2023	Excessive Heat	0	0	$-	$-
6/16/2023	Excessive Heat	0	0	$-	$-
6/25/2023	Excessive Heat	0	0	$-	$-
7/12/2023	Excessive Heat	0	0	$-	$-
8/5/2023	Excessive Heat	0	0	$-	$-
8/5/2023	Excessive Heat	0	0	$-	$-
8/5/2023	Excessive Heat	0	0	$-	$-
8/23/2023	Excessive Heat	0	0	$-	$-
8/23/2023	Excessive Heat	0	0	$-	$-
8/23/2023	Excessive Heat	0	0	$-	$-
9/5/2023	Heat	0	0	$-	$-
9/5/2023	Heat	0	0	$-	$-
9/5/2023	Heat	0	0	$-	$-

Presidential Disaster Declarations

There have been no federally declared heat or extreme heat disaster declarations in Brazoria County or the City of Angleton since 1950.[1,2]

USDA Disaster Declarations

The Secretary of Agriculture is authorized to designate counties as disaster areas to make EM loans available to producers suffering losses in those counties and in counties that are contiguous to a designated county. In addition to EM loan eligibility, other emergency assistance programs, such as FSA disaster assistance programs, have historically used disaster designations as an eligibility trigger. USDA Secretarial disaster designations must be requested of the Secretary of Agriculture by a governor or the governor's authorized representative, by an Indian Tribal Council leader, or by an FSA SED. The Secretarial disaster designation is the most widely used. When there is a presidential disaster declaration, FEMA immediately notifies FSA of the primary counties named in a Presidential declaration. USDA Disaster Declarations for Brazoria County and the City of Angleton since 2018 are listed in the table below.[39]

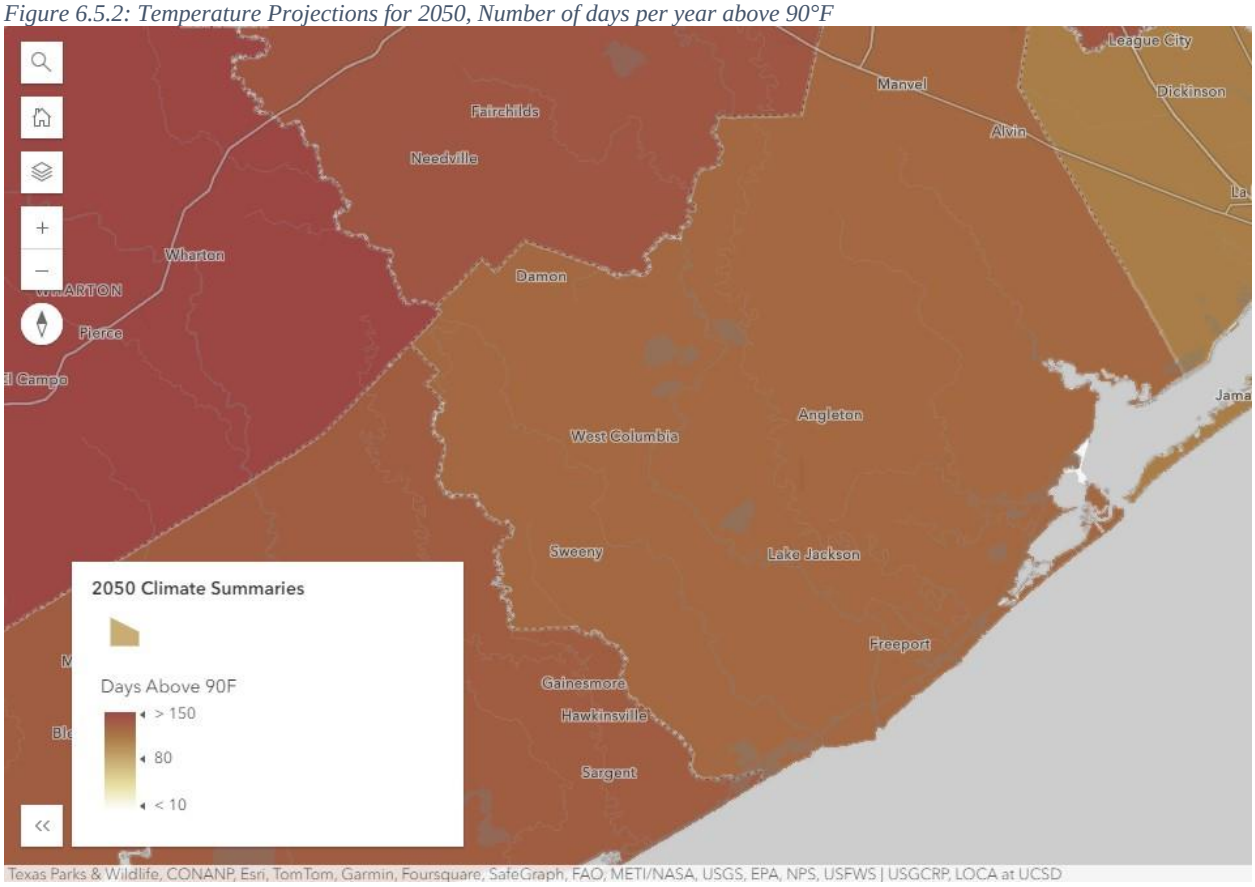
Table 6.5.4: USDA Declared Disasters (2018-2023), Extreme Heat

Crop Disaster Year	Disaster Description	Designation Number
2022	Excessive Heat	S5350
2023	Excessive Heat and Drought	S5569

Probability of Future Occurrences

The State of Texas HMP estimates the occurrence of extreme heat and heat events is trending upward, with a 600.5% increase in the 5-year planning cycle between 2017-2021.[40] According to the FEMA NRI for heat waves in Brazoria County, in which the City of Angleton is located, annualized frequency values are 0.2 events per year over a 16-year period of record (2005-2021), with 2 events on record for this timeframe.[44] This may change in the near future as NRI data is updated and more recent heat events that have occurred within the county occurred after the reporting period used by the NRI. Additionally, as seen in the figures below, projections for the number of days per year above 90°F, and the number of days per year warmer than the top 1% historically, have both increased since previous reporting periods. These projections are expected to increase further by 2050.[78]

Figure 6.5.2: Temperature Projections for 2050, Number of days per year above 90°F



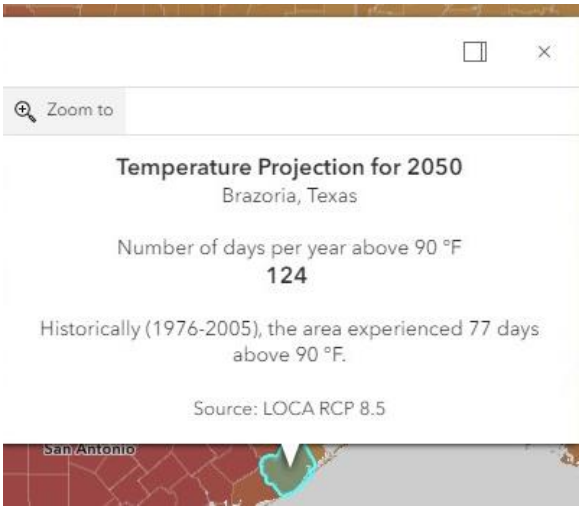
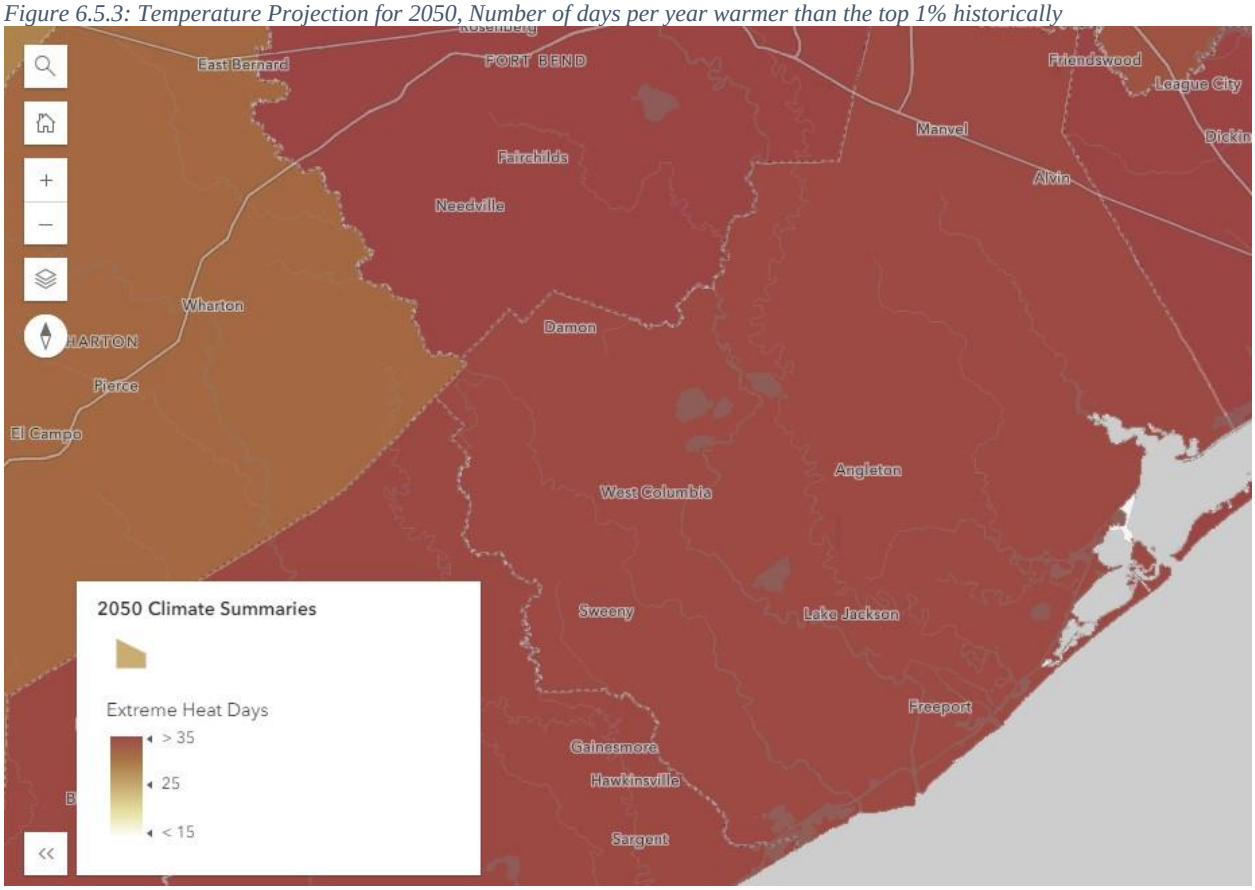


Figure 6.5.3: Temperature Projection for 2050, Number of days per year warmer than the top 1% historically



Temperature Projection for 2050
Brazoria, Texas

Number of days per year warmer than the top 1% historically
35

Historically (1976-2005), the area experienced 4 extreme heat days.

Source: LOCA RCP 8.5

Populations at Risk

While heat events have the potential to damage buildings and crops, vulnerable populations are most at risk in the county during these events. The National Integrated Heat Health Information System lists those most at risk for extreme heat as older/elderly adults, children, athletes, pregnant people, people with disabilities, people with chronic health conditions/pre-existing conditions, homeless populations, emergency responders, pets and service animals, and outdoor/indoor workers.

In older populations, health conditions like cardiovascular issues can be exacerbated by extreme heat. During power outages that may occur during peak heat hours of the day, older populations may be disproportionately affected if they require access to life-sustaining devices. Older adults and children are more vulnerable to this hazard because they are unable to thermoregulate. Children also play outside often which exposes them to the same risks due to the combination of exposure and exertion. Athletes are similar in their risk as outdoor activities, sometimes while wearing protective gear, in combination with exposure and exertion will trap heat. As athletes are expected to push themselves physically, the line between acceptable levels of exertion and dangerous levels of exertion during heat may be blurred. Those who are pregnant are more vulnerable to this hazard due to a general increase in their core body temperature regardless of the air temperature, but also because extreme heat events can increase the likelihood of common challenges during pregnancy (excessive sweating and heat rash). Extreme heat also poses health risks for pregnant people and the developing fetus. There is increasing evidence that extreme heat can increase the risk of preterm birth, low birth weight, fetal death, and infant mortality. High temperatures can cause stress on the body which exacerbates respiratory and cardiovascular diseases, diabetes, and renal disease.

Some medical conditions, such as obesity and heart disease, increase people's sensitivity to heat, putting them at greater risk of heat illnesses. In addition, some medications (such as some antidepressants, diuretics, and beta-blockers) taken for a chronic illness may increase an individual's sensitivity to heat by interfering with the body's ability to regulate temperature, fluids, or electrolytes. Homeless populations are more at risk of this hazard as they may face significant stress due to their living conditions, insomnia due to poor sleeping arrangements, and lack of food or spoiled food, which also contributes to a higher risk for heat-related illness and death. Additionally, they may not seek medical treatment during a heat event due to distance, lack of access to transportation, and lack of financial resources. Their access to cooling centers or shelters may be limited due to distance and lack of transportation, building hours of access, stigma, and several other factors. People who live in rural areas may have even less access to these resources and services. If the temperature at night remains high, homeless populations are further at risk as the body will be unable to cool itself off. Emergency responders are at a greater risk due to their often heavy and bulky equipment that can trap heat it, like firefighters. Pets and service animals have differing thermoneutral zones depending on their age, size, and breed. Pets and service animals have a higher metabolic rate which makes them more vulnerable to this hazard. Service animals also face the added risk of burning their paw pads as paved surfaces become hot during a heat wave. Those who work outdoors, or indoors without access to air conditioning are also at a higher risk for heat-related illnesses. Most often these jobs require a level of physical exertion and exposure, and can also require personal protective clothing that can trap heat and prevent cooling. Workers may also not have access to water and shade.[79]

The vulnerability of communities to this hazard increases with the addition of impervious pavement from any future developments, especially those occurring in urban areas. The urban heat island effect could become more prominent in these areas of the city. Additionally, as the population grows so does

the vulnerability of residents, especially vulnerable populations, to this hazard. This is due to progressively increasing surface temperatures and the increasing probability of heat events occurring. As the population increases there will be more demand placed on resources, critical facilities such as cooling centers, and critical infrastructure such as the power grid, as they experience increased strain from individuals trying to stay cool.

National Risk Index

FEMA's NRI utilizes data from multiple sources including historical hazard events, hazard intensity, exposure of people and property to hazards, socioeconomic factors, and community resilience indicators. The NRI also incorporates hazard data to determine the frequency and intensity of various natural hazards. This information helps assess the likelihood of specific hazards occurring in different regions.[41]

The NRI considers the exposure of communities to hazards and incorporates factors such as population density, infrastructure systems, and critical facilities that may be at risk during a hazard event. The NRI also generates risk scores for communities across the U.S. that provide a relative ranking of areas based on their overall risk level. This helps to identify areas that may require additional resources and attention for mitigation and planning efforts. The NRI risk equation includes 3 components. EAL represents the average economic loss in dollars resulting from natural hazards each year, the Community Risk Factor is a scaling factor that incorporates social vulnerability (the susceptibility of social groups to the adverse impacts of natural hazards), and community resilience (the ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions). The outcome, the risk index, represents the potential negative impacts of natural hazards on the county level or individually by census tracts. The NRI EAL score and rating, represent a community's relative level of expected loss each year when compared to all other communities at the same level. [44]

EAL Exposure Values and EAL Values for Brazoria County can be found in the tables below.

Table 6.5.5: Expected Annual Loss Exposure Values, Heat Wave

Hazard Type	Building Value ($)	Population Equivalence ($)/ Population (#)	Agricultural Value ($)	EAL Total ($)
Heat Wave	$57,514,792,486	$4,309,091,556,009/ 371,4733.41	$91,232,428	$4,366,697,580,923

Table 6.5.6: Expected Annual Loss Values, Heat Wave

Hazard Type	Building Value ($)	Population Equivalence ($)/ Population (#)	Agriculture Value
Heat Wave	$236	$321,675/ 0.03	$11

N/A- Not Applicable

EAL for the City of Angleton was derived by creating a report that used census tract information for tracts that included the Angleton city limits. These were census tracts 48039662100, 48039662200, 48039662400, 48039662300, 48039662500, 48039663100, and 48039664100.[45]

EAL according to the FEMA NRI for heat wave events for these census tracts is listed as relatively low. EAL values, risk index ratings, risk index scores, social vulnerability, and community resilience for each census tract can be found in the figures below.[45] Additionally, the FEMA NRI lists the HLR, a hazard- and county-specific estimate of the percentage of the exposed consequence type (building value, population, or agriculture value) expected to be lost due to a hazard occurrence, for heat wave within

Brazoria County is listed as very low.[46] This may change soon as the FEMA NRI data is updated and recent heat events that have occurred within the county are added to the reporting and analyzation period used by the NRI.

Figure 6.5.4: Risk Index by Census Tract, Heat Wave

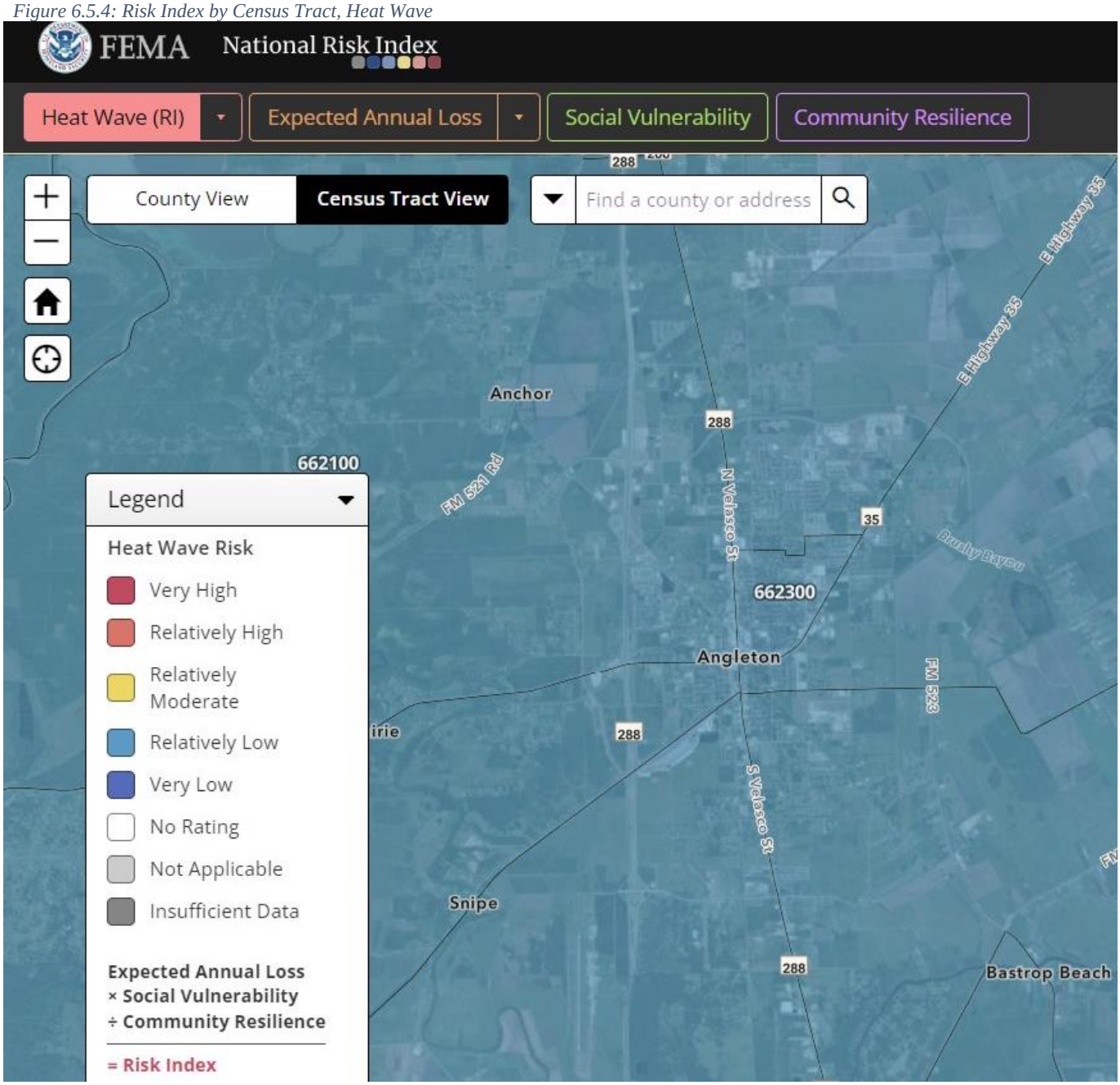


Figure 6.5.5: Social Vulnerability by Census Tract, City of Angleton

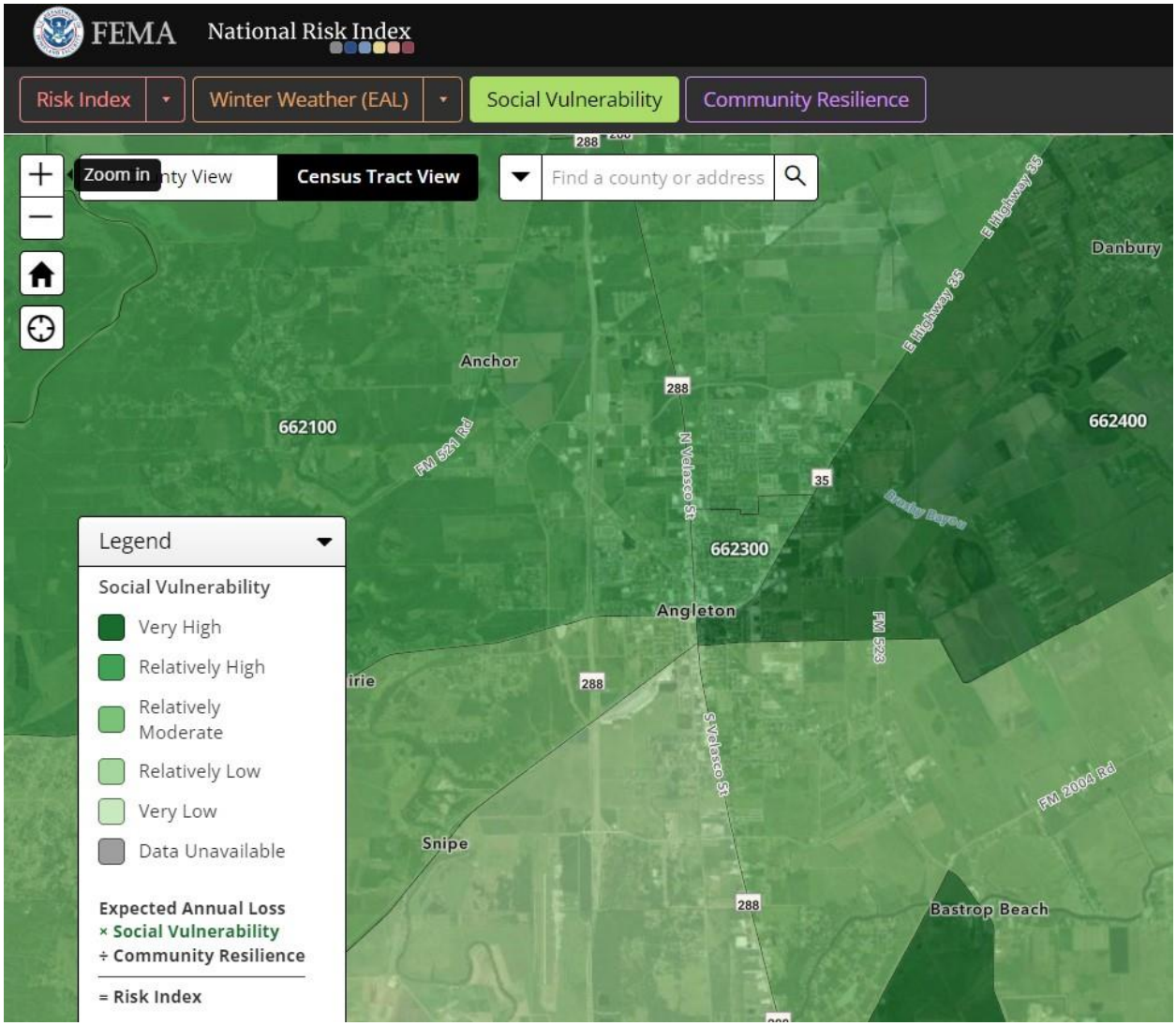


Figure 6.5.6: Community Resilience by Census Tract, City of Angleton

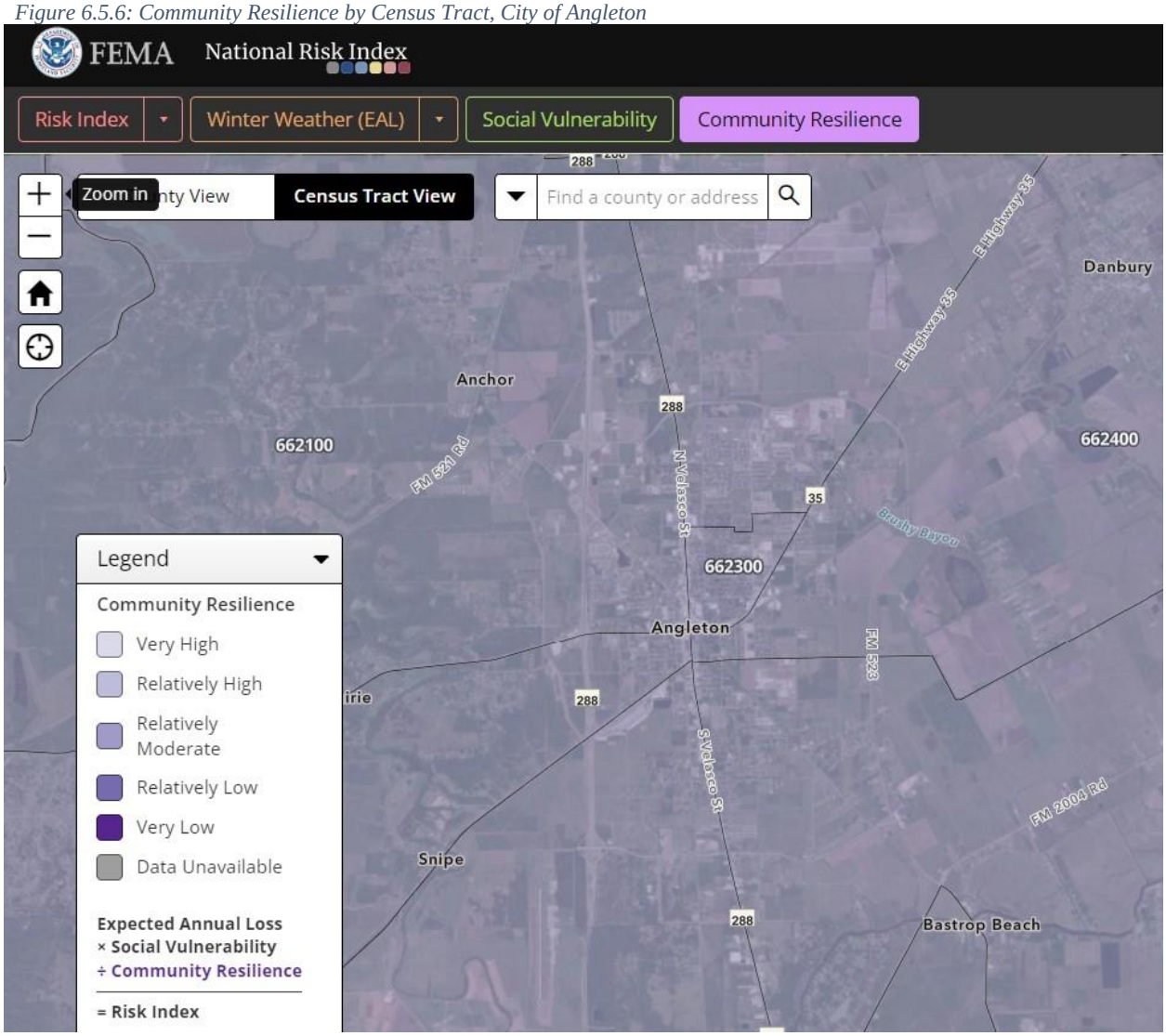


Figure 6.5.7: FEMA NRI Summary, Heat Wave

Rank	Community	State	Risk Index Rating	Risk Index Score	National Percentile
1	Census tract 48039663100	TX	Relatively Low	46.39	0 100
2	Census tract 48039662200	TX	Relatively Low	45.74	0 100
3	Census tract 48039662400	TX	Relatively Low	44.53	0 100
4	Census tract 48039662100	TX	Relatively Low	43.69	0 100
5	Census tract 48039664100	TX	Relatively Low	43.18	0 100
6	Census tract 48039662300	TX	Relatively Low	40.17	0 100
7	Census tract 48039662500	TX	Relatively Low	31.52	0 100

Rank	Community	State	EAL Value	Social Vulnerability	Community Resilience	CRF	Risk Value	Risk Index Score
1	Census tract 48039663100	TX	$7,459	Relatively Low	Relatively Moderate	1	$7,465	46.39
2	Census tract 48039662200	TX	$5,372	Relatively High	Relatively Moderate	1.34	$7,186	45.74
3	Census tract 48039662400	TX	$4,659	Very High	Relatively Moderate	1.43	$6,685	44.53
4	Census tract 48039662100	TX	$5,185	Relatively High	Relatively Moderate	1.22	$6,345	43.69
5	Census tract 48039664100	TX	$5,880	Relatively Moderate	Relatively Moderate	1.05	$6,161	43.18
6	Census tract 48039662300	TX	$3,699	Relatively High	Relatively Moderate	1.38	$5,099	40.17
7	Census tract 48039662500	TX	$2,480	Relatively Moderate	Relatively Moderate	1.12	$2,770	31.52

Climate Change Impacts

According to the Office of the Texas State Climatologist, extreme heat has recently become more frequent and more severe. For example, extreme summer heat is approaching values not seen since the early part of the 20th Century and is likely to surpass those numbers by 2036. The typical number of triple-digit days by 2036 is projected to be substantially larger, about 40%, than typical values so far in the 21st Century.[58] Additionally, with an increase in development and impervious pavement in areas the heat island effect will become more prominent in urban areas of the county. The fourth national climate assessment, an authoritative assessment of the science of climate change with a focus on the United States, notes that the annual average temperature over the contiguous U.S. increased by 1.2°F over the period 1986–2016 relative to 1901–1960. The frequency of heat waves has increased since the mid-1960s. Climate projections indicate that extreme heat events will be more frequent and intense in coming decades.[80]

Table 6.5.7: Climate Change Impacts Summary, Extreme Heat

Location	The location of extreme heat and heat events are expected to increase in urban areas of the county.
Extent/Intensity	The extent and intensity of extreme heat and heat events are expected to increase.
Frequency	The frequency of extreme heat and heat events is expected to increase.
Duration	The duration of extreme heat and heat events is expected to increase.

Section 6.6: Wildfire

6.6 Wildfire

Wildfire refers to any non-structure fire that occurs in the wildland, an area in which development is essentially nonexistent except for roads, railroads, power lines, and similar transportation or utility structures. This definition does not refer to fires that are conducted via prescribed burns.[81] Wildfires typically occur more often in the summer during dry months and can be exacerbated by droughts or drought-like conditions when plants and other brush contain less moisture and easily ignite. In Texas, nearly 85 percent of wildfires occur within two miles of a community. Wildfires can be ignited by a variety of causes from lightning strikes, downed powerlines, smoking (or improper disposal of cigarettes), debris burning, and fireworks.

Location

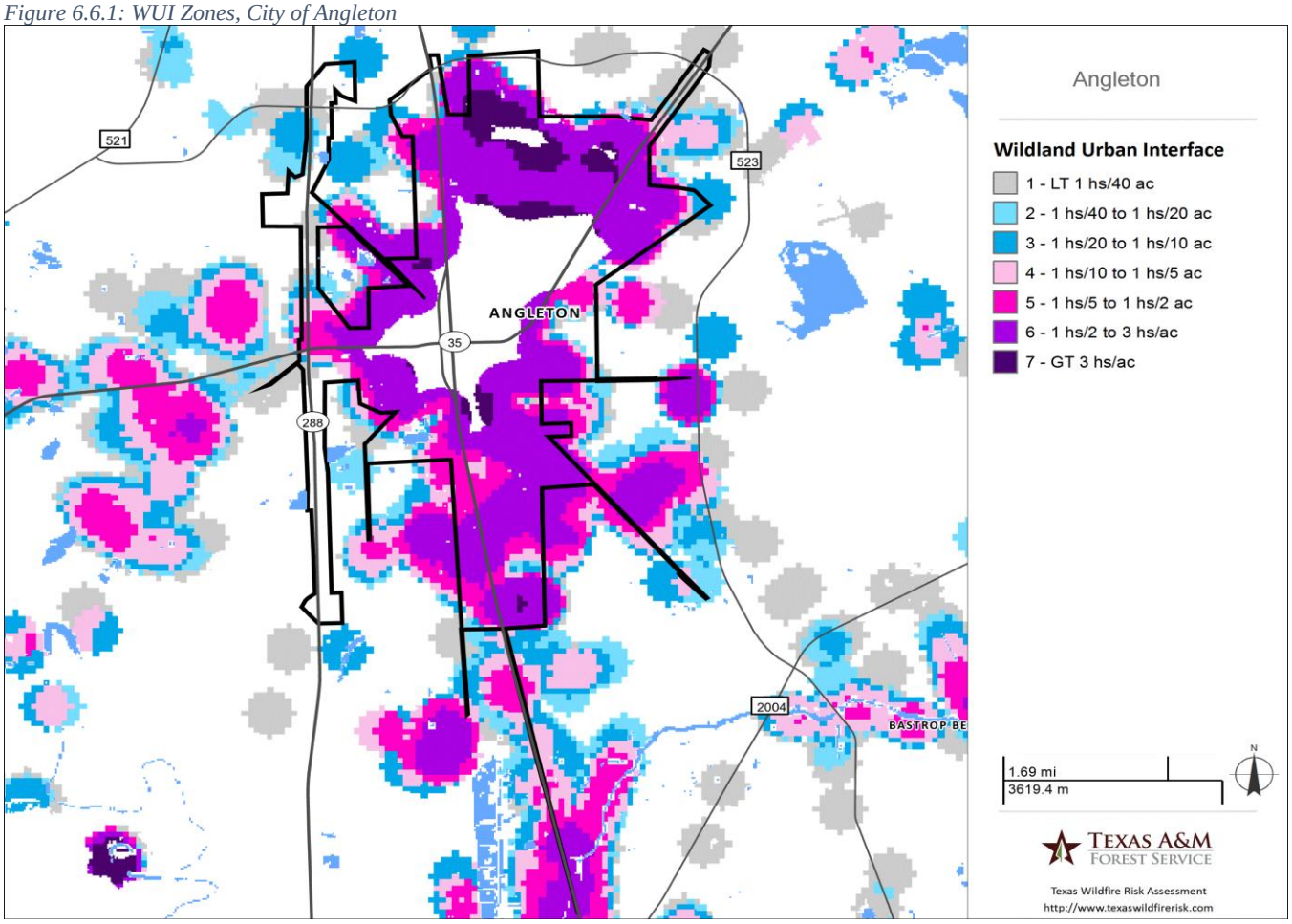
This is a reoccurring natural hazard in every Texas county and has no geographic boundary. The Texas Wildfire Risk Assessment (TWRA) Explorer is the primary mechanism for the Texas A&M Forest Service to deploy wildfire risk information and create awareness about wildfire issues across the state.[82] The Texas Wildfire Risk Assessment Portal (TxWRAP) allows users to easily view their wildfire risk online. TxWRAP uses a variety of factors such as wildfire threat, wildland urban interface, surface fuels, historic wildfire ignitions, fire behavior, and much more to determine the fire potential of specific land areas and depicts through a set of rating areas that are most prone to wildfires.[83] Particularly vulnerable are the Wildland Urban Interface (WUI) areas.

The WUI is the area where development, people, and homes, mix with areas of wildland or other vegetation. It is within these areas that wildfire risks substantially increase. With continued population growth throughout the county, the WUI zones will become more abundant. Since most wildfires are caused by human activities, the intersection of WUI and drought is particularly dangerous. Wildfires and their size can vary greatly depending on a variety of factors such as location, fire intensity, and duration. It is estimated that 6,168 people or 68.5 % percent (23,596) of residents within the City of Angleton live within the WUI. The table and Figure below depict the population and acreage in each of the WUI zones within the City of Angleton, which closely follow housing density.

