SECTION 4. RISK ASSESSMENT

4.3 Hazard Profiles

4.3.2 Drought

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

Hazard Profile

Hazard Description

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

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

Location

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

Extent

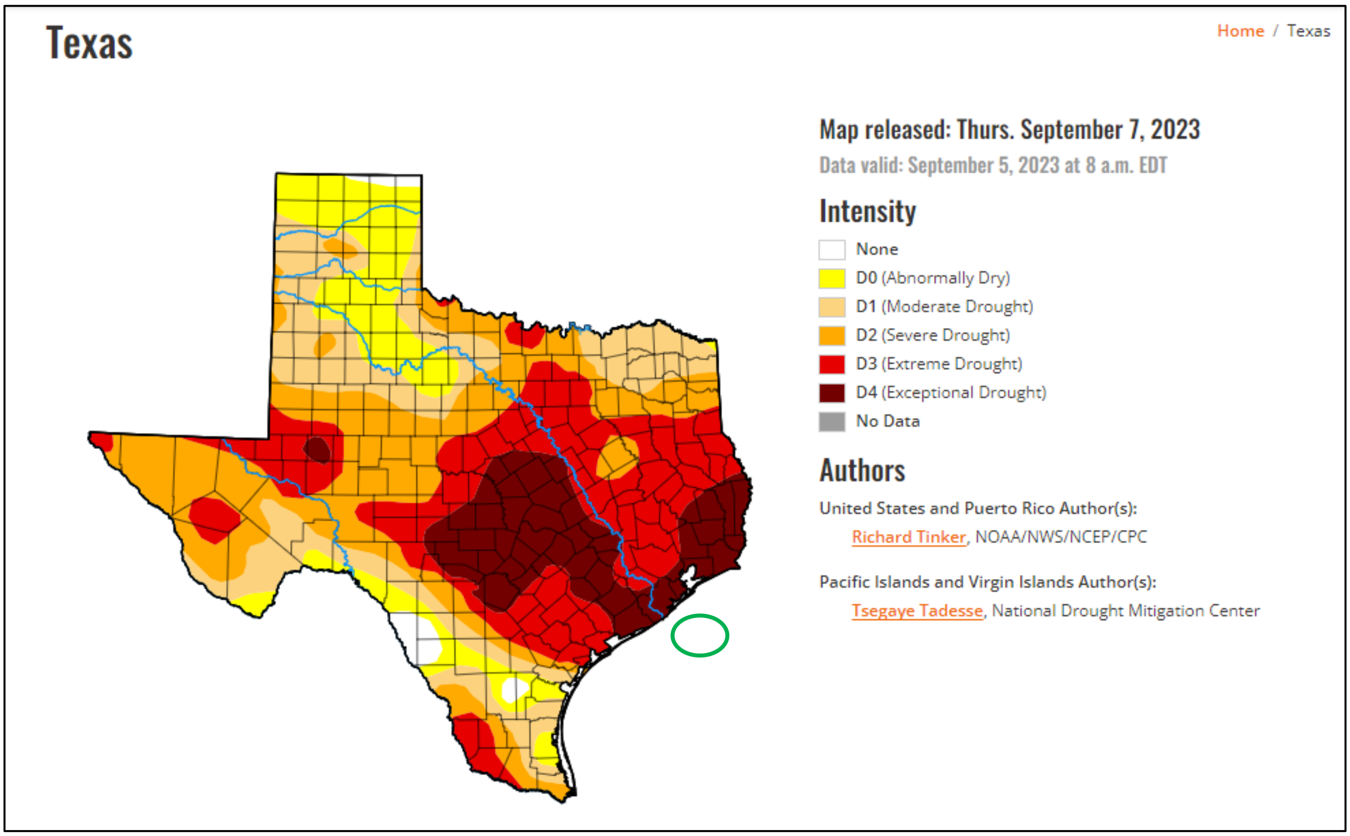
The severity of a drought depends on the degree of moisture deficiency, the duration of the event, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts (University of Nevada, Reno Extension College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

U.S. Drought Monitor

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

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

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



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

Palmer Drought Severity Index

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

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

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

Source: U.S. Drought Monitor 2021

Keetch-Byram Drought Index (KBDI)

