Lower Brazos Planning Region Description

Note: highlighted items indicate that the item is out-of-date and is waiting on the completion of future tasks for updated information. These items will be updated prior to the completion of the final draft.

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1.1 Introduction: The Regional Flood Plan in Context

1.1.1 Origins of the State Flood Planning Process

In Texas, the billion-dollar flood disaster is becoming a regular occurrence. Between 2015 and 2017, flooding alone caused nearly $5 billion in damage to Texas communities. In conjunction with the impact of Hurricane Harvey, the total cost in 2017 approached $200 billion in financial losses (National Oceanic and Atmospheric Administration, 2021) and nearly 100 deaths. As Texas grappled with how to manage flood risk better and reduce loss of life and property from future disasters, the Texas Water Development Board (TWDB) prepared the first-ever statewide flood assessment, which described Texas' flood risks, provided an overview of roles and responsibilities, and included an estimate of potential flood mitigation costs and a summary of interest groups views on the future of flood planning.

This plan was prepared because:

- flood risks, impacts, and mitigation costs had never been assessed at a statewide level
- flood risks pose a serious threat to lives and livelihoods
- much of Texas is unmapped or uses out-of-date maps (Peter M. Lake, Chairman of TWDB, 2019)

The TWDB presented its findings to the 86th Texas legislative session in 2019. Later that year, the legislature adopted changes to the Texas Water Code §16.061 establishing a regional and state flood planning process led by the TWDB. The legislation provided funding to improve the floodplain mapping efforts and develop regional plans to mitigate the impact of future flooding.

In 2020, the TWDB started the flood planning process by establishing 15 Regional Flood Planning Groups (RFPGs) based on the natural watershed boundaries of the major rivers in the state. This regional approach to flood planning is intended to take into consideration the state's diverse geography, hydrology, culture, and population. In January of 2023, each RFPG submitted its initial regional flood plan in January 2023 to TWDB, followed by amended plans in July 2023. These were formally approved by the TWDB and integrated into the 2024 State Flood Plan which was adopted on August 15, 2024. The state flood plan will be updated every 5 years, and the current flood planning period represents the second cycle.

1.1.2 Overview of the Planning Process

The State of Texas is divided into 15 flood planning regions Lower Brazos Planning Region (also known as "Region 8") is 1 of 15 Texas flood planning regions (see Figure 1.1)

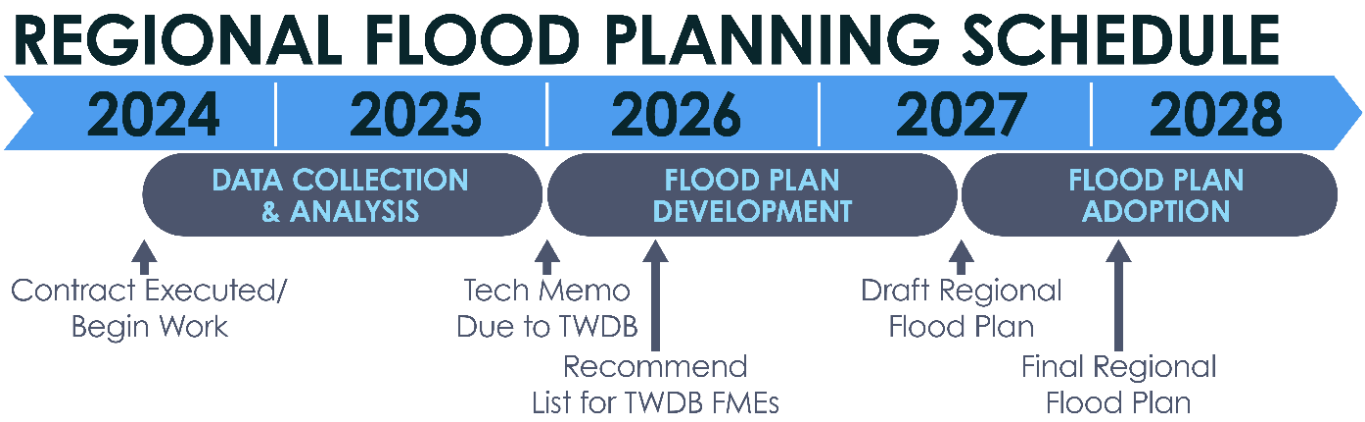
Figure 1.1: Flood Planning Regions

With the assistance of a technical team, each region prepares a regional flood plan that focuses on the flood risk and flood management needs for the region. When complete, the regional plans will outline a path to reducing existing risk to life and property and improve floodplain management data and practices. They will also identify potential Flood Management Evaluations (FMEs), Flood Management Strategies (FMSs), and Flood Mitigation Projects (FMPs), which may be appropriate for future study and funding. These regional plans are compiled into a single

statewide flood plan by the TWDB which is then presented to the legislature to help inform law makers and other governmental organizations to inform flood management decisions.

Flood plans for each region must be updated and submitted every five years to reflect the latest data, models, and flood risk and management changes within the region. The second planning cycle is now underway, with regional plans due by January 10, 2028, and the second State Flood Plan due by September 1, 2029. (TWDB Flood Planning Frequently Asked Questions, 2021).

Figure 1.2: 2028 Regional Flood Planning Schedule



Plan Funding Sources

The Texas Infrastructure Resiliency Fund (TIRF) was approved by Texas voters in November 2019, and this fund is now managed by TWDB. The TIRF provides funding for the preparation of these regional flood plans and helps finance the recommended flood-related studies and projects along with the Flood Infrastructure Fund (FIF). These funding vehicles ensure that flood planning is both comprehensive and actionable. Communities that identify prospective flood mitigation projects may seek financial assistance through TWDB grants and loans. Further information on available funding sources for flood mitigation—including federal and state programs—is provided in Chapter 9 of this plan.

Who's Preparing the Plan?

The TWDB has appointed RFPGs for each flood planning region and has provided them with funding to hire a technical consultant to help prepare their plans. The TWDB administered the regional planning process members through a contract with the planning group's sponsor, who the RFPG selected. The Lower Brazos RFPG chose the Brazos River Authority (BRA) to serve as its sponsor for this cycle. The sponsor's role is to support meetings and communications and manage the technical consultant contract. The Technical Consultant Team, led by Halff, was selected to help prepare this 2028 regional flood plan.

The RFPG's responsibilities include directing the work of the technical consultant, soliciting, and considering public input, identifying specific flood risks, and identifying and recommending flood management evaluations, strategies, and projects to reduce risk in their regions. To ensure a diversity of perspectives are included, members represent a wide variety of interest groups potentially affected by flooding, including:

- agriculture
- counties
- electric generation utilities
- environmental interests
- flood districts
- industry
- small municipalities
- large municipalities
- public
- river authorities
- small businesses
- water districts
- water utilities

With this second cycle of flood planning, the Region 8 RFPG decided to split the "municipality" category into two distinct categories: small municipalities (populations under 25,000) and large municipalities (populations over 25,000). This change ensures more accurate representation of both groups' experiences and challenges and recognizes that the size of a municipality significantly affects its capacity and approach to addressing flood-related issues.

Although each region operates under its own leadership and may implement regional flood plans in different ways, the TWDB has established comprehensive specifications to guide the development of these plans, ensuring consistency statewide. The TWDB's guidelines define the required content, structure, and main objectives of each regional flood plan, as well as stipulate acceptable data sources and compilation methods. At the same time, RFPGs retain discretion regarding regional priorities and strategies for collaborating with local communities.

Supporting Information

GIS Data

To ensure that flood plans are based upon consistent and reliable information in every region, the TWDB compiled geographic information system (GIS) data resources in the TWDB Flood Planning Data Hub. GIS layers are provided for:

- critical infrastructure
- flood infrastructure
- flood risk
- hydrology
- jurisdiction boundaries
- parks
- population
- property
- terrain
- transportation

A dedicated GIS team organized and analyzed this data for Region 8, identified additional data sources needed to meet the TWDB's objectives, and used the data to prepare the illustrative maps included in this report.

Completed Flood Studies

Coordination has been conducted and continues with government agencies involved in flood-related studies in the region, on a study-by-study basis, including the United States Army Corps of Engineers (USACE), TWDB, and the Texas General Land Office.