Table 6.6.1: WUI Population and Acres, City of Angleton

	Housing Density	WUI Population	Percent of WUI Population	WUI Acres	Percent of WUI Acres
	LT 1hs/40ac	4	0.0 %	236	5.2 %
	1hs/40ac to 1hs/20ac	0	0.0 %	111	2.4 %
	1hs/20ac to 1hs/10ac	18	0.1 %	210	4.6 %
	1hs/10ac to 1hs/5ac	43	0.3 %	261	5.7 %
	1hs/5ac to 1hs/2ac	386	2.4 %	683	15.0 %
	1hs/2ac to 3hs/1ac	10,464	64.7 %	2,661	58.5 %
	GT 3hs/1ac	5,253	32.5 %	390	8.6 %
	Total	**16,168**	**100.0 %**	4,552	100.0 %

Figure 6.6.1: WUI Zones, City of Angleton



Extent

Characteristic Fire Intensity Scale (FIS) specifically identifies areas where significant fuel hazards and associated dangerous fire behavior potential exist based on a weighted average of four percentile weather categories. This is like the Richter scale for earthquakes. FIS provides a standard scale to measure potential wildfire intensity. FIS consists of 5 classes where the order of magnitude between classes is ten-fold. The minimum class, Class 1, represents very low wildfire intensities, and the maximum class, Class 5, represents very high wildfire intensities. The Characteristic FIS is described in the table below.

Table 6.6.2: Characteristic FIS Descriptions

	Wildfire Intensity Class	Description
	1- Very Low	Very small, discontinuous flames, usually less than 1 foot in length; very low rate of spread; no spotting. Fires are typically easy to suppress by firefighters with basic training and non-specialized equipment.
	2- Low	Small flames, usually less than two feet long; small amount of very short-range spotting possible. Fires are easy to suppress by trained firefighters with protective equipment and specialized tools.
	3- Moderate	Flames up to 8 feet in length; short-range spotting is possible. Trained firefighters will find these fires difficult to suppress without support from aircraft or engines, but dozer and plows are generally effective. Increasing potential for harm or damage to life and property.

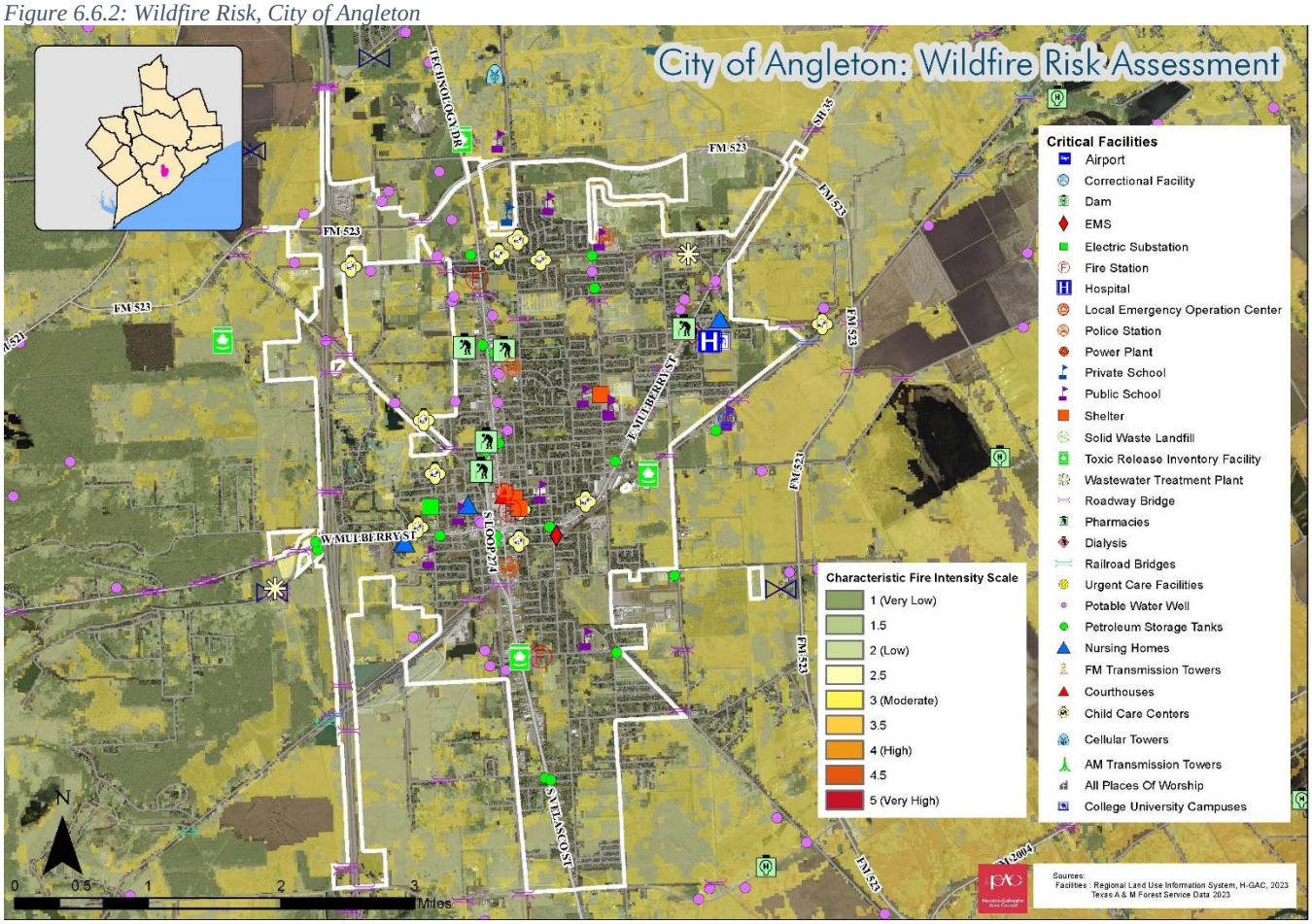
	Wildfire Intensity Class	Description
	4- High	Large Flames, up to 30 feet in length; short-range spotting common; medium range spotting possible. Direct attack by trained firefighters, engines, and dozers is generally ineffective, indirect attack may be effective. Significant potential for harm or damage to life and property.
	5- Very High	Very large flames up to 150 feet in length; profuse short-range spotting, frequent long-range spotting; strong fire-induced winds. Indirect attack marginally effective at the head of the fire. Great potential for harm or damage to life and property.

The table below show the class, acreage, and percent within each class within the City of Angleton. The figure below shows these wildfire intensity areas from TxWrap in relation to critical facilities within the city.

Table 6.6.3: Fire Intensity Scale Acreage, City of Angleton

	Class	Acres	Percent
	Non-Burnable	4,284	64.6 %
	1 (Very Low)	323	4.9 %
	1.5	168	2.5 %
	2 (Low)	1,022	15.4 %
	2.5	34	0.5 %
	3 (Moderate)	799	12.0 %
	3.5	2	0.0 %
	4 (High)	0	0.0 %
	4.5	0	0.0 %
	5 (Very High)	0	0.0 %
	Totals:	**6,632**	**100.0 %**

Figure 6.6.2: Wildfire Risk, City of Angleton



A worst-case scenario for this hazard would be a wildfire sparked during a drought or a heat event where temperatures are high, the ground and vegetation are dry, and water supplies may already be in high demand. Similar events occurring within areas bordering the city would further exacerbate the risks to life and property. Large scale events could also affect transportation and evacuation corridors, power supply, access to critical facilities, and lead to degraded air quality and health impacts. Similar events have occurred in 2022 where Brazoria County saw 7 buildings destroyed through the Damon Fire located 25 miles NW of Angleton.

Historic Occurrences

The Texas A&M Forest Service tracks wildfire events, acres destroyed, and the initial ignition cause of the fire. The table below shows the historical data associated with burns that caused recorded damage. Figure 6.6.3 shows the point location of all fire ignitions from 2005-2024, symbolized by color to depict the cause of the fire. There were no ignition points reported after 2012 for the City of Angleton.

Figure 6.6.3: Fire Ignition Points (2000-2023), City of Angleton

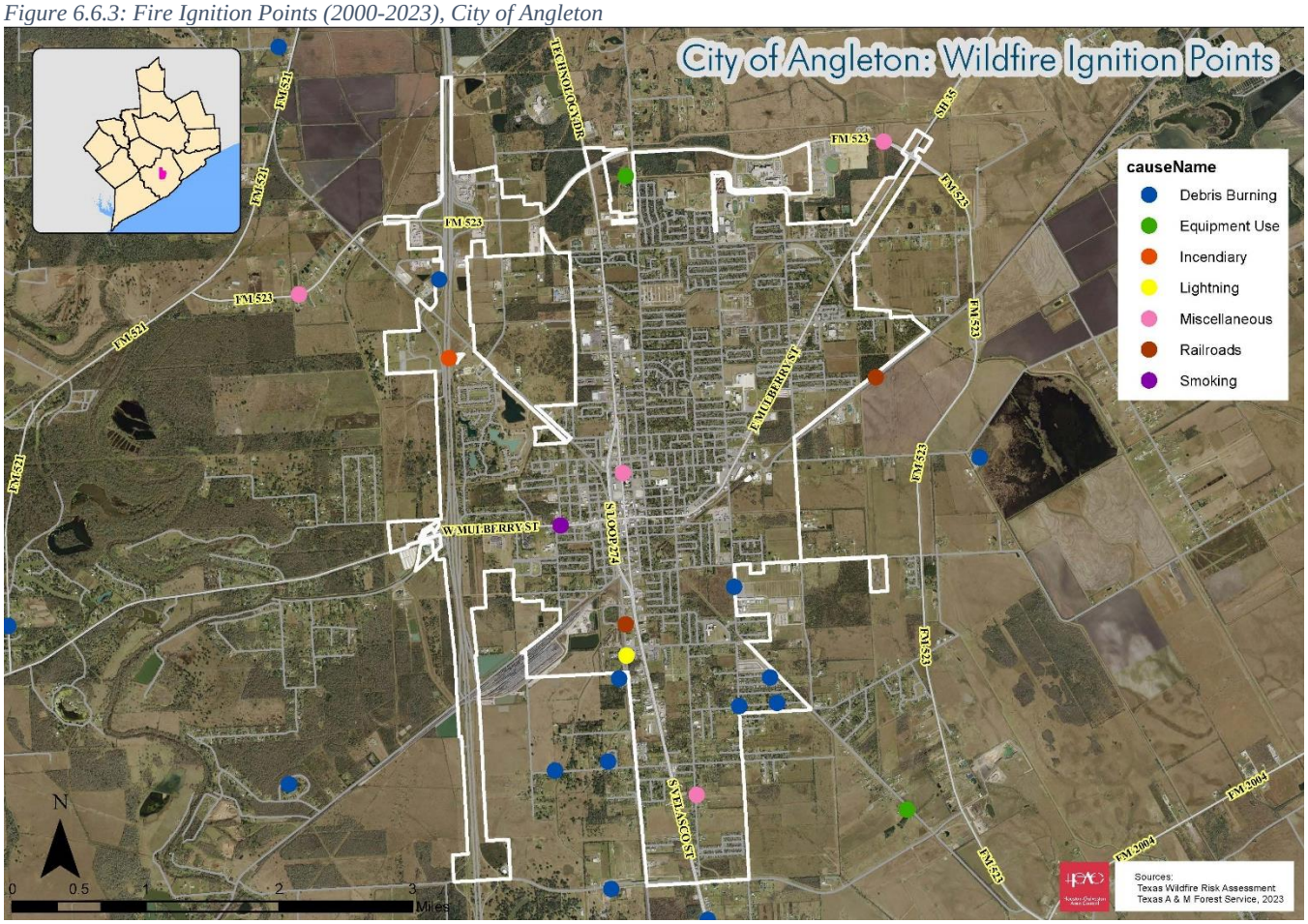
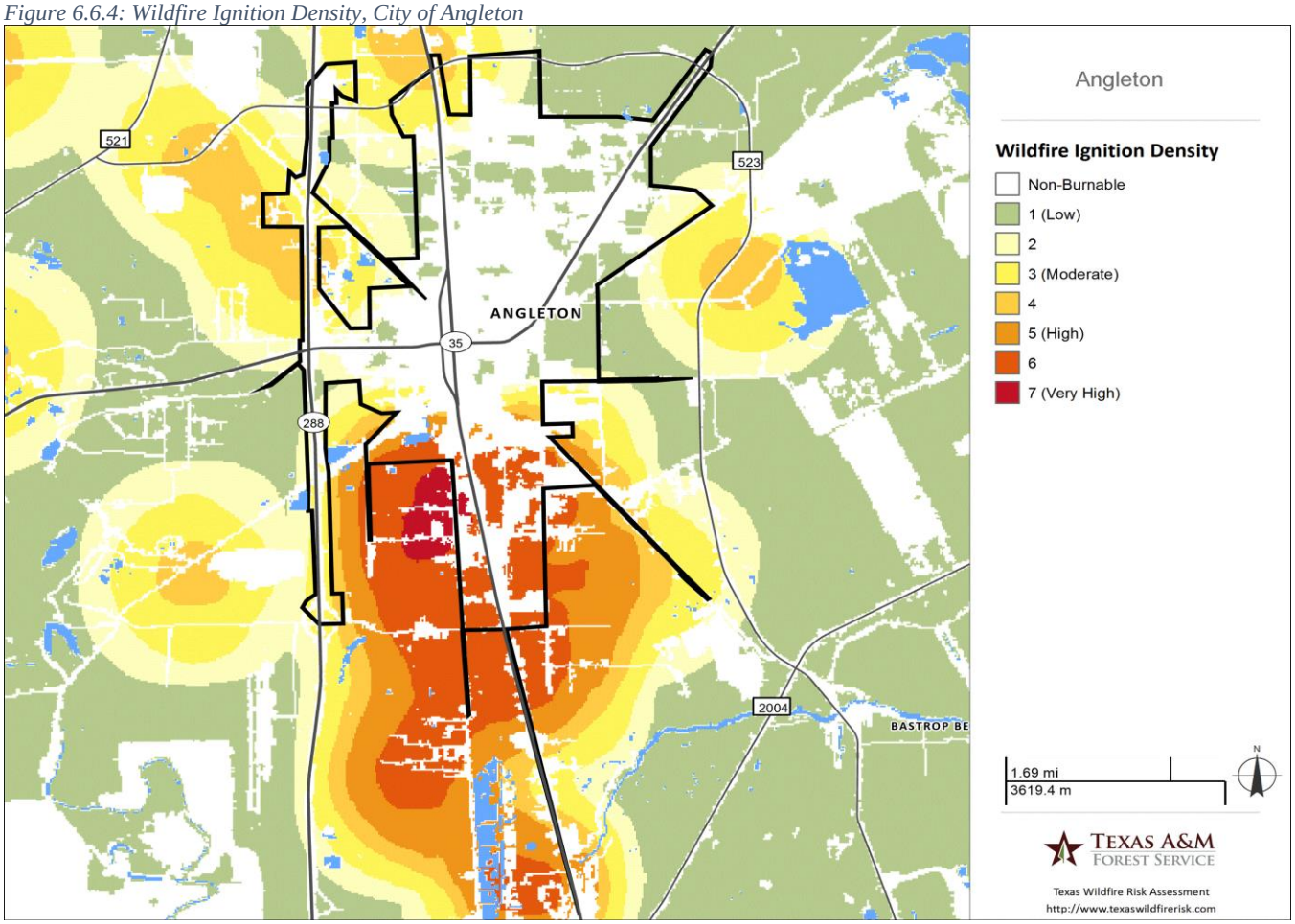


Table 6.6.4: Fire Ignition Point Causes (2005-2024)

Cause Name	Damaged Acres	Start Date
Railroads	2	1/1/2009
Debris Burning	1	1/23/2009
Debris Burning	1	1/25/2009
Incendiary	6	1/29/2009
Miscellaneous	2	1/29/2009
Miscellaneous	1	6/28/2012
Miscellaneous	1	8/3/2012
Smoking	0.1	8/29/2012
Lightning	0.1	9/23/2012
Debris Burning	2	9/26/2012

The measure of wildfire occurrence used in the TWRA is called the Wildfire Ignition Density. Wildfire Ignition Density is the likelihood of a wildfire starting based on historical ignition patterns. Occurrence is derived by modeling historic wildfire ignition locations to create an average ignition rate map. The ignition rate is measured in the number of fires per year per 1000 acres. Five years of historic fire report data was used to create the ignition points for all Texas fires. Data was obtained from federal, state and local fire department report data sources for the years 2005 to 2009. The compiled wildfire occurrence database was cleaned to remove duplicate records and to correct inaccurate locations. The database was then modeled to create a density map reflecting historical fire ignition rates. The Ignition Density map, below, is derived at a 30-meter resolution. This scale of data was chosen to be consistent with the accuracy of the primary surface fuels dataset used in the assessment. While not appropriate for site specific analysis, it is appropriate for regional, county, or local planning efforts.[84]

Figure 6.6.4: Wildfire Ignition Density, City of Angleton



Presidential Disaster Declarations

There have been 2 disaster declarations for fire/wildfire within Brazoria County, in which the City of Angleton is located, since 1953, as depicted in the table below.[1,2]

Table 6.6.5: Disaster Declarations, Wildfire

Declaration Date	Incident Type	Title	Disaster Number	Declaration Type
9/1/1999	Fire	Extreme Fire Hazards	3142	Emergency Declaration
1/11/2006	Fire	Extreme Wildfire Threat	1624	Major Disaster Declaration

USDA Disaster Declarations

The Secretary of Agriculture is authorized to designate counties as disaster areas to make EM loans available to producers suffering losses in those counties and in counties that are contiguous to a designated county. In addition to EM loan eligibility, other emergency assistance programs, such as FSA disaster assistance programs, have historically used disaster designations as an eligibility trigger. USDA Secretarial disaster designations must be requested of the Secretary of Agriculture by a governor or the governor's authorized representative, by an Indian Tribal Council leader or by an FSA SED. The Secretarial disaster designation is the most widely used. When there is a presidential disaster declaration, FEMA immediately notifies FSA of the primary counties named in a Presidential declaration. USDA Disaster Declarations for the City of Angleton since the last HMP are listed in the table below.[39]

Table 6.6.6: USDA Declared Disasters (2018-2023), Wildfire

Crop Disaster Year	Disaster Description	Designation Number
None		

Probability of Future Occurrences

As jurisdictions across the state move into wildland and increase the WUI areas, the potential for wildfires substantially increases. Wildfire probability depends on a variety of factors such as local weather conditions, topographic factors, and existing fuels within a given area (natural vegetation or wildlands). A variety of activities can spark wildfires, most of which are human induces such as camping, debris burning, and smoking can affect the number and the extent of wildfires within a given year. Wildfires can occur at any time of the year under the right conditions. Wildfires can be exacerbated by droughts, which are more likely to occur in summer months when temperatures are higher, and precipitation is less frequent. according to the FEMA NRI for drought, annualized frequency values for drought are 22.3 events per year over a 22-year period of record for Brazoria County (2000-2021), while annualized frequency values for wildfires is 0.162% chance per year based on the 2021 dataset. The probability of future occurrences of wildfires for the county per FEMA's NRI, is relatively moderate.[44]

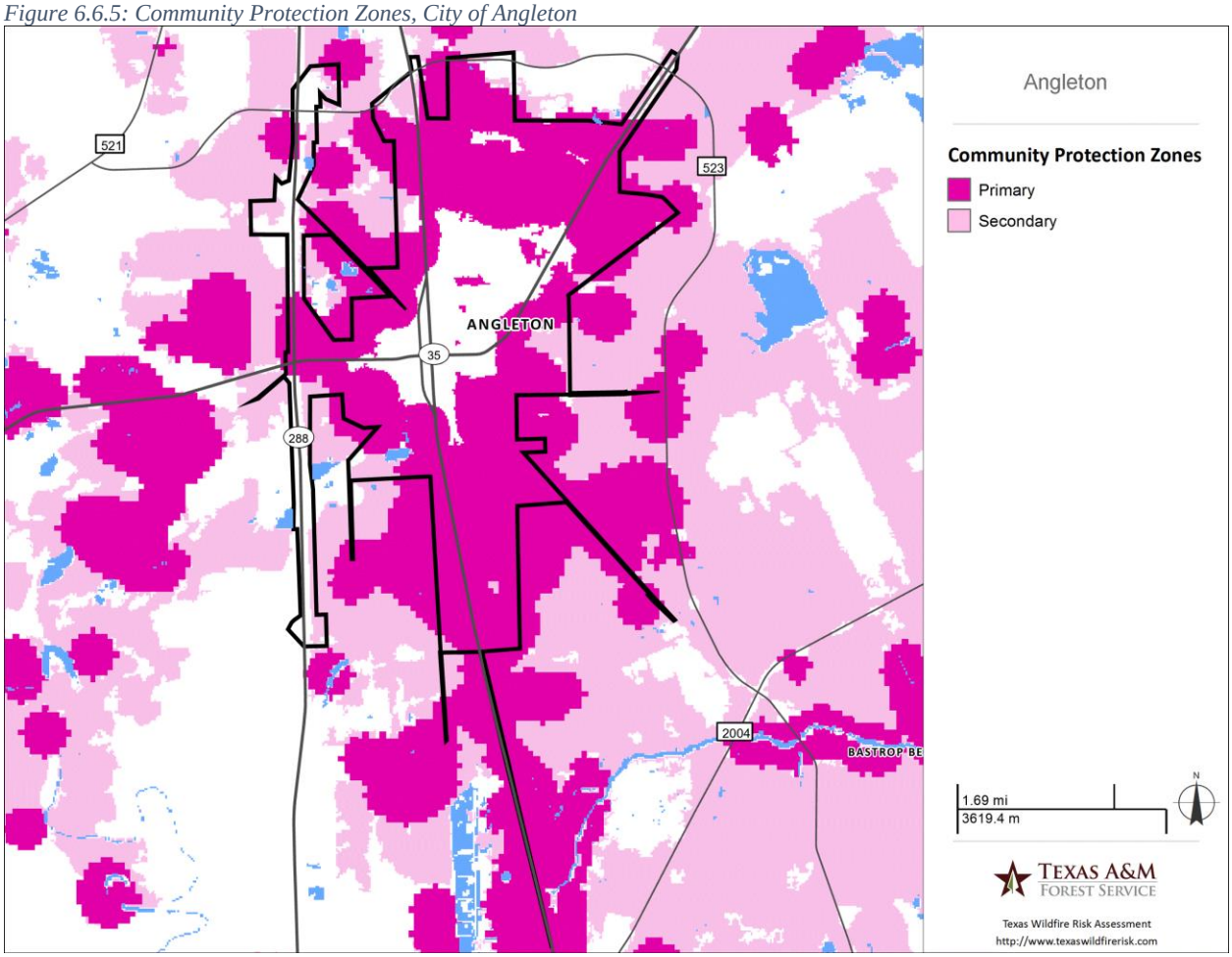
Populations at Risk

The TFS outlines Community Protection Zones (CPZ), areas that are outlined as primary and secondary and should be the highest priority for mitigation planning activities. CPZs are based on where population and housing density is highest using data regarding surrounding fire potential and fire behavior. Per the TFS "General consensus among fire planners is that for fuel mitigation treatments to be effective in reducing wildfire hazard, they must be conducted within a close distance of a community. In Texas, the WUI housing density has been used to reflect populated areas in place of community boundaries. This ensures that CPZs reflect where people are living in the wildland, not jurisdictional boundaries." The table and figure below outline these primary and secondary CPZs and their acreage within the City of Angleton.

Table 6.6.7: Community Protection Zone Acreage

Class	Acres	Percent
Primary	4,355	88.6 %
Secondary	563	11.4 %
Total	**4,918**	**100.0 %**

Figure 6.6.5: Community Protection Zones, City of Angleton



Wildfires negatively impact air quality impacting the surrounding areas and areas further away depending on how wind direction and the fire intensity distribute the smoke. This smoke exposure can put certain vulnerable populations at greater risk of adverse effects from this hazard event. According to the Environmental Protection Agency, these vulnerable populations include People with asthma and other respiratory diseases, people with cardiovascular disease, children (18 years of age or younger), pregnant people older adults, people of low socio-economic status, and outdoor workers. Underlying respiratory diseases result in compromised health status that can result in the triggering of severe respiratory responses by environmental irritants, such as wildfire smoke. Underlying circulatory diseases result in compromised health status that can result in the triggering of severe cardiovascular events by environmental irritants, such as wildfire smoke. In younger populations, children's lungs are still developing, and there is a greater likelihood of increased exposure to wildfire smoke resulting from more time spent outdoors, engagement in more vigorous activity, and inhalation of more air per pound of body weight compared to adults. Pregnancy-related physiologic changes (e.g., increased breathing rates) may increase vulnerability to environmental exposures, such as wildfire smoke. In addition, during critical development periods, the fetus may experience increased vulnerability to these exposures. In older populations, there is a higher prevalence of pre-existing lung and heart disease and decline of physiologic process, such as defense mechanisms. This can lead to exacerbation of heart and lung diseases can lead to emergency department visits, hospital admissions, and even death. Those of low socioeconomic status are vulnerable to these types of hazards as they have less access to health care which could lead to higher likelihood of untreated or insufficient treatment of underlying health conditions (asthma, diabetes), and greater exposure to wildfire smoke resulting from less access to measures to reduce exposure such as air conditioning. Outdoor workers can be more vulnerable to this hazard due to increased exposure of smoke.[85]

This hazard has no set geographic boundaries. As the population and future developments in the city grow, so too will the risk of people and properties to this hazard. As seen in the City's Future Residential Development Map (Figure 3.9), many of these areas for future development fall within the primary CPZ class as seen in Figure 6.6.5.

National Risk Index

FEMA's NRI utilizes data from multiple sources including historical hazard events, hazard intensity, exposure of people and property to hazards, socioeconomic factors, and community resilience indicators. The NRI also incorporates hazard data to determine the frequency and intensity of various natural hazards. This information helps assess the likelihood of specific hazards occurring in different regions.[44]

The NRI considers the exposure of communities to hazards and incorporates factors such as population density, infrastructure systems, and critical facilities that may be at risk during a hazard event. The NRI also generates risk scores for communities across the U.S. that provide a relative ranking of areas based on their overall risk level. This helps to identify areas that may require additional resources and attention for mitigation and planning efforts. The NRI risk equation includes 3 components. EAL represents the average economic loss in dollars resulting from natural hazards each year, the Community Risk Factor is a scaling factor that incorporates social vulnerability (the susceptibility of social groups to the adverse impacts of natural hazards), and community resilience (the ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions). The outcome, the risk index, represents the potential negative impacts of natural hazards on the county level or individually by census tracts. The NRI EAL score and rating, represent a community's relative level of expected loss each year when compared to all other communities at the same level.[44]

EAL Exposure Values and EAL Values for Brazoria County can be found in the tables below.

Table 6.6.8: Expected Annual Loss Exposure Values, Wildfire

Hazard Type	Building Value ($)	Population Equivalence ($)/ Population (#)	Agricultural Value ($)	EAL Total ($)
Wildfire	$3,126,143,435	$215,215,491,648/ 18,553.06	$6,997,533	$218,348,632,616

Table 6.6.9: Expected Annual Loss Values, Wildfire

Hazard Type	Building Value ($)	Population Equivalence ($)/ Population (#)	Agriculture Value
Wildfire	$950,240	$99,306/ 0.01	$370

N/A- Not Applicable

EAL for the City of Angleton was derived by creating a report that used census tract information for tracts that included the Angleton city limits. These were census tracts 48039662100, 48039662200, 48039662400, 48039662300, 48039662500, 48039663100, and 48039664100.[45]

EAL according to the FEMA NRI for wildfire events for these census tracts is listed as relatively moderate, with one tract rating relatively high and one rating relatively low. EAL values, risk index ratings, risk index scores, social vulnerability, and community resilience for each census tract can be found in the figures below. Additionally, the FEMA NRI lists the HLR, a hazard- and county-specific estimate of the percentage of the exposed consequence type (building value, population, or agriculture value) expected to be lost due to a hazard occurrence, for wildfire within Brazoria County is listed as very low.[46]

Figure 6.6.6: Risk Index by Census Tract, Wildfire

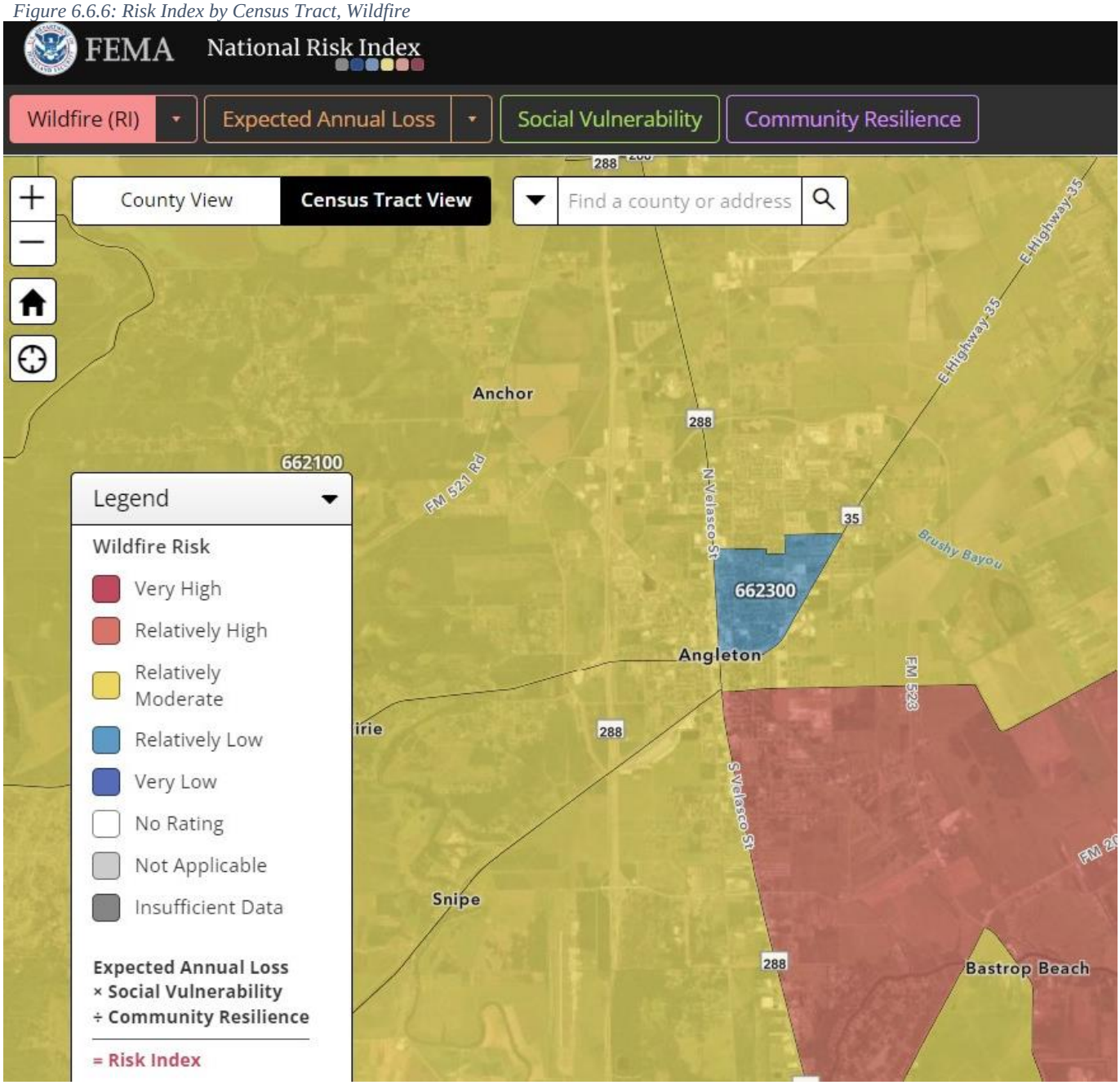


Figure 6.6.7: Social Vulnerability by Census Tract, City of Angleton

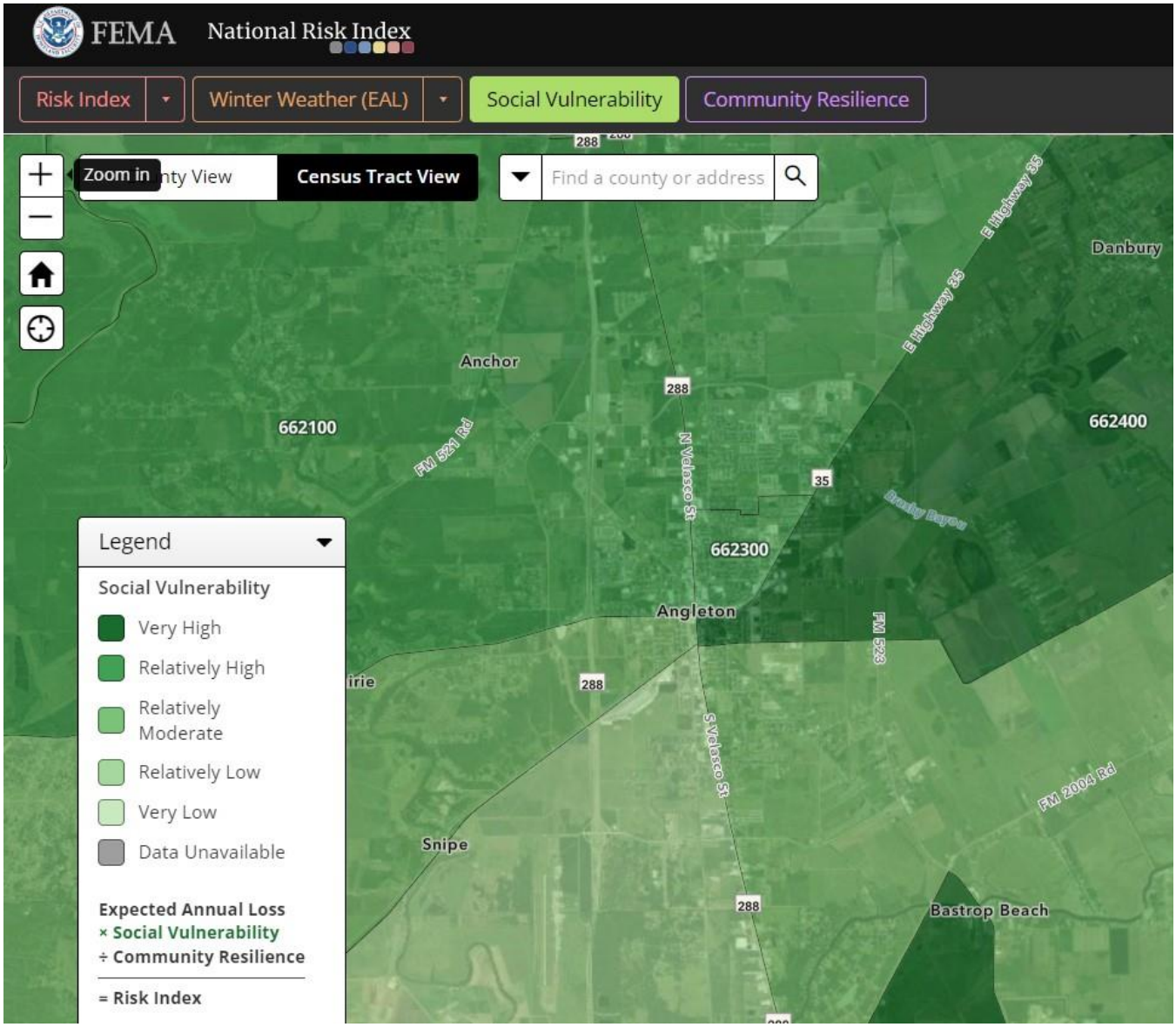


Figure 6.6.8: Community Resilience by Census Tract, City of Angleton

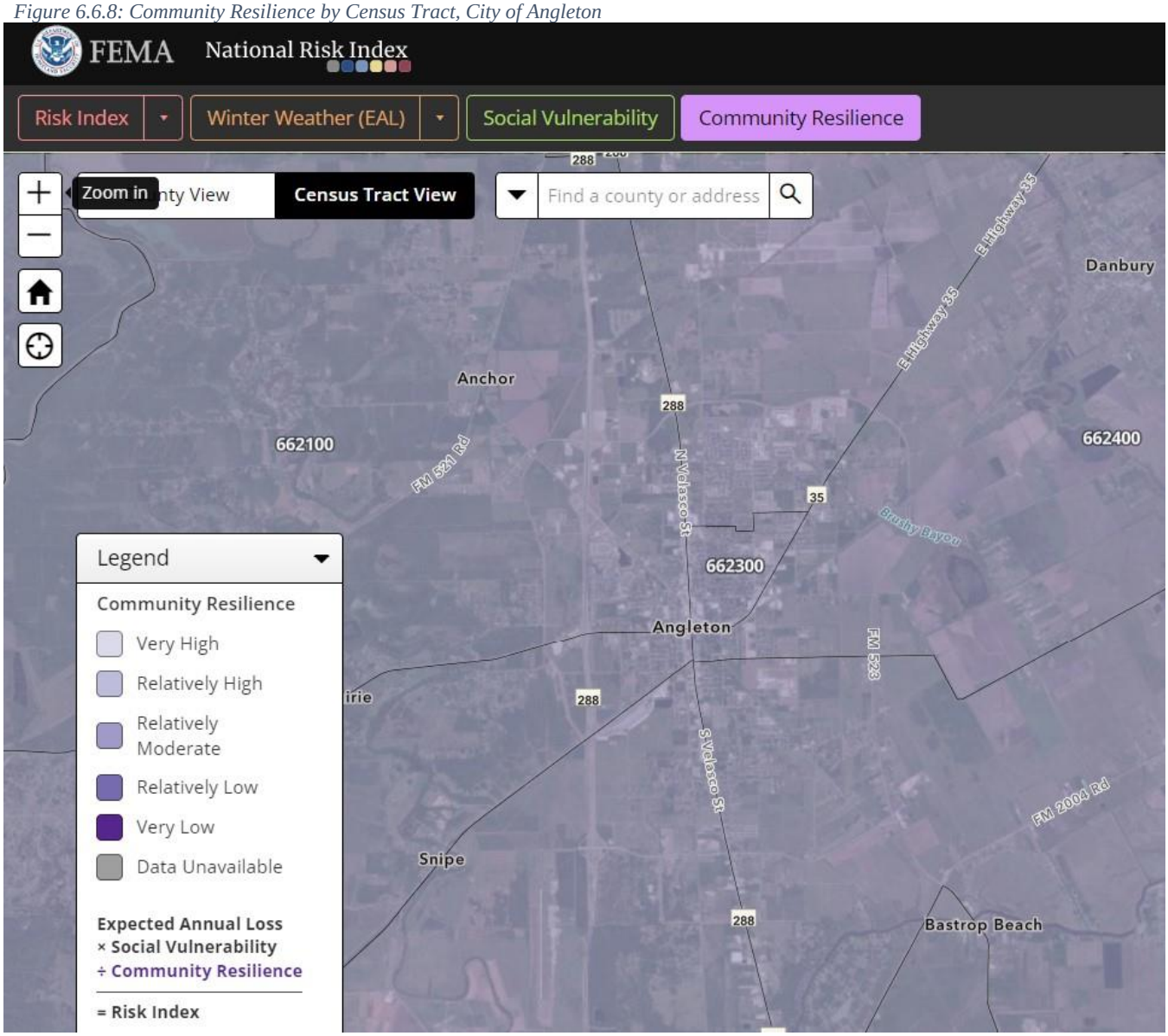


Figure 6.6.9: FEMA NRI Summary, Wildfire

Rank	Community	State	Risk Index Rating	Risk Index Score	National Percentile
1	Census tract 48039664100	TX	Relatively High	96.61	0 100
2	Census tract 48039662400	TX	Relatively Moderate	91.8	0 100
3	Census tract 48039662100	TX	Relatively Moderate	91.48	0 100
4	Census tract 48039662200	TX	Relatively Moderate	89.74	0 100
5	Census tract 48039663100	TX	Relatively Moderate	89.63	0 100
6	Census tract 48039662500	TX	Relatively Moderate	85.48	0 100
7	Census tract 48039662300	TX	Relatively Low	82.69	0 100

Rank	Community	State	EAL Value	Social Vulnerability	Community Resilience	CRF	Risk Value	Risk Index Score
1	Census tract 48039664100	TX	$238,969	Relatively Moderate	Relatively Moderate	1.05	$250,422	96.61
2	Census tract 48039662400	TX	$40,817	Very High	Relatively Moderate	1.43	$58,566	91.8
3	Census tract 48039662100	TX	$44,275	Relatively High	Relatively Moderate	1.22	$54,176	91.48
4	Census tract 48039662200	TX	$26,570	Relatively High	Relatively Moderate	1.34	$35,539	89.74
5	Census tract 48039663100	TX	$34,568	Relatively Low	Relatively Moderate	1	$34,597	89.63
6	Census tract 48039662500	TX	$12,653	Relatively Moderate	Relatively Moderate	1.12	$14,131	85.48
7	Census tract 48039662300	TX	$5,669	Relatively High	Relatively Moderate	1.38	$7,813	82.69

Climate Change Impacts

Wildfires are often a natural phenomenon and part of the normal cycle of the natural environment that help keep ecosystems healthy. Weather conditions often affect the duration of a wildfire and how it will gro. These factors are lower precipitation, high temperatures, wind, and more.[86] Wildfires are more likely to occur during summer months and during periods of drought. According to the Office of the Texas State Climatologist, drivers of wildfire risk are projected to increase the risk of wildfires throughout the state, primarily due to increased rates of drying and increased fuel load.[58]

Table 6.6.10: Climate Change Impacts, Wildfire

Location	The location of wildfires is not expected to change. Areas within or near the WUI are at the greatest risk.
Extent/Intensity	The extent and intensity of wildfires within the county may change (increase) due to rising surface temperatures, heat events, and increases in drought severity.
Frequency	Weather and other factors that lead to wildfires are expected to increase throughout the state, thus the frequency of wildfires is expected to increase.
Duration	There is no clear trend regarding the duration of wildfire events.

Section 6.7: Drought & Expansive Soils

6.7 Drought & Expansive Soils

The NWS defines drought as "A deficiency of moisture that results in adverse impacts on people, animals, or vegetation over a sizeable area." The American Meteorological Survey defines drought as "A period of abnormally dry weather sufficiently long enough to cause a serious hydrological imbalance."[87] Drought can have several different classifications for monitoring purposes. Table 6.7.1 below outlines these classifications and their definitions.

Table 6.7.1: Drought Classifications

Drought Classification	Definition
Meteorological	When dry weather patterns dominate an area.
Hydrological	When low water supply becomes evident in the water system.
Agricultural	When crops become affected by drought.
Socioeconomic	When the supply and demand of various commodities is affected by drought.
Ecological	When natural ecosystems are affected by drought.

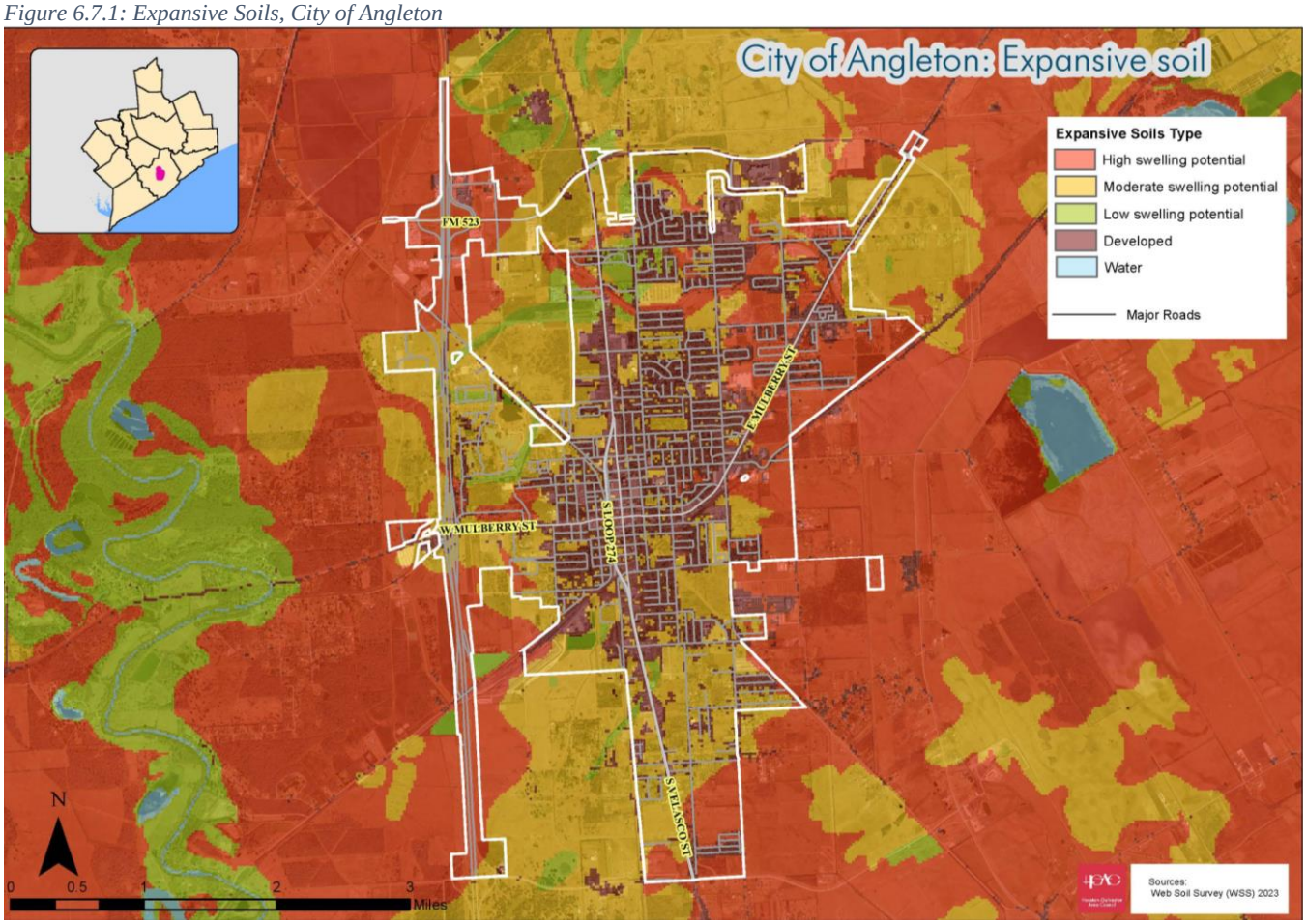
Expansive or swelling soils are soils intertwined with layers of various clay particles that can absorb large quantities of water. Changes in precipitation or other moisture conditions cause these soils to shrink and swell. They can expand up to 20% by volume when exposed to water and exert a force of up to 30,000 pounds per square foot, enough to break up any structure they encounter. Expansive soils are one of the nation's most prevalent causes of damage to buildings and construction. Annual losses are estimated in the billions of dollars. Losses include severe structural damage, cracked driveways, cracked or upheaval in sidewalks, slab on grade foundations, roads, and highway structures, which can lead to the condemnation of buildings and disruption of pipelines and sewer lines. The destructive forces of these soils may be upward, horizontal, or both, and can be exacerbated by drought conditions.[88] For this plan update, drought & expansive soils are included in the same hazard profile as they directly correlate to greater losses and risk for the county.

Location

Drought can lead to a wide range of impacts on agriculture, public health, water quality, ecosystems, transportation, and wildfire risk. This is a reoccurring natural hazard in every Texas county and has no geographic boundary. Droughts are also difficult to predict and monitor as the effects vary from region to region.[89] The entire planning area, the City of Angleton, and its residents are susceptible to drought and its associated primary and secondary impacts.

Similarly, expansive soils pose a greater risk during times of drought followed by heavy rainfall and periods of dryness. The figure below shows the differences for expansive soil hazard impacts within the planning area via their shrink-swell potentials within the City of Angleton and outside the city limits. Areas with high shrink-swell potential are more at risk than those with low shrink-swell potential.

Figure 6.7.1: Expansive Soils, City of Angleton



The chart below shows the Linear Extensibility Percent (LEP) and Coefficient of Linear Extent (COLE) to show the Shrink-Swell Class of expansive soils. COLE is a test frequently used to characterize expansive soils. COLE is a measure expressed as a fraction of the change in a soil sample dimension from the moist to dry state. The LEP is a measure expressed as a percentage of the change in a soil sample dimension from the moist to dry state. The Shrink-Swell Class is found in comparing these two measurements. A Moderate to Very High rating marks soils that have the potential to contract and expand, leading to damage to critical infrastructure, foundations, and transportation structures. The city is located almost entirely within areas that have soil with moderate and high shrink-swell potential. A visual depiction of these soils and their shrink-swell class can be seen in Figure 6.7.1 above.

Table 6.7.2: Linear Extensibility Percent & Coefficient of Linear Extent for Expansive Soils

Shrink-Swell Class	Linear Extensibility Percent	Coefficient of Linear Extent
Low	3	0.03
Moderate	3 to 6	.03-.06
High	6 to 9	.06-.09
Very High	Greater than or equal to 9	Greater than or equal to 0.09

Extent

The U.S. Drought Monitor (USDM) is a map that is updated each Thursday to show the location and intensity of drought across the country. The USDM uses a five-category system to classify levels of drought. These categories, seen in the figure below, 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.[90] Abnormally Dry (D0) shows areas that may be going into or are coming out of drought conditions, while the remaining four categories characterize levels of drought (D1–D4).

Figure 6.7.2: Drought Monitor Categories

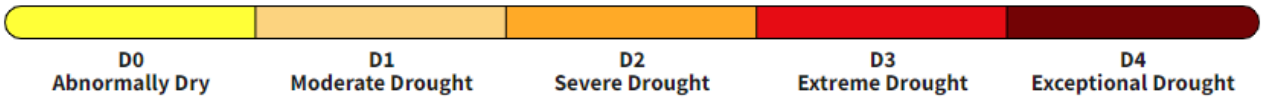
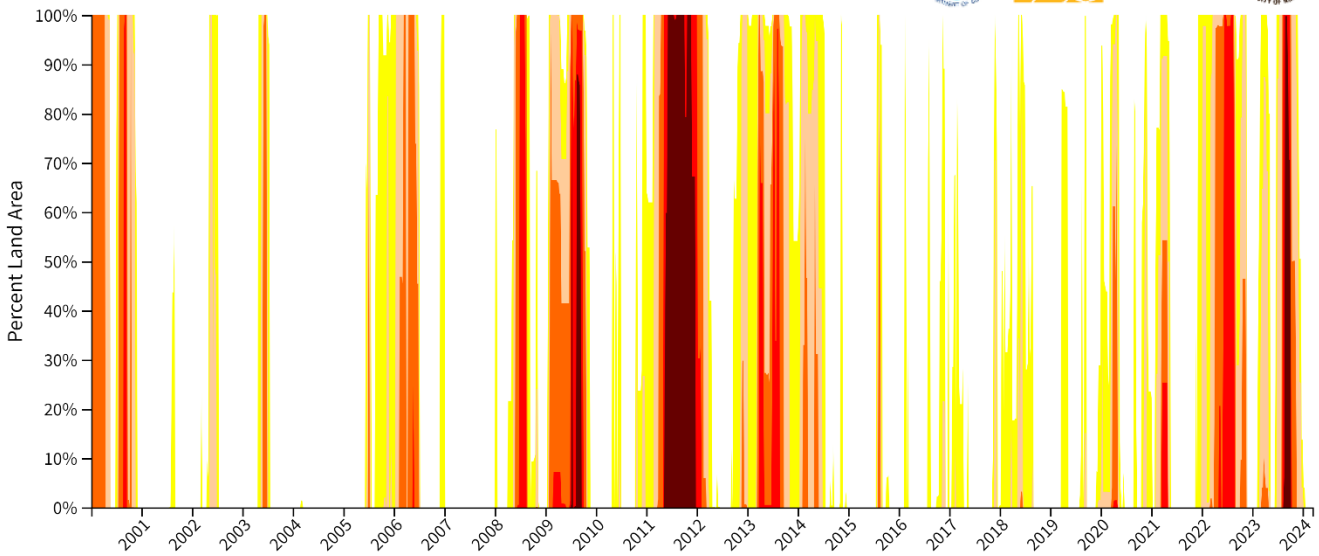


Figure 6.7.3 shows the USDM Drought Categories for Brazoria County, of which the City of Angleton is located, since the year 2000. The risk of drought occurring applies the same to the entire county. There are no known factors that make one area or community more prone to drought events than another.

The extent and intensity of drought and associated risks from expansive soils within the county may increase due to increased precipitation and stronger storms which can lead to an increase in flooding events and rising surface temperatures, heat events, and increases in drought severity.

However, drought can adversely impact individuals employed in agriculture and natural resources over other industries. Severe droughts can also lead to crop and livestock losses, impacting the food supply and economy.[91] Extreme (D3) drought conditions result in multiple sectors of the economy experiencing some level of financial burden, dry and cracked soil that leads to greater crop and livestock losses, and severe fish, plant, and wildlife loss due to low soil moisture and surface water levels and impacted air quality from increased dust and sandstorms. Exceptional drought (D4) impacts can see water levels at historic lows leading to water shortages, exceptional and widespread crop and livestock losses, widespread tree mortality, water sanitation and water quality concerns, extreme wildfire risks, and significant financial losses within the forestry, tourism, and agricultural sectors.[92]

Figure 6.7.3: U.S. Drought Monitor for the City of Angleton (2000-2024)



For the City of Angleton, the worst-case scenario for drought would include a prolonged period of drought within the D3 to D4, extreme and exceptional drought, categories. This is similar to what occurred in 2011-2012, and more recently in 2022-2023. Regarding expansive soils, a worst-case scenario for this hazard would be these unique soils shifting and causing foundation and infrastructure damage to underground pipes. Expansive soil risks are exacerbated during a drought, when temperatures are high, and rainfall is scarce.

Historic Occurrences

NOAA collects historic climate data for the entire nation. NOAA's storm event data can be accessed on the NCEI Storm Events Database. These events are shown at the county level with some referencing a specific location, city, or zone. The database currently contains data from January 1950 to December 2023, as entered by NOAA's NWS. Due to changes in the data collection and processing procedures over time, there are unique periods of record available depending on the event type. The table below highlights events for this hazard that have occurred within Brazoria County from 1950-2023.[38]

Table 6.7.3: Brazoria County Drought Events (1950-2023)

Event Date	Event Type	Injuries	Fatalities	Property Damage ($)	Crop Damage ($)
4/1/1996	Drought	0	0	$-	$-
5/1/1996	Drought	0	0	$-	$-
6/1/1996	Drought	0	0	$-	$-
5/1/1998	Drought	0	0	$-	$-
6/1/1998	Drought	0	0	$-	$-
7/1/1998	Drought	0	0	$-	$-
8/1/1998	Drought	0	0	$1,000,000	$7,300,000
8/1/2000	Drought	0	0	$-	$-
9/1/2000	Drought	0	0	$-	$-
4/5/2022	Drought	0	0	$-	$-
4/5/2022	Drought	0	0	$-	$-
4/26/2022	Drought	0	0	$-	$-
5/1/2022	Drought	0	0	$-	$-
5/1/2022	Drought	0	0	$-	$-
5/1/2022	Drought	0	0	$-	$-
5/1/2022	Drought	0	0	$-	$-
6/1/2022	Drought	0	0	$-	$-
6/1/2022	Drought	0	0	$-	$-
6/1/2022	Drought	0	0	$-	$-
7/1/2022	Drought	0	0	$-	$-
7/1/2022	Drought	0	0	$-	$-
8/1/2022	Drought	0	0	$-	$-
8/1/2022	Drought	0	0	$-	$-
9/1/2023	Drought	0	0	$-	$-
9/1/2023	Drought	0	0	$-	$-
9/1/2023	Drought	0	0	$-	$-
10/1/2023	Drought	0	0	$-	$-
10/1/2023	Drought	0	0	$-	$-
10/1/2023	Drought	0	0	$-	$-

In 2022, many areas within the region experienced water main and other piping breaks during a period of drought that caused soils to dry up and begin to shift underground. This led to higher level water restrictions for many areas while city staff attempted to make repairs.

Historic occurrences of expansive soils and related damages are not currently tracked or documented in any dataset from local, state, or national levels. This is due to the unique nature of this hazard happening gradually over time. Damages to homeowners and business owners are typically discovered when repairs or mitigation needs to be made. The costs for these repairs are shouldered by the individuals when damage is discovered. Though the effects and extent of expansive soils have been studied over a great period, there is no system in place and no future tracking method for these damages or associated costs.[63] There is no way to quantify or show historic occurrences of this hazard. This has been noted as a data deficiency and is addressed within Section 7: Mitigation Action Plan as an action item (A5).

Presidential Disaster Declarations

Presidential major disaster declarations, which must be requested of the President by a governor, are administered through FEMA. A Presidential major disaster declaration can be made within days or hours of the initial request. There have been no federally declared drought disasters for drought within the county since 1950.[1,2]

USDA Disaster Declarations

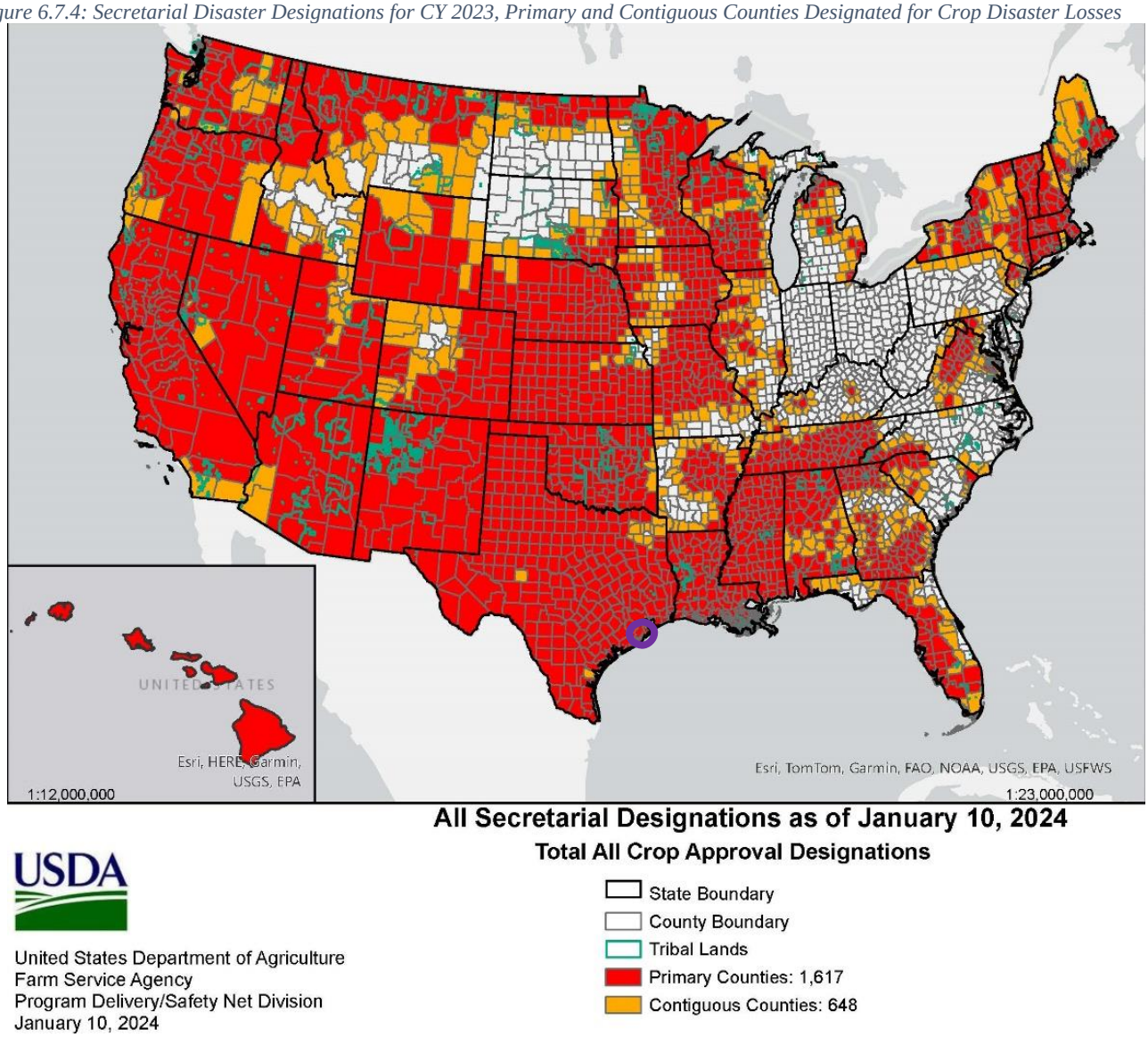
The Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency EM loans available to producers suffering losses in those counties and in counties that are contiguous to a designated county. In addition to EM loan eligibility, other emergency assistance programs, such as FSA disaster assistance programs, have historically used disaster designations as an eligibility trigger. USDA Secretarial disaster designations must be requested of the Secretary of Agriculture by a governor or the governor's authorized representative, by an Indian Tribal Council leader, or by an FSA SED. The Secretarial disaster designation is the most widely used. When there is a presidential disaster declaration, FEMA immediately notifies FSA of the primary counties named in a Presidential declaration. USDA Disaster Declarations for Brazoria County since 2018 are listed in the table below.[39]

Table 6.7.4: USDA Declared Disasters (2018-2023), Drought

Crop Disaster Year	Disaster Description	Designation Number
2020	Drought-FAST TRACK	S4654
2020	Drought-FAST TRACK	S4669
2021	Drought-FAST TRACK	S4932
2022	Drought-FAST TRACK	S5188
2022	Drought-FAST TRACK	S5197
2022	Drought-FAST TRACK	S5209
2022	Drought-FAST TRACK	S5214
2023	Drought-FAST TRACK	S5499

Figure 6.7.4 below displays counties declared primary (red) or contiguous (orange) disaster counties, where producers may be eligible for emergency aid. Brazoria is listed as a primary county for CY 2023 and is outlined in purple.

Figure 6.7.4: Secretarial Disaster Designations for CY 2023, Primary and Contiguous Counties Designated for Crop Disaster Losses



Probability of Future Occurrences

Droughts are more likely to occur in summer months when temperatures are higher, and precipitation is less frequent. according to the FEMA NRI for drought, annualized frequency values for drought are 22.3 events per year over a 22-year period of record (2000-2021).[44] There have been 770 reports of drought for the county during this period of record. There are no clear trends in the probability of future occurrences of drought, according to the Office of the Texas State Climatologist. However, droughts are expected to increase in severity.

Impacts from expansive soils are directly associated with both drought and flooding hazards within the planning area. As stated above, expansive soil impacts happen gradually over time and impacts often go unnoticed until there is damage to address or mitigate. As such, expansive soil hazards are unique as there is no distinct beginning and end for the hazard and its impacts. Expansive soils will impact locations within the planning area every year. The probability of future occurrences of expansive soils are based on climatic shifts and follow that of drought, thunderstorms, and flooding.

Populations at Risk

Populations most at risk, or that may be disproportionately affected by drought impacts according to the National Integrated Drought Information System are people with chronic health conditions or respiratory illnesses, people with compromised immune systems, and people with mental health or mood disorders. Drought impacts on public health include changes in air quality, changes in water quality and quantity, increased incidence of illness and disease, and mental health effects. Air quality can decrease during drought events because of dust storms or wildfires. Particulates in the air irritate the lungs and bronchial passages and exacerbate chronic respiratory conditions. Drought conditions can also put those with compromised immune systems at risk as drought conditions can change how often and where certain diseases occur. Mosquitoes that carry West Nile virus can move to new locations when water bodies become stagnant and create new breeding grounds. There is also a higher risk for contracting a lung infection called Valley Fever, caused by a fungus in the soil, in dry and dusty soil conditions. Complex relationships between drought and its associated economic consequences can increase mood disorders, domestic violence, and suicide.[93]

National Risk Index

FEMA's NRI utilizes data from multiple sources including historical hazard events, hazard intensity, exposure of people and property to hazards, socioeconomic factors, and community resilience indicators. The NRI also incorporates hazard data to determine the frequency and intensity of various natural hazards. This information helps assess the likelihood of specific hazards occurring in different regions.[44]

The NRI considers the exposure of communities to hazards and incorporates factors such as population density, infrastructure systems, and critical facilities that may be at risk during a hazard event. The NRI also generates risk scores for communities across the U.S. that provide a relative ranking of areas based on their overall risk level. This helps to identify areas that may require additional resources and attention for mitigation and planning efforts. The NRI risk equation includes 3 components. EAL represents the average economic loss in dollars resulting from natural hazards each year, the Community Risk Factor is a scaling factor that incorporates social vulnerability (the susceptibility of social groups to the adverse impacts of natural hazards), and community resilience (the ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions). The outcome, the risk index, represents the potential negative impacts of natural hazards on the county level or individually by census tracts. The NRI EAL score and rating, represent a community's relative level of expected loss each year when compared to all other communities at the same level.[44]

EAL Exposure Values and EAL Values for Brazoria County for drought can be found below.

Table 6.7.5: Expected Annual Loss Exposure Values, Drought

Hazard Type	Building Value ($)	Population Equivalence ($)/ Population (#)	Agricultural Value ($)	EAL Total ($)
Drought	N/A	N/A	$44,293,143	$44,293,143

N/A- Not Applicable

Table 6.7.6: Expected Annual Loss Values, Drought

Hazard Type	Building Value ($)	Population Equivalence ($)/ Population (#)	Agriculture Value
Drought	N/A	N/A	$305,509

N/A- Not Applicable

Expansive soils are not included in the NRI. However, businesses and residents can be impacted by expensive financial costs to repair foundations and water lines for public facilities. School districts, homeowners, and business owners could also be impacted by broken pipes, cracked foundations, and other structural costly repairs caused by expanding and contracting soils. Pipes in critical facilities may also lead to a loss of service, or damaged roads/bridges can increase response time for emergency personnel. While newer buildings can be impacted; older buildings including critical facilities and homes are more likely to be impacted due to older buildings being exposed to numerous weather events and seasons, having building standards that do not take expansive soils into account, and the lack of engineering solutions to mitigate expansive soils used in the past.

EAL for the City of Angleton was derived by creating a report that used census tract information for tracts that included the Angleton city limits. These were census tracts 48039662100, 48039662200, 48039662400, 48039662300, 48039662500, 48039663100, and 48039664100.[45]

EAL according to the FEMA NRI for drought events for these census tracts is listed as relatively low, with two tracts rating relatively moderate and one with no rating. EAL values, risk index ratings, risk index scores, social vulnerability, and community resilience for each census tract can be found in the figures below.[44] Additionally, the FEMA NRI lists the HLR, a hazard- and county-specific estimate of the percentage of the exposed consequence type (building value, population, or agriculture value) expected to be lost due to a hazard occurrence, for drought within Brazoria County is listed as very low.[46]

Figure 6.7.5: Risk Index by Census Tract, Drought

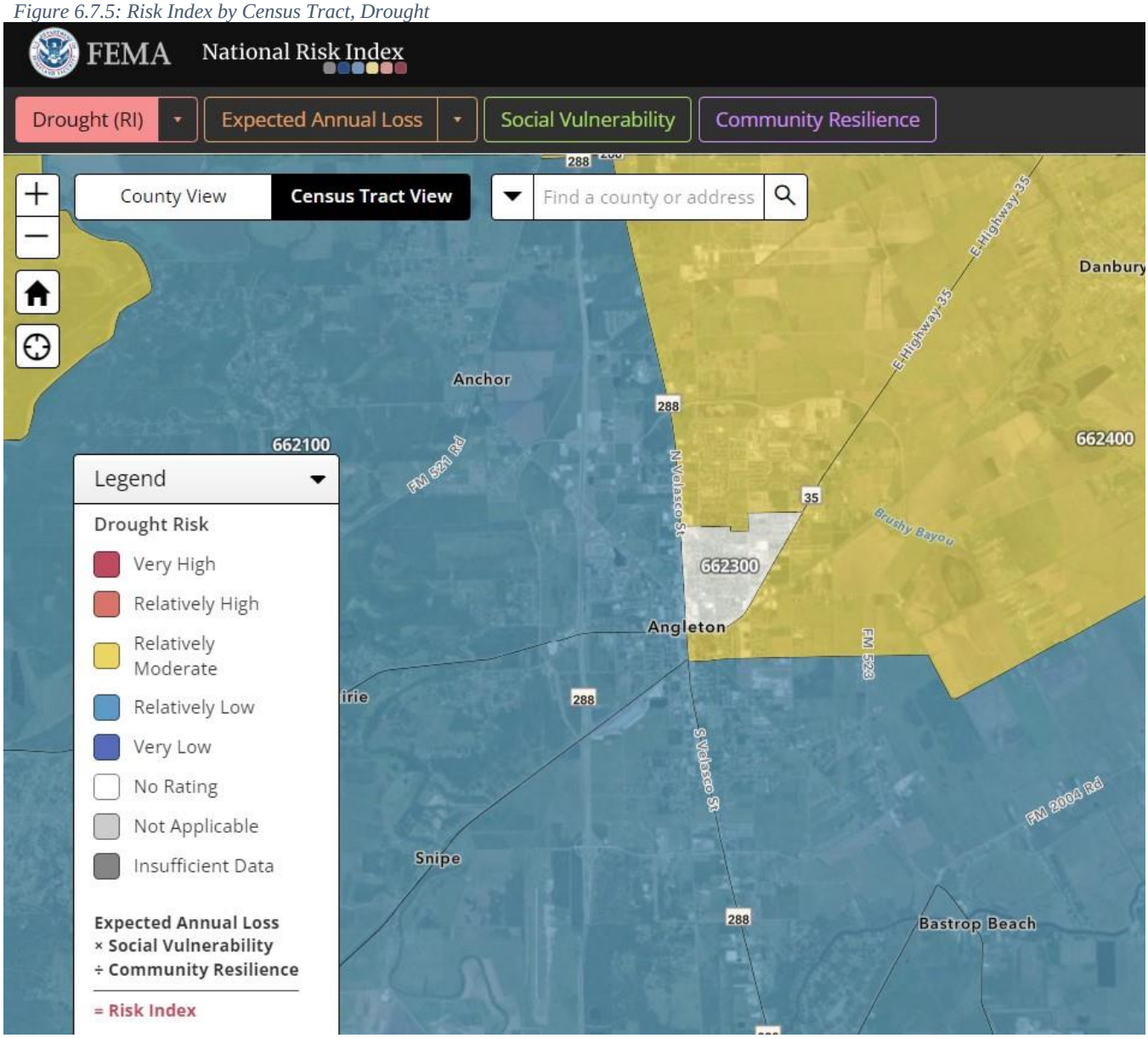


Figure 6.7.6: Social Vulnerability by Census Tract, City of Angleton

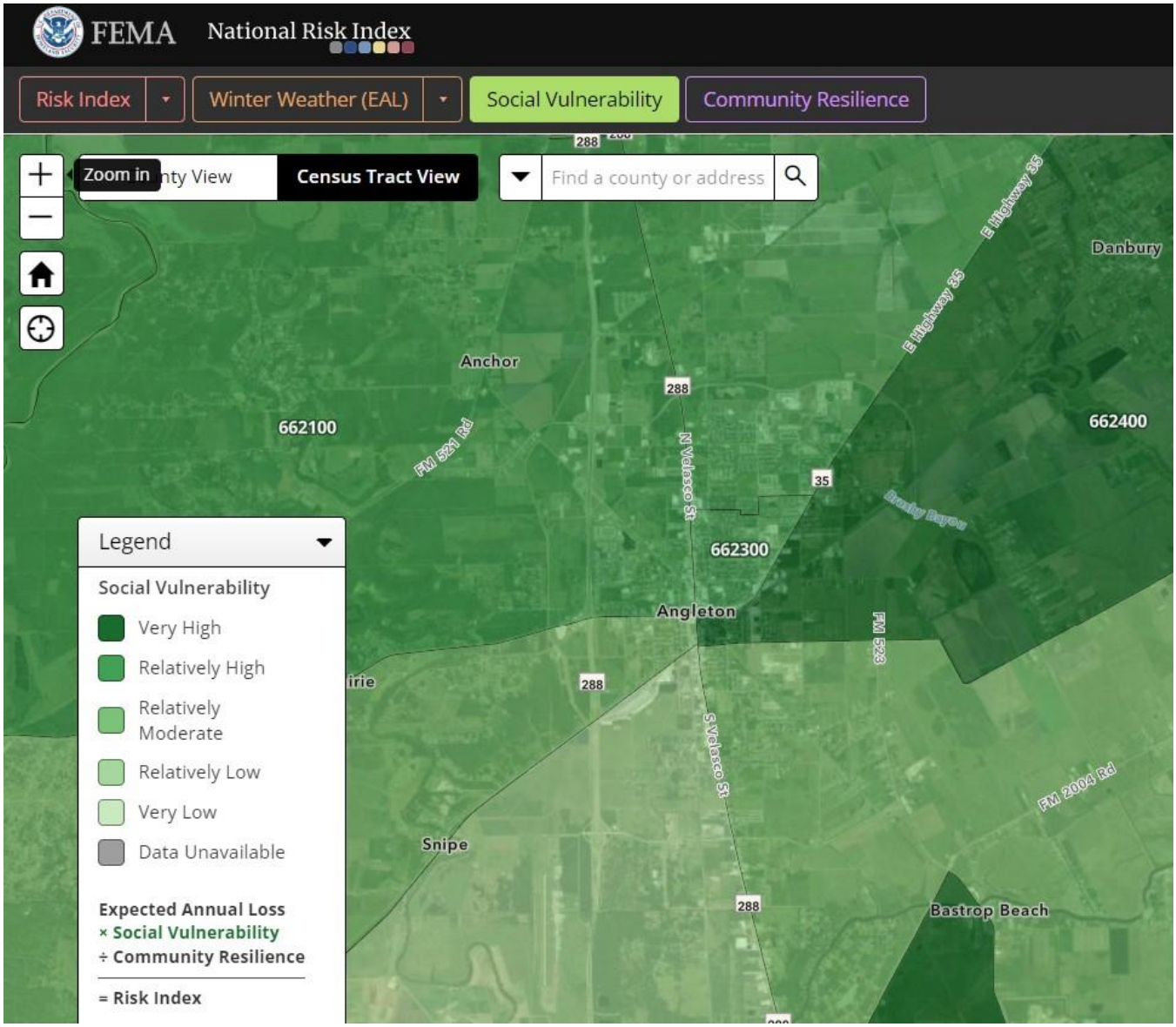


Figure 6.7.7: Community Resilience by Census Tract, City of Angleton

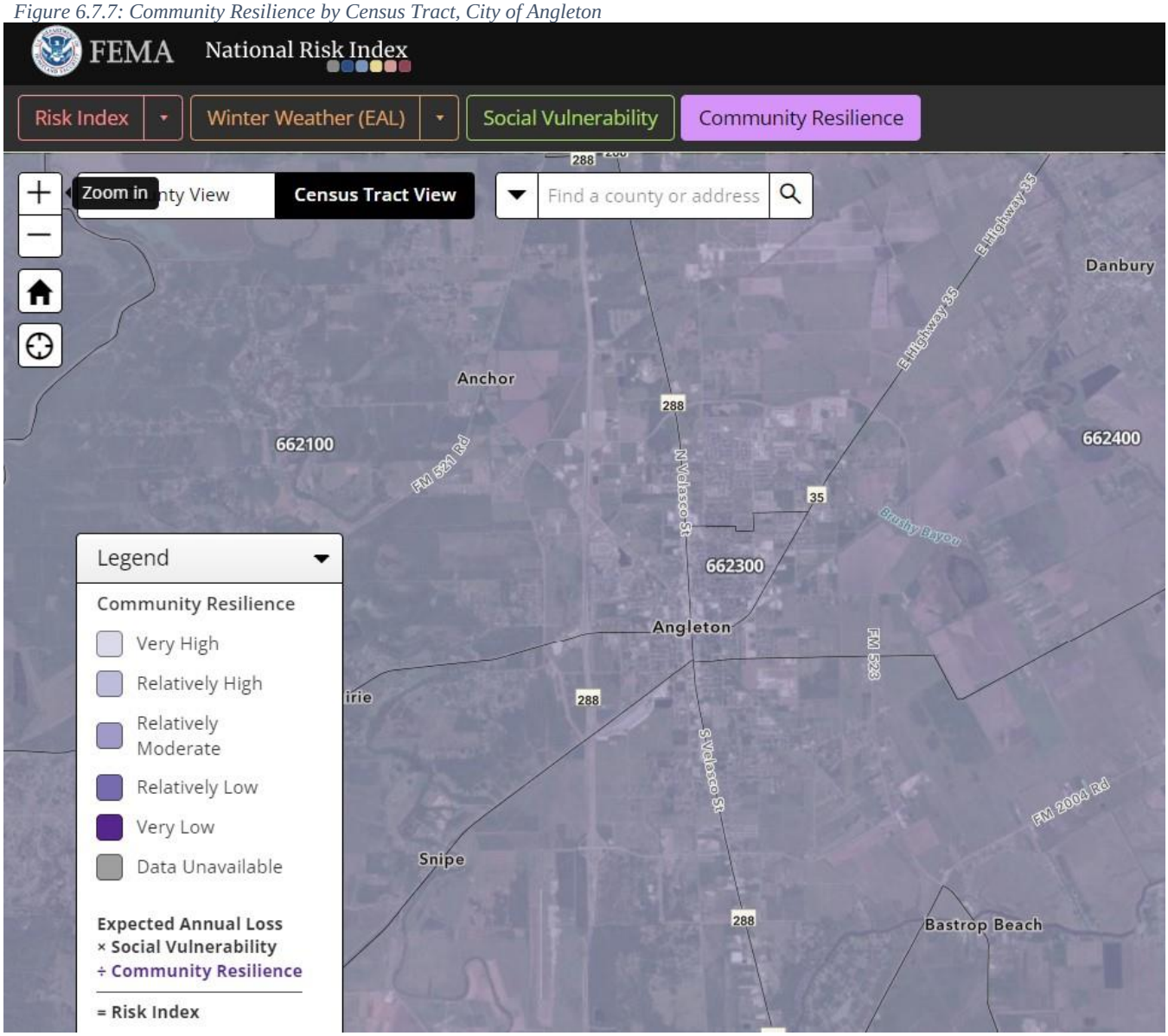


Figure 6.7.8: FEMA NRI Summary, Drought

Rank	Community	State	Risk Index Rating	Risk Index Score	National Percentile
1	Census tract 48039662400	TX	Relatively Moderate	94.82	0 100
2	Census tract 48039662200	TX	Relatively Moderate	94.81	0 100
3	Census tract 48039663100	TX	Relatively Low	90.6	0 100
4	Census tract 48039662100	TX	Relatively Low	88.91	0 100
5	Census tract 48039664100	TX	Relatively Low	87.92	0 100
6	Census tract 48039662500	TX	Relatively Low	86.45	0 100
	Census tract 48039662300	TX	No Rating	0	0 100

Rank	Community	State	EAL Value	Social Vulnerability	Community Resilience	CRF	Risk Value	Risk Index Score
1	Census tract 48039662400	TX	$19,096	Very High	Relatively Moderate	1.43	$27,400	94.82
2	Census tract 48039662200	TX	$20,340	Relatively High	Relatively Moderate	1.34	$27,206	94.81
3	Census tract 48039663100	TX	$6,833	Relatively Low	Relatively Moderate	1	$6,839	90.6
4	Census tract 48039662100	TX	$3,455	Relatively High	Relatively Moderate	1.22	$4,228	88.91
5	Census tract 48039664100	TX	$3,030	Relatively Moderate	Relatively Moderate	1.05	$3,175	87.92
6	Census tract 48039662500	TX	$1,856	Relatively Moderate	Relatively Moderate	1.12	$2,072	86.45
	Census tract 48039662300	TX	$0	Relatively High	Relatively Moderate	1.38	$0	0

Climate Change Impacts

According to the Office of the Texas State Climatologist, it is impossible to make a quantitative statewide projection of drought trends. However, most factors at play point to an increase in drought severity.[58] It can be inferred that the impacts of climate change on expansive soils will grow as drought and flooding risks and associated impacts become more prevalent.

Table 6.7.7: Climate Change Impacts, Drought & Expansive Soils

Location	The location of droughts and expansive soils is not expected to change.
Extent/Intensity	The extent and intensity of drought and associated risks from expansive soils within the county may change (increase) due to increased precipitation and stronger storms which can lead to an increase in flooding events and rising surface temperatures, heat events, and increases in drought severity.
Frequency	There are no clear trends in drought frequency due to considerable variability in conditions that lead to droughts. Since expansive soils pose the most risk during periods of drought and flooding, and there is no way to data to track losses due to expansive soils, the frequency of expansive soil impacts also shows no clear trends.
Duration	The duration of drought events is not likely to change, however the intensity of droughts is expected to increase.

Section 6.8: Severe Thunderstorms & Lightning

6.8 Severe Thunderstorm & Lightning

The NWS defines a thunderstorm as "A local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder." A severe thunderstorm is defined as "A thunderstorm that produces a tornado, winds of at least 58 mph (50 knots), and/or hail at least 1" in diameter. Structural wind damage may imply the occurrence of a severe thunderstorm. A thunderstorm wind equal to or greater than 40 mph (35 knots) and/or hail of at least 1" is defined as approaching severe."[94] Thunderstorms form when certain factors are present. These are moisture, instability, lifting, and in the case of severe thunderstorms wind shear. The difference between thunderstorms and severe thunderstorm formation resides in the wind field or wind sheer.[95] There are different types of thunderstorms with varying characteristics and degrees of severity.[96] Descriptions of these can be found in Table 6.3.1.

Table 6.8.1: Types of Thunderstorms

Type of Thunderstorm	Description
Ordinary Cell (Pulse Thunderstorm)	A one-time updraft and one-time downdraft. The rising updraft will suspend growing raindrops until the point where the weight of the water is greater than what can be supported. Drag between the air and the falling drops begins to diminish the updraft, which allows more raindrops to fall. While hail and gusty wind can develop, these occurrences are typically not severe. However, if atmospheric conditions are right and the ordinary cell is strong enough, more than one cell can potentially form and can include microburst winds (usually less than 70 mph/112 km/h) and weak tornadoes.
Multi-Cell Cluster	A thunderstorm with numerous cells in various stages of development merging together. While each individual thunderstorm cell in a multi-cell cluster behaves as a single cell, the prevailing atmospheric conditions are such that as the first cell matures, it is carried downstream by the upper-level winds, with a new cell forming upwind of the previous cell to take its place. Sometimes the atmospheric conditions encourage vigorous new cell growth – they form so fast that each new cell develops further and further upstream. Tremendous rainfall amounts can be produced over very small areas by back-building thunderstorms.
Multi-cell Line (Squall Line)	Thunderstorms that form in a line and can extend laterally for hundreds of miles. These "squall lines" can persist for many hours and produce damaging winds and hail. Updrafts, and therefore new cells, continually re-form at the leading edge of the system, with rain and hail following behind. Individual thunderstorm updrafts and downdrafts along the line can become quite strong, resulting in episodes of large hail and strong outflow winds that move rapidly ahead of the system. While the leading edge of squall lines occasionally form tornadoes, they primarily produce "straight-line" wind damage, a result of the force of the downdraft spreading horizontally as it reaches the Earth's surface.
Supercell Thunderstorms	Supercell thunderstorms are a special kind of single cell thunderstorm that can persist for many hours. They are responsible for nearly all of the significant tornadoes produced in the U.S. and for most of the hailstones larger than golf ball size. Supercells are also known to produce extreme winds and flash flooding.

Lightning is defined by NWS as "A visible electrical discharge produced by a thunderstorm. The discharge may occur within or between clouds, between the cloud and air, between a cloud and the ground, or between the ground and a cloud."[97] Lightning accompanies all thunderstorms and poses a threat to lives and property. While the odds of being struck by lightning are relatively low (1/1,222,000)[98], lightning kills about 20 people per year while hundreds more are injured or suffer lifelong neurological damage.[99] There are different types of lightning with varying characteristics. Most lighting starts within a thunderstorm and travels through the cloud.[100] Descriptions of these can be found in Table 6.8.2.

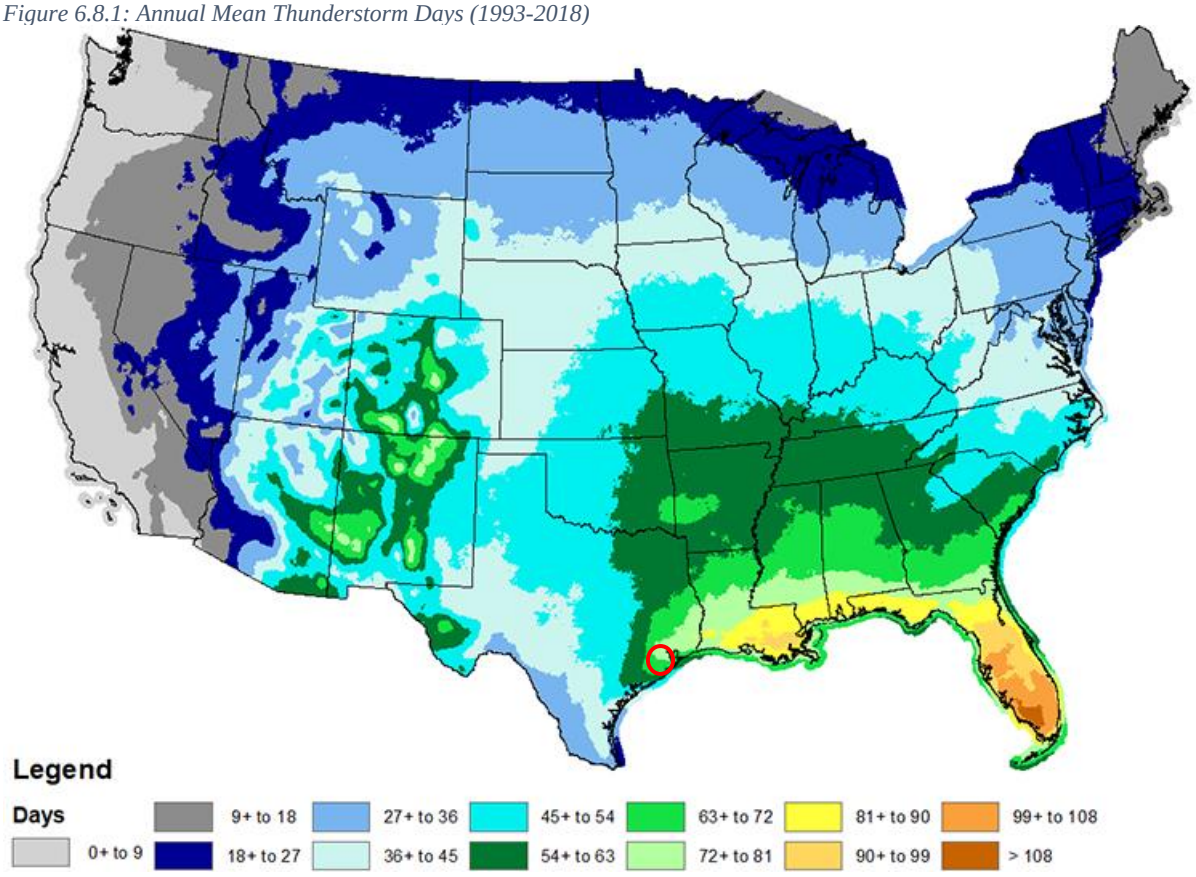
Table 6.8.2: Types of Lightning

Type of Lightning	Description
Cloud-to-Ground Flashes (Cloud-to-Ground Lightning)	A channel of negative charge, called a stepped leader, will zigzag downward in roughly 50-yard segments in a forked pattern. This stepped leader is invisible to the human eye, and shoots to the ground in less time than it takes to blink. As it nears the ground, the negatively charged stepped leader causes streamer channels of positive charge to reach upward, normally from taller objects in the area, such as a tree, house, or telephone pole. When the oppositely charged leader and streamer connect, a powerful electrical current begins flowing. This return stroke current of bright luminosity travels about 60,000 miles per second back towards the cloud.
	A "**bolt from the blue**" is Cloud-to-Ground lightning which starts inside a cloud, goes out the side of the storm, then travels horizontally away from the cloud before going to ground. A bolt from the blue can strike ground at a spot with "blue sky" above it. *Even a storm that is 6 miles away can be dangerous.*
Cloud Flashes (Intra-Cloud Lightning)	Many flashes of lightning within a cloud that do not reach the ground. Cloud flashes sometimes have visible channels that extend out into the air around the storm

Location

Thunderstorms, and the accompanying lightning, are not confined to any geographic boundaries. These hazards can happen anywhere, during any time of the year. However, typically thunderstorms will occur in warmer months such as Summer and Spring, and during the warmest parts of the day. Figure 6.8.1 shows the average number of thunderstorm days each year throughout the U.S. (defined as two lightning flashes within 10 nautical miles (nmi) radius). The most frequent occurrence is in the southeastern states due to warm, moist air from the Gulf of Mexico and Atlantic Ocean are readily available to fuel atmospheric conditions that produce thunderstorms. The City of Angleton is in an area that can see anywhere from 63-72 thunderstorm days per year as indicated by the red circled area on the figure below.[101]

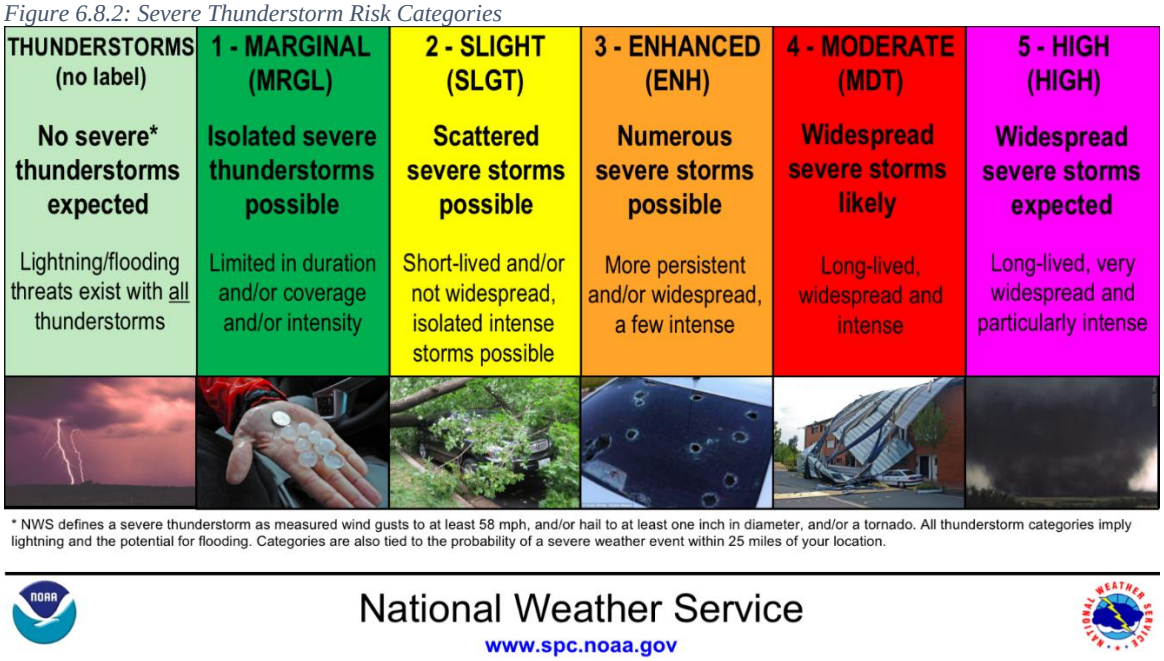
Figure 6.8.1: Annual Mean Thunderstorm Days (1993-2018)



Extent

Thunderstorm intensity can be measured by NWS and the Storm Prediction Center (SPC) of the NWS risk categories. The SPC issues Convective Outlooks that depict non-severe thunderstorm areas and severe thunderstorm threats across the contiguous United States, along with a text narrative. The categorical forecast specifies the level of the overall severe weather threat via numbers, descriptive labeling, and colors, as seen in the figure below. The probabilistic forecast directly expresses the best estimate of a severe weather event occurring within 25 miles of a given point.[102] Components of a severe thunderstorm include a tornado, winds of at least 58 mph (50 knots), and/or hail at least 1" in diameter. Structural wind damage may imply the occurrence of a severe thunderstorm. A thunderstorm wind equal to or greater than 40 mph (35 knots) and/or hail of at least 1" is defined as approaching severe.

Figure 6.8.2: Severe Thunderstorm Risk Categories



Likewise, lightning intensity is measured by the NWS and defined as Lightning Threat Level. The NWS's "Lightning Hazard Map" depicts the local threat of lightning for specified areas. It is largely based on the likelihood that cloud-to-ground (CG) lightning from thunderstorms will occur combined with the anticipated flash rate. The hazard map depicts these likelihoods with varying colors along with a text narrative, as depicted in the table below.[103]

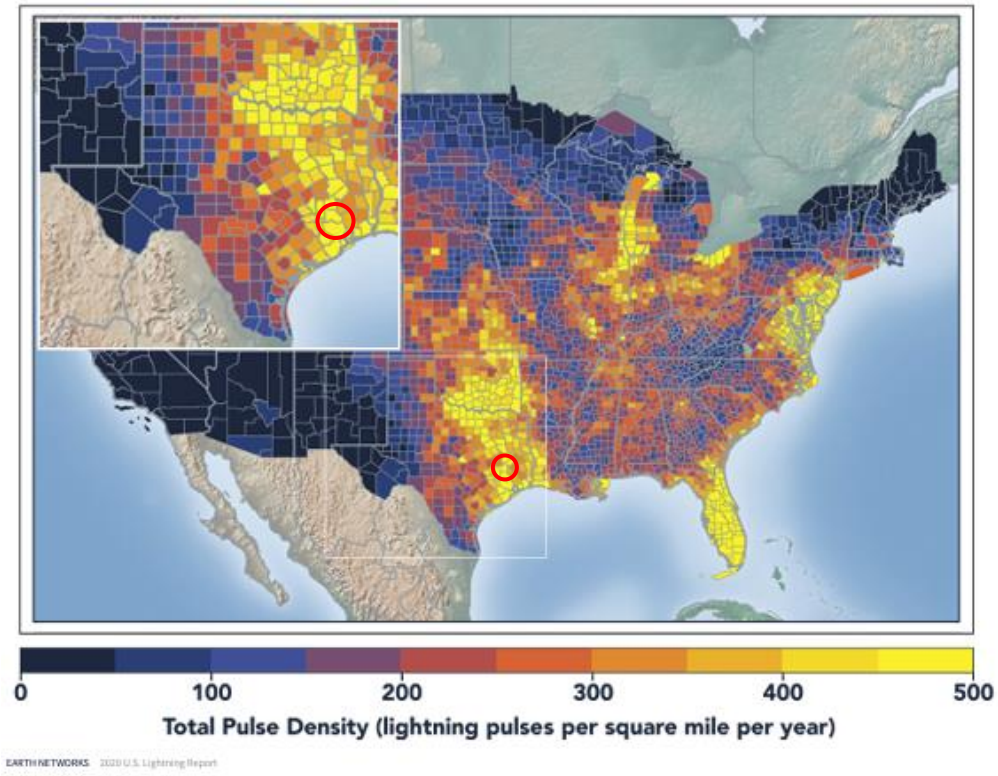
Table 6.8.3: Types of Lightning

Lightning Threat Level	Description
Extreme	**"An Extreme Threat to Life and Property from Lightning."** Within 12 miles of a location, a moderate likelihood of CG lightning (or 50% thunderstorm probability), with storms capable of excessive CG lightning. AND/OR...a high likelihood of CG lightning (or 60% to 70% thunderstorm probability), with storms capable of frequent CG lightning. AND/OR...a very high likelihood of CG lightning (or 80% to 90% thunderstorm probability), with storms capable of occasional CG lightning.
High	**"A High Threat to Life and Property from Lightning."**

Lightning Threat Level	Description
	Within 12 miles of a location, a low likelihood of CG lightning (or 30% to 40% thunderstorm probability), with storms capable of excessive CG lightning. AND/OR...a moderate likelihood of CG lightning (or 50% thunderstorm probability), with storms capable of frequent CG lightning. AND/OR...a high likelihood of CG lightning (or 60% to 70% thunderstorm probability), with storms capable of occasional CG lightning.
Moderate	**"A Moderate Threat to Life and Property from Lightning."** Within 12 miles of a location, a very low likelihood of CG lightning (or 10% to 20% thunderstorm probability), with storms capable of excessive CG lightning. AND/OR...a low likelihood of CG lightning (or 30% to 40% thunderstorm probability), with storms capable of frequent CG lightning. AND/OR...a moderate likelihood of CG lightning (or 50% thunderstorm probability), with storms capable of occasional CG lightning.
Low	**"A Low Threat to Life and Property from Lightning."** Within 12 miles of a location, a very low likelihood of CG lightning (or 10% to 20% thunderstorm probability), with storms capable of frequent CG lightning. AND/OR...a low likelihood of CG lightning (or 30% to 40% thunderstorm probability), with storms capable of occasional CG lightning.
Very Low	**"A Very Low Threat to Life and Property from Lightning."** Within 12 miles of a location, a very low likelihood of CG lightning (or 10% to 20% thunderstorm probability), with storms capable of occasional CG lightning.
Non-Threatening	**"No Discernable Threat to Life and Property from Lightning."** Within 12 miles of a location, environmental conditions do not support CG lightning.
Note: With cloud-to-ground (CG) lightning, every strike is potentially lethal. • **Occasional- CG lightning at the rate of 1 to 3 flashes per minute (about 5 to 15 flashes per 5 minutes) associated with a given lightning storm.** • **Frequent- CG lightning at the rate of 4 to 11 flashes per minute (about 20 to 55 flashes per 5 minutes) associated with a given lightning storm.** • **Excessive- CG lightning rate of 12 flashes or more per minute (about 60 flashes or more per 5 minutes) and is nearly** continuously **associated with a given lightning storm.**	

According to Earth Networks 2020 Texas Lightning Report, Texas ranked #1 in total lightning pulses for 2020. Brazoria County had the second largest lightning counts, just under 750,000 total for the year from both cloud-to-ground and intra-cloud pulses. This lightning report outlines pulse density, a better indicator of lightning activity than total lightning counts because it allows the comparison of different-sized areas (like states and counties). Pulses are clustered together into flashes. With every pulse detected, there is a more precise measure of lightning activity. In the figure below, areas in bright yellow experienced the highest lightning pulse density per square mile in 2020.[104] Brazoria County is outlined by the red circle. The county listed as having the second highest amount of thunder days (the total number of days in the year when lightning was detected by Earth Network's Total Lightning Network) at 105, with Harris County having the most thunder days, at 125 per year on average.

Figure 6.8.3: Total Pulse Density, Brazoria County



Historic Occurrences

NOAA collects historic climate data for the entire nation. NOAA's storm event data can be accessed on the NCEI Storm Events Database. These events are shown at the county level with some referencing a specific location, city, or zone. The database currently contains data from January 1950 to December 2023, as entered by NOAA's NWS. Due to changes in the data collection and processing procedures over time, there are unique periods of record available depending on the event type. There are 198 events listed in the Storm Events Database for thunderstorm and lightning. The table below highlights a condensed version of events for this hazard that have occurred within Brazoria County from 2018-2023. Events that occurred within the City of Angleton are highlighted in purple.[38]

Table 6.8.4: City of Angleton Severe Thunderstorm and Lightning Events (2018-2023)

Date	Location	Event Type	Injuries	Fatalities	Property Damage ($)	Crop Damage ($)	Wind Speed (knots)
3/29/2018	Brazoria	Thunderstorm Wind	0	0	$1,000	$-	51
3/29/2018	Sweeny	Thunderstorm Wind	0	0	$-	$-	52
3/29/2018	Alvin	Thunderstorm Wind	0	0	$-	$500	50
5/26/2018	Iowa Colony	Thunderstorm Wind	0	0	$3,000	$3,000	56
5/26/2018	Bonney	Thunderstorm Wind	0	0	$15,000	$0	58
5/26/2018	Angleton	Thunderstorm Wind	0	0	$-	$-	52
5/26/2018	Van Pelt	Thunderstorm Wind	0	0	$-	$-	51
10/31/2018	Alvin	Thunderstorm Wind	0	0	$-	$-	50
4/7/2019	Oyster Creek	Thunderstorm Wind	0	0	$7,000	$3,000	51
5/4/2019	Pearland	Thunderstorm Wind	0	0	$-	$2,000	52
8/14/2019	Iowa Colony	Lightning	0	0	$-	$-	ND
1/11/2020	Pearland	Thunderstorm Wind	0	0	$3,000	$-	52

5/16/2020	Pearland	Thunderstorm Wind	0	0	$2,000	$2,000	53
1/6/2021	Manvel	Thunderstorm Wind	0	0	$-	$-	50
5/18/2021	Angleton	Thunderstorm Wind	0	0	$-	$-	50
5/28/2021	Alvin	Thunderstorm Wind	0	0	$-	$-	50
12/18/2021	Pearland Arpt	Thunderstorm Wind	0	0	$-	$-	52
3/22/2022	Old Brazoria	Thunderstorm Wind	0	0	$20,000	$-	50
5/25/2022	Iowa Colony	Thunderstorm Wind	0	0	$-	$-	50
6/21/2023	Hastings	Thunderstorm Wind	0	0	$-	$-	50

Rows highlighted in purple are events that reference the City of Angleton within the event narrative or event location (beginning or end).
$- No dollar amount ($0.00).
ND- No Data

Presidential Disaster Declarations

There have been 6 disaster declarations for severe storms within Brazoria County, in which the City of Angleton is located, as depicted in the table below. There were 0 disaster declarations for lightning.[1,2]

Table 6.8.5: Federal Disaster Declarations, Severe Thunderstorm

Declaration Date	Incident Type	Title	Disaster Number	Declaration Type
4/12/1991	Severe Storm	Severe Storms, Tornadoes & Flooding	900	Major Disaster Declaration
8/26/1998	Severe Storm	Tropical Storm Charley	1239	Major Disaster Declaration
9/23/1998	Severe Storm	Hurricane Georges- Texas	1245	Major Disaster Declaration
11/5/2002	Severe Storm	Severe Storms, Tornadoes & Flooding	1439	Major Disaster Declaration
5/29/2015	Severe Storm	Severe storms, tornadoes, straight-line winds, and flooding	4223	Major Disaster Declaration
11/25/2015	Severe Storm	Severe storms, tornadoes, straight-line winds, and flooding	4245	Major Disaster Declaration

USDA Disaster Declarations

The Secretary of Agriculture is authorized to designate counties as disaster areas to make EM loans available to producers suffering losses in those counties and in counties that are contiguous to a designated county. In addition to EM loan eligibility, other emergency assistance programs, such as FSA disaster assistance programs, have historically used disaster designations as an eligibility trigger. USDA Secretarial disaster designations must be requested of the Secretary of Agriculture by a governor or the governor's authorized representative, by an Indian Tribal Council leader or by an FSA SED. The Secretarial disaster designation is the most widely used. When there is a presidential disaster declaration, FEMA immediately notifies FSA of the primary counties named in a Presidential declaration. USDA Disaster Declarations for Brazoria County since 2018 are listed in the table below. These declarations included USDA declarations for excessive rain. There were no USDA disaster declarations categorized under severe storms or thunderstorms.[39]

Table 6.8.6: USDA Declared Disasters (2018-2023), Severe Thunderstorm and Lightning

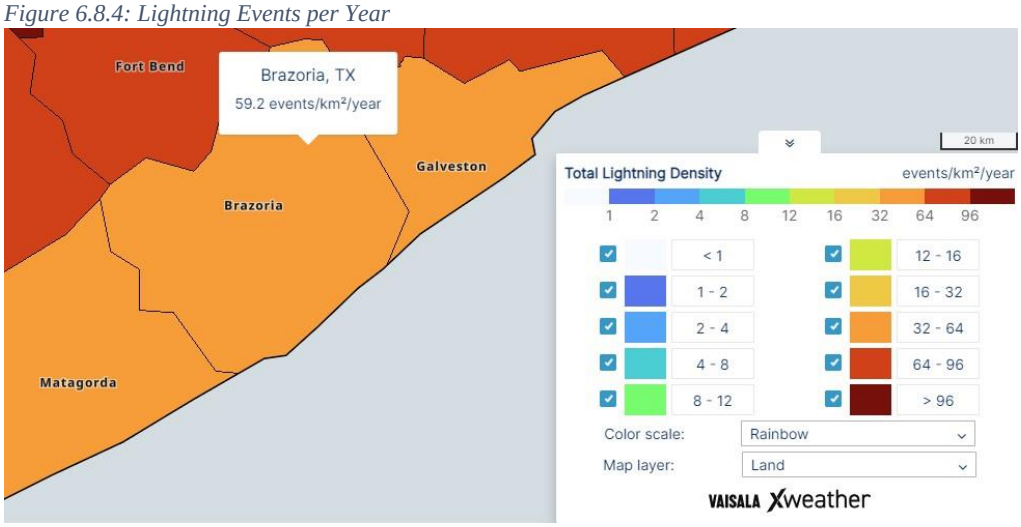
Crop Disaster Year	Disaster Description	Designation Number
2019	Excessive moisture and flooding	S4534
2021	Excessive moisture and excessive rainfall	S5052
2021	Excessive moisture and excessive rainfall	S5053
2021	Excessive Moisture	S5088
2021	Excessive Moisture	S5089

Probability of Future Occurrences

Severe thunderstorms and lightning are more likely to occur in summer months when temperatures are higher and moisture from the gulf helps to fuel thunderstorm development. According to the FEMA NRI for lightning, annualized frequency values for lightning in Brazoria County are 80.2 events per year over a 22-year period of record (1991-2012), with 1,590 events on record for this timeframe. Severe thunderstorms are not included in the FEMA NRI. It can be inferred that the probability of future occurrences for this hazard will be the same as lightning as all thunderstorm risk categories defined in Figure 6.8.2 imply lightning and the potential for flooding.[42] Annualized frequency values for these hazards are expected to stay the same.

The National Lightning Detection Network (NLDN) consists of over 100 remote, ground-based sensing stations located across the United States that instantaneously detect the electromagnetic signals given off when lightning strikes the earth's surface. These remote sensors send the raw data via a satellite-based communications network to the Network Control Center (NCC) operated by Vaisala Inc. in Tucson, Arizona. Within seconds of a lightning strike, the NCC's central analyzers process information on the location, time, polarity, and communicates to users across the country. Through a partnership with Vaisala and a cooperative effort with the U.S. Air Force 14th Weather Squadron, summarized daily files from 1986 to the present are archived at the NOAA NCEI. Through a contract with Vaisala, the raw data from NCEI is available only to government and military users. [105] Through use of Vaisala's Interactive Global Lightning Density Map, the figure below shows the average number of lightning events per km2 per year for Brazoria County. This interactive map utilizes data from 2016 to 2022.

Figure 6.8.4: Lightning Events per Year



With 739,476 lightning strikes recorded by Earth Networks in 2020, and an annualized frequency value of 80.2 events per the FEMA NRI, Brazoria County and the City of Angleton could experience 9,000+ lightning strikes per event. Alternatively, using Brazoria County's thunder days (105) from Earth Networks report as the annualized frequency value puts lightning strikes at 7,042 per event.

Populations at Risk

Populations at risk for severe thunderstorms and lightning include similar groups to those listed under Section 6.1 as hurricanes, tropical storms, and tropical depressions can bring some of the same hazards to vulnerable populations. Severe storms and lightning can cause property damage, flooding, lack of access to critical facilities that provide food, water, medications, or other forms of medical assistance, and lack of utilities such as electricity and clean water, which can increase the risk of illness. According to the NCHH, those at greater risk from these hazards include older adults, children, people experiencing

homelessness, people with disabilities, and people with chronic health conditions. Older adults, in addition to the dangers listed above, can also face social isolation, lack of electricity needed to run medical equipment, and lack of access to other critical supplies. In younger populations, such as children, severe storms can disrupt schooling via power outages, the need to shelter in place during the school-day, or even necessary evacuation or early-release days due to inclement weather. This can not only jeopardize their academic success, but it can also cause mental and emotional stress, as well as add stress to adults who work full-time and rely on schooling during normal work hours to keep children occupied and safe. Children are more vulnerable to certain medical conditions like asthma, lead poisoning, allergies, and bacterial infections which can be caused by the resulting flood damage and increased moisture of severe storms. For people experiencing homelessness, housing and adequate shelter are critical in keeping populations safe during these types of hazard events. People with disabilities may require additional assistance to stay safe and prepare for these hazards such as creating a support network, finding accessible transportation to evacuate or get medical attention, and loss of power for needed medical equipment. Likewise, those with chronic health conditions may need similar assistance as those with disabilities. People with chronic health conditions also face exposure to diseases or illnesses from standing water and increased exposure to these illnesses when utilizing a shelter or evacuation centers due to power outages or the resulting flooding.[42] People living in mobile homes are also at greater risk of injury and death from these hazards. Despite mobile homes providing a form of shelter, severe storms are the catalyst for strong winds and tornadoes. Dangerous winds can cause mobile homes, even mobile homes that utilize anchoring, to be seriously damaged or destroyed when winds gust over 80 mph.[43]

Any areas of growth or future development within the county could be impacted by these hazards because the entire county is vulnerable to severe thunderstorms and lightning. As the population within the county increases, so does the vulnerability of residents to these hazards, especially vulnerable populations without access to shelter.

National Risk Index

FEMA's NRI utilizes data from multiple sources including historical hazard events, hazard intensity, exposure of people and property to hazards, socioeconomic factors, and community resilience indicators. The NRI also incorporates hazard data to determine the frequency and intensity of various natural hazards. This information helps assess the likelihood of specific hazards occurring in different regions.[44]

The NRI considers the exposure of communities to hazards and incorporates factors such as population density, infrastructure systems, and critical facilities that may be at risk during a hazard event. The NRI also generates risk scores for communities across the U.S. that provide a relative ranking of areas based on their overall risk level. This helps to identify areas that may require additional resources and attention for mitigation and planning efforts. The NRI risk equation includes 3 components. EAL represents the average economic loss in dollars resulting from natural hazards each year, the Community Risk Factor is a scaling factor that incorporates social vulnerability (the susceptibility of social groups to the adverse impacts of natural hazards), and community resilience (the ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions). The outcome, the risk index, represents the potential negative impacts of natural hazards on the county level or individually by census tracts. The NRI EAL score and rating, represent a community's relative level of expected loss each year when compared to all other communities at the same level.[44]

EAL Exposure Values and EAL Values for Brazoria County can be found in the tables below. The FEMA NRI does not include severe storms in its analysis, lightning is included in the tables below.

Table 6.8.7: Expected Annual Loss Exposure Values, Lightning

Hazard Type	Building Value ($)	Population Equivalence ($)/ Population (#)	Agricultural Value ($)	EAL Total ($)
Lightning	$57,514,822,174	$4,309,098,400,000 / 371,474.00	$6,997,533	$4,366,613,222,174

Table 6.8.8: Expected Annual Loss Values, Lightning

Hazard Type	Building Value ($)	Population Equivalence ($)/ Population (#)	Agriculture Value
Lightning	$52,101	$2,076,681 / 0.18	N/A

N/A- Not Applicable

EAL for the City of Angleton was derived by creating a report that used census tract information for tracts that included the Angleton city limits. These were census tracts 48039662100, 48039662200, 48039662400, 48039662300, 48039662500, 48039663100, and 48039664100.

EAL according to the FEMA NRI for lightning events for these census tracts is listed as relatively high, with two tracts rating very high. EAL values, risk index ratings, risk index scores, social vulnerability, and community resilience for each census tract can be found in the figures below. Additionally, the FEMA NRI lists the HLR, a hazard- and county-specific estimate of the percentage of the exposed consequence type (building value, population, or agriculture value) expected to be lost due to a hazard occurrence, for lightning within Brazoria County is listed as relatively low.[44]

Figure 6.8.5: Risk Index by Census Tract, Lightning

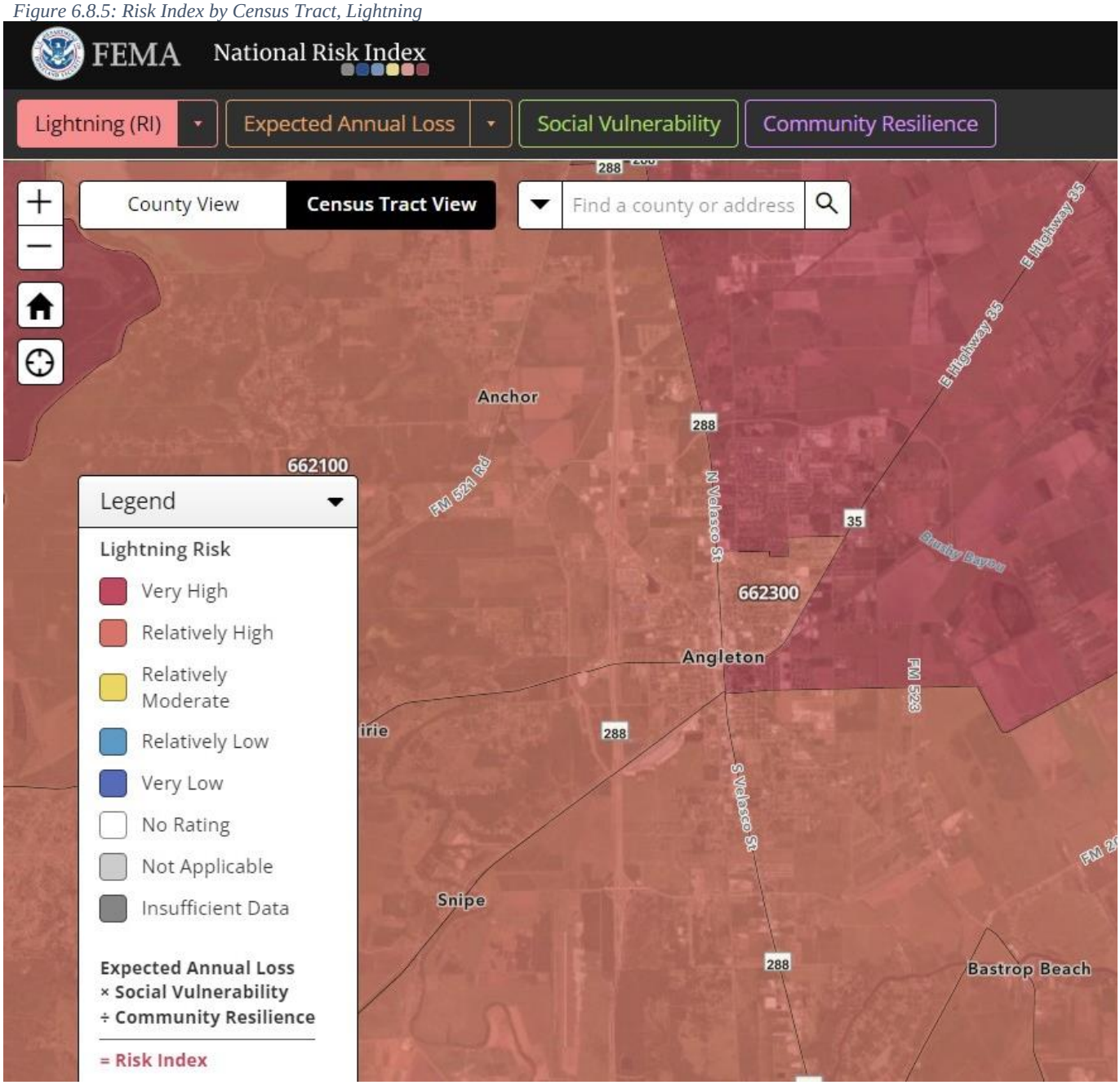


Figure 6.8.6: Social Vulnerability by Census Tract, City of Angleton

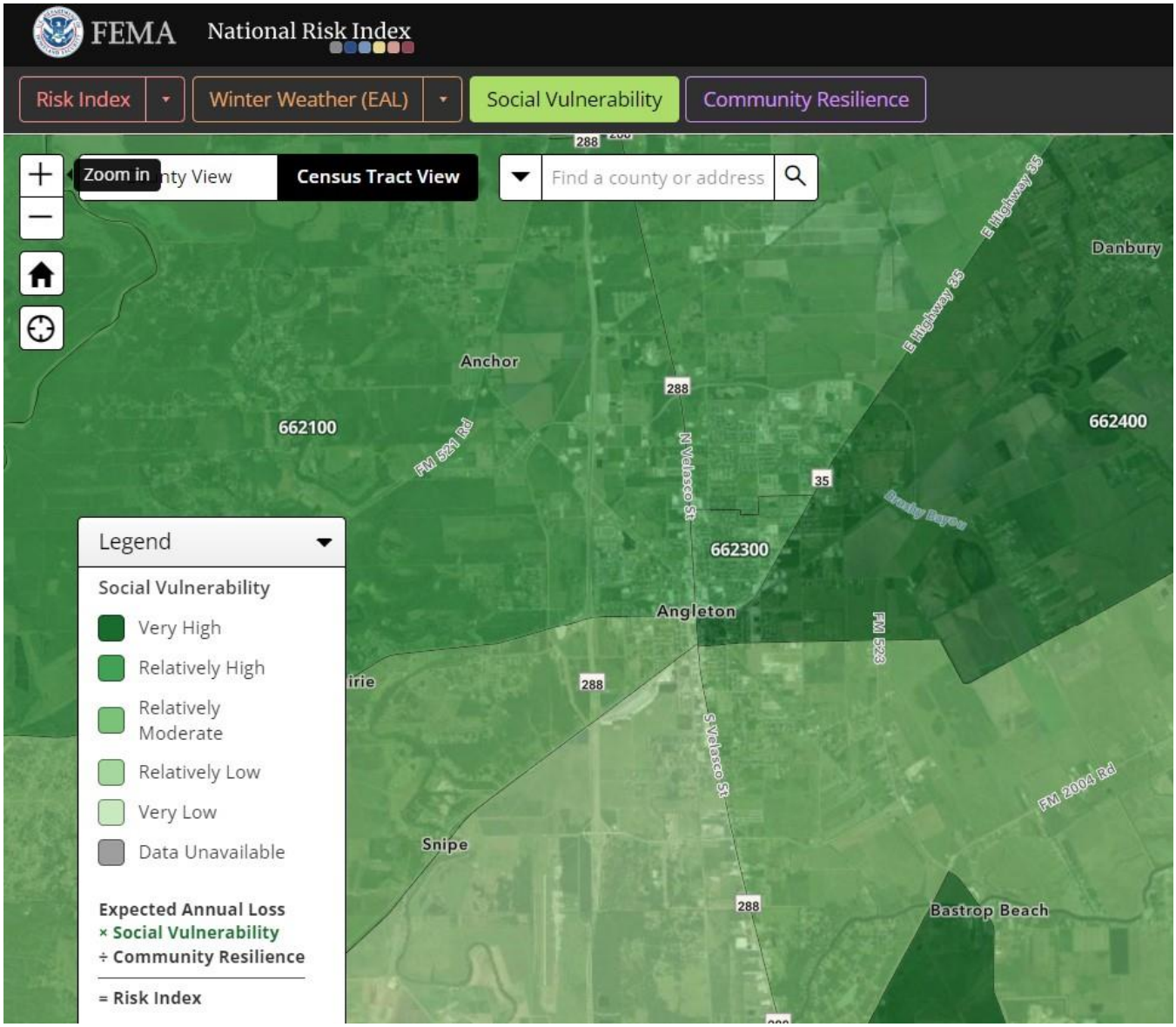


Figure 6.8.7: Community Resilience by Census Tract, City of Angleton

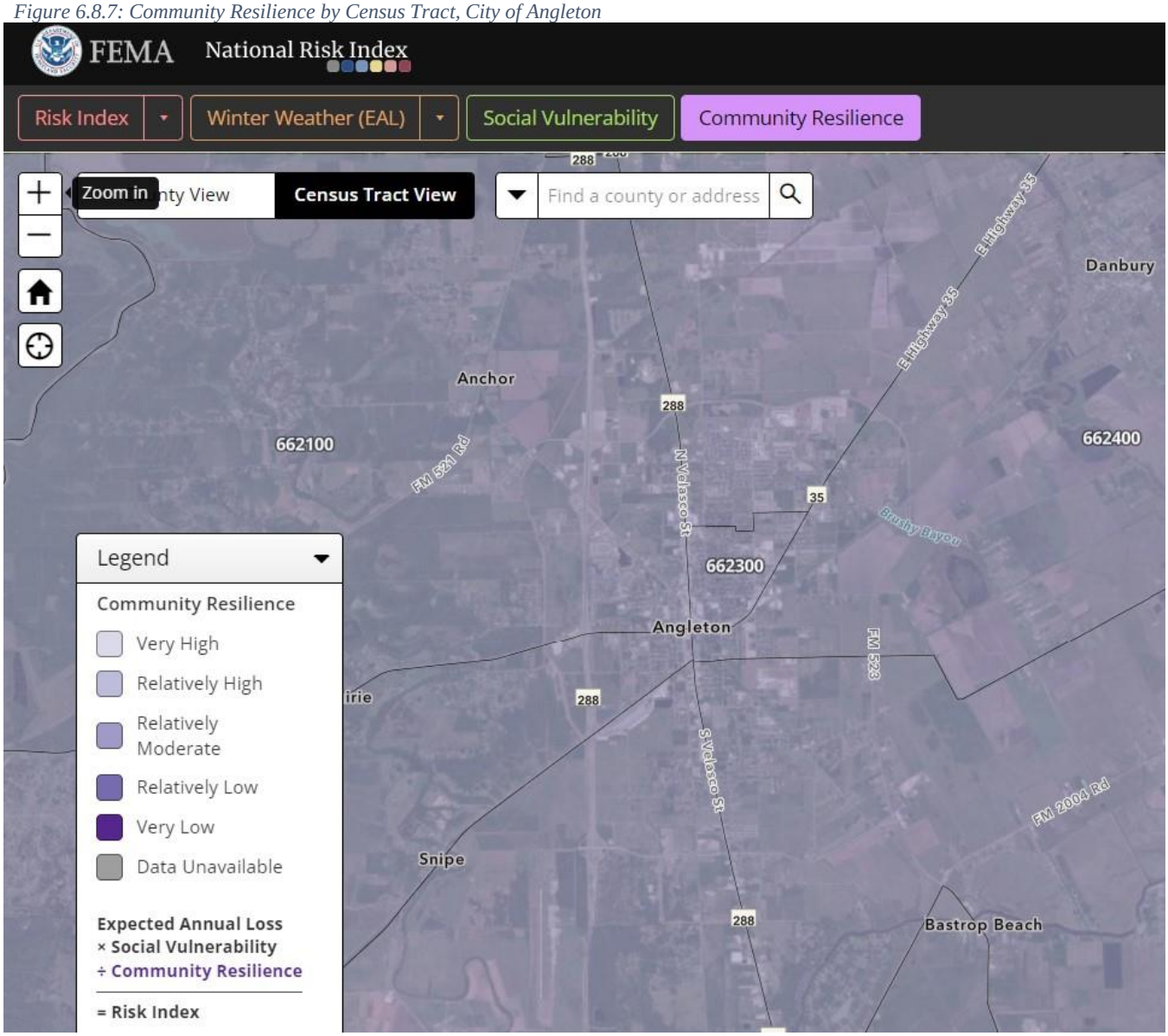


Figure 6.8.8: FEMA NRI Summary, Lightning

Rank	Community	State	Risk Index Rating	Risk Index Score	National Percentile
1	Census tract 48039662200	TX	Very High	95.22	0 100
2	Census tract 48039662400	TX	Very High	94.59	0 100
3	Census tract 48039662100	TX	Relatively High	93.43	0 100
4	Census tract 48039664100	TX	Relatively High	91.13	0 100
5	Census tract 48039663100	TX	Relatively High	90.49	0 100
6	Census tract 48039662300	TX	Relatively High	89.72	0 100
7	Census tract 48039662500	TX	Relatively High	77.54	0 100

Rank	Community	State	EAL Value	Social Vulnerability	Community Resilience	CRF	Risk Value	Risk Index Score
1	Census tract 48039662200	TX	$30,018	Relatively High	Relatively Moderate	1.34	$40,152	95.22
2	Census tract 48039662400	TX	$26,441	Very High	Relatively Moderate	1.43	$37,939	94.59
3	Census tract 48039662100	TX	$28,243	Relatively High	Relatively Moderate	1.22	$34,559	93.43
4	Census tract 48039664100	TX	$28,218	Relatively Moderate	Relatively Moderate	1.05	$29,571	91.13
5	Census tract 48039663100	TX	$28,448	Relatively Low	Relatively Moderate	1	$28,471	90.49
6	Census tract 48039662300	TX	$19,807	Relatively High	Relatively Moderate	1.38	$27,298	89.72
7	Census tract 48039662500	TX	$14,173	Relatively Moderate	Relatively Moderate	1.12	$15,828	77.54

Climate Change Impacts

According to the Office of the Texas State Climatologist, the climate data record for severe thunderstorms is poor, and severe thunderstorms are too small to be simulated directly by present-day climate models. Over the past few decades, the severe storm environment over Texas has changed in complex and opposing ways. The amount of energy available for convection has decreased, and the amount of energy needed to initiate convection has increased at the same time. This suggests that environmental conditions have become less favorable for the occurrence of thunderstorms. However, the amount of low-level shear has increased, which would be expected to make thunderstorms more likely to become severe once they develop.

Changes in severe storm environments have not been uniform throughout the year, with environments becoming more favorable for severe thunderstorms and significant hail in Texas early in the spring and less favorable later in the spring. Lightning occurs most often during the months of May and June. Climate model simulations imply different prospects going forward. As temperatures increase, the amount of energy available to fuel these storms is simulated to increase as temperature and low-level moisture increase. This results in an overall increase in the number of days capable of producing severe thunderstorms. With these complex trends and partially contradictory information between models and observations, there is low confidence in any ongoing trend in the overall frequency and severity of severe thunderstorms.[58]

Table 6.8.9: Climate Change Impacts, Severe Thunderstorm and Lightning

Location	The location of severe thunderstorms and lightning is not expected to change.
Extent/Intensity	The extent and intensity of severe thunderstorms and lightning within the county may change (increase) due to increased temperatures and energy available to fuel severe thunderstorm development and the accompanying lightning.
Frequency	There are no clear trends in severe thunderstorms and lightning frequency due to considerable variability in conditions that lead to them occurring. However, these hazards occur most frequently in warmer months, around May and June.
Duration	The duration of severe thunderstorms and lightning events is not likely to change, however the intensity of them is expected to increase due to rising temperatures and the proximity of the County to the Gulf of Mexico.

Section 6.9: Hail

6.9 Hail

NOAA's National Severe Storms Laboratory (NSSL) defines hail as "A form of precipitation consisting of solid ice that forms inside thunderstorm updrafts. Hail can damage aircraft, homes and cars, and can be deadly to livestock and people."[106] Hail varieties are determined by how they grow and the maximum size. These differentiating frozen precipitations and their definitions from NOAA's NSSL can be seen in the table below.[107]

Table 6.9.1: Types of Frozen Precipitation

Frozen Precipitation Type	Description
Snow	forms mainly when water vapor turns to ice without going through the liquid stage. This process is called deposition. Snow can form in the gentle updrafts of stratus clouds or at high altitudes in very cold regions of a thunderstorm.
Graupel	soft, small pellets formed when supercooled water droplets (at a temperature below 32°F) freeze onto a snow crystal, a process called riming. If the riming is particularly intense, the rimed snow crystal can grow to an appreciable size but remain less than 0.2 inches. Graupel is also called snow pellets or soft hail, as the graupel particles are particularly fragile and generally disintegrate when handled.
Sleet	small ice particles that form from the freezing of liquid water drops, such as raindrops. At ground level, sleet is only common during winter storms when snow melts as it falls, and the resulting water refreezes into sleet prior to hitting the ground. In thunderstorms, sleet is possible above the melting level where cloud droplets become supercooled and may instantaneously freeze when making contact with other cloud particles or debris, such as dust particles. Sleet is also called ice pellets.
Hail	frozen precipitation that can grow to very large sizes through the collection of water that freezes onto the hailstone's surface. Hailstones begin as embryos, which include graupel or sleet, and then grow in size. Hailstones can have a variety of shapes and include lumps and bumps that may even take the shape of small spikes. Hailstones must be at least 0.2 inches in size.

When forecasting for hail, forecasters look for deep moist convection, in addition to adequate updraft to keep the hailstone aloft for an appropriate amount of time, sufficient supercooled water near the hailstone to enable growth as it travels through an updraft, and a piece of ice, snow or dust for it to grow upon. There is no clear distinction between storms that do and do not produce hailstones. Nearly all severe thunderstorms probably produce hail aloft, though it may melt before reaching the ground.

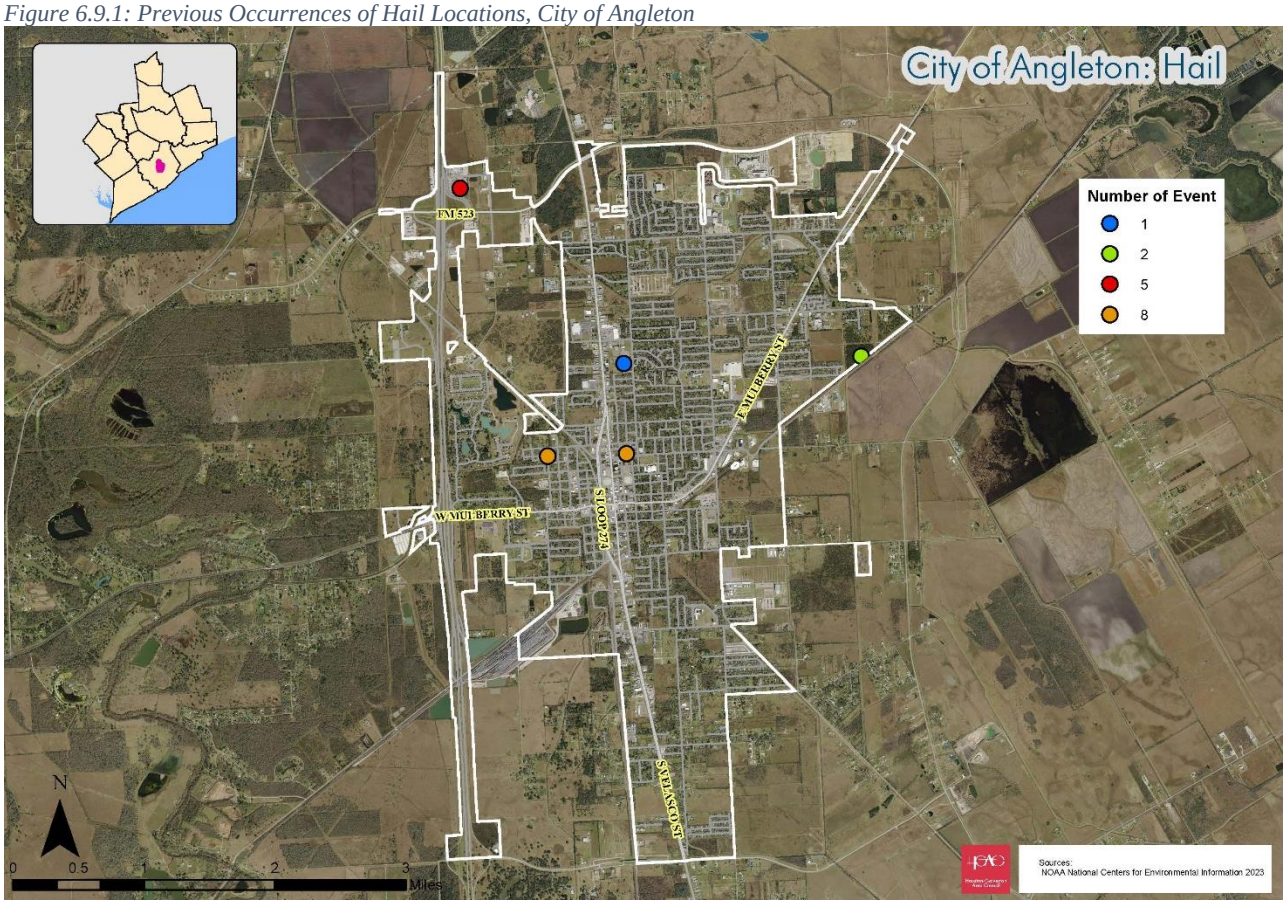
Multi-cell thunderstorms can produce many small hailstones that are relatively short-lived and do not grow. In contrast, supercell thunderstorms have sustained updrafts that support large hail formation by repeatedly lifting the hailstones into the very cold air at the top of the thunderstorm cloud where they can accumulate more layers of ice. In general, hail 2 inches or larger in diameter is associated with supercells. Hail falls to the ground when the thunderstorm's updraft can no longer support the weight of the ice. The stronger the updraft, the larger the hailstone can grow. Additionally, large hail often appears near the area within a thunderstorm where tornadoes are most likely to form[108]

Location

Similar to the Severe Thunderstorms & Lightning (Section 6.8) hazard profile, and the Tornado (Section 6.4) hazard profile, hail is not confined to any geographic boundaries and can occur if the right conditions are present within a thunderstorm, such as a supercell with a strong updraft. The entire county is at risk for this hazard. Thunderstorms and hail can happen at any time of the year. Typically, they occur most in warmer months such as Summer and Spring, and during the warmest parts of the day. Warm, moist air from the Gulf of Mexico is readily available to help fuel atmospheric conditions that produce thunderstorms and the updrafts that bring hail and damaging winds associated with them. City

of Angleton is in an area that can see anywhere from 54-81 thunderstorm days per year.[97] Figure 6.9.1 depicts the locations within the county where previous hails events have occurred.

Figure 6.9.1: Previous Occurrences of Hail Locations, City of Angleton



Extent

The NWS classifies a hailstorm as "severe" if there is hail 0.75 inches in diameter or greater. Hail threats are categorized from non-threatening to extreme with associated map colors to depict hazard levels, as seen in the table below. NWS also generalizes hail sizes as small (less than 0.75 inches in diameter), large (0.75-1.75 inches in diameter), very large (1.75-2.75 inches in diameter), and giant (hail larger than 2.75 inches).[109]

Table 6.9.2: Severe Hail Threat Levels and Descriptions

Severe Hail Threat Level	Map Color	Threat Level Descriptions
Extreme		**"An Extreme Threat to Life and Property from Severe Hail."** • Within 12 miles of a location, a moderate likelihood or greater (16% probability or greater) of severe hail, with storms capable of baseball to softball sized stones. *See diameter description below.* • A high likelihood or greater (26% probability or greater) of severe hail, with storms capable of golf ball to baseball sized hail stones. • Avery high likelihood (36% or greater) of severe hail, with storms capable of nickel to golf ball sized hail stones.
High		**"A High Threat to Life and Property from Severe Hail."** • Within 12 miles of a location, a low likelihood (6% to 15% probability) of severe hail, with storms capable of baseball to softball sized stones. • A moderate likelihood (16% to 25% probability) of very large hail (golf ball to baseball sized hail stones). • A high likelihood (26% to 35% probability) of large hail (nickel to golf ball sized hail stones).
Moderate		**"A Moderate Threat to Life and Property from Severe Hail."** • Within 12 miles of a location, a very low likelihood (2% to 5% probability) of severe hail, with storms capable of baseball to softball sized stones. • A low likelihood (6% to 15% probability) of severe hail, with storms capable of golf ball to baseball sized hail stones. • A moderate likelihood (16% to 25% probability) of severe hail, with storms capable of nickel to golf ball sized hail stones.
Low		**"A Low Threat to Life and Property from Severe Hail."** • Within 12 miles of a location, a very low likelihood (2% to 5% probability) of severe hail, with storms capable of golf ball to baseball sized hail stones • A low likelihood (6% to 15% probability) of severe hail, with storms capable of nickel to golf ball sized hail stones.
Very Low		**" A Very Low Threat to Life and Property from Severe Hail."** • Within 12 miles of a location, a very low likelihood (2% to 5% probability) of severe hail, with storms capable of nickel to golf ball sized hail stones. • A low likelihood or greater (6% or greater) of small hail (less than 3/4 inch).
Non-Threatening		**" No Discernable Threat to Life and Property from Severe Hail."** • Within 12 miles of a location, environmental conditions do not support the occurrence of severe hail.

Hail intensity is measured by the TORRO scale. The scale starts with H0 and goes to H10 with each increment of intensity or damage potential related to hail size, texture, numbers, fall speed, speed of storm translation, and strength of the accompanying wind. The table below outlines the TORRO Hail Intensity Scale and some associated size comparisons.[110]

Table 6.9.3: TORRO Hail Intensity Scale

Scale	Intensity category	Typical hail diameter (in)	Size Comparison	Typical damage impacts
H0	Hard hail	Up to 0.33	Pea	No damage
H1	Potentially damaging	0.33-0.60	Marble	Slight general damage to plants, crops
H2	Significant	0.60-0.80	Dime	Significant damage to fruit, crops, vegetation
H3	Severe	0.80-1.20	Nickel	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	1.20-1.60	Quarter	Widespread glass damage, vehicle bodywork damage
H5	Destructive	1.60-2.0	Half Dollar	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries

Scale	Intensity category	Typical hail diameter (in)	Size Comparison	Typical damage impacts
H6	Destructive	2.0-2.4	Ping Pong Ball	Bodywork of grounded aircraft dented; brick walls pitted
H7	Destructive	2.4-3.0	Golf Ball	Severe roof damage, risk of serious injuries
H8	Destructive	3.0-3.5	Hen Egg	(Severest recorded in the British Isles) Severe damage to aircraft bodywork
H9	Super Hailstorms	3.5-4.0	Tennis Ball	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
H10	Super Hailstorms	>4.0	Baseball	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

A worst-case scenario for this hazard would include a severe thunderstorm event that could produce straight-line winds, tornadoes, hail of H5 or above, and lightning which results in dangerous and life-threatening conditions. Brazoria County has seen more instances of larger hail, 1-1.75 inches or more in diameter or H5, since the last plan update. Most recently in 2024, a hail event reached an intensity of H5 within the City of Angleton. This intensity of hail is considered destructive and can pose the risk of structural damages to windows and roofs, vehicle damages, and injuries to residents.

Historic Occurrences

NOAA collects historic climate data for the entire nation. NOAA's storm event data can be accessed on the NCEI Storm Events Database. These events are shown at the county level with some referencing a specific location, city, or zone. The database currently contains data from January 1950 to December 2023, as entered by NOAA's NWS. Due to changes in the data collection and processing procedures over time, there are unique periods of record available depending on the event type. There have been 124 recorded events for hail within the storm events database. The table below highlights a condensed versions of events for this hazard that have occurred within Brazoria County since 2018. Events that occurred within the City of Angleton are highlighted in purple.[38]

Table 6.9.4: Hail Events (2018-2024), Brazoria County

Date	Location	Event Type	Injuries	Fatalities	Property Damage	Crop Damage	Magnitude (in.)
5/26/2018	Manvel	Hail	0	0	$-	$-	1
5/26/2018	Manvel	Hail	0	0	$-	$-	0.75
5/26/2018	Angleton	Hail	0	0	$-	$-	0.75
2/26/2019	Iowa Colony	Hail	0	0	$-	$-	1
2/26/2019	Alvin	Hail	0	0	$-	$-	1
1/6/2021	Manvel Coyle Arpt	Hail	0	0	$-	$-	1
5/6/2022	Pearland Arpt	Hail	0	0	$-	$-	0.88
3/15/2024	Angleton Cameron ARP	Hail	0	0	$-	$-	1
3/15/2024	Angleton Bailes ARP	Hail	0	0	$-	$-	1.75
3/16/2024	Damon	Hail	0	0	$-	$-	1.5

Rows highlighted in purple are events that reference the City of Angleton within the event narrative or event location (beginning or end).
$- No dollar amount ($0.00).
ND- No Data

Presidential Disaster Declarations

There have been no disaster declarations in which hail was included Brazoria County.[1,2]

USDA Disaster Declarations

The Secretary of Agriculture is authorized to designate counties as disaster areas to make EM loans available to producers suffering losses in those counties and in counties that are contiguous to a designated county. In addition to EM loan eligibility, other emergency assistance programs, such as FSA disaster assistance programs, have historically used disaster designations as an eligibility trigger. USDA Secretarial disaster designations must be requested of the Secretary of Agriculture by a governor or the governor's authorized representative, by an Indian Tribal Council leader, or by an FSA SED. The Secretarial disaster designation is the most widely used. When there is a presidential disaster declaration, FEMA immediately notifies FSA of the primary counties named in a Presidential declaration. USDA Disaster Declarations for Brazoria County, in which the City of Angleton since the last HMP for this hazard are listed in the table below.[39]

Table 6.9.5: USDA Declared Disasters (2018-2023), Hail

Crop Disaster Year	Disaster Description	Designation Number
None		

Probability of Future Occurrences

Severe thunderstorms and hail associated with them are more likely to occur in summer months when temperatures are higher and moisture from the gulf helps to fuel thunderstorm development. According to the FEMA NRI for hail, annualized frequency values are 1.7 events per year over a 34-year period of record (1986-2021), with 54 events on record for this timeframe. [44]

Populations at Risk

Hail can occur during thunderstorms, but larger hail occurs more often during warmer months because the heat that builds the thunderstorms up higher in the air also strengthens these storms and can create sustained updrafts, as mentioned above. Populations most at risk for hail include outdoor workers, athletes, and pets/animals. Outdoor workers, such as farmers or landscapers have a higher chance of exposure to hail due to the nature of their work. Likewise, athletes can be caught in a hailstorm and are more exposed to their hazard when engaged in outdoor activities. Pets and animals are also at risk from hail due to their increased exposure to outdoor elements. To cause serious injury to humans and animals, hail would have to be relatively larger in size (1" or larger).

Any areas of growth or future development within the city could be impacted by this hazard because the entire region and county is vulnerable to hailstorms. As the population and development within the city increases, so does the vulnerability of residents and property to this hazard.

National Risk Index

FEMA's NRI utilizes data from multiple sources including historical hazard events, hazard intensity, exposure of people and property to hazards, socioeconomic factors, and community resilience indicators. The NRI also incorporates hazard data to determine the frequency and intensity of various natural hazards. This information helps assess the likelihood of specific hazards occurring in different regions.[44]

The NRI considers the exposure of communities to hazards and incorporates factors such as population density, infrastructure systems, and critical facilities that may be at risk during a hazard event. The NRI also generates risk scores for communities across the U.S. that provide a relative ranking of areas based on their overall risk level. This helps to identify areas that may require additional resources and attention for mitigation and planning efforts. The NRI risk equation includes 3 components. EAL represents the

average economic loss in dollars resulting from natural hazards each year, the Community Risk Factor is a scaling factor that incorporates social vulnerability (the susceptibility of social groups to the adverse impacts of natural hazards), and community resilience (the ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions). The outcome, the risk index, represents the potential negative impacts of natural hazards on the county level or individually by census tracts. The NRI EAL score and rating, represent a community's relative level of expected loss each year when compared to all other communities at the same level.[44]

EAL Exposure Values and EAL Values for Brazoria County can be found in the tables below.

Table 6.9.6: Expected Annual Loss Exposure Values, Hail

Hazard Type	Building Value ($)	Population Equivalence ($)/ Population (#)	Agricultural Value ($)	EAL Total ($)
Hail	$57,514,822,174	$4,309,098,400,000 / 371,474.00	$91,232,428	$4,366,704,454,602

Table 6.9.7: Expected Annual Loss Values, Hail

Hazard Type	Building Value ($)	Population Equivalence ($)/ Population (#)	Agriculture Value
Hail	$52,221	$283,548 / 0.02	$20,506

EAL for the City of Angleton was derived by creating a report that used census tract information for tracts that included the Angleton city limits. These were census tracts 48039662100, 48039662200, 48039662400, 48039662300, 48039662500, 48039663100, and 48039664100.[45]

EAL according to the FEMA NRI for hail events for these census tracts is listed as relatively low. EAL values, risk index ratings, risk index scores, social vulnerability, and community resilience for each census tract can be found in the figures below.[45] Additionally, the FEMA NRI lists the HLR, a hazard- and county-specific estimate of the percentage of the exposed consequence type (building value, population, or agriculture value) expected to be lost due to a hazard occurrence, for hail within Brazoria County as very low.[46]

Figure 6.9.2: Risk Index by Census Tract, Hail

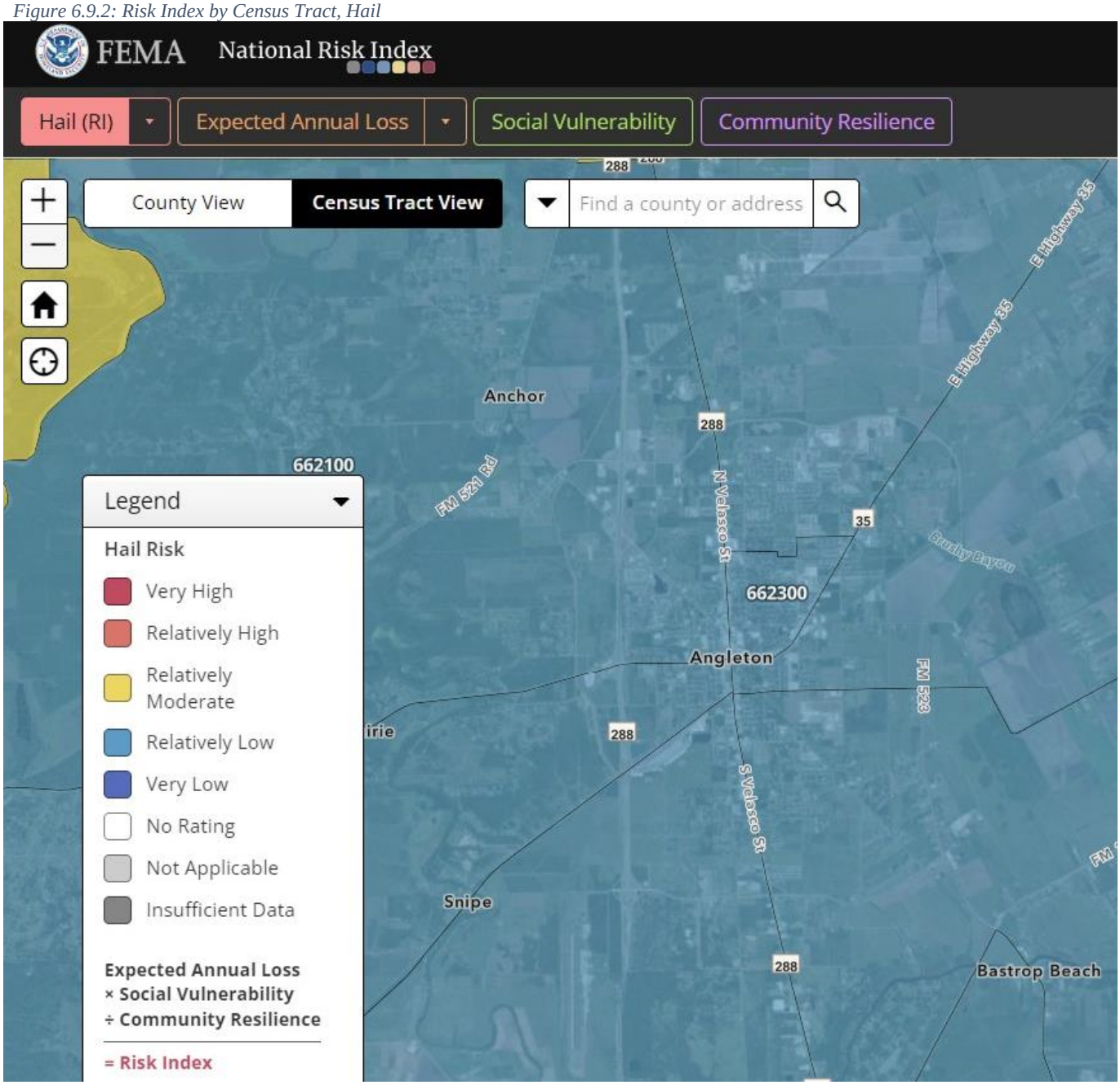


Figure 6.9.3: Social Vulnerability by Census Tract, City of Angleton

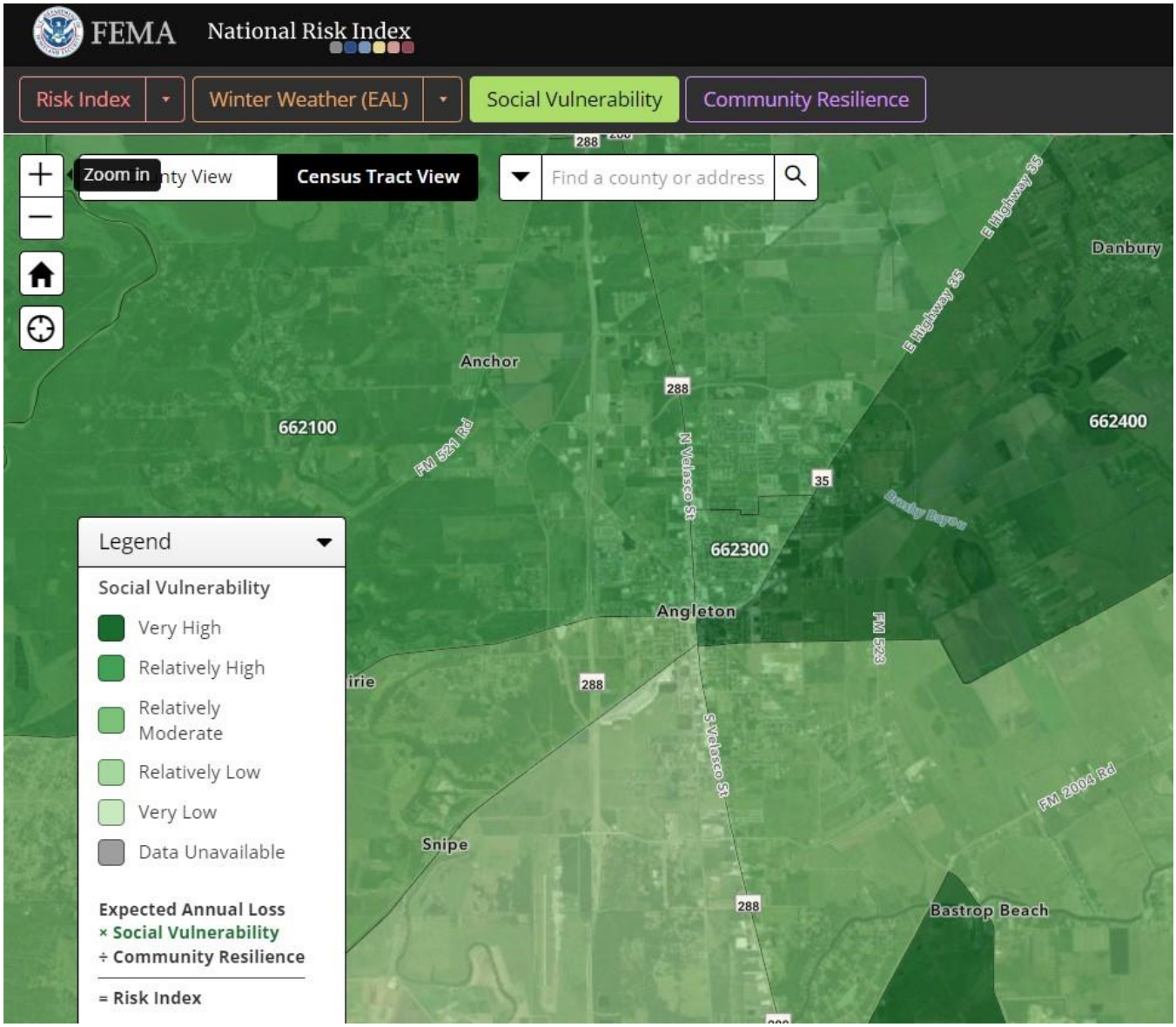


Figure 6.9.4: Community Resilience by Census Tract, City of Angleton

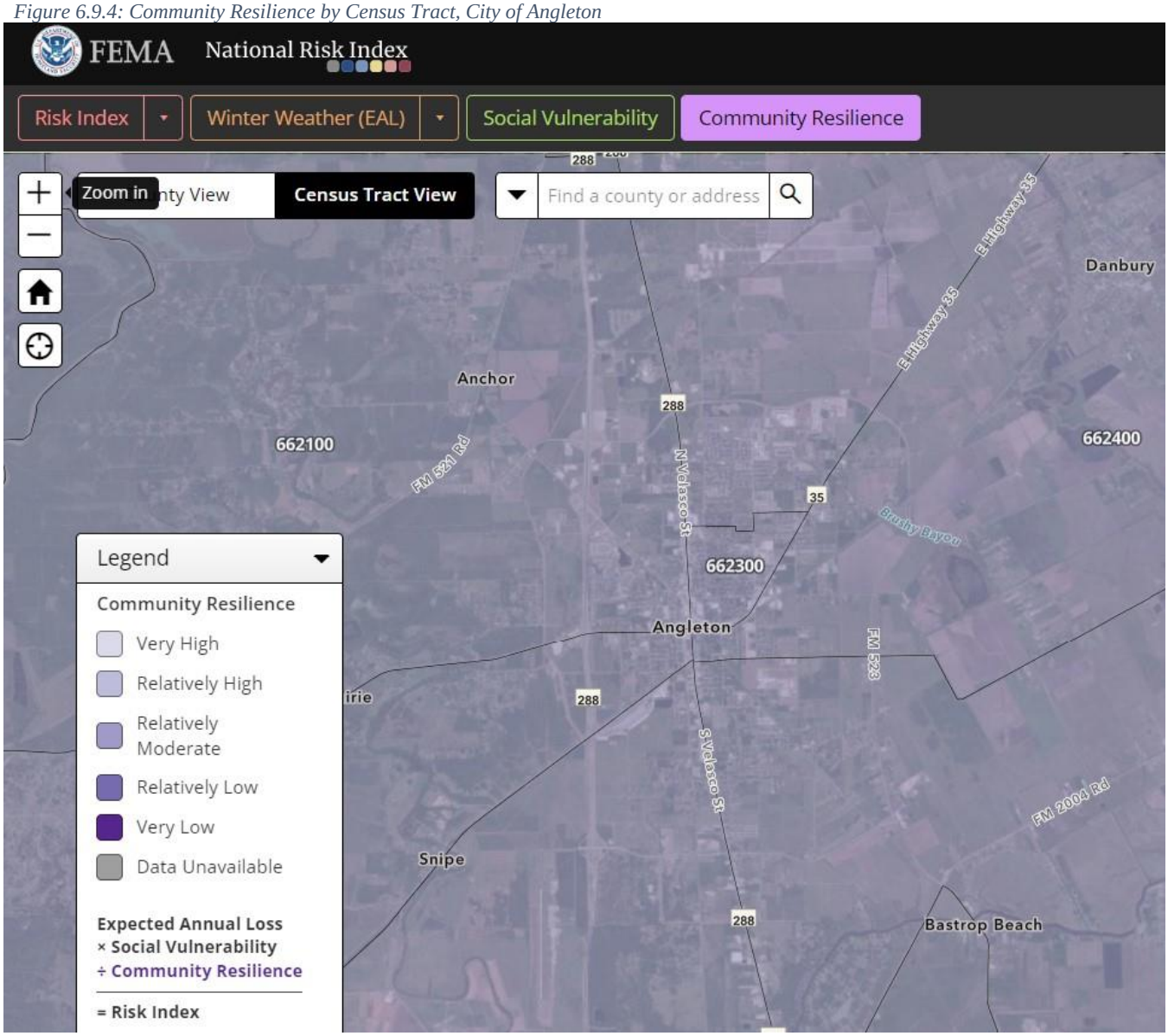


Figure 6.9.5: FEMA NRI Summary, Hail

Rank	Community	State	Risk Index Rating	Risk Index Score	National Percentile
1	Census tract 48039662200	TX	Relatively Low	69.71	0 100
2	Census tract 48039662400	TX	Relatively Low	67.81	0 100
3	Census tract 48039662100	TX	Relatively Low	66.94	0 100
4	Census tract 48039663100	TX	Relatively Low	65.41	0 100
5	Census tract 48039664100	TX	Relatively Low	63.35	0 100
6	Census tract 48039662300	TX	Relatively Low	62.73	0 100
7	Census tract 48039662500	TX	Relatively Low	58.02	0 100

Rank	Community	State	EAL Value	Social Vulnerability	Community Resilience	CRF	Risk Value	Risk Index Score
1	Census tract 48039662200	TX	$6,099	Relatively High	Relatively Moderate	1.34	$8,158	69.71
2	Census tract 48039662400	TX	$4,842	Very High	Relatively Moderate	1.43	$6,948	67.81
3	Census tract 48039662100	TX	$5,260	Relatively High	Relatively Moderate	1.22	$6,436	66.94
4	Census tract 48039663100	TX	$5,602	Relatively Low	Relatively Moderate	1	$5,607	65.41
5	Census tract 48039664100	TX	$4,497	Relatively Moderate	Relatively Moderate	1.05	$4,713	63.35
6	Census tract 48039662300	TX	$3,249	Relatively High	Relatively Moderate	1.38	$4,477	62.73
7	Census tract 48039662500	TX	$2,789	Relatively Moderate	Relatively Moderate	1.12	$3,115	58.02

Climate Change Impacts

Since tornadoes, windstorms, and hail are heavily associated with severe thunderstorm development, this section will mirror that of Section 6.8, seen previously. According to the Office of the Texas State Climatologist, the climate data record for severe thunderstorms is poor and severe thunderstorms are too small to be simulated directly by present-day climate models. Over the past few decades, the severe storm environment over Texas has changed in complex and opposing ways. The amount of energy available for convection has decreased, and the amount of energy needed to initiate convection has increased at the same time. This suggests that environmental conditions have become less favorable for the occurrence of thunderstorms. However, the amount of low-level shear has increased, which would be expected to make thunderstorms more likely to become severe once they develop. Changes in severe storm environments have not been uniform throughout the year, with environments becoming more favorable for severe thunderstorms and significant hail in Texas early in the spring and less favorable later in the spring. Warmer temperatures are likely to lead to less hail overall, particular during the summer, but increases in available thunderstorm energy may lead to an increase of the risk of very large hail earlier in springtime. With these complex trends and partially contradictory information between models and observations, there is low confidence in any ongoing trend in the overall frequency and severity of severe thunderstorms.[58]

Table 6.9.8: Climate Change Impacts Summary, Hail

Location	The location of hail is not expected to change.
Extent/Intensity	The extent and intensity of hail is not expected to change. However, environments are becoming more favorable for hail in early spring.
Frequency	There are no clear trends in the frequency of hail within the county.
Duration	The duration of hail is not expected to change.

Section 6.10: Windstorm

6.10 Windstorm

Damaging winds are often called straight-line winds to differentiate the damage they cause from tornadoes or other hazards. Winds that cause damage at the ground are a result of outflows generated by a thunderstorm downdraft. Damaging winds are classified as those exceeding 50-60 mph. Damage from severe winds accounts for half of all damage reports and is more common than damage from tornadoes. Wind speeds can reach up to 100 mph and can produce a damage path extending for hundreds of miles. These damaging winds are often associated with other hazards such as thunderstorms, tornadoes, hurricanes, tropical storms, and tropical depressions.[111] Windstorms, or damaging winds, include many different variations. These damaging wind types and their definitions from NOAA can be seen in the table below.[112]

Table 6.10.1: Types of Damaging Winds

Damaging Wind Type	Description
Straight-line Wind	Used to define thunderstorm wind, which is not linked with rotation and is mainly used to differentiate from tornadic winds
Down Draft	A small-scale column of air that sinks toward the ground
Macroburst	An outward burst of strong winds that are more than 2.5 miles in diameter, occurs when a strong downdraft reaches the surface
Microburst	A small, concentrated downburst that produces an outward burst of relatively strong winds near the surface. Microbursts are less than 4 km in diameter and short-lived, lasting only five to 10 minutes. Maximum wind speeds sometimes exceed 100 mph. There are two kinds of microbursts: wet and dry. • A wet microburst is accompanied by heavy precipitation at the surface. • A dry microburst is common in places like the high plains and occur with little or no precipitation reaching the ground.
Downburst	A general term to describe macro and microbursts
Gust Front	The leading edge of rain-cooled air that clashes with a warm thunderstorm inflow
Derecho	A widespread and long-lived windstorm is associated with rapidly moving showers or thunderstorms. A typical derecho consists of numerous microbursts, downbursts, and downburst clusters. If the wind damage swath extends more than 240 miles and includes wind gusts of at least 58 mph or greater along most of its length, then the event may be classified as a derecho.

Location

Similar to thunderstorms (Section 6.8), and the Tornado (Section 6.4) hazard profiles, windstorms/ damaging winds are not confined to any geographic boundaries and can occur anywhere if the right conditions are present. The entire county is at risk for this hazard type. Thunderstorms will typically occur in warmer months such as Summer and Spring, and during the warmest parts of the day. Warm, moist air from the Gulf of Mexico is readily available to help fuel atmospheric conditions that produce thunderstorms, and the damaging winds associated with them. The City of Angleton is in an area that can see anywhere from 63-72 thunderstorm days per year.[97]

Extent

Wind intensity is measured by the NWS through the Beaufort Wind Scale. One of the first scales to estimate wind speeds and their effects was created by Britain's Admiral Sir Francis Beaufort (1774-1857). He developed the scale in 1805 to help sailors estimate the winds via visual observations. The scale starts with 0 and goes to a force of 12. The Beaufort scale is still used today to estimate wind strengths.[113] The table below outlines the measurements used by the Beaufort Wind Scale for use on land.

Table 6.10.2: Beaufort Wind Scale

Force	Speed (mph)	Description	Specifications for use on land
0	0-1	Calm	Calm; smoke rises vertically.
1	1-3	Light Air	Direction of wind shown by smoke drift, but not by wind vanes.
2	4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary vanes moved by wind.
3	8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag.
4	13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved.
5	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets form on inland waters.
6	25-31	Strong Breeze	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.
7	32-38	Near Gale	Whole trees in motion; inconvenience felt when walking against the wind.
8	39-46	Gale	Breaks twigs off trees; generally impedes progress.
9	47-54	Severe Gale	Slight structural damage occurs (chimneypots and slates removed)
10	55-63	Storm	Seldom experienced inland; trees uprooted; considerable structural damage occurs.
11	64-72	Violent Storm	Very rarely experienced; accompanied by wide-spread damage.
12	72-83	Hurricane	Reference the Saffir-Simpson Hurricane Scale

Additionally, NOAA and the NWS issues watches, warnings, and advisories for wind events when wind speeds can pose a hazard or are life-threatening. Table 6.10.3 describes the various wind-related warnings, watches, and advisories below.[114]

Table 6.10.3: Wind-Related Warnings, Watches, and Advisories

Watch/ Warning/ Advisory	Description
High Wind Warning	Sustained, strong winds with even stronger gusts are happening. Seek shelter. If you are driving, keep both hands on the wheels and slow down.
High Wind Watch	Sustained, strong winds are possible. Secure loose outdoor items and adjust plans as necessary so you're not caught outside.
Wind Advisories	Strong winds are occurring but are not so strong as to warrant a High Wind Warning. Objects that are outdoors should be secured and caution should be taken if driving.
Hurricane Force Wind Warning	Hurricane Force Wind Warnings are issued for locations along the water when one or both of the following conditions are expected to begin within 36 hours and are not directly associated with a tropical cyclone: sustained winds of 64 knots or greater or frequent gusts (duration of two or more hours) of 64 knots (74 mph) or greater.

A worst-case scenario for this hazard would include a severe thunderstorm, hurricane, or tropical storm event that could produce hurricane-force winds of 72 mph or more, straight-line winds, downbursts, or derechos. These winds could damage critical infrastructure that lead to a power outage, blocked roadways, and even result in a loss of communication within the county if a radio or cell tower is destroyed. If the wind event occurs during a heat event or drought and disrupts power supply in the area for a prolonged amount of time, secondary hazards pose greater risks to citizens due to the heat. This scenario is similar to what occurred within the region during the 2024 derecho and Hurricane Beryl where power lines were destroyed by winds or tree debris in July when the region was under an excessive heat advisory, and restoration/repairs took longer to address than anticipated.

Historic Occurrences

NOAA collects historic climate data for the entire nation. NOAA's storm event data can be accessed on the NCEI Storm Events Database. These events are shown at the county level with some referencing a specific location, city, or zone. The database currently contains data from January 1950 to December 2023, as entered by NOAA's NWS. Due to changes in the data collection and processing procedures over time, there are unique periods of record available depending on the event type. The table below highlights events for this hazard that have occurred within Brazoria County from 1950-2023.[38]

Table 6.10.4: City of Angleton Wind Events (1950-2023)

Date	Location	Event Type	Injuries	Fatalities	Property Damage ($)	Crop Damage ($)	Wind Speed (knots/mph)
2/20/1997	Brazoria (Zone)	Strong Wind	0	0	$2,000	$-	ND
1/22/2017	Brazoria (Zone)	Strong Wind	0	0	$1,500	$-	38/43
TOTALS:			**0**	**0**	**$3,500**	**$-**	N/A

ND- No Data, N/A- Not Applicable
$- No dollar amount ($0.00).

Presidential Disaster Declarations

There have been 3 disaster declaration in which wind (straight-line winds) was included in the declaration title for Brazoria County. However, the declarations incident type differs.[1,2]

Table 6.10.5: Federal Disaster Declarations, Tornado/ Microburst

Declaration Date	Incident Type	Title	Disaster Number	Declaration Type
5/29/2015	Severe Storm	Severe storms, tornadoes, straight-line winds, and flooding	4223	Major Disaster Declaration
11/25/2015	Severe Storm	Severe storms, tornadoes, straight-line winds, and flooding	4245	Major Disaster Declaration
5/17/2024	Flood	Severe Storms, Straight-line Winds, Tornadoes, and Flooding	4781	Major Disaster Declaration

USDA Disaster Declarations

The Secretary of Agriculture is authorized to designate counties as disaster areas to make EM loans available to producers suffering losses in those counties and in counties that are contiguous to a designated county. In addition to EM loan eligibility, other emergency assistance programs, such as FSA disaster assistance programs, have historically used disaster designations as an eligibility trigger. USDA Secretarial disaster designations must be requested of the Secretary of Agriculture by a governor or the governor’s authorized representative, by an Indian Tribal Council leader, or by an FSA SED. The Secretarial disaster designation is the most widely used. When there is a presidential disaster declaration,

FEMA immediately notifies FSA of the primary counties named in a Presidential declaration. USDA Disaster Declarations for Brazoria County since 2018 are listed in the table below.[39]

Table 6.10.6: USDA Declared Disasters (2018-2023), Windstorm

Crop Disaster Year	Disaster Description	Designation Number
None		

Probability of Future Occurrences

Severe thunderstorms and their associated damaging winds are more likely to occur in summer months when temperatures are higher and moisture from the gulf helps to fuel thunderstorm development. According to the FEMA NRI for strong wind events, annualized frequency values are 1.1 events per year over a 34-year period of record (1986-2021), with 34 events on record for this timeframe.[44]

Populations at Risk

Populations at risk for strong wind events include similar groups to those listed under the Section 6.4 (Tornado) and Section 6.8 (Severe Thunderstorms & Lightning) hazard profiles. All residents within the county are exposed to this hazard. The impacts of strong winds on the life, health, and safety of City of Angleton residents depend on several factors, including the severity of the event and adequate warning time being provided to residents to secure projectiles and take shelter. Strong wind events can lead to a disruption in emergency response services, loss of electricity, loss of clean water, and delayed forms of necessary medical assistance while repairs are made to critical facilities or power is being restored within the county.

The NCHH summarizes at-risk populations for several hazards. For strong wind events, these include older adults, people experiencing homelessness, people with disabilities, and people with chronic health conditions. In addition to the dangers listed above, older adults can face social isolation, lack of electricity needed to run medical equipment, lack of access to a vehicle for evacuation, and lack of access to other critical supplies. Evacuation for these events is fast-paced, and older adults may not be able to seek adequate shelter or secure dangerous projectiles on their property before a wind event impacts their area. For people experiencing homelessness, adequate shelter is critical in keeping populations safe during these events as they are heavily associated with severe thunderstorms and even tornadoes. People with disabilities may require additional assistance to stay safe and prepare for these hazards and their after-effects such as creating a support network, finding accessible transportation to evacuate or get medical attention, and loss of power for needed medical equipment. Likewise, those with chronic health conditions may need similar assistance as those with disabilities. Residents impacted may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by the strong winds associated with severe thunderstorms or tornadoes can lead to further injury or loss of life. Socially vulnerable populations are most susceptible based on several factors, including their physical and financial ability to react or respond during or directly following a hazard event. These issues disproportionately affect low-income communities and families who may lack the resources to pay for damages to their homes, lack insurance, or lack the resources to replace home contents or personal belongings.[42] Those living in mobile/manufactured housing are also at greater risk from this hazard as even anchored mobile homes can be seriously damaged or destroyed when winds gust over 80 mph.[43]

National Risk Index

FEMA's NRI utilizes data from multiple sources including historical hazard events, hazard intensity, exposure of people and property to hazards, socioeconomic factors, and community resilience indicators. The NRI also incorporates hazard data to determine the frequency and intensity of various natural hazards. This information helps assess the likelihood of specific hazards occurring in different regions.[44]

The NRI considers the exposure of communities to hazards and incorporates factors such as population density, infrastructure systems, and critical facilities that may be at risk during a hazard event. The NRI also generates risk scores for communities across the U.S. that provide a relative ranking of areas based on their overall risk level. This helps to identify areas that may require additional resources and attention for mitigation and planning efforts. The NRI risk equation includes 3 components. EAL represents the average economic loss in dollars resulting from natural hazards each year, the Community Risk Factor is a scaling factor that incorporates social vulnerability (the susceptibility of social groups to the adverse impacts of natural hazards), and community resilience (the ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions). The outcome, the risk index, represents the potential negative impacts of natural hazards on the county level or individually by census tracts. The NRI EAL score and rating, represent a community's relative level of expected loss each year when compared to all other communities at the same level.[44]

EAL Exposure Values and EAL Values for Brazoria County can be found in the tables below.

Table 6.10.7: Expected Annual Loss Exposure Values, Strong Wind

Hazard Type	Building Value ($)	Population Equivalence ($)/ Population (#)	Agricultural Value ($)	EAL Total ($)
Strong Wind	$57,514,822,174	$4,309,098,400,000 / 371,474.00	$6,997,533	$4,366,613,222,174

Table 6.10.8: Expected Annual Loss Values, Strong Wind

Hazard Type	Building Value ($)	Population Equivalence ($)/ Population (#)	Agriculture Value
Strong Wind	$161,599	$50,688 / 0.00	$512

N/A- Not Applicable

EAL for the City of Angleton was derived by creating a report that used census tract information for tracts that included the Angleton city limits. These were census tracts 48039662100, 48039662200, 48039662400, 48039662300, 48039662500, 48039663100, and 48039664100.[45]

EAL according to the FEMA NRI for strong wind events for these census tracts is listed as relatively low, with one tract rating very low. EAL values, risk index ratings, risk index scores, social vulnerability, and community resilience for each census tract can be found in the figures below. Additionally, the FEMA NRI lists the HLR, a hazard- and county-specific estimate of the percentage of the exposed consequence type (building value, population, or agriculture value) expected to be lost due to a hazard occurrence, for strong wind events within Brazoria County is listed as very low.[46]

Figure 6.10.1: Risk Index by Census Tract, Strong Wind

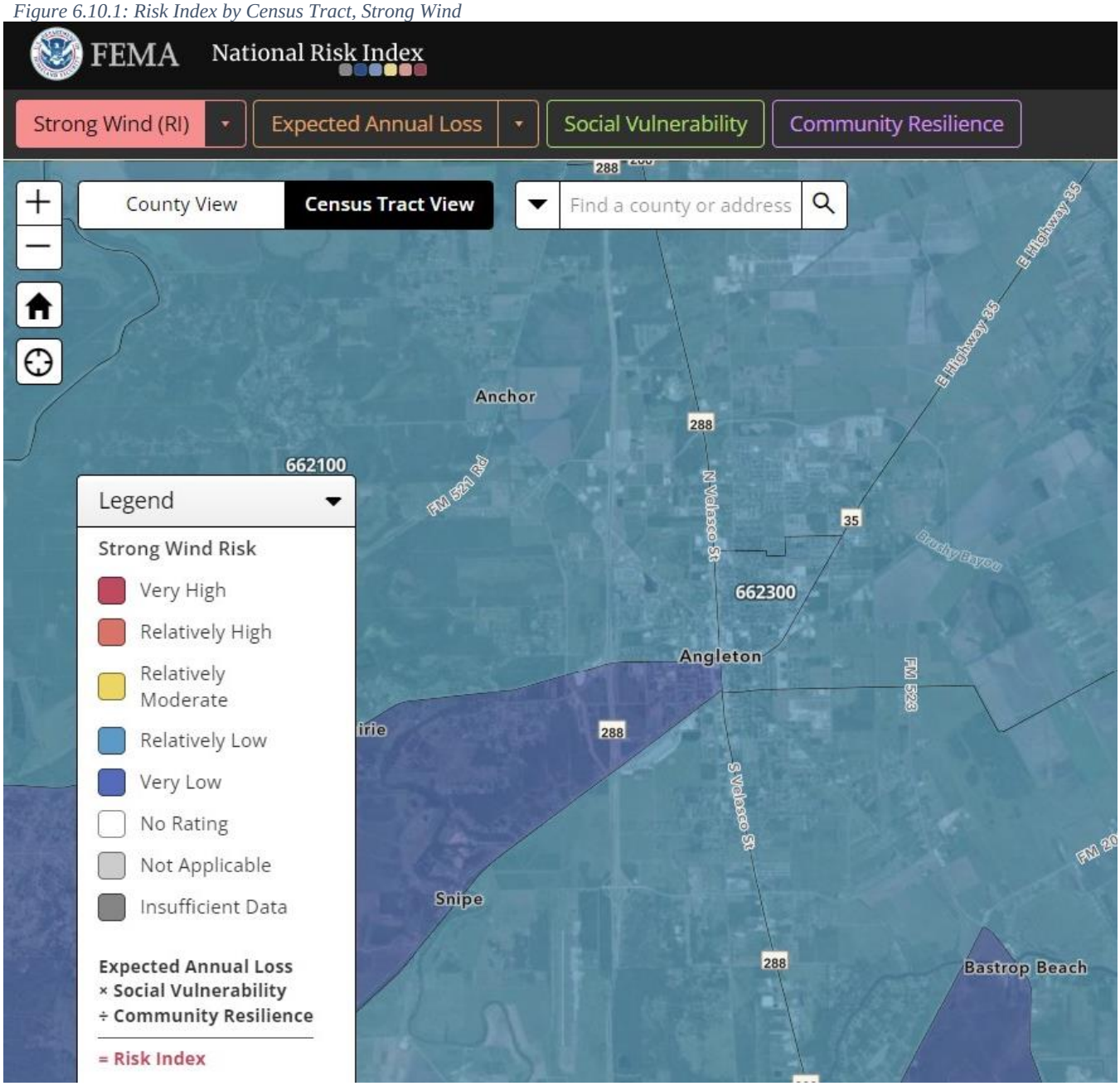


Figure 6.10.2: Social Vulnerability by Census Tract, City of Angleton

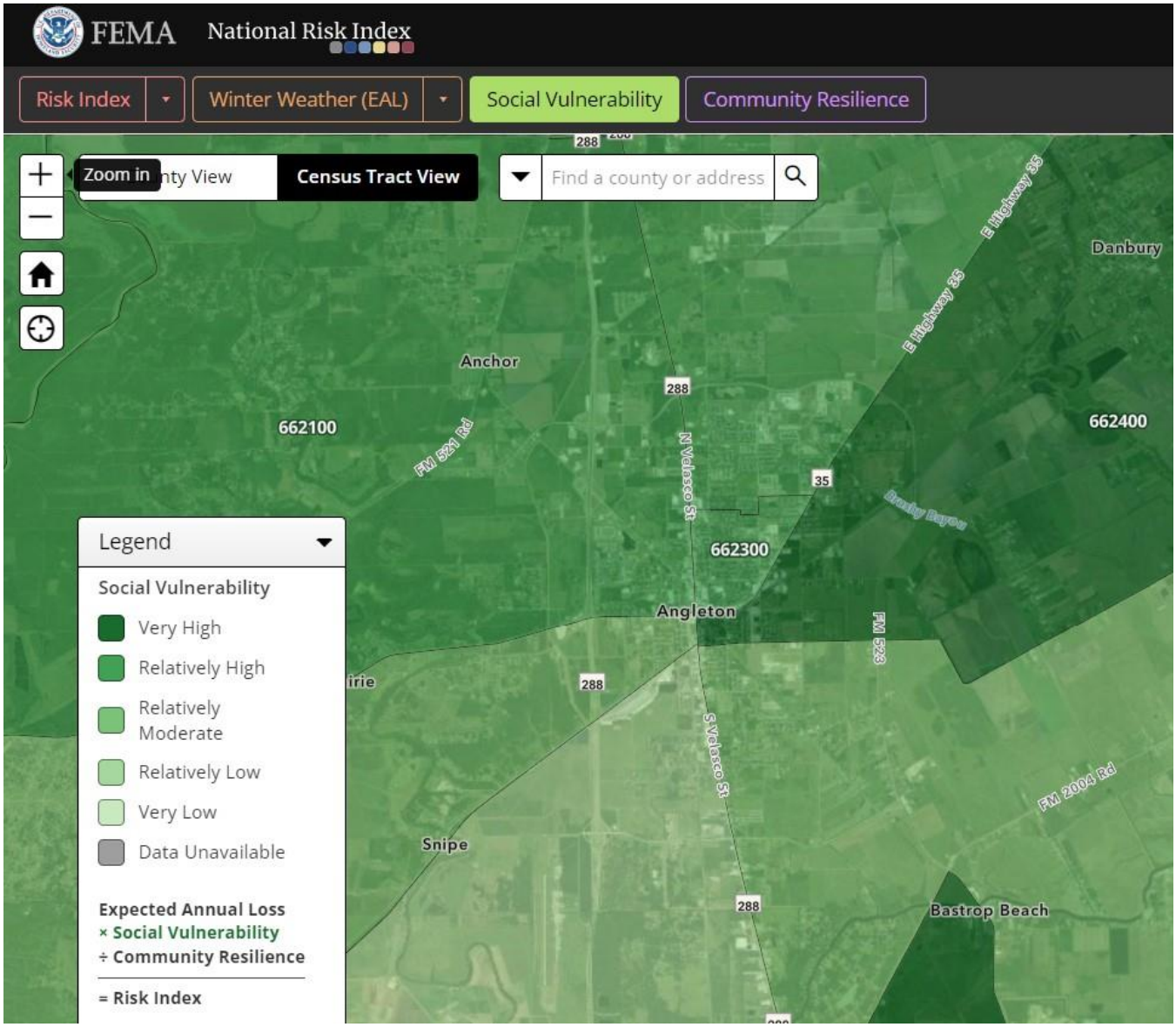


Figure 6.10.3: Community Resilience by Census Tract, City of Angleton

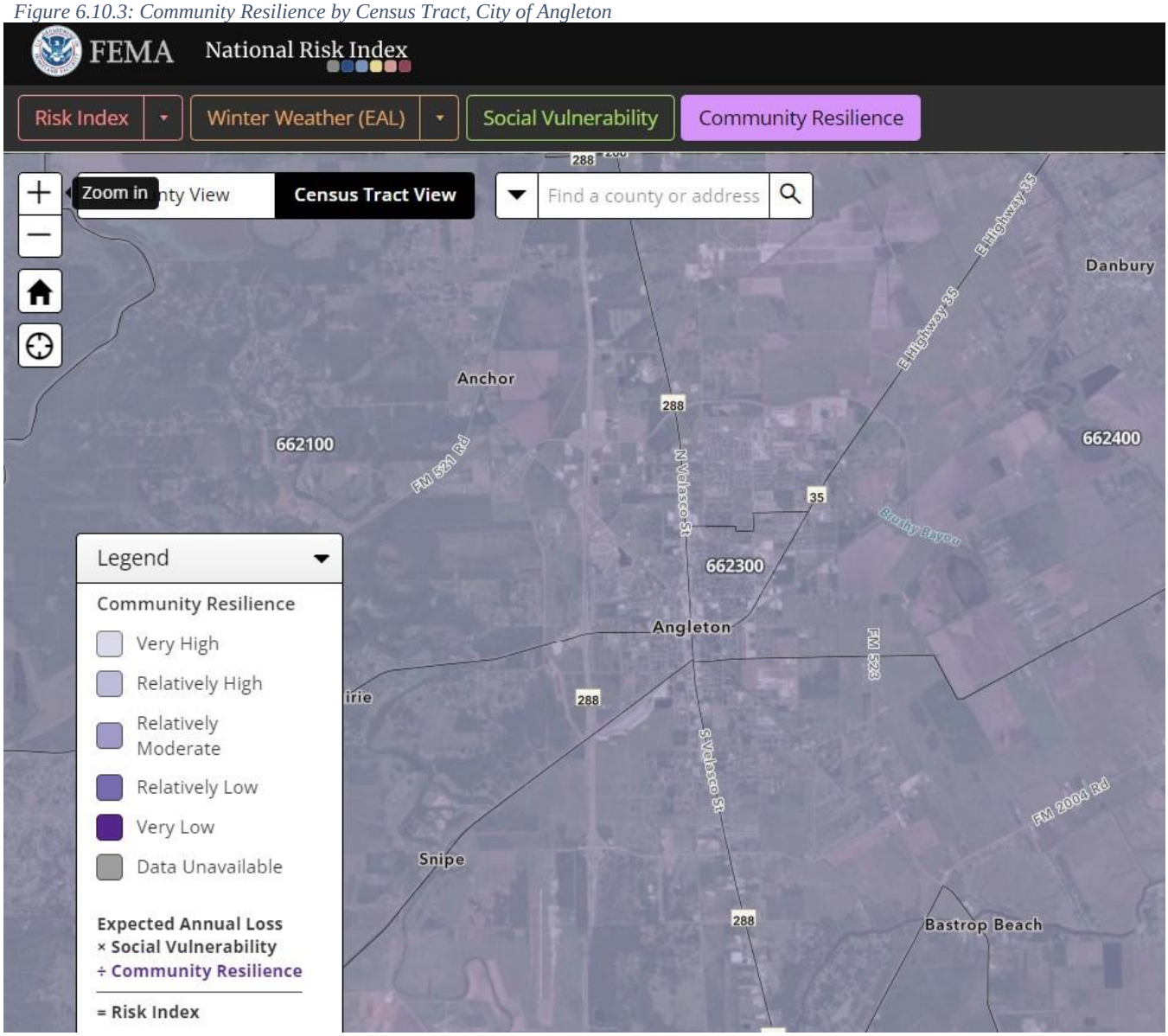


Figure 6.10.4: FEMA NRI Summary, Strong Wind

Rank	Community	State	Risk Index Rating	Risk Index Score	National Percentile
1	Census tract 48039662400	TX	Relatively Low	33.37	0 100
2	Census tract 48039662200	TX	Relatively Low	33.2	0 100
3	Census tract 48039662100	TX	Relatively Low	32.02	0 100
4	Census tract 48039663100	TX	Relatively Low	31.69	0 100
5	Census tract 48039664100	TX	Relatively Low	28.89	0 100
6	Census tract 48039662300	TX	Relatively Low	27.75	0 100
7	Census tract 48039662500	TX	Very Low	23.5	0 100

Rank	Community	State	EAL Value	Social Vulnerability	Community Resilience	CRF	Risk Value	Risk Index Score
1	Census tract 48039662400	TX	$2,831	Very High	Relatively Moderate	1.43	$4,062	33.37
2	Census tract 48039662200	TX	$3,010	Relatively High	Relatively Moderate	1.34	$4,026	33.2
3	Census tract 48039662100	TX	$3,026	Relatively High	Relatively Moderate	1.22	$3,702	32.02
4	Census tract 48039663100	TX	$3,629	Relatively Low	Relatively Moderate	1	$3,632	31.69
5	Census tract 48039664100	TX	$2,796	Relatively Moderate	Relatively Moderate	1.05	$2,930	28.89
6	Census tract 48039662300	TX	$1,942	Relatively High	Relatively Moderate	1.38	$2,676	27.75
7	Census tract 48039662500	TX	$1,601	Relatively Moderate	Relatively Moderate	1.12	$1,788	23.5

Climate Change Impacts

Since windstorms and strong winds are heavily related to severe thunderstorm development, this section will mirror that of Section 6.8 seen previously. According to the Office of the Texas State Climatologist, the climate data record for severe thunderstorms is poor and severe thunderstorms are too small to be simulated directly by present-day climate models. Over the past few decades, the severe storm environment over Texas has changed in complex and opposing ways. The amount of energy available for convection has decreased, and the amount of energy needed to initiate convection has increased at the same time. This suggests that environmental conditions have become less favorable for the occurrence of thunderstorms. However, the amount of low-level shear has increased, which would be expected to make thunderstorms more likely to become severe once they develop.

Changes in severe storm environments have not been uniform throughout the year, with environments becoming more favorable for severe thunderstorms and significant hail in Texas early in the spring and less favorable later in the spring. Strong winds associated with severe storms occur most often during the months of May and June. Climate model simulations imply different prospects in the future. As temperatures increase, the amount of energy available to fuel these storms is simulated to increase as temperature and low-level moisture increase. This results in an overall increase in the number of days capable of producing severe thunderstorms. With these complex trends and partially contradictory

information between models and observations, there is low confidence in any ongoing trend in the overall frequency and severity of severe thunderstorms.[58]

Table 6.10.9: Climate Change Impacts Summary, Windstorm

Location	The location of windstorms is not expected to change.
Extent/Intensity	The extent and intensity of windstorms within the county may change (increase) due to increased temperatures and energy available to fuel severe thunderstorms.
Frequency	There are no clear trends in windstorm frequency just as there are no clear trends in severe thunderstorm frequency. This is due to considerable variability in conditions that lead to them occurring. However, these hazards occur most frequently in warmer months, around May and June.
Duration	The duration of windstorms is not likely to change, however, the intensity of them is expected to increase due to rising temperatures and the proximity of the county to the Gulf of Mexico aiding to fuel thunderstorms.

Section 6.11: Erosion

6.11 Erosion

Soil erosion consists of a series of natural processes that move earth and rock material. The land surface is worn away through the detachment and transport of soil and rock by moving water, wind, and other geologic agents.[115] Erosion removes topsoil (areas with the highest levels of organic matter and nutrients), reduces levels of organic matter within the soil, and creates a less favorable environment for plants due to breakdown within the soil structure. The different types of erosion are described in table 6.11.1 below.

FEMA defines erosion as "The process of the gradual wearing away of land masses. Erosion can occur along coasts and rivers and streams." Although flood-related erosion is covered by flood insurance, this hazard is not covered under the NFIP. The mapping and regulatory standards of the NFIP do not currently address erosion, however, CRS credit is given to communities that include this hazard in their regulations, planning, public information, hazard disclosure, and flood warning programs. For example: communities that have established setbacks and other requirements in areas subject to erosion.

Table 6.11.1: Types of Erosion[116]

Type of Erosion	Description
Wind Erosion	Wind erosion is a natural process that moves loose soil from one location to another. Wind erosion can harm the fields where it picks up soil, as well as the areas where the dirt—and whatever minerals and contaminants it includes—are deposited. It can also have health impacts: worsening air quality, obscuring visibility, and causing people to experience breathing difficulties.
Water Erosion, Rainfall	Occurs when the rainfall intensity that hits the ground exceeds the absorbing capacities or the infiltration rate of soil affected. This leads to soil in water runoff and sediment transport to waterways resulting in deterioration in soil and water quality.
Water Erosion, Sheet	Sheet erosion is the removal of soil in thin, uniform layers (sheets) by raindrop impact and shallow surface water flow. Sheet erosion can sometimes be difficult to detect unless the soil is deposited nearby or if the damage is already severe. This erosion process removes the fine soil particles that contain most of the important nutrients and organic matter.
Water Erosion, Rill	Occurs when runoff becomes concentrated enough to cut small rivulets in the soil that carry sediment down hillsides.
Water Erosion, Gully	Gully Erosion is the washing away of soil through deep grooves or channels across unprotected land. Gully erosion can refer to soil being washed away through human-made drainage lines or describe the process of soil traveling through grooves created by hard rains. Farmers will typically fill these grooves back in with fresh soil as a temporary solution. Gully erosion can hinder the ability to plow fields and grow crops.
Water Erosion, Bank	The progressive undercutting, scouring, and slumping of natural rivers and streams as well as man-made drainage channels by the intense movement of water. When land managers remove vegetation or ranchers allow their livestock to overgraze the land near streams and riverbanks, it can exacerbate the problem.

Location

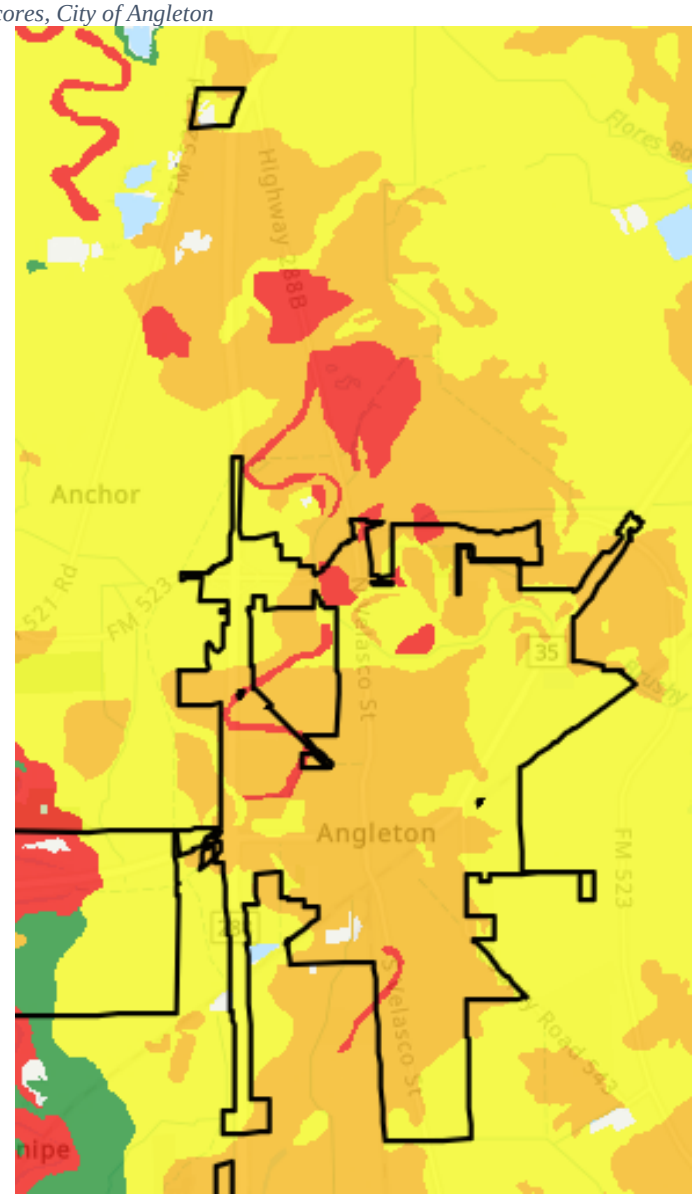
Soil erosion is typically measured in a variety of ways, both qualitative and quantitative. Within the county, inland erosion due to water is the main hazard of concern. One method is the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE). Potential erodibility for sheet and rill erosion is estimated by multiplying the following factors of the Universal Soil Loss Equation USLE: Rainfall and runoff factor (R), Susceptibility of the soil to water erosion (K), and Combined effects of slope length and steepness (LS). The K factor represents the susceptibility of soil to water erosion.[117] Past management or misuse of a soil by intensive cropping can increase a soil's erodibility. The K factor may need to be increased if the subsoil is exposed or where the organic matter has been depleted, the soil's

structure destroyed, or soil compaction has reduced permeability.[118] Table 6.11.2 below shows K factor scores, soil descriptions, and their associated soil erodibility. Figure 6.11.1 depicts these k-factors within the City of Angleton. K-factors with high erodibility of 0.4 or greater are depicted in red. The legend breaks down the soil erodibility factor and how they were colored on the map. There are very few areas within the city that have a high erodibility score.

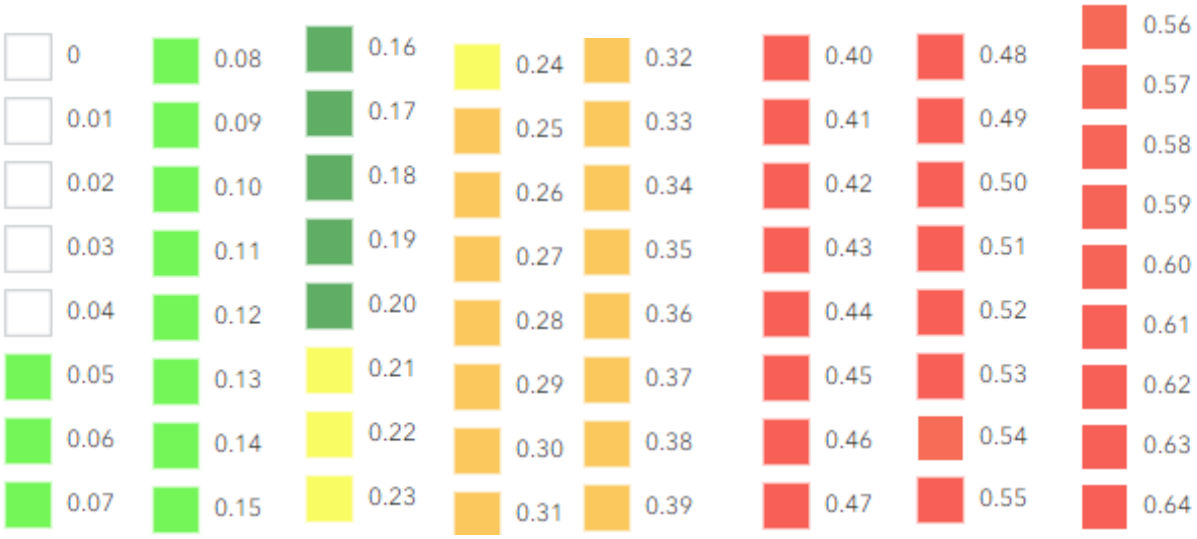
Table 6.11.2: K Factor, Soil Erodibility Scores

K-Factor	Soil Description	Erodibility
0.05 to 0.15	High in clay	Resistant to detachment
0.05 to 0.2	Coarse textured soils, such as sandy soils	Low runoff, easily detached
0.25 to 0.4	Medium textured soils, such as the silt loam soils	Moderately susceptible to detachment and they produce moderate runoff
>0.4	Soils with a high silt content	Most erodible of all soils, easily detached; tend to crust and produce high rates of runoff

Figure 6.11.1: Soil Erodibility Scores, City of Angleton



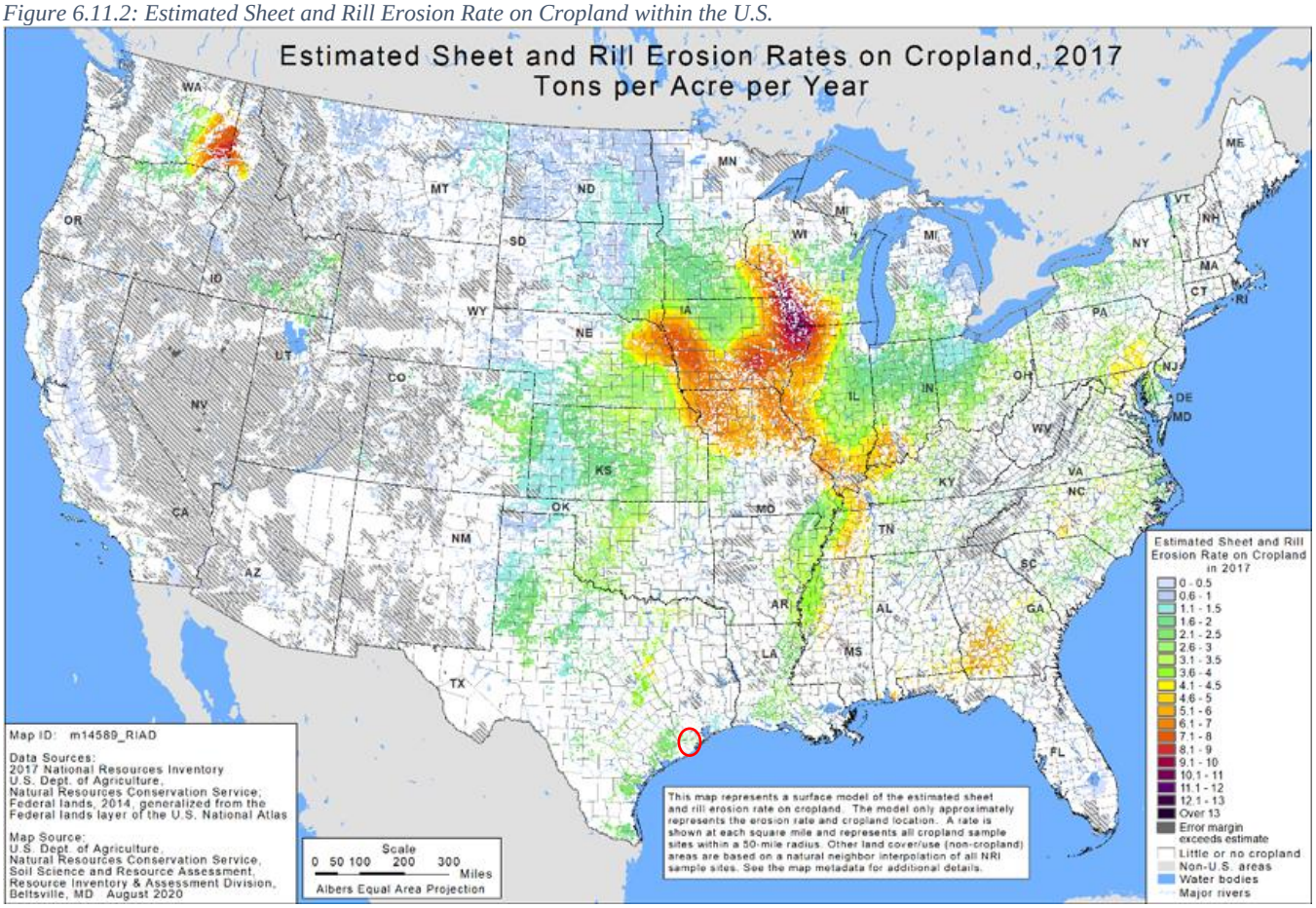
Legend- Soil Erodibility, K Factors



Extent

Soil erosion and its risk of occurring is difficult to measure without proper documentation techniques in place. Measuring certain properties in specific locations in the field, such as the surface and aggregate stability of the soil, infiltration rates, organic matter content, and sediment delivery ratios are all necessary components to quantify the rate of erosion in a given area Furthermore, using these quantitative measurements with photographs or visual observations of the soil or landmarks at specific locations would help to paint a clearer picture if erosion is occurring or likely to occur. Soil erosion rates on cropland within the U.S. decreased 35 percent between 1982 and 2017. The water (sheet and rill) erosion rate declined from 3.89 tons per acre per year to 2.67 tons per acre per year, and the erosion rate due to wind decreased from 3.24 tons per acre per year to 1.96 tons per acre per year.[119] Figure 6.11.2 shows the estimated sheet and rill erosion rates on cropland in tons per acre per year within the U.S. The rate of erosion due to sheet and rill within areas of Brazoria County ranged from 2.1 to 2.5 tons per acre per year. Within the City of Angleton has very few areas of erodible soils within the city limits (as seen above). This map is derived from the 2017 summary resource report developed by the U.S. Department of Agriculture Natural Resources Conservation Service. It is the most recent report available and was published in 2020.

Figure 6.11.2: Estimated Sheet and Rill Erosion Rate on Cropland within the U.S.



A worst-case scenario for this hazard would be a heavy rainfall event that created major flooding conditions within the Brazos River and leading to stream bank erosion and flooding from the river cresting. This happened most recently in May 2024 when rainfall caused the Brazos River to reach major flood stage. This resulted in lowland flooding, impassable roads, high water areas, and water in homes. In 2017 the river reached historic flood stage levels due to precipitation from Hurricane Harvey.[120]

Historic Occurrences

Presidential Disaster Declarations

There have been no disaster declarations for erosion within Brazoria County, in which the City of Angleton is located, since 1950.[1,2]

USDA Disaster Declarations

The Secretary of Agriculture is authorized to designate counties as disaster areas to make EM loans available to producers suffering losses in those counties and in counties that are contiguous to a designated county. In addition to EM loan eligibility, other emergency assistance programs, such as FSA disaster assistance programs, have historically used disaster designations as an eligibility trigger. USDA Secretarial disaster designations must be requested of the Secretary of Agriculture by a governor or the governor's authorized representative, by an Indian Tribal Council leader or by an FSA SED. The Secretarial disaster designation is the most widely used. When there is a presidential disaster declaration, FEMA immediately notifies FSA of the primary counties named in a Presidential declaration. USDA Disaster Declarations for Brazoria County since 2018 are listed in the table below.[39]

Table 6.11.3: USDA Declared Disasters (2018-2023), Erosion

Crop Disaster Year	Disaster Description	Designation Number
None		

Probability of Future Occurrences

As mentioned above, the rate of erosion on croplands has been decreasing across the U.S. over time. It is hard to estimate the probability of future occurrence for this hazard due to a lack of data regarding previous erosion events through any formal system. This noted data deficiency is addressed by Action Item A5.

Populations at Risk

Populations at risk from erosion include those who work in agricultural fields. Erosion can greatly affect agriculture production through lost revenue and agricultural production. Those who own private property particularly along areas near creek and rivers may be more susceptible to this hazard as river cresting can exacerbate erosion damage that could require costly repairs and infrastructure reinforcement. The FEMA NRI does not account for erosion within its various analysis of natural hazards.

Areas of growth or future development within the city that are in close proximity to the Brazos River or other streams and creeks could be impacted by this hazard. Future development occurring in these areas would increase the vulnerability to impacts. As the population within the county increases by these waterbodies, so does the vulnerability of residents and property downstream with Angleton.

Climate Change Impacts

Climate change can increase the impacts felt from water erosion from more frequent and intense rainfall, longer periods of extreme heat and drought can lead to an increase in wind erosion, and as wildfires destroy areas- the loss of vegetation and groundcover are more prone to erosion by both wind and water. In

addition, soil erosion can drive climate change. Soil is a vast storage center for carbon dioxide, organic matter, and microbes. When soil becomes degraded it can release carbon back into the atmosphere.[58]

Table 6.11.4: Climate Change Impacts, Erosion

Location	The location of erosion is not expected to change.
Extent/Intensity	The extent of erosion is not expected to change.
Frequency	The frequency of erosion is not expected to change. The rate of erosion on croplands have been decreasing across the U.S. over time. Frequency of this hazard is difficult to estimate.
Duration	The duration of erosion is not expected to change.

Section 6.12: Emerging Infectious Diseases

6.12 Emerging Infectious Diseases

Emerging Infectious Diseases (EID) are defined by the National Institute of Allergy and Infectious Diseases as "infectious diseases that have newly appeared in a population or have existed but are rapidly increasing in incidence or geographic range."[121] Similarly, a pandemic is a disease outbreak that spans several countries and affects many people. Pandemics are most often caused by viruses which can easily spread from person to person.[122] This hazard profile will refer to EID and use the 2019 coronavirus, SARS-CoV-2, pandemic to give a clearer picture of the risk and vulnerability of this new hazard of concern for the county.

Location

The risk of EID applies the same to the entire county as this hazard has no geographic boundaries. However, areas that are more densely populated can contribute to the rapid spread of EID.

Extent

The extent of an infected population depends on how the illness is spread and methods of transmissibility and detection. In areas that are more densely populated, contact between infected and uninfected individuals may be greater than in rural areas leading to more chances for infection.

Historic Occurrences

Pandemics can emerge anywhere and quickly spread. It is difficult to predict when or where the next pandemic will occur.[123] According to the CDC, five pandemics have occurred in the United States since 1918. The table below outlines these pandemics, when they occurred, and their underlying cause.[124]

Table 6.12.1: Historic Pandemic Occurrences in the US

Pandemic Name	Estimated Deaths (US only)	Cause
1918 Pandemic	675,000	Influenza virus, H1N1
1957- 1958 Pandemic	116,000	Influenza virus, H2N2
1968 Pandemic	100,000	Influenza virus, H3N2
2009 H1N1 Pandemic	12,469	Influenza virus, H1N1 pdm09 virus
2020 Covid-19 Pandemic	1,181,607	SARS-CoV-2 virus

Presidential Disaster Declarations

There have been 2 federally declared emerging infectious disease related disaster declarations in Brazoria County, in which the City of Angleton is located, for EID listed under biological incidents.[1,2]

Table 6.12.2: Federal Disaster Declarations for Emerging Infectious Diseases

Date	Disaster Number	Declaration Types	Incident Type	Declaration Title
3/13/2020	3458	Major Disaster Declaration	Biological	Covid-19
3/25/2020	4485	Emergency Declaration	Biological	Covid-19 Pandemic

USDA Disaster Declarations

The Secretary of Agriculture is authorized to designate counties as disaster areas to make EM loans available to producers suffering losses in those counties and in counties that are contiguous to a designated county. In addition to EM loan eligibility, other emergency assistance programs, such as FSA disaster assistance programs, have historically used disaster designations as an eligibility trigger. USDA Secretarial disaster designations must be requested of the Secretary of Agriculture by a governor or the governor's authorized representative, by an Indian Tribal Council leader, or by an FSA SED. The Secretarial disaster designation is the most widely used. When there is a presidential disaster declaration,

FEMA immediately notifies FSA of the primary counties named in a Presidential declaration. USDA Disaster Declarations for Brazoria County since 2018 are listed in the table below.[39]

Table 6.12.3: USDA Declared Disasters (2018-2023), Emerging Infectious Diseases

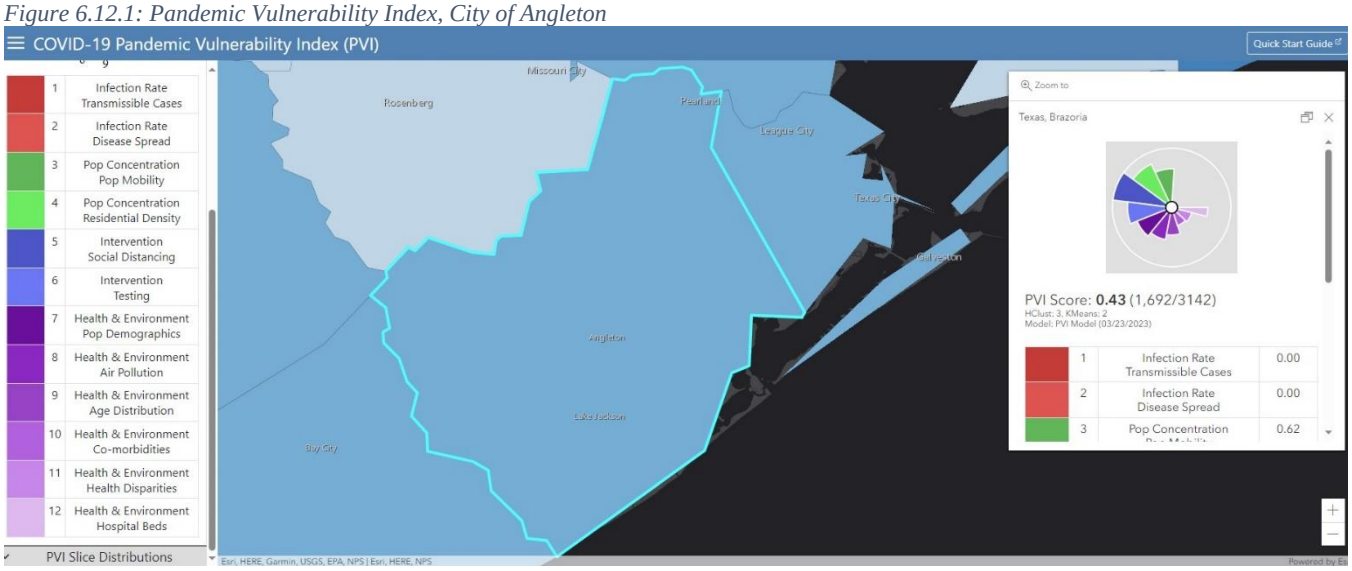
Crop Disaster Year	Disaster Description	Designation Number
None		

Probability of Future Occurrences

EID and pandemics can emerge anywhere and quickly spread. It is difficult to predict when or where the next pandemic will occur. As seen in The National Center for Biotechnology Information review titled "The consequences of human actions on risks for infectious diseases", The number of events of emerging infections has been increasing over the last 100 years. EIDs have been reviewed extensively during the last two decades, and it is now generally accepted that most drivers of emerging diseases are ecological, and the majority of these caused by anthropogenic influences such as increased travelling and transport of animals and goods; changes in ecosystems; deforestation and reforestation; altered land use; increased irrigation and creation of water dams and reservoirs; and urbanization.[125]

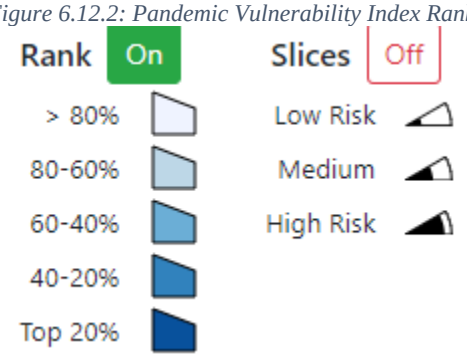
The National Institute of Environmental Health Sciences developed the COVID-19 Pandemic Vulnerability Index (PVI) Dashboard. This Dashboard creates risk profiles, called PVI Scorecards, for each county in the United States. The PVI summarizes and visualizes overall risk in a radar chart, which is a type of pie chart with various data sources comprising each slice of the pie. The city of Angleton saw 114,526 Covid-19 cases and 1,025 deaths during the most recent pandemic. As seen in the figure below, Brazoria County's PVI score is 0.43.[126]

Figure 6.12.1: Pandemic Vulnerability Index, City of Angleton



The slices shown in the chart to the right indicate a different data source (as described on the left of the figure). The information from each slice is combined to generate a PVI score for each county. A 0.43 PVI score puts Brazoria in the > 80% vulnerability ranking. Additionally, the bigger the "slice" shown for each item in the pie chart indicates the county has a higher risk for that area.

Figure 6.12.2: Pandemic Vulnerability Index Ranking Legend



Populations at Risk

EID can vary on severity for different populations based on age, underlying conditions, and how the disease is spread. The last 5 pandemics experienced in the US were respiratory illnesses. Populations that were/are most at risk include people who are older, those with heart or lung conditions, people with compromised immune systems, and people who are obese or diabetic.[127] As the county and city continue to grow, the vulnerability of residents to this hazard will also grow. Any areas of future development could be exposed to this hazard, especially if locations built draw people to gather.

Climate Change Impacts

According to the CDC, milder winters, warmer summers, and fewer days of frost make it easier for these and other infectious diseases to expand into new geographic areas and infect more people. As climate changes, new infections may emerge that threaten human health or livelihood.[128]

Table 6.12.4: Climate Change Impacts Summary, Emerging Infectious Diseases

Location	The location of EID is expected to increase in urban areas of the county.
Extent/Intensity	The extent and intensity of EID is expected to increase.
Frequency	Frequency of EID is expected to increase.
Duration	There is no clear trend in duration of EID.

Section 6.13: Cybersecurity

6.13 Cybersecurity

The Internet has improved communication, innovation, and access to information, however due to its largely open and unregulated nature municipal governments are more vulnerable to the hazards associated with cybersecurity threats and incidents. FEMA defines cyberattacks as "malicious attempts to access or damage a computer or network system." Cyberattacks can lead to the loss of money or the theft of personal, financial, and medical information." Cybersecurity involves preventing, detecting, and responding to those cyberattacks that can have wide-ranging effects on individuals, organizations, the community, and the nation.[129] Cyber terrorism refers to an attack on information technology itself in a way that would radically disrupt networked services. For example, cyber terrorists could disable networked emergency systems or hack into networks housing critical financial information. Cyber-attacks can take many forms. They can use computers, mobile phones, gaming systems and other devices, they can include fraud or identity theft, block access or delete personal documents and pictures, may target children, and may cause problems with business services, transportation, and power.[130] The table below outlines some key terms and definitions for this hazard of concern.

Table 6.13.1: Key terms and definitions for Cybersecurity

Key terms	Definition
Threat actor	Who is behind the event? This could be the external "bad guy" that launches a phishing campaign or an employee who leaves sensitive documents in their seat back pocket.
Threat action	What tactics (actions) were used to affect an asset? The seven primary categories of threat actions include: Malware, Hacking, Social, Misuse, Physical, Error and Environmental.
Incident	A security event that compromises the integrity, confidentiality or availability of an information asset.
Breach	An incident that results in the confirmed disclosure—not just potential exposure—of data to an unauthorized party. A Distributed Denial of Service (DDoS) attack, for instance, is most often an incident rather than a breach, since no data is exfiltrated. That doesn't make it any less serious.

Location

These attacks have no set geographic boundary and can occur anywhere, facilitated by the internet. Cybersecurity is an evolving, borderless challenge especially if there are vulnerabilities in software, unsecure or weak passwords, social engineering attacks, and unsecure internet connections.

Extent

The effect of a cyber-attack event can vary depending on the type of attack and the magnitude of the event or events. According to the Verizon Data Breach Investigations Report (DBIR), "There are four key paths leading cyber-attacks: Credentials, Phishing, Exploiting vulnerabilities, and Botnets. All four are pervasive in all areas of the DBIR, and no organization is safe without a plan to handle each of them."[131]

Historic Occurrences

There have been no historic occurrences or documented cyber-attacks within the City of Angleton. According to the Verizon DBIR, the North American Region (comprised of the US and Canada) has experienced 9,036 cybersecurity incidents, 1,924 of those with confirmed data disclosure between November 1, 2021, through October 31, 2022. 85% of breaches were due to system intrusion, basic web application attacks and social engineering. Threat actors for these breaches included external (94%), internal (12%), multiple (9%), and partner (2%). Motives for these cyber-attacks were financial (99%), espionage (1%), and grudge (1%). Data comprised included credentials (67%), internal (50%), personal (38%), and other (24%).[127]

Presidential Disaster Declarations

There have been no federally declared cyber-attack or cyber terrorism-related disaster declarations in Brazoria County, in which the City of Angleton is located, since 1950. [1,2]

USDA Disaster Declarations

Cyber-attacks and cyber terrorism are a human-caused hazard, there are no USDA Disaster Declarations associated with the hazard.[39]

Probability of Future Occurrences

As cybercriminals become more sophisticated in the future, the county's vulnerability to cyber-attacks may change significantly. It is difficult to predict the probability of future occurrences due to the unpredictable nature of this hazard. Opportunistic criminals might also leverage natural disasters to target already vulnerable systems.

To decrease the number of future cybersecurity related attacks, FEMA suggests a variety of prevention methods that can be incorporated now, such as: keeping anti-virus software updated, using strong passwords. Changing passwords monthly, watching for suspicious activity, checking account statements and credit reports regularly, using secure internet communications, using a Virtual Private Network that creates a secure connection, using antivirus solutions (malware, and firewalls) to block threats., regularly back up files in an encrypted file or encrypted file storage device, limiting any personal information shared online, changing privacy settings, and protecting home networks.[132]

Populations at Risk

Everyone is equally at risk for this hazard within Brazoria County and the City of Angleton. As the US becomes increasingly reliant on technology, the vulnerability to cyber threats will increase. A significant number of people fear data breaches as the outcomes result in disruptions to sectors like transportation and healthcare and include societal impacts like mistrust.

Climate Change Impacts

Terrorism is a human-caused hazard, no climate change impacts are associated with the hazard.

Section 7: Mitigation Strategy

This section covers the mitigation strategy summary, which provides the mitigation goals, objectives, and action items included in the Hazard Mitigation Action Plan in response to identified hazards.

Section 7: MITIGATION STRATEGY

The planning process, hazard analysis, and vulnerability assessment are foundations for a meaningful hazard mitigation strategy. The mitigation strategy provides an outline for how the county and the local jurisdictions aim to address and reduce the risks associated with the natural hazards identified in the HMP and reduce the potential impact on residents and structures. The mitigation strategy is divided into three sections the mission statement, goals and objectives, and the mitigation action plan (HMAP). The mission statement provides the overall purpose of the mitigation strategy and the HMP. The goals and objectives provide milestones for how the county aims to meet this purpose. The mitigation action plan details specific mitigation actions, or projects, programs, and policies the county aims to meet these goals and objectives.

Mission Statement

The HMP aims to implement new policies, programs, and projects to reduce the risks and impacts associated with natural hazards, including public education and partnerships between local officials and residents.

Goals

1) Educate citizens regarding emergency situations related to hazards.
2) Develop publications and educational information on all hazards and make them easily accessible to all within the City of Angleton.
3) Promote the use of emergency notification systems and weather alerts for all hazards.
4) Decrease the risk to life and property from hazards through planning, preparation, and mitigation.
5) Develop policies and strategies to effectively manage and reduce risk.
6) Increase the resiliency of the City of Angleton through projects and strategies that reduce the impacts of hazards.
7) Enhance coordination between local jurisdictions, county, state, and federal agencies.
8) Support the continuity of operations before, during, and after hazard events.
9) Incorporate hazard mitigation into community planning such as codes/ordinances, day-to-day operations, and projects.
10) Identify, protect, and assist socially vulnerable populations in recovery from hazard impacts.

Objectives

- Protect the lives and property of residents and business owners.
- Eliminate the number of vulnerable structures in areas susceptible to repetitive flooding.
- Increase public education and awareness of hazards that affect the city.
- Provide alternative power sources for critical facilities and infrastructure.
- Upgrade deteriorating infrastructure.

Mitigation Action Plan

The mitigation action plan explains the specific programs, policies, and projects that the county and the local jurisdictions aim to implement for the county to reach its HMAP objectives and goals. The mitigation action plan provides the details of each mitigation action including which local department will oversee implementing the actions, how the city intends to fund these actions, and the estimated time for implementing these actions.

The city submitted its mitigation actions based on the greatest vulnerabilities, goals, and needs. Each action was evaluated for feasibility using local knowledge, municipal staff and HMC recommendations, and FEMA's Benefit Cost Analysis (BCA) Toolkit when applicable. Mitigation actions were given a

priority rating of 1-high, 2-medium, or 3-low based on a combination of factors including the items feasibility, potential funding options, overall cost, BCA score (if applicable), and implementation timelines.