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

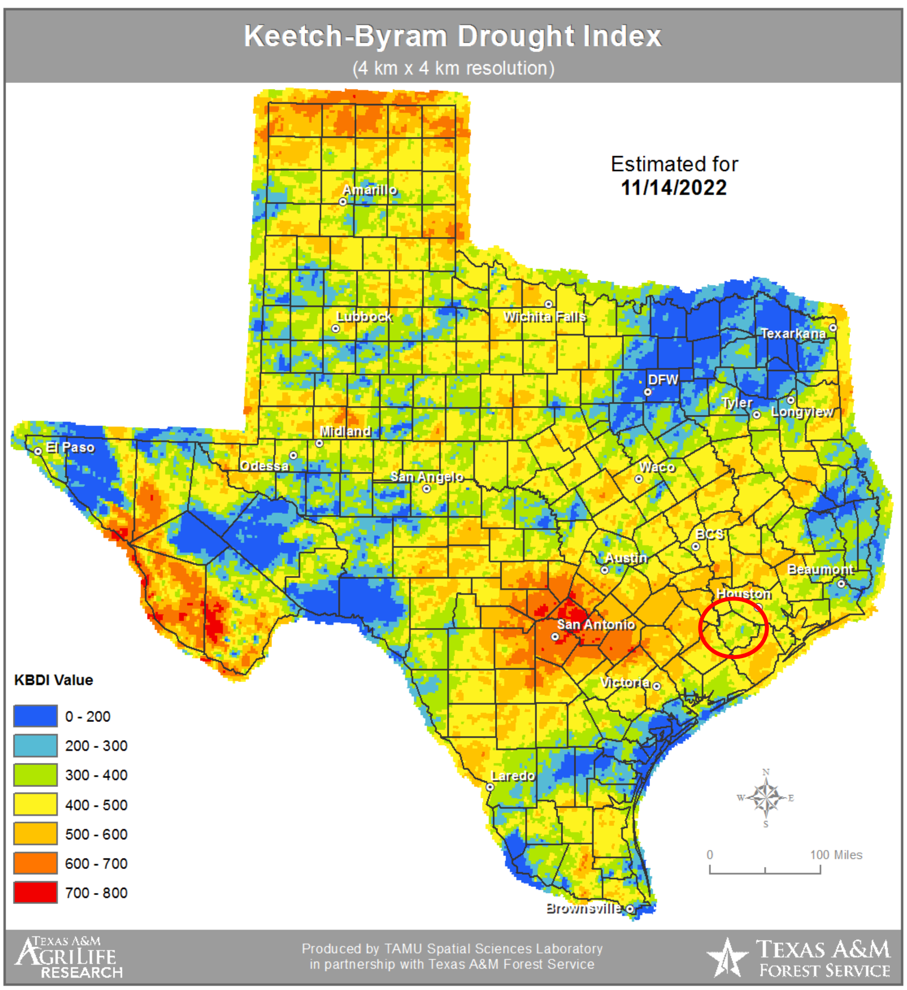
Table 4.3.2-2. KBDI Index

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

Source: TAMU n.d.

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

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



Source: TAMU 2022

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

Worst-Case Scenario

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

Previous Occurrences and Losses

FEMA Disaster Declarations

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

USDA Disaster Declarations

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

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

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

Source: USDA Farm Service Agency 2022

Previous Events

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

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

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

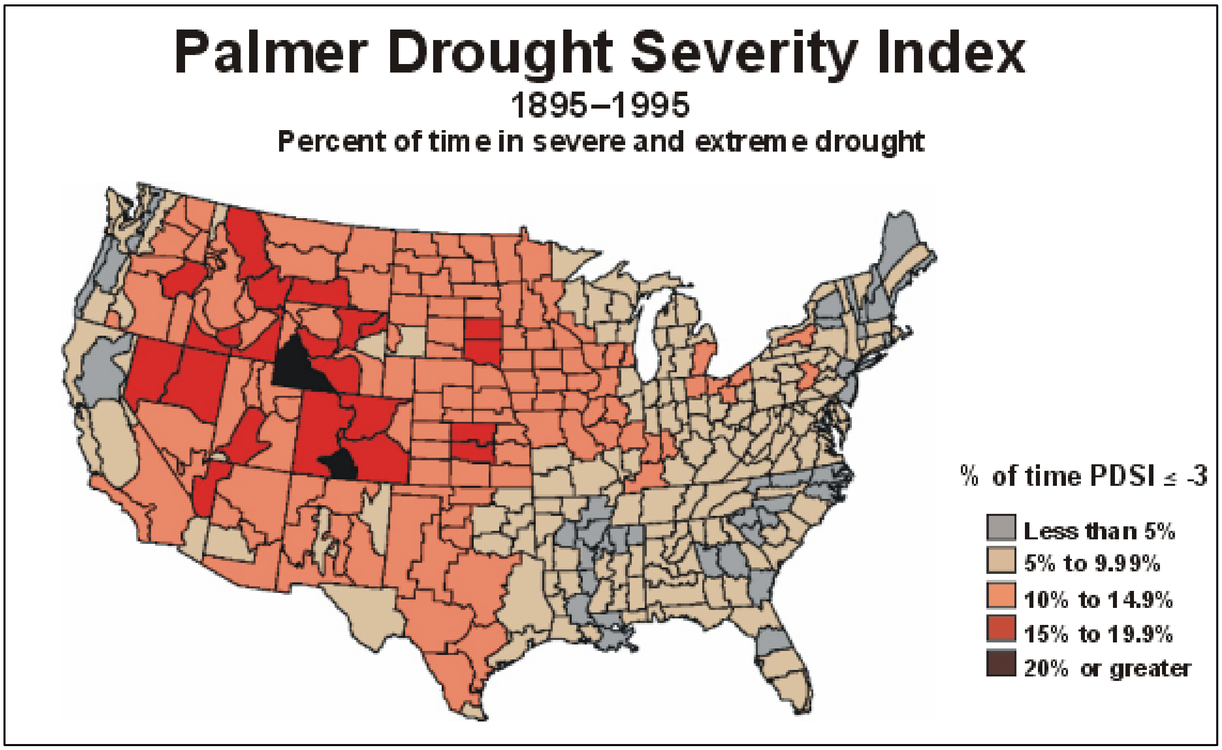
Source: USDA 2022; NDMC 2023; NIDIS 2022