Relevant studies previously performed in Region 8 were collected to be used for reference material with relevant data being incorporated into various analyses. Some of the major studies that were utilized throughout the planning process are described below; however, this is not an exhaustive list of the efforts to assess flood risk within the region.

Three studies were performed that looked at the impacts of the Brazos River in the southern portion of the region. The *Lower Brazos Flood Protection Planning Study*, completed in 2019, the *Hydrologic and Hydraulic Analysis of the Brazos River*, completed in 2021, and the *Brazos River Flood Update Study*, completed in 2024 provide overviews of the current conditions along the Brazos River in Waller, Fort Bend, and Brazoria counties. Additionally, the *Fort Bend Drainage Master Plans* provide detailed analysis of flooding conditions throughout the county. The *Lower Brazos Flood Protection Planning Study* was conducted by the Brazos River Authority (BRA) using Flood Protection Planning Grant funds from the TWDB. The *Hydrologic and Hydraulic Analysis of the Brazos River* and the *Fort Bend Drainage Master Plans* were both conducted by the Fort Bend County Drainage District using local funds. The *Brazos River Flood Update Study* was conducted by Waller County using Flood Infrastructure Financing (FIF).

The General Land Office (GLO) initiated several studies covering 49 counties that were within the presidential disaster declaration issues after Hurricane Harvey. The *Central Region GLO River Basin Study* overlaps a significant portion of the Lower Brazos Region from Milam County down to the Gulf of Mexico. For the 2024 Regional Flood Planning Cycle, only the existing conditions analysis portion of the Central Region River Basin Study was complete and utilized in the planning process. The GLO is continuing to work on the studies to identify flood risk mitigation solutions.

The *Brazos River Watershed Hydrology Assessment (WHA)* performed by the Interagency Flood Risk Management (InFRM) group consisting of the Federal Emergency Management Agency, US Army Corps of Engineers, US Geological Survey, and the National Weather Service was

completed in 2025. This assessment used historical data and statistical analyses to perform detailed modeling of hydrology for large rivers throughout the region.

Several studies were also provided by sponsors to support projects submitted to the RFPG for inclusion in the Regional Flood Plan, including master drainage plans and FIF studies.

Additional studies were performed by the RFPG, as discussed in Chapter 4: Assessment and Identification of Flood Mitigation Needs. These studies assisted in developing projects for areas within the region that were identified as having high flood risk and outdated flood risk data.

Public Outreach

The Technical Consultant Team also developed a Community Questionnaire for Region 8 to gather data from public officials with flood-related responsibilities (cities, counties, districts, etc.).

The questionnaire requested that respondents provide contact information and flood-related responsibilities, verified flood information that had already been collected, responded to questions to support the development of the Regional Flood Plan, and verified and provided geospatial data through data uploads and an interactive web map. The web map allowed survey respondents to draw in both problem areas and proposed projects that were not included otherwise.

At least two recipients from each community received this detailed survey to increase response rates. The total number of recipients in any given community varied with the size of the community – larger communities had four to five recipients, while smaller communities had two to three. Over 640 contacts representing 350 interest groups with flood-related responsibilities received a link via email to the community questionnaire in January of 2025. This email included information on flood planning basics along with a link to the community questionnaire and guidance on why it is critical to the planning process.

Figure 1.2 illustrates all categories of interest groups included in the outreach effort. *Table 1.1* describes the various methods used to contact interest groups and the number of interest groups reached by each effort.

Figure 1.3: Outreach Efforts and Contacts Made

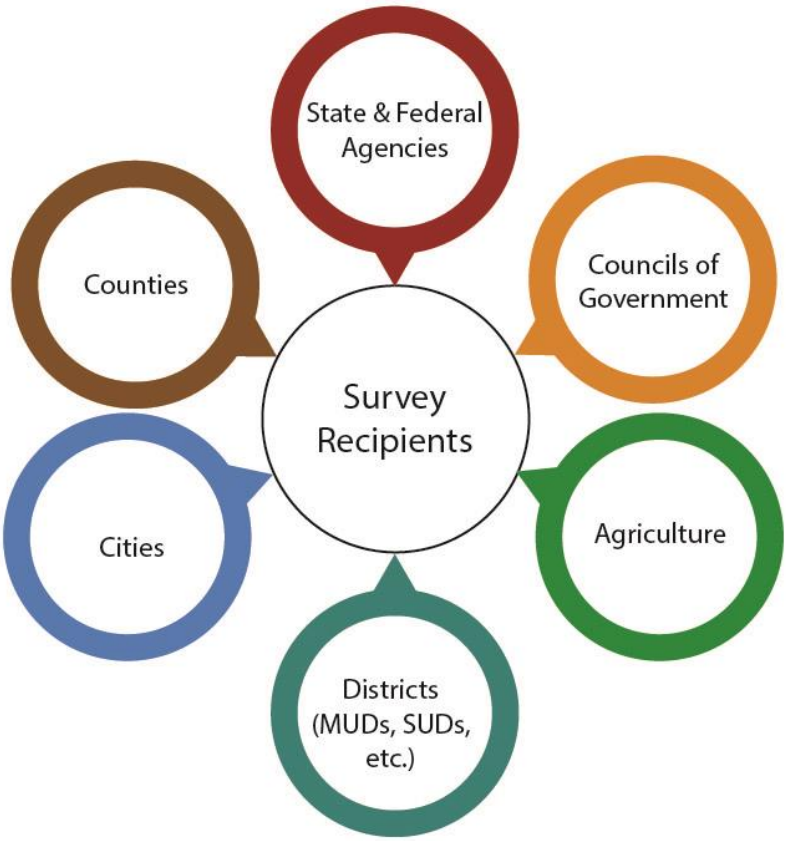


Table 1.1: Outreach Efforts to the Lower Brazos Planning Region Interest Groups

Method of Outreach	Number of Interest Group Contacts Reached
Initial Email Blast (January 2025)	350
Follow Up Email Blast (March 2025)	350
Personal Outreach (phone calls and emails)	99

(Halff Associates, Outreach Effort Data)

To ensure everyone had the opportunity to participate, the Technical Consultant Team followed the general email blast with targeted outreach efforts. Reminder email blasts were sent in March of 2025, along with a notification of the questionnaire deadline being extended. Calls and personal emails were made to recipients who did not respond to the survey within the first month of its distribution. These personal contact efforts included almost 100 entities, primarily targeting communities and interest groups representing populations of at least 10,000. The questionnaire closed on April 17, 2025, with a response rate of approximately 13 percent.

Although the response rate was relatively low, many large municipalities and counties provided responses representing their large population base. The questionnaire responses represent roughly 43 percent of the population in Region 8. Survey results are included throughout Chapter 1 and the chapters to follow. More information regarding public outreach is included in Task 10 of this plan.

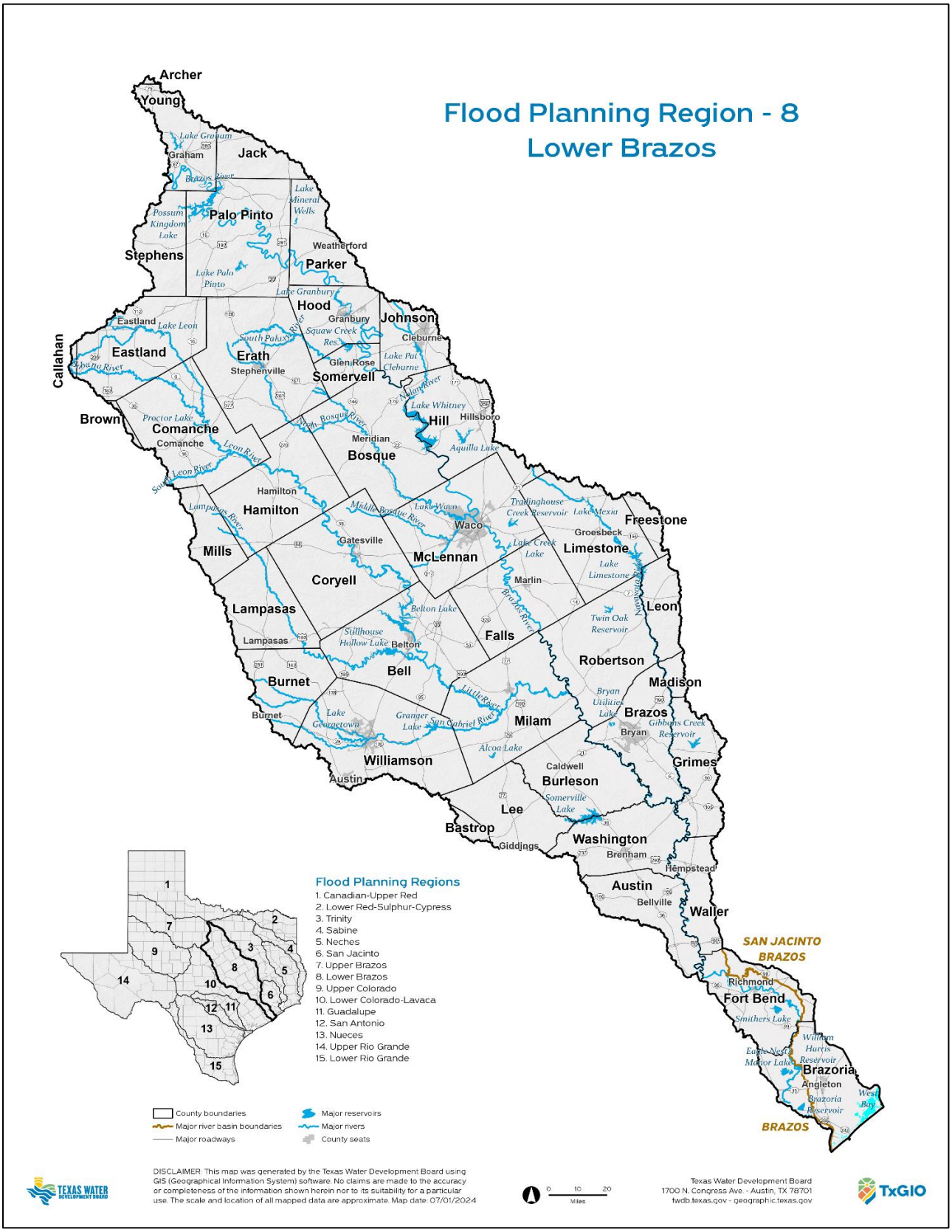
1.2 Characterizing the Lower Brazos Planning Region

1.2.1 Social and Economic Character

Region 8 encompasses more than 23,000 square miles, with its boundaries defined by the downstream segment of the Brazos River watershed. This region comprises 43 counties and 193 municipalities, and is characterized by significant diversity in population, industry, economic profile, as well as types and levels of flood risk. See *Figure 1.4* for a map of Region 8 showing the region's counties, major cities, and major hydrologic features.

To better understand the current and future character and conditions of the Lower Brazos Planning Region, this section will provide a brief, general description of communities, population, the various types of development, economic activities, and industrial sectors at the greatest risk of flood impacts.

Figure 1.4: Flood Planning Region 8 – Lower Brazos



Population and Future Growth

For current and future population estimates, two population datasets are used: Water User Group (WUG) population estimates and the American Community Survey (ACS) data. Population densities for Region 8 are determined using both the 2030 WUG community population estimates and the 2024 ACS census tract estimates. The 2030 WUG data mainly serves as a baseline for comparing with 2050 population estimates to analyze projected growth.

The 2024 ACS population estimates are provided by the United States Census Bureau and are the most current population estimates for Region 8. The ACS population estimates are quantified by census tract.

The WUG Data is based on the ACS data but quantifies populations by community boundaries (e.g., cities, counties, MUDs, etc.) instead of census tracts and estimates population projections in 10-year increments starting with the year 2030. This dataset was produced by the TWDB in collaboration with the 2026 Regional Water Plans and subsequently refined to accurately quantify the population of each portion of the WUG within the respective flood planning regions.

Current Population

According to 2030 WUG population estimates developed by the TWDB, the current estimated population of Region 8 is 3.5 million and constitutes approximately 10 percent of the population of Texas. *Figure 1.5* presents the total population of the Region by census tract, as reported in the 2024 ACS data. *Figure 1.6* illustrates the population density of the Region, utilizing the same dataset.

As depicted in these two figures, population is currently concentrated in communities neighboring major metropolitan areas and along interstate corridors. This concentration is due to heavy suburban development outside of major cities that provide jobs and many amenities. The major metropolitan areas are listed below in order from north to south):

1. Dallas-Fort Worth – located near the northeastern portion of the region to the west of the City of Forth Worth
2. Waco – the only major city in this area, Waco, is located near the Brazos River in McLennan County in the middle of the region
3. Killeen-Temple – middle of Region 8 between the City Waco and the City of Austin
4. Bryan-College Station – near the Brazos River in Brazos County near the middle to southern end of the region
5. North Austin – located in the western portion of the region north of the City of Austin
6. Sugarland-Houston – located in southern portion of the region southwest of the City of Houston

Figure 1.5: Total Population by Census Tract (2024 ACS)

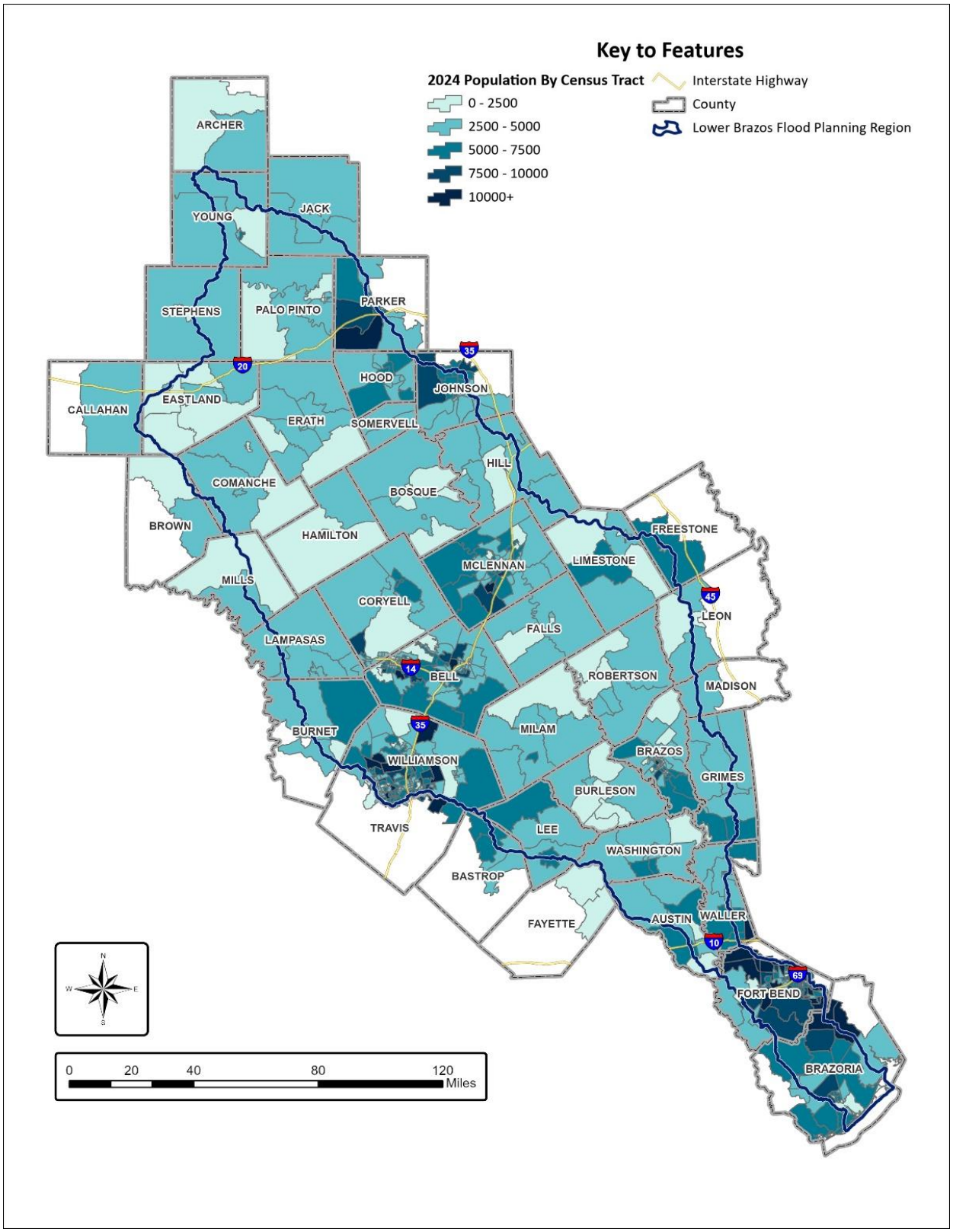
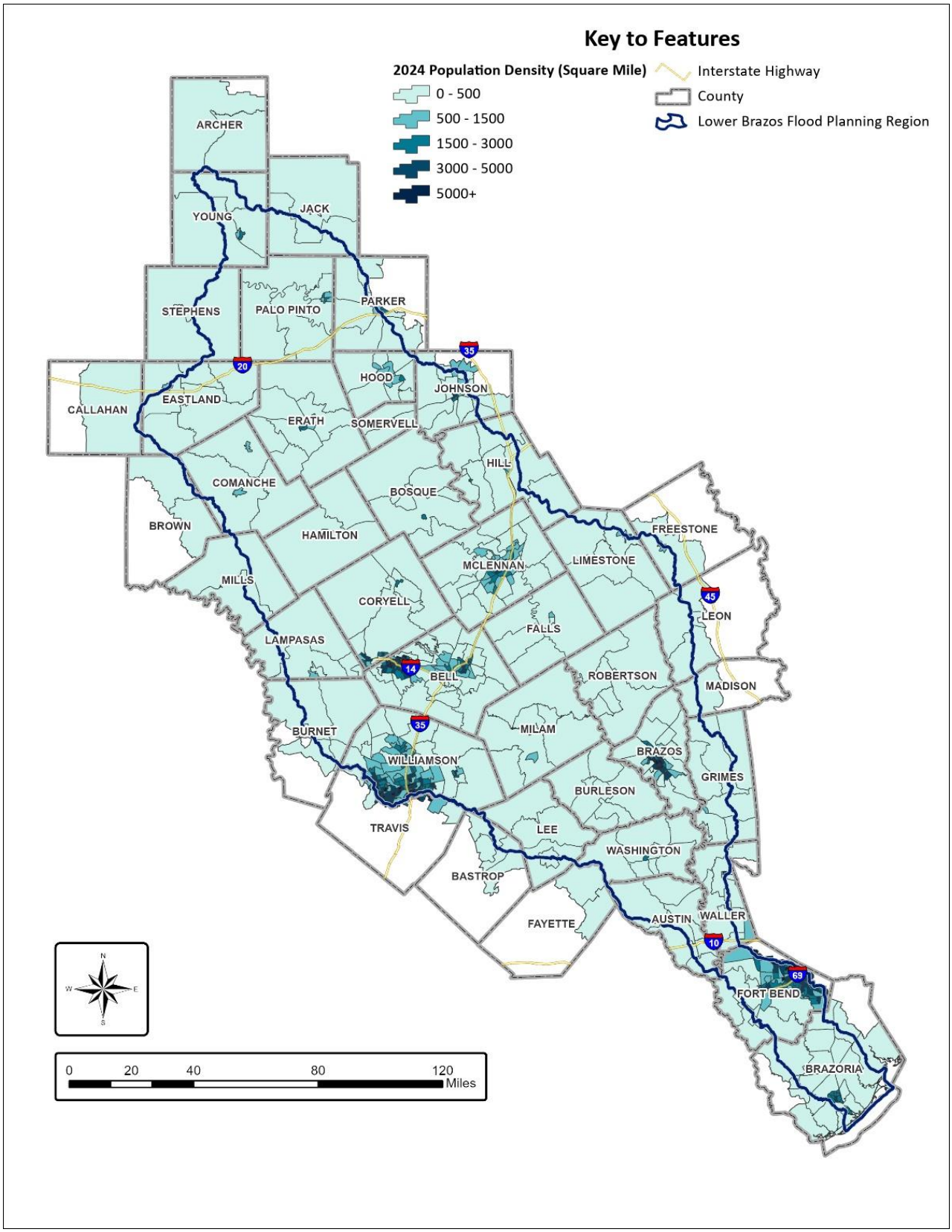


Figure 1.6: Population Density by Census Tract (2024 ACS)



Projected Growth within the Lower Brazos Planning Region

Based on 2050 WUG population projections, the communities in Region 8 that are expected to have the highest population growth rate between 2030 and 2050 are located near the metropolitan areas listed in the previous section. *Table 1.2* lists the cities with a projected population greater than 100,000 people in the year 2050 along with their estimated population growth from 2030 to 2050.

Table 1.2: Cities with Populations Projected to be Greater than 100,000 in 2050

City	County	Metro Area	Population 2030	Population 2050	Percent Increase
Georgetown	Williamson	North Austin	252,762	602,705	138%
Killeen	Bell	Killeen-Temple	173,431	221,697	28%
Round Rock*	Williamson	North Austin	139,505	204,774	47%
Waco	McLennan	Waco	156,758	184,144	17%
Leander*	Williamson	North Austin	133,304	180,025	35%
College Station	Brazos	Bryan-College Station	124,105	165,452	33%
Bryan	Brazos	Bryan-College Station	103,527	145,418	40%
Temple	Bell	Killeen-Temple	115,562	139,891	21%

*City is not fully contained in Region 8. The populations listed are the estimates for the portion of the population located within Region 8. (Texas Water Development Board)

Attention should be given to these areas regarding floodplain management, with the goal of implementing effective regulations that minimize flood risk for future residents and limit the necessity for additional infrastructure to address flood hazards.

Figure 1.7 shows the total population by community boundary for the year 2030 and *Figure 1.8* shows the total population by community boundary for the year 2050. One additional conclusion to be drawn, based on these figures, is that the unincorporated areas near the major metropolitan areas, such as Fort Bend County and Brazoria County, will also experience high growth.

Figure 1.7: Total Population in 2030 by WUG Boundary (2030 WUG Data)

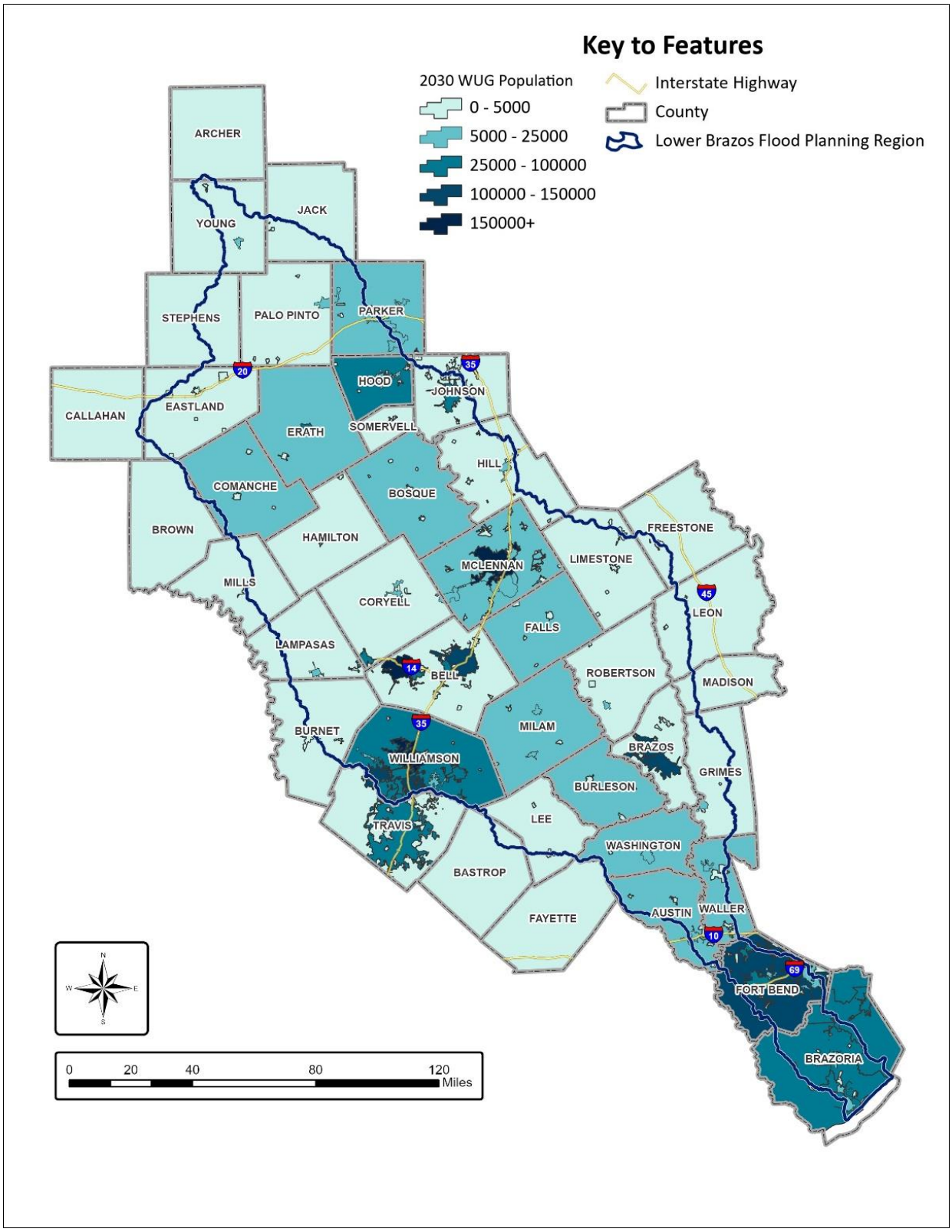


Figure 1.8: Total Population in 2050 by WUG Boundary (2050 WUG Data)

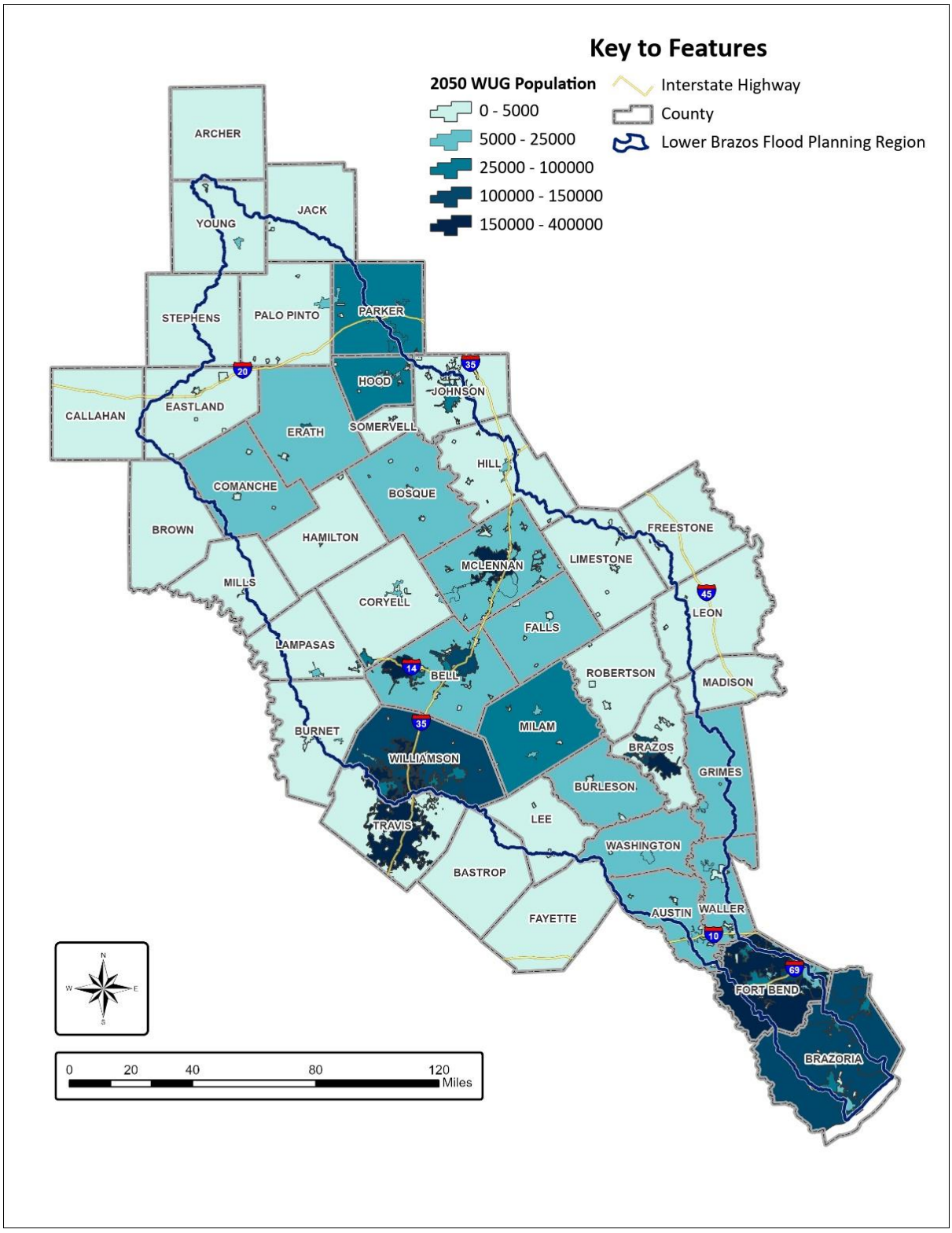


Table 1.3 list the 10 cities and towns with the greatest rate of projected population growth within counties in the region between the years 2030 and 2050.

Table 1.3: Top Ten Fastest Growing Cities (WUG Projections 2030-2050)

City	Population 2030	Population 2050	Rate of Population Growth
Georgetown	252,762	602,705	138.4%
Liberty Hill	6,367	12,675	99.1%
Taylor	27,500	53,155	93.3%
Hutto	23,452	45,199	92.7%
Needville *	3,261	6,147	88.5%
Austin*	94,844	163,421	72.3%
Fulshear*	25,239	42,554	68.6%
Bertram*	4,578	7,093	54.9%
Copperas Cove	49,804	76,432	53.5%
Round Rock*	139,505	204,774	46.8%

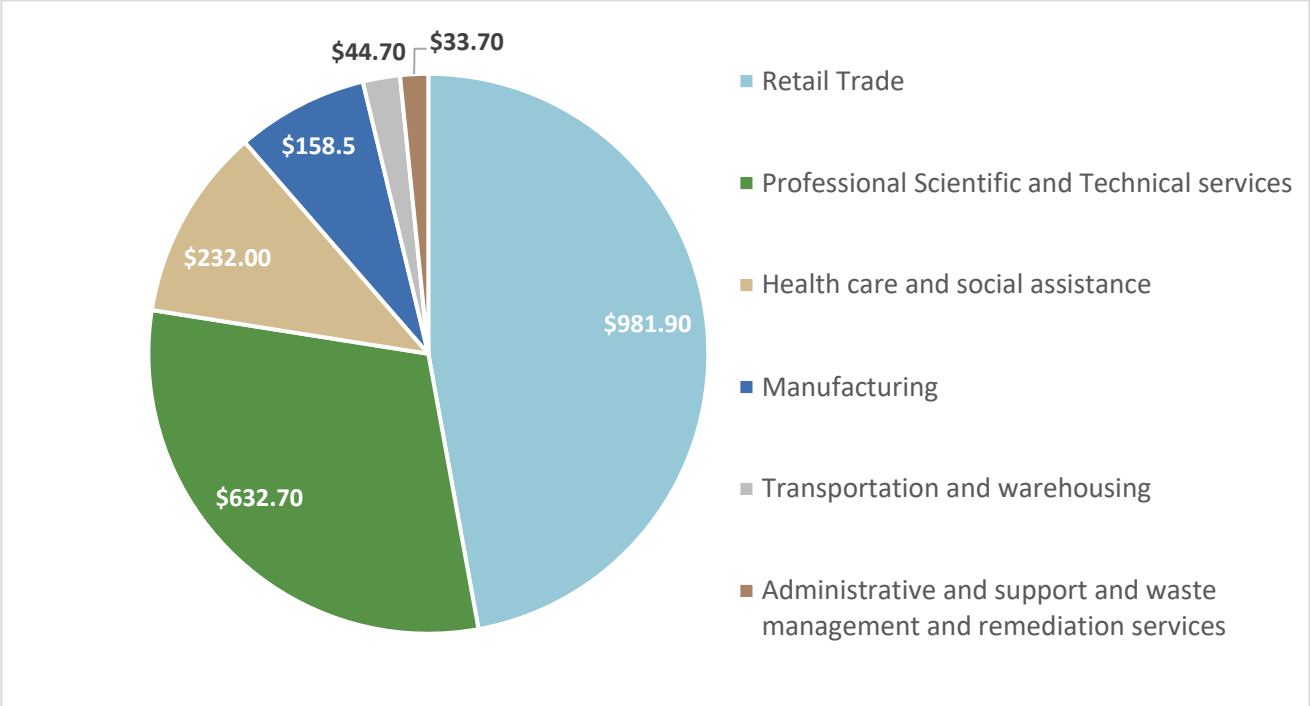
*City is not fully contained in the Lower Brazos Region. The population for the portion of the city within the region listed may be smaller than the total population. (Texas Water Development Board)

As mentioned before, attention should be given to these cities regarding floodplain management, with the goal of implementing effective regulations that minimize flood risk for future residences and limit the necessity for additional infrastructure to address flood hazards.

Economic Activity

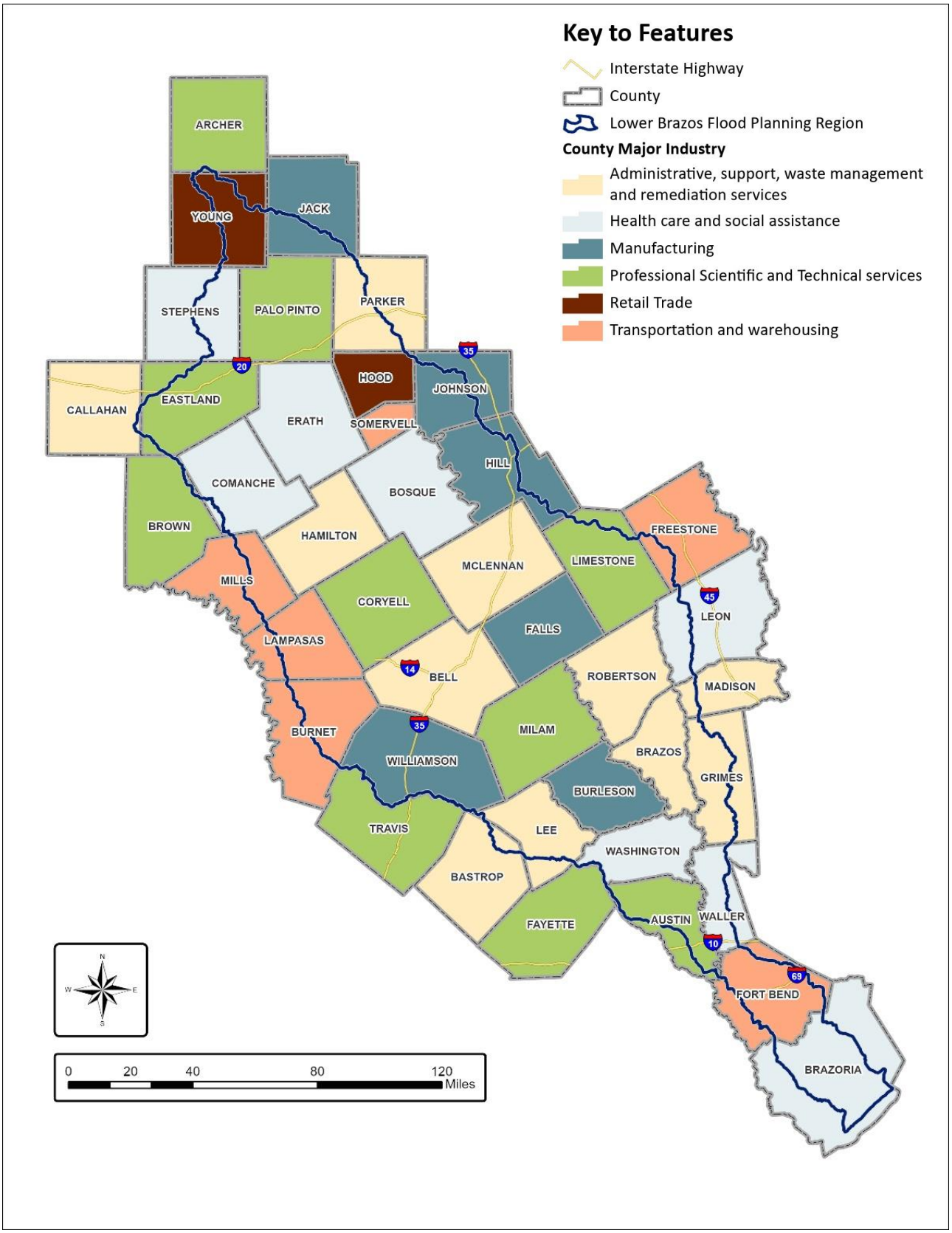
Region 8 is home to key industries, such as wholesale and retail trade, manufacturing, health care, and social assistance, which contribute to the gross domestic product of Region 8 and support the local and state economies. Based on the most recent Economic Survey from the United States Census Bureau, the total value of sales or revenue generated by firms and businesses in Region 8 amounts to over $2.08 trillion, constituting approximately 11.6 percent of the total revenue generated by all firms and businesses in Texas. *Figure 1.9* lists the major industries in the Lower Brazos Planning Region along with their annual revenue and *Figure 1.10* shows the major industry of each county in the region.

Figure 1.9: Annual Revenue (in billions) for Major Industries in the Lower Brazos Planning Region



(United States Census Bureau, 2022)

Figure 1.10: Major Industry by County



Commercial Activity

Within Region 8, Williamson County generates the most commercial activity, the largest revenue, and has the second highest number of firms or businesses. Its dominant industry sector is retail trade. Fort Bend County has the largest number of total firms and the second-largest revenue, of which more than half is in the retail trade industry. Brazoria County, south of Region 8 and bordering Fort Bend County, generates the third-largest revenue.

Table 1.4 lists the five counties generating the most sales and revenue in the Lower Brazos Planning Region. These counties also have the largest number of firms and businesses, and their dominant industry sectors employ between 27,000 and 550,000 employees.

Table 1.4: Top Five Counties by Total Revenue, Firms, and Employees

County	Total Revenue (in Billion)	Total Number of Firms and Businesses	Total Number of Employees	Dominant Industry Sector
Williamson	$246.5	77,459	1,096,704	Manufacturing
Fort Bend*	$223.6	103,491	1,171,883	Transportation and Warehousing
Brazoria*	$139	33,334	470,725	Health Care and Social Assistance
McLennan	$74.7	21,861	508,248	Administrative, support, waste management and remediation services
Bell	$73.1	26,339	558,708	Administrative, support, waste management and remediation services

*Counties are not fully contained within Region 8
(United States Census Bureau, 2022)

Agricultural Activity

According to the United States Geological Survey (USGS) data, over 13 million acres in Region 8 are rural, contributing to the economy of the state and the region through farming, ranching, and forestry. Approximately 7.2 million acres of Region 8 are utilized for ranching, providing critical support to Texas's cattle production, which remains the state's top agricultural commodity in market value (U.S. Geological Survey (USGS), 2023).

Similarly, 4.6 million acres of rural lands in Region 8 are comprised of forestry, the sixth top agricultural commodity in the state. Of the 1.2 million acres of farmland in the Lower Brazos

Planning Region, significant areas of the rural land are producing wheat, sorghum, corn, and oats, which are in the top 10 most important agricultural commodities in terms of market value in Texas. *Figure 1.11* illustrates the variety of agricultural uses in the region (U.S. Geological Survey (USGS), 2023).

Economic Status of Population

According to the 2023 five-year American Community Survey, the median household income for Texas is $76,292. About half of all census tracts in the Lower Brazos Planning Region, approximately 47 percent, have a median household income below the median household income for Texas.

The census tracts with the lowest median household income (less than $25,000) are primarily in the urban centers of Temple, Waco, Marlin, and College Station.

The census tracts with median household income greater than $30,000 but less than the state's median household income in the central area of the region are primarily Limestone, Falls, Milam, and Lampasas counties. In the northern area of the region, census tracts in Bosque, Eastland, and Palo Pinto counties also have a median household income below the median value for Texas.

Census tracts with a median household income higher than $92,000 are primarily found in the suburban areas of the major metropolitan areas listed earlier (North Austin, Waco, Sugarland-Houston, Bryan-College Station).

Figure 1.12 illustrates the different median household incomes across the Lower Brazos Planning Region

Figure 1.11: Land Cover

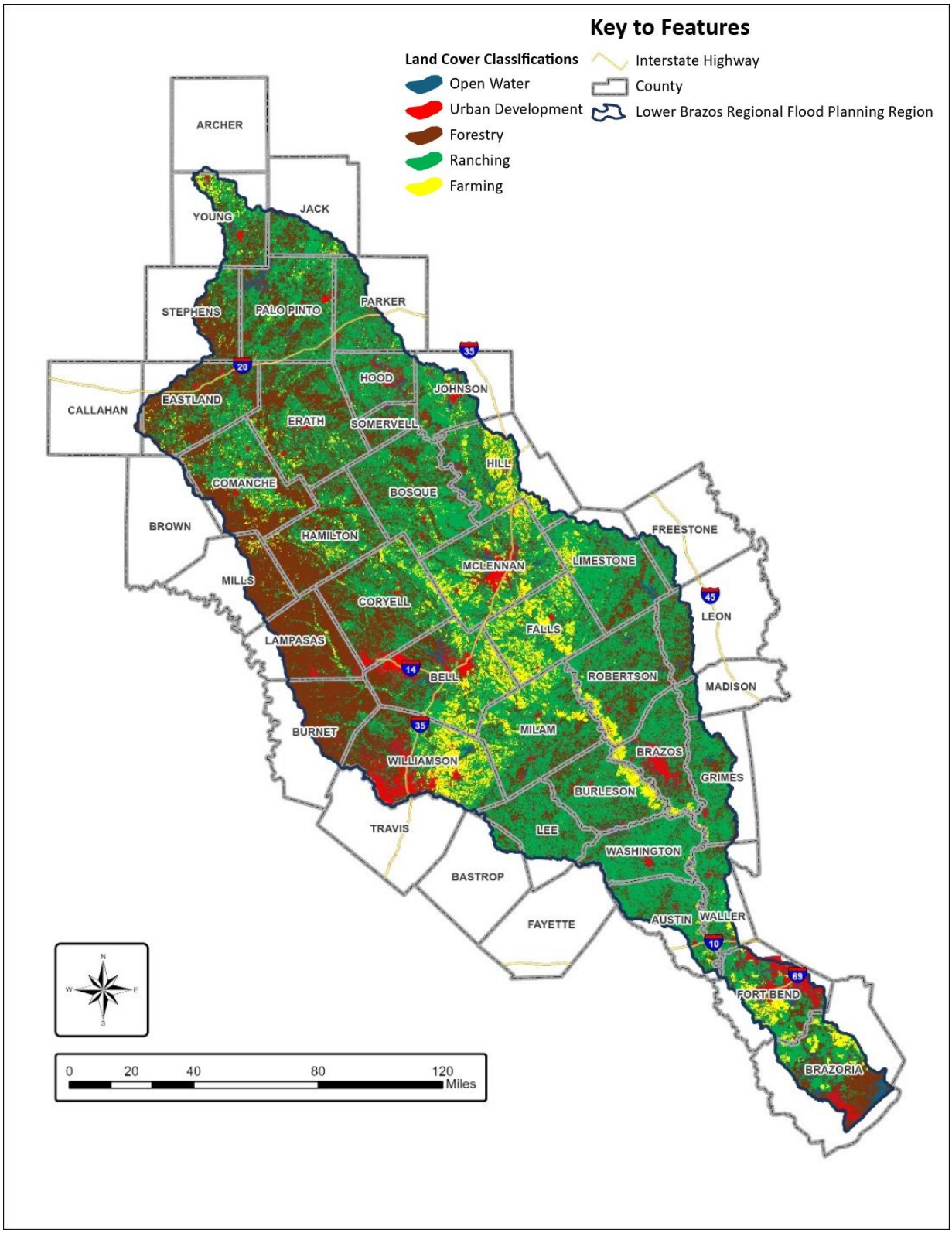
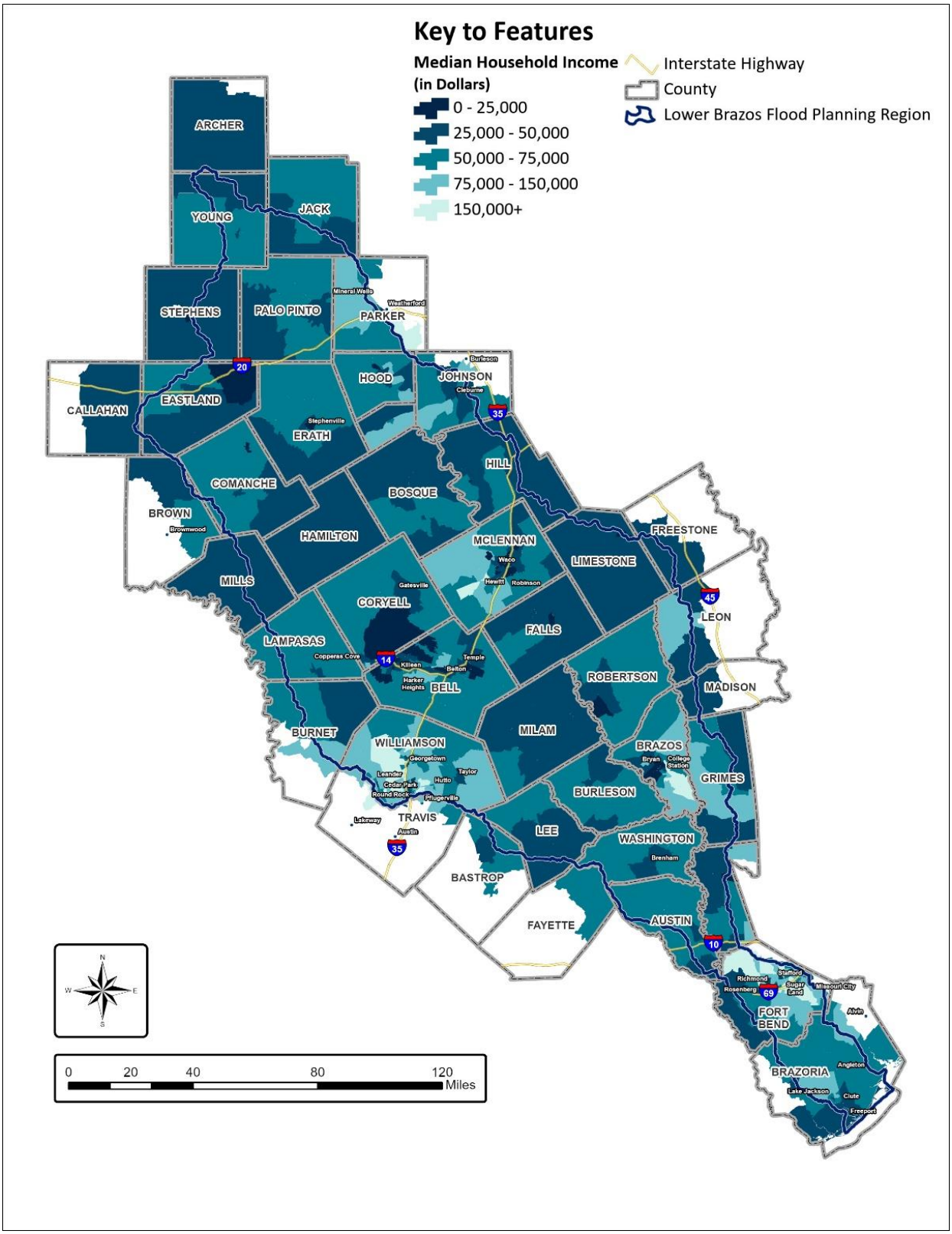


Figure 1.12: Median Household Income by Census Tract

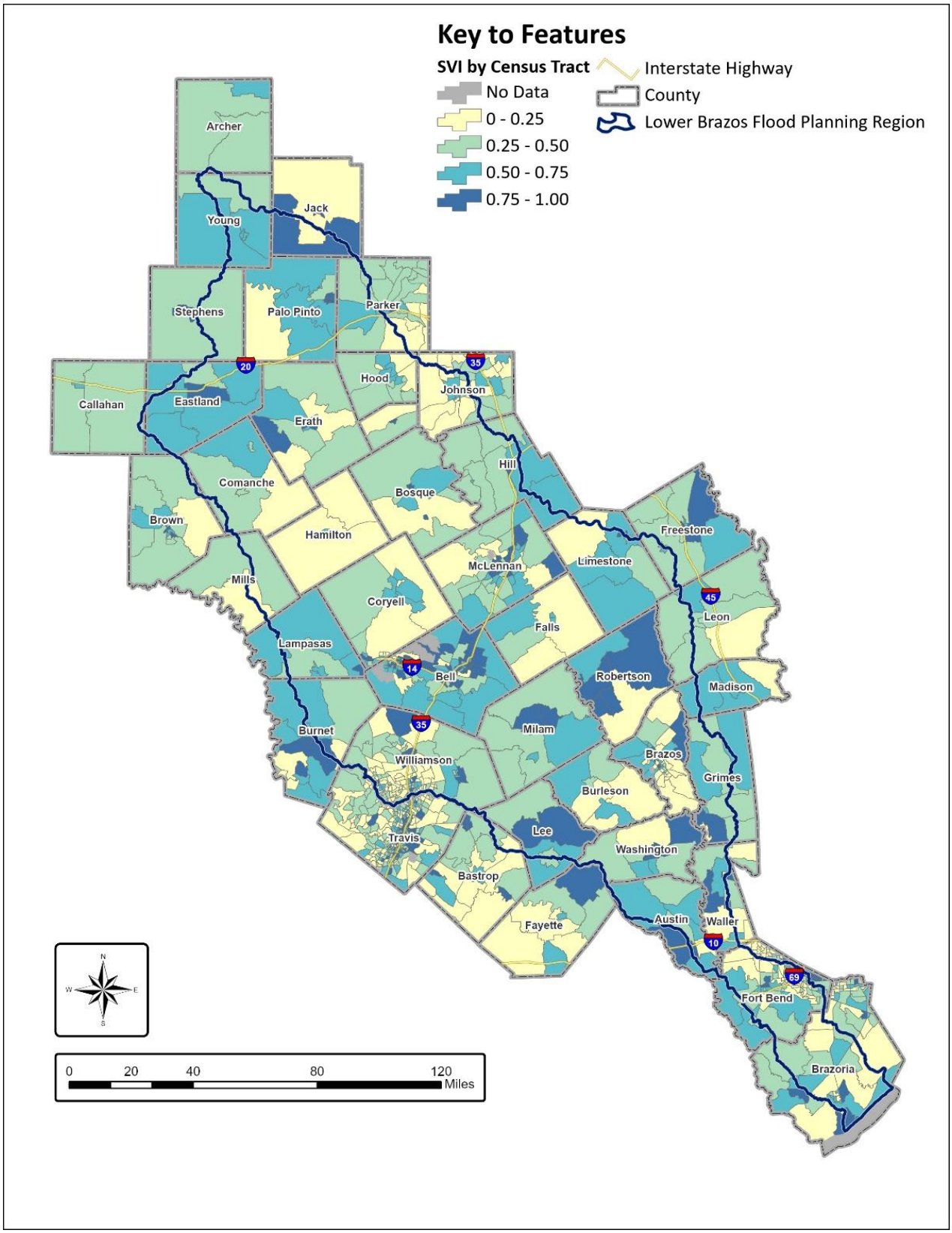


Social Vulnerability in the Lower Brazos Planning Region

Social vulnerability refers to the potential negative effects on communities caused by external stresses on human health, according to the Centers for Disease Control and Prevention (CDC). Stresses include natural or human-caused disasters, such as floods or disease outbreaks. According to the CDC, identifying communities with high social vulnerability in Region 8 is critical for flood planning and mitigation since communities with high social vulnerability are at a greater risk of incurring loss of life and property during a flood event. Factors contributing to a community's social vulnerability include the number of residents in poverty, lack of access to transportation, and housing type. These conditions reduce residents' capacity to withstand and recover from disasters like hurricanes. Federal agencies like the Federal Emergency Management Agency (FEMA) and the United States Department of Housing and Urban Development (HUD) utilize the Social Vulnerability Index (SVI) to assist communities during and after human-made and natural disasters. The Texas Flood Social Vulnerability Index (TX F-SVI), developed by the Texas Water Development Board, addresses limitations of the CDC SVI, which is more general in nature, by tailoring the index to hazards specific to flooding and the social and environmental characteristics unique to Texas.

The TX F-SVI indicates the relative social vulnerability of every census tract in Texas and ranks each tract based on percentile values between zero and one, with higher values indicating greater vulnerability. The index considers 18 factors: access to phone/internet, age, disability, environmental risk factors, housing age, housing value, income, limited English-speaking ability, migration, housing type, vehicle ownership, race/minority status, poverty, home ownership, rural/urban status, employment type, unemployment, and single-parent households. The census tracts with the highest SVI value (census tracts that are in the top quartile of social vulnerability) are primarily in and around the mid-sized communities of Waco and Temple in the central area of the region and the small-sized communities of Cameron and Calvert in Milam and Robertson counties (refer to *Figure 1.13).* Other census tracts with high social vulnerability include the less-populated communities of Hempstead in Waller County and Freeport in Brazoria County. These communities are at a greater risk of incurring loss of life, property, and livelihood due to high social vulnerability attributed to a higher poverty rate, diminished mobility or access to transportation, and unsafe housing conditions.

Figure 1.13: Social Vulnerability by Census Tract



1.2.2 Location of Critical Facilities

Critical facilities are community assets, such as hospitals, fire stations, police stations, storage of critical records, energy-producing facilities, water and wastewater treatment plants, and similar facilities that require special consideration in floodplain management and disaster planning. Critical facilities must always continue to function and provide services during a flood. Critical facilities are located in high population centers such as metropolitan areas. *Figure 1.14* illustrates the density of critical facilities in the Lower Brazos Planning Region.

1.2.3 Flood-Prone Areas and Flood Risk to Life and Property

Based on the existing flood risk analysis performed under Task 2A, about 20-percent of Region 8 is in the 1-percent annual chance exceedance (ACE) floodplain (see *Figure 1.15*). This flooding presents significant risks to human life and can cause considerable damage to infrastructure and property in both rural and urban areas.

Flood Risk to Structures and Infrastructure

A critical metric in floodplain management is the risk of flooding for habitable structures, critical infrastructure (hospitals, police stations, schools, etc.), and roadways. A region-wide flood risk analysis was performed under Task 2A which collected the best available flood risk products, consolidated this data into a single flood risk mapping product, and intersected this flood risk layer against existing structure and roadway data provided by TWDB. *Table 1.5* summarizes the structures, critical facilities, and roadways that are at risk of flooding for the entire region based on the Task 2A analysis. For additional information, see chapter two.

Table 1.5: Flood-Prone Infrastructure

Potential Flood Risk Event	Number of At-Risk Structures	Number of At-Risk Critical Facilities	Number of At-Risk Roadway Crossings*	Impacted Agricultural Areas (sq mi)
Existing 1 percent ACE	63,060	200	5,170	840
Existing 0.2 percent ACE	107,720	380	5,390	940

*Includes low water crossings only.

(Texas Water Development Board and Federal Emergency Management Agency)

Figure 1.14: Density Map of Critical Facilities