Mitigation Actions, City of Angleton

Jurisdiction:	City of Angleton	Action Number:	A1
Hazard(s) Addressed:	Flooding Hurricanes, Tropical Storms & Tropical Depressions Windstorm Tornado Severe Thunderstorms & Lightning Winter Weather Extreme Heat		
Project Title:	Generator for Lift Station # 8		
Project Description:	Purchase and install Generator for Lift Station # 8, the second largest lift station within the City of Angleton.		
Responsible Entity:	City of Angleton Public Works & Emergency Management Departments		
Losses Avoided:	Loss of wastewater utilities to a majority of city residents due to power outage.		
Priority Rating:	High- 1		
Partners:	N/A		
Cost Estimate:	$161,173.20	Timeframe:	12 -24 months
Potential Funding Sources:	HMPG	**Benefit-Cost Analysis:**	42.53
Is this action related to a critical facility or lifeline?			Yes
Does this action reduce the effects of hazards on existing buildings?			No
Does this action reduce the effects of hazards for new buildings, infrastructure, or future development?			Yes
Does the action identify, analyze, and prioritize actions related to continued compliance with the NFIP?			Yes

Jurisdiction:	City of Angleton	Action Number:	A2
Hazard(s) Addressed:	Flooding Hurricanes, Tropical Storms & Tropical Depressions Windstorm Tornado Severe Thunderstorms & Lightning Winter Weather Extreme Heat		
Project Title:	Generator for Stormwater Pump		
Project Description:	Install a generator on Stormwater pump		
Responsible Entity:	City of Angleton Public Works & Emergency Management Departments		
Losses Avoided:	Life safety and prevention of homes lost due to rising water flooding as a backup in the event of power loss.		
Priority Rating:	High- 1		
Partners:	N/A		
Cost Estimate:	$134,528	Timeframe:	12-24 months
Potential Funding Sources:	HMGP	**Benefit-Cost Analysis:**	1.10
Is this action related to a critical facility or lifeline?			Yes
Does this action reduce the effects of hazards on existing buildings?			No
Does this action reduce the effects of hazards for new buildings, infrastructure, or future development?			Yes
Does the action identify, analyze, and prioritize actions related to continued compliance with the NFIP?			Yes

Jurisdiction:	City of Angleton	Action Number:	A3
Hazard(s) Addressed:	Flooding Hurricanes, Tropical Storms & Tropical Depressions Windstorm Tornado Severe Thunderstorms & Lightning Winter Weather Extreme Heat		
Project Title:	Install a Permanent 350KW 277/480v, 3PH, 60hz Generator to the City Recreation Center		
Project Description:	Install a permanent generator that will power the City's Recreation Center so it can be used during and after a disaster event to shelter and stage city staff and provide a recovery center immediately after a disaster.		
Responsible Entity:	City of Angleton Parks and Recreation & Emergency Management Departments		
Losses Avoided:	Damage to a key piece of city infrastructure		
Priority Rating:	High- 1		
Partners:	N/A		
Cost Estimate:	$250,000	Timeframe:	12 months
Potential Funding Sources:	HMPG, CDBG-MIT	**Benefit-Cost Analysis:**	0.43
Is this action related to a critical facility or lifeline?			Yes
Does this action reduce the effects of hazards on existing buildings?			Yes
Does this action reduce the effects of hazards for new buildings, infrastructure, or future development?			Yes
Does the action identify, analyze, and prioritize actions related to continued compliance with the NFIP?			No

Jurisdiction:	City of Angleton	Action Number:	A4
Hazard(s) Addressed:	Hurricanes, Tropical Storms, & Depressions Flooding Winter Weather Tornado Extreme Heat Wildfire Drought & Expansive Soils Severe Thunderstorms & Lightning Hail Cybersecurity Windstorm Erosion Emerging Infectious Diseases		
Project Title:	Public Education Materials		
Project Description:	Implement an outreach and education campaign to educate the public on all hazards that affect the City of Angleton		
Responsible Entity:	City of Angleton Emergency Management Department		
Losses Avoided:	Increase in citizen education regarding hazards- preservation of property, decreased financial losses due to natural hazards, and mitigating the loss of human life and injuries		
Priority Rating:	Medium- 2		
Partners:	N/A		
Cost Estimate:	$5,000	Timeframe:	12 months
Potential Funding Sources:	HMPG, Local funds, staff time/wages	**Benefit-Cost Analysis:**	N/A
Is this action related to a critical facility or lifeline?			No
Does this action reduce the effects of hazards on existing buildings?			No
Does this action reduce the effects of hazards for new buildings, infrastructure, or future development?			No
Does the action identify, analyze, and prioritize actions related to continued compliance with the NFIP?			No

Jurisdiction:	City of Angleton	Action Number:	A5
Hazard(s) Addressed:	Drought & Expansive Soils Erosion		
Project Title:	Data Deficiencies		
Project Description:	Address data deficiencies for erosion and expansive soil hazards to identify the extent, vulnerability, and potential impacts of these hazards. Record and track future instances of erosion and expansive soil events.		
Responsible Entity:	City of Angleton, Emergency Management Department		
Losses Avoided:	Increase in citizen education regarding hazards- preservation of property, decreased financial losses due to natural hazards, and mitigating the loss of human life and injuries		
Priority Rating:	Low- 3		
Partners:	N/A		
Cost Estimate:	$50,000	Timeframe:	12-36 months
Potential Funding Sources:	HMGP, USACE, USGS FIM, TWDB, TCEQ	**Benefit-Cost Analysis:**	N/A
Is this action related to a critical facility or lifeline?			Yes
Does this action reduce the effects of hazards on existing buildings?			Yes
Does this action reduce the effects of hazards for new buildings, infrastructure, or future development?			Yes
Does the action identify, analyze, and prioritize actions related to continued compliance with the NFIP?			Yes

Section 8: Plan Maintenance

This section provides an overview of plan maintenance procedures which includes information on monitoring, evaluating, and updating the plan, and a description of how this plan will be incorporated into existing programs.

Section 8: PLAN MAINTENANCE

To remain an effective tool, this HMP will undergo continuous review and updates. This practice is known as plan maintenance and requires monitoring, evaluating, updating, and implementing the entirety of the written plan and planning process. To accomplish this, a Plan Maintenance Team (PMT) has been determined and is comprised of representatives from various departments within the City of Angleton. The Plan Maintenance Team Leader shall be the City of Angleton Emergency Management Coordinator.

Public Involvement

Continued stakeholder and public involvement will remain a vital component of the HMP. The HMP will be hosted on the City of Angleton and H-GAC websites, and public input can be submitted at any time to the listed contacts. The PMT Leader is responsible for documenting public feedback and presenting the comments for discussion at each annual Plan Maintenance meeting.

The PMT Leader will also conduct outreach and invite the public to annual Plan Maintenance meetings. The PMT Leader will notify the public of all annual meetings by posting meeting flyers and agendas online via the city website and social media and providing printed copies of the meeting agenda flyers at city buildings 30 days prior to the meetings. In addition, the city will seek input from the public on the status of existing hazards, emerging vulnerabilities, and evaluate the HMP's strategy with the public. During each meeting, the PMT will provide an open comment forum for interactive discussion with the public. The development of new goals and strategies will be a joint effort between the PMT Leader, PMT, and public participants.

Procedures & Schedule

Procedures ensure that the goals, objectives, and mitigation strategy are regularly examined for feasibility and that the HMP remains a relevant and adaptive tool. The PMT will meet annually and hold its first meeting within one year after the plan’s approval date. An additional mid-year meeting will be held 18 months prior to the plan’s expiration to develop a timeline and strategy to update the HMP.

Any new mitigation actions, strategies, required studies, suggestions for improvements, or changes to the entire written plan or planning process will be submitted to the PMT Leader. The representative will evaluate the items for compliance with TDEM and FEMA regulations before leading the process to adopt or approve the new items or suggestions. Recommended changes, updates, and revisions will be implemented based on available funding to support revisions and updates and will be assigned to appropriate officials with pre-determined timelines for completion. Updates to the HMP will then be adopted by the appropriate governing body.

Table 8.1.1: Plan Maintenance: Evaluation & Monitoring Procedures

Method and Procedures	Schedule	Responsible Entity
The PMT Leader will advertise all annual meetings via city websites, social media pages, and post flyers at the City Hall and city buildings 30 days prior to the meetings.	30 days prior to annual meetings	PMT Leader
The PMT Leader is responsible for evaluating the entire plan prior to the meeting. Each PMT member will be asked to identify and discuss any deficiencies in the plan as it relates to their jurisdiction. Each PMT member will discuss their findings followed by public input and comments.	Annually	PMT Leader, PMT member for each participating department, and Public
Emerging hazards, risks, and vulnerabilities will be identified and discussed. 1) PMT members are responsible for monitoring each natural hazard and providing a written and/or verbal update on any new occurrences and emerging risks. 2) The PMT Leader will seek input from participants and the public at the annual meetings by opening the meeting for public comment. 3) Newly identified hazards, risks, and vulnerabilities will be assigned to a PMT member to research and monitor.	Annually	Public and all PMT members
The PMT will evaluate the mitigation goals and objectives to ensure the HMP remains relevant, and the strategy continues to be effective. 1) PMT members will identify new projects and/or re-prioritize existing strategies, emerging hazards, and shifting priorities. 2) Mitigation strategies for the newly identified hazards, risks, and vulnerabilities will be proposed and discussed. 3) Funding sources and cooperation for new initiatives will be determined.	Annually	PMT member for each participating department
The city will evaluate its progress in implementing the HMP and suggest improvements to the entire current written plan, public participation**,** and planning process**.** 1) Representatives will publicly discuss progress and submit written progress reports to the PMT Leader. 2) Completed and ongoing mitigation actions will be discussed by the responsible entity. 3) Unaddressed mitigation actions will be evaluated for relevancy and/or amended to increase feasibility. 4) The feasibility of the mitigation strategy will be evaluated, and any necessary revisions will be proposed. 5) The PMT Leader will report on all suggestions received throughout the past year on the planning process and the entire written plan and discuss how to incorporate these suggestions into current and future planning efforts.	Annually	PMT, the responsible department identified in the mitigation action up for discussion, and the public.
The PMT will develop a timeline and strategy to update the plan 12-18 months before it expires. The update strategy will include: 1) Identify entities responsible for drafting and submitting the update to TDEM. 2) Send appropriate representatives to G-318 training. 3) Determine funding needs and funding sources for plan update. 4) Review the entirety of the plan; discuss hazards, vulnerabilities and impacts identified in the plan and what to include/ revise in the update	12-18 months prior to HMP expiration	PMT Leader and PMT

Plan Integration

Integrating the HMP into local planning mechanisms is key to its success. Effective integration allows communities to benefit from existing plans and procedures to further reduce their vulnerability and risk. Upon approval of the plan and approval of updates or revisions, as proposed by the PMT, each participating department will follow the pre-determined actions:

To update and revise existing planning mechanisms to further integrate the HMP the PMT will follow a basic process(es) described in this section.

1.) Propose a policy, strategy, or regulatory amendment to City Council.
2.) Advertise the amendment 15 days prior to the meeting where it will be discussed. Advertising procedures for the public meeting(s) are outlined in the public involvement measures described in Section 8 of this plan.
3.) Provide the public, elected officials, and governing bodies the opportunity to discuss and comment upon proposed change(s).
4.) If the proposal is accepted, the change is implemented by the City Council.

Several existing plans and programs that require integration of the HMP have been identified by the PT. The PMT will initiate the process described above. As each participating jurisdiction develops or approves new planning mechanisms, the mechanism's name and the integration method will be added to the HMP.

Table 8.1.2: Adoption and Integration Procedures

Participating Jurisdiction	Adoption and Integration Procedures
City of Angleton	HMP and plan amendments will be presented to the City Council by the City of Angleton Emergency Management Office. An agenda for the meeting will be posted 30 days in advance, and a 30-day period of public comment will be provided. Upon approval, the approved HMP will be integrated into existing planning mechanisms described in Table 8.1.2.

Table 8.1.3: Integration of HMP and Planning Mechanisms

Plan Name	Integration Methods
Disaster Recovery Plan	Both plans should be updated and maintained in accordance with the other plan's goals and strategies. The HMP will be consulted before any revisions or updates to the disaster recovery plans are made.
Floodplain Management Plan	The City of Angleton's floodplain regulations and floodplain management, as provided by the Angleton Drainage District, will provide preventative measures to prevent future development in the floodplains, and it also provides corrective guidance on development in the floodplain. When the regulations are updated, it will be reflected in the mitigation action strategy for flooding in Section 6.2 of this plan.
Emergency Operations Plan	Both plans will be continuously evaluated and monitored. Any Emergency Operations Plan updates will refer to, incorporate, and/or complement the HMP.
Subdivision/Zoning Ordinance	The city will review its codes and propose the adoption of codes that support mitigation activities defined in the HMP when appropriate.
Planning & Development Regulations	Each department has reviewed the vulnerabilities defined in the HMP and will adopt codes that support mitigation strategy and mitigation activities. PMT members will propose code amendments to the appropriate governing body, following to process to amend codes in the city, and document any regulation amendments to be included in the HMP.
Annual Budget	The City of Angleton and each participating jurisdiction will review their annual budget each year for opportunities to fund their highest-priority mitigation actions.

Plan Name	Integration Methods
Flood Damage Prevention Ordinance	When the plan is updated or revised, the PMT will propose the adoption of codes that support mitigation strategy and mitigation activities.
Comprehensive Plan	Both plans will be continuously evaluated and monitored. Any Comprehensive Plan updates will refer to, incorporate, and/or complement the HMP.
Capital Improvements Plan	The city will review its capital improvement plan for projects that can also serve as natural hazard mitigation infrastructure. The CIP will be updated with project schedules and policies that support the implementation of each jurisdiction's highest-priority projects.

References

[1] Federal Emergency Management Agency. "Declared Disasters" Retrieved from: https://www.fema.gov/disaster/declarations
[2] Federal Emergency Management Agency. "Disaster Declarations for States and Counties" Retrieved from: https://www.fema.gov/data-visualization/disaster-declarations-states-and-counties
[3] U.S. Census Bureau. "QuickFacts, Brazoria County, Texas. Angleton, City, Texas" Retrieved from: https://www.census.gov/quickfacts/fact/table/brazoriacountytexas,angletoncitytexas/PST045222
[4] U.S. Bureau of Labor Statistics, Unemployment Rate in Brazoria County, TX. Retrieved from FRED, Federal Reserve Bank of St. Louis: https://fred.stlouisfed.org/series/TXBRAZ0URN
[5] U.S. Bureau of Labor Statistics, Unemployment Rate in Texas. Retrieved from FRED, Federal Reserve Bank of St. Louis: https://fred.stlouisfed.org/series/LAUST480000000000003A
[6] Texas Demographic Center, Population Estimates and Projections Program. Retrieved at: https://demographics.texas.gov/Resources/TPEPP/Estimates/2022/2022_txpopest_place.pdf
[7] Texas Demographic Center, "What's driving population change in Texas counties?". Retrieved at: https://idser.maps.arcgis.com/apps/MapSeries/index.html?appid=99dbf561151b4a2993248557e8f7aa56
[8] Mary Beth Jones, "Angleton, Texas" Handbook of Texas Online. Retrieved from: https://www.tshaonline.org/handbook/entries/angleton-tx. Published by the Texas State Historical Association.
[9] United States Department of Agriculture, Natural Resources Conservation Service. 2022. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture, Agriculture Handbook 296. Retrieved from: https://www.nrcs.usda.gov/resources/data-and-reports/major-land-resource-area-mlra
[10] Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Official Soil Series Descriptions. Retrieved from: https://www.nrcs.usda.gov/resources/data-and-reports/official-soil-series-descriptions-osd
[11] Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Official Soil Series Descriptions. Retrieved from: https://websoilsurvey.nrcs.usda.gov/app/
[12] Texas Water Development Board, River Basins. Retrieved at: https://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp
[13] Multi-Resolution Land Characteristics Consortium, National Land Cover Database. CONUS Land Cover Change Index Retrieved from: https://www.mrlc.gov/viewer/
[14] Texas Local Government Code § 211.001. Regulation of land use, structures, businesses, and related activities, Municipal regulatory authority, general zoning regulations. Retrieved from: https://statutes.capitol.texas.gov/SOTWDocs/LG/htm/LG.211.htm
[15] The City of Angleton, Official Zoning Map. Retrieved at: https://www.angleton.tx.us/DocumentCenter/View/2257/Official-Zoning-Map-04-2017-PDF?bidId=
[16] USA Facts, "Our Changing Population: Brazoria County, Texas". Retrieved from: https://usafacts.org/data/topics/people-society/population-and-demographics/our-changing-population/state/texas/county/brazoria-county/?endDate=2022-01-01&startDate=1971-01-01
[17] U.S. Census Bureau. "Profile, Angleton City, Texas" Retrieved from: https://data.census.gov/profile/Angleton_city,_Texas?g=160XX00US4803264
[18] H-GAC, "Vulnerable Population Index (VPI)", Retrieved from: https://www.h-gac.com/getmedia/d2d9690a-929e-4721-ae5c-3f6035da5f94/vulnerable-population-indexing.pdf
[19] Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry/Geospatial Research, Analysis, and Services Program. CDC/ATSDR Social Vulnerability Index Interactive Map 2020 Database Texas. https://svi.cdc.gov/Documents/CountyMaps/2020/Texas/Texas2020_Brazoria.pdf.
[20] Data USA. "Angleton, TX Profile" Retrieved from: https://datausa.io/profile/geo/angleton-tx/#housing
[21] Federal Emergency Management Agency. "Hazus" Retrieved from: https://www.fema.gov/flood-maps/products-tools/hazus
[22] Homeland Infrastructure Foundation-Level Data (HIFLD), Open Data. Retrieved from: https://hifld-geoplatform.opendata.arcgis.com/
[23] 44 Code of Federal Regulations 77.2(i). Retrieved from: https://www.ecfr.gov/current/title-44/chapter-I/subchapter-B/part-77/section-77.2#p-77.2(i)

[24] 44 Code of Federal Regulations 77.2(j). Retrieved from: https://www.ecfr.gov/current/title-44/part-77/section-77.2#p-77.2(j)
[25] Natural Resources Defense Council (NRDC), "Losing Ground: Flood Data Visualization Tool". Retrieved from: https://www.nrdc.org/resources/losing-ground-flood-visualization-tool
[26] Federal Emergency Management Agency. "Flood Insurance Data and Analytics". Retrieved from: https://nfipservices.floodsmart.gov//reports-flood-insurance-data
[27] Federal Emergency Management Agency. "Community Status Book". Retrieved from: https://www.fema.gov/flood-insurance/work-with-nfip/community-status-book
[28] Federal Emergency Management Agency. "Flood Insurance". Retrieved from: https://www.fema.gov/flood-insurance
[29] Federal Emergency Management Agency. "Special Flood Hazard Area (SFHA)". Retrieved from: https://www.fema.gov/glossary/special-flood-hazard-area-sfha
[30] Federal Emergency Management Agency. "Community Rating System". Retrieved from: https://www.fema.gov/floodplain-management/community-rating-system
[31] Federal Emergency Management Agency. "Flood Insurance Data and Analytics". Retrieved from: https://nfipservices.floodsmart.gov//reports-flood-insurance-data
[32] National Oceanic and Atmospheric Administration's National Hurricane Center, "Hurricane Preparedness - Hazards", Retrieved at: https://www.nhc.noaa.gov/prepare/hazards.php
[33] National Oceanic and Atmospheric Administration's National Hurricane Center, "Tropical Cyclone Climatology", Retrieved at: https://www.nhc.noaa.gov/climo/
[34] National Oceanic and Atmospheric Administration's National Weather Service, "Hurricane and Tropical Storm Watches, Warnings, Advisories and Outlooks". Retrieved at: https://www.weather.gov/safety/hurricane-ww
[35] National Oceanic and Atmospheric Administration, "Historical Hurricane Tracks", Retrieved at: https://coast.noaa.gov/hurricanes/#map=4/32/-80
[36] National Oceanic and Atmospheric Administration's National Hurricane Center, "The Saffir-Simpson Hurricane Wind Scale, Updated May 2021", Retrieved at: www.nhc.noaa.gov/pdf/sshws.pdf
[37] National Oceanic and Atmospheric Administration's National Hurricane Center, "Saffir-Simpson Hurricane Wind Scale", Retrieved at: https://www.nhc.noaa.gov/aboutsshws.php
[38] National Oceanic and Atmospheric Administration's National Centers for Environmental Information, Storm Events Database. Retrieved from: https://www.ncdc.noaa.gov/stormevents/
[39] U.S. Department of Agriculture, Farm Service Agency, "Disaster Designation Information". Retrieved from: https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/disaster-designation-information/index
[40] Texas Division of Emergency Management, "Texas State Hazard Mitigation Plan". Retrieved at: https://txdem.sharepoint.com/:b:/s/TDEMWebsiteFiles/EYpeKiYJdYtCtdoSyqIYGDQBJ_2RMO0QEOjIVSjC9c2fzA?e=wZwXcQ
[41] Federal Emergency Management Agency, National Risk Index Dataset and Online Tool. Retrieved at: https://hazards.fema.gov/nri/map
[42] National Center for Healthy Housing, Emergency Preparedness and Response: Hurricanes, "At-Risk Populations". Retrieved at: https://nchh.org/information-and-evidence/learn-about-healthy-housing/emergencies/hurricanes/at-risk-populations/
[43] National Oceanic and Atmospheric Administration's National Severe Storms Laboratory, "Severe Weather 101-Damaging Winds FAQ". Retrieved at: https://www.nssl.noaa.gov/education/svrwx101/wind/faq
[44] Federal Emergency Management Agency, National Risk Index County Profile, Brazoria County, Texas. Retrieved at: https://hazards.fema.gov/nri/report/viewer?dataLOD=Counties&dataIDs=C48039
[45] Federal Emergency Management Agency, National Risk Index, Risk Comparison Report (Census Tracts: T48039662100, T48039662200, T48039662400, T48039662300, T48039662500, T48039663100, and T48039664100). Retrieved at: https://hazards.fema.gov/nri/report/viewer?dataLOD=Census%20tracts&dataIDs=T48039662100,T48039662200,T48039662400,T48039662300,T48039662500,T48039663100,T48039664100
[46] Federal Emergency Management Agency, National Risk Index, "Historic Loss Ratio". Retrieved at: https://hazards.fema.gov/nri/historic-loss-ratio

[47] Federal Emergency Management Agency, "Flood Zones." Retrieved from: https://www.fema.gov/glossary/flood-zones#:~:text=SFHA%20are%20defined%20as%20the,flood%20or%20100%2Dyear%20flood
[48] Federal Emergency Management Agency, National Risk Index, Riverine Flooding. Retrieved at: https://hazards.fema.gov/nri/riverine-flooding
[49] Federal Emergency Management Agency, National Risk Index, Coastal Flooding. Retrieved at: https://hazards.fema.gov/nri/coastal-flooding
[50] National Weather Service, "Flood Preparedness Week - Flooding and Related Phenomena." Retrieved from: https://www.weather.gov/ffc/flood_awareness_flooding
[51] Surging Seas, Risk Finder, Angleton, Texas, USA. Retrieved at: https://riskfinder.climatecentral.org/place/angleton.tx.us?comparisonType=place&forecastType=NOAA2017_int_p50&level=5&unit=ft
[52] NOAA, Sea Level Rise Viewer. Retrieved from: https://coast.noaa.gov/slr/#
[53] National Weather Service, "Flash Flooding Definition." Retrieved from: https://www.weather.gov/phi/FlashFloodingDefinition
[54] National Weather Service, "Coastal Flood Threat." Retrieved from: https://www.weather.gov/mlb/coastalflood_threat
[55] Federal Emergency Management Agency, Hazard Mitigation Assistance Program and Policy Guide, Flood Mitigation Assistance. Retrieved from: https://www.fema.gov/grants/mitigation/guide/part-10/d
[56] Risk Factor, "Does Angleton have Flood Risk?". Retrieved from:https://riskfactor.com/city/angleton-tx/4803264_fsid/flood
[57] Risk Factor, "Does Angleton have Flood Risk?". Retrieved from:https://riskfactor.com/city/angleton-tx/4803264_fsid/flood
[58] Texas A&M University Office of the Texas State Climatologist, Assessment of Historic and Future Trends of Extreme Weather in Texas, 1900-2036, 2021 update. Retrieved from: https://climatexas.tamu.edu/files/ClimateReport-1900to2036-2021Update
[59] National Oceanic and Atmospheric Administration's National Weather Service, "National Weather Service Expanded Winter Weather Terminology". Retrieved at: https://www.weather.gov/bgm/WinterTerms
[60] National Oceanic and Atmospheric Administration's National Weather Service, "Winter Storm Severity Index (WSSI), Product/Service Description Document". Retrieved at: https://www.wpc.ncep.noaa.gov/wwd/wssi/WSSI_PDD_2022-23.pdf
[61] ASCE Hazard Tool. Retrieved at: https://ascehazardtool.org/
[62] ASCE Risk Categories Explained. Retrieved at: https://www.engineeringexpress.com/wiki/asce-risk-categories-explained/
[63]Weather Spark, Climate and Average Weather Year Round in Brazoria. Retrieved at: https://weatherspark.com/y/9220/Average-Weather-in-Brazoria-Texas-United-States-Year-Round#google_vignette
[64] National Oceanic and Atmospheric Administration's NCEI, "The Great Texas Freeze: February 11-20, 2021"Retrieved at: https://www.ncei.noaa.gov/news/great-texas-freeze-february-2021
[65] National Oceanic and Atmospheric Administration's National Weather Service, Watch/Warning/Advisory Definitions". Retrieved at: https://www.weather.gov/lwx/WarningsDefined
[66] National Oceanic and Atmospheric Administration's National Severe Storms Laboratory, "Severe Weather 101-Winter Weather". Retrieved at:https://www.nssl.noaa.gov/education/svrwx101/winter/forecasting/
[67] National Oceanic and Atmospheric Administration's National Weather Service, "Tornado Definition". Retrieved at: https://www.weather.gov/phi/TornadoDefinition#:~:text=Tornado%20%2D%20A%20violently%20rotating%20column,nature%22s%20most%20violent%20storms.
[68] Texas Division of Emergency Management, "Texas State Hazard Mitigation Plan". Retrieved at: https://txdem.sharepoint.com/:b:/s/TDEMWebsiteFiles/EYpeKiYJdYtCtdoSyqIYGDQBJ_2RMO0QEOjIVSjC9c2fzA?e=wZwXcQ
[69] Texas Almanac, "Texas Tornados". Retrieved at: https://www.texasalmanac.com/articles/texas-tornados#:~:text=The%20greatest%20number%20of%20tornadoes,of%20spring%20tornadoes%20in%20Texas

[70] National Oceanic and Atmospheric Administration's National Weather Service, Storm Prediction Center, "Average Annual Number of Tornadoes per State (1993-2022)". Retrieved at: https://www.spc.noaa.gov/wcm/ustormaps/1993-2022-stateavgtornadoes.png
[71] National Oceanic and Atmospheric Administration's National Weather Service, Storm Prediction Center, "Total Number of Tornadoes per County (1950-2022)". Retrieved at:https://www.spc.noaa.gov/wcm/ustormaps/tornadoes-by-county.png
[72] National Oceanic and Atmospheric Administration's National Severe Storms Laboratory, "Severe Weather 101- Tornadoes". Retrieved at: https://www.nssl.noaa.gov/education/svrwx101/tornadoes/
[73] Centers for Disease Control and Prevention, "About Extreme Heat". Retrieved at: https://www.cdc.gov/disasters/extremeheat/heat_guide.html
[74] FEMA, Ready.gov, "Extreme Heat". Retrieved at: https://www.ready.gov/heat
[75] National Oceanic and Atmospheric Administration's National Weather Service, "Glossary- Heat". Retrieved at: https://w1.weather.gov/glossary/index.php?word=Heat
[76] National Integrated Heat Health Information System, Urban Heat Islands. Retrieved at: https://www.heat.gov/pages/urban-heat-islands
[77] National Oceanic and Atmospheric Administration's National Weather Service, "What is the heat index?". Retrieved at: https://www.weather.gov/ama/heatindex
[78] National Integrated Heat Health Information System, Current Conditions and Future Outlooks. Retrieved at: https://www.heat.gov/
[79] National Integrated Heat Health Information System, "Who Is Most at Risk To Extreme Heat?". Retrieved at: https://www.heat.gov/pages/who-is-at-risk-to-extreme-heat
[80] USGCRP, 2017: Climate Science Special Report: Fourth National Climate Assessment, Volume I [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 470 pp, doi: 10.7930/J0J964J6.Retrieved at: https://science2017.globalchange.gov/
[81]Texas A&M Forest Service, Wildland Firefighting Terminology Glossary. Retrieved at: https://tfsweb.tamu.edu/uploadedFiles/TFS_Main/Finance_and_Administration/Communications/Wildland%20Fire%20Glossary%20of%20terms%20TFS.pdf
[82] Texas A&M Forest Service, Wildfire Risk, About TxWrap. Retrieved at: https://texaswildfirerisk.com/#about
[83] Texas A&M Forest Service, Wildfire Risk. Retrieved at: https://tfsweb.tamu.edu/WildfireRisk/
[84] Texas A&M Forest Service, TxWRAP, Wildfire Ignition Density Layer Information. Retrieved at: https://wrap.texaswildfirerisk.com/Map/Pro#map-themes
[85] U.S. Environmental Protection Agency, "Which Populations Experience Greater Risks of Adverse Health Effects Resulting from Wildfire Smoke Exposure?", Retrieved from: https://www.epa.gov/wildfire-smoke-course/which-populations-experience-greater-risks-adverse-health-effects-resulting
[86] National Geographic, "Wildfires". Retrieved at: https://education.nationalgeographic.org/resource/wildfires/
[87] National Oceanic and Atmospheric Administration's National Integrated Drought Information System, "What is Drought- Drought Basics". Retrieved at: https://www.drought.gov/what-is-drought/drought-basics
[88] Colorado Geological Survey, "Expansive Soil and Rock". Retrieved at: https://coloradogeologicalsurvey.org/hazards/expansive-soil-rock/
[89] National Oceanic and Atmospheric Administration's National Integrated Drought Information System, "Drought Basics- Types of Droughts". Retrieved at:https://www.drought.gov/what-is-drought/drought-basics https://www.drought.gov/what-is-drought/drought-basics#types-of-drought
[90] National Oceanic and Atmospheric Administration's National Integrated Drought Information System, "U.S. Drought Monitor (USDM)". Retrieved at: https://www.drought.gov/data-maps-tools/us-drought-monitor
[91] National Oceanic and Atmospheric Administration's National Integrated Drought Information System, "Historical Data and Conditions". Retrieved at: https://www.drought.gov/historical-information
[92] National Oceanic and Atmospheric Administration's National Integrated Drought Information System, "U.S. Drought Monitor (USDM)". Retrieved at: https://www.drought.gov/data-maps-tools/us-drought-monitor
[93] National Integrated Drought Information System, Public Health. Retrieved at: https://www.drought.gov/topics/public-health
[94] National Oceanic and Atmospheric Administration's National Weather Service, Glossary, Severe Thunderstorm. Retrieved at: https://w1.weather.gov/glossary/index.php?word=severe+thunderstorm

[95] Weather.Gov, "Thunderstorm Ingredients". Retrieved at: https://www.weather.gov/source/zhu/ZHU_Training_Page/thunderstorm_stuff/Thunderstorms/thunderstorms.htm
[96] National Oceanic and Atmospheric Administration, "Types of Thunderstorms", Retrieved at: https://www.noaa.gov/jetstream/tstrmtypes
[97] National Oceanic and Atmospheric Administration's National Weather Service, Glossary, Lightning. Retrieved at: https://w1.weather.gov/glossary/index.php?word=Lightning
[98] National Oceanic and Atmospheric Administration's National Weather Service, "How Dangerous is Lightning?", Retrieved at: https://www.weather.gov/safety/lightning-odds
[99] National Oceanic and Atmospheric Administration's National Weather Service, "Lightning Victims", Retrieved at: https://www.weather.gov/safety/lightning-victims#:~:text=Lightning%20kills%20about%2020%20people,survivors%20suffer%20lifelong%20neurological%20damage
[100] National Oceanic and Atmospheric Administration's National Severe Storms Laboratory, "Severe Weather 101- Lightning", Retrieved at: https://www.nssl.noaa.gov/education/svrwx101/lightning/types/
[101] Annual number of thunderstorm days in the U.S. From: Koehler, Thomas L., 2019: Cloud-to-Ground Lightning Flash Density and Thunderstorm Day Distributions over the Contiguous United States Derived from NLDN Measurements: 1993-2018. Retrieved at: https://www.noaa.gov/jetstream/thunderstorms
[102] National Oceanic and Atmospheric Administration's National Weather Service, Storm Prediction Center, SPC Products. Retrieved at: https://www.spc.noaa.gov/misc/about.html
[103] National Oceanic and Atmospheric Administration's National Weather Service, Lightning Threats. Retrieved at: https://www.weather.gov/mlb/lightning_threat
[104] Earth Networks, Texas Lightning Report, 2020. Retrieved at: https://get.earthnetworks.com/hubfs/2021%20State%20Lightning%20Reports/Lightning_Report_Texas1.pdf
[105] National Oceanic and Atmospheric Administration's National Centers for Environmental Information, "Vaisala National Lightning Detection Network Flash Data (Restricted)". Retrieved at: https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.ncdc:C00989
[106] National Oceanic and Atmospheric Administration's National Severe Storms Laboratory, "Severe Weather 101- Hail", Retrieved at: https://www.nssl.noaa.gov/education/svrwx101/hail/
[107] National Oceanic and Atmospheric Administration's National Severe Storms Laboratory, "Severe Weather 101- Hail Types", Retrieved at: https://www.nssl.noaa.gov/education/svrwx101/hail/types/
[108] National Oceanic and Atmospheric Administration's National Severe Storms Laboratory, "Severe Weather 101- Hail FAQ", Retrieved at: https://www.nssl.noaa.gov/education/svrwx101/hail/faq/
[109] National Oceanic and Atmospheric Administration's National Weather Service, "Hail Threat Defined". Retrieved at: https://www.weather.gov/mlb/hail_threat
[110] The Tornado and Storm Research Organization, "The TORRO Hailstorm Intensity Scale". Retrieved at: https://www.torro.org.uk/research/hail/hscale
[111] National Oceanic and Atmospheric Administration's National Severe Storms Laboratory, "Severe Weather 101- Wind", Retrieved at: https://www.nssl.noaa.gov/education/svrwx101/wind/
[112] National Oceanic and Atmospheric Administration's National Severe Storms Laboratory, "Severe Weather 101- Wind Types", Retrieved at: https://www.nssl.noaa.gov/education/svrwx101/wind/types/
[113] National Oceanic and Atmospheric Administration's National Weather Service, "Beaufort Wind Scale". Retrieved at: https://www.weather.gov/mfl/beaufort
[114] National Oceanic and Atmospheric Administration's National Weather Service, "Wind Warnings, Watches and Advisories". Retrieved at: https://www.weather.gov/safety/wind-ww
[115] U.S. Department of Agriculture, Natural Resources Conservation Service, "Erosion and Sediment Delivery". Retrieved at: https://www.nrcs.usda.gov/sites/default/files/2022-09/Erosion_%26_sediment_delivery__IA-NRCS_Procedures.pdf
[116] Natural Resources Defense Council, Soil Erosion 101. Retrieved at: https://www.nrdc.org/stories/soil-erosion-101
[117] U.S. Department of Agriculture, Natural Resources Conservation Service, Field Guide Technical Document, "Highly Erodible Land". Retrieved at: https://efotg.sc.egov.usda.gov/references/public/MD_defunct/HEL_323.htm
[118] Institute of Water Research, K Factor. Retrieved at: http://www.iwr.msu.edu/rusle/kfactor.htm

[119] U.S. Department of Agriculture. 2020. Summary Report: 2017 National Resources Inventory, Natural Resources Conservation Service, Washington, DC, and Center for Survey Statistics and Methodology, Iowa State University, Ames, Iowa. Retrieved from: https://www.nrcs.usda.gov/sites/default/files/2022-10/2017NRISummary_Final.pdf
[120] National Oceanic and Atmospheric Administration, National Water Prediction Service, Brazos River near Rosharon. Retrieved at: https://water.noaa.gov/gauges/ROST2
[121] National Institute of Allergy and Infectious Diseases, "NIAID Emerging Infectious Diseases/Pathogens". Retrieved at: https://www.niaid.nih.gov/research/emerging-infectious-diseases-pathogens
[122] FEMA, Ready.gov, "Pandemics". Retrieved at: https://www.ready.gov/pandemic
[123] FEMA, Ready.gov, "Novel Pandemic Hazard Sheet". Retrieved at: https://www.ready.gov/sites/default/files/2020-11/novel-pandemic_hazard-sheet.pdf
[124] CDC, "Past Flu Pandemics". Retrieved at: https://www.cdc.gov/flu/pandemic-resources/basics/past-pandemics.html
[125] Lindahl JF, Grace D. The consequences of human actions on risks for infectious diseases: a review. Infect Ecol Epidemiol. 2015 Nov 27;5:30048. doi: 10.3402/iee.v5.30048. PMID: 26615822; PMCID: PMC4663196. Retrieved at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4663196/
[126] National Institute of Environmental Health Sciences, Covid-19 Pandemic Vulnerability Index (PVI). Retrieved at: https://covid19pvi.niehs.nih.gov/
[127] Mayo Clinic, "COVID-19: Who's at higher risk of serious symptoms?". Retrieved at: https://www.mayoclinic.org/diseases-conditions/coronavirus/in-depth/coronavirus-who-is-at-risk/art-20483301#:~:text=The%20risk%20of%20developing%20dangerous,systems%2C%20obesity%2C%20or%20diabetes.
[128] CDC, "OUR RISK FOR INFECTIOUS DISEASES". Retrieved at: https://www.cdc.gov/ncezid/pdf/climate-change-and-infectious-diseases-H.pdf
[129] FEMA, Ready.Gov, "Cybersecurity". Retrieved at: https://www.ready.gov/cybersecurity
[130] FEMA, Cyberattack. Retrieved at: https://community.fema.gov/ProtectiveActions/s/article/Cyberattack
[131] Verizon 2023, Data Breach Investigations Report. Retrieved at: https://www.verizon.com/business/resources/reports/dbir/
[132] FEMA, Ready.Gov, "Cyber-attack Information Sheet". Retrieved at: https://www.ready.gov/sites/default/files/2020-11/ready_cyberattack_information-sheet.pdf