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

Probability of Future Occurrences

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

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



Source: National Drought Mitigation Center 2020

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

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

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

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

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

Climate Change Projections

Climate is defined not simply as average temperature and precipitation but also by the type, frequency, and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of extremes such as droughts. While predicting changes in drought events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment (EPA 2016).

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

Vulnerability Assessment

Impact on Life, Health, and Safety

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

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

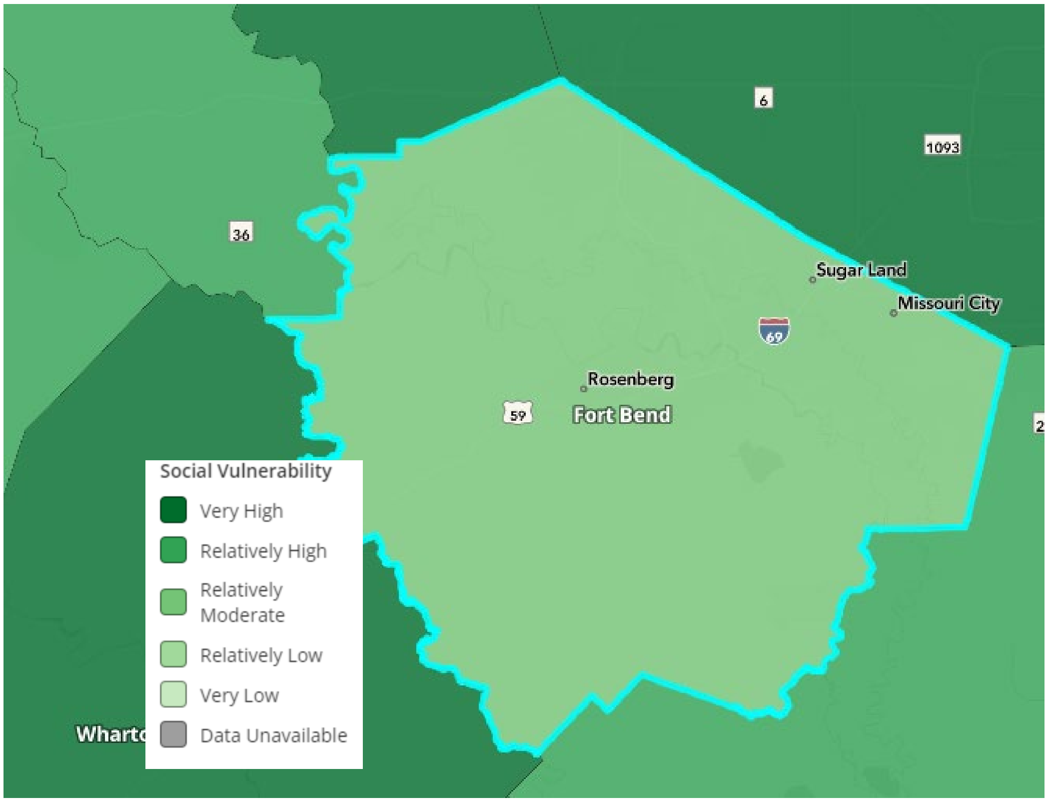
Socially Vulnerable Populations

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

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

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

Figure 4.3.2-4. FEMA Social Vulnerability Index for Drought



Source: FEMA NRI

Impact on General Building Stock

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

Impact on Critical Facilities

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

Impact on Economy

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

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

Impact on Environment

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

Future Changes That May Impact Vulnerability

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

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

Projected Development

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

Projected Changes in Population

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

Climate Change

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

Change in Vulnerability Since 2018 HMP

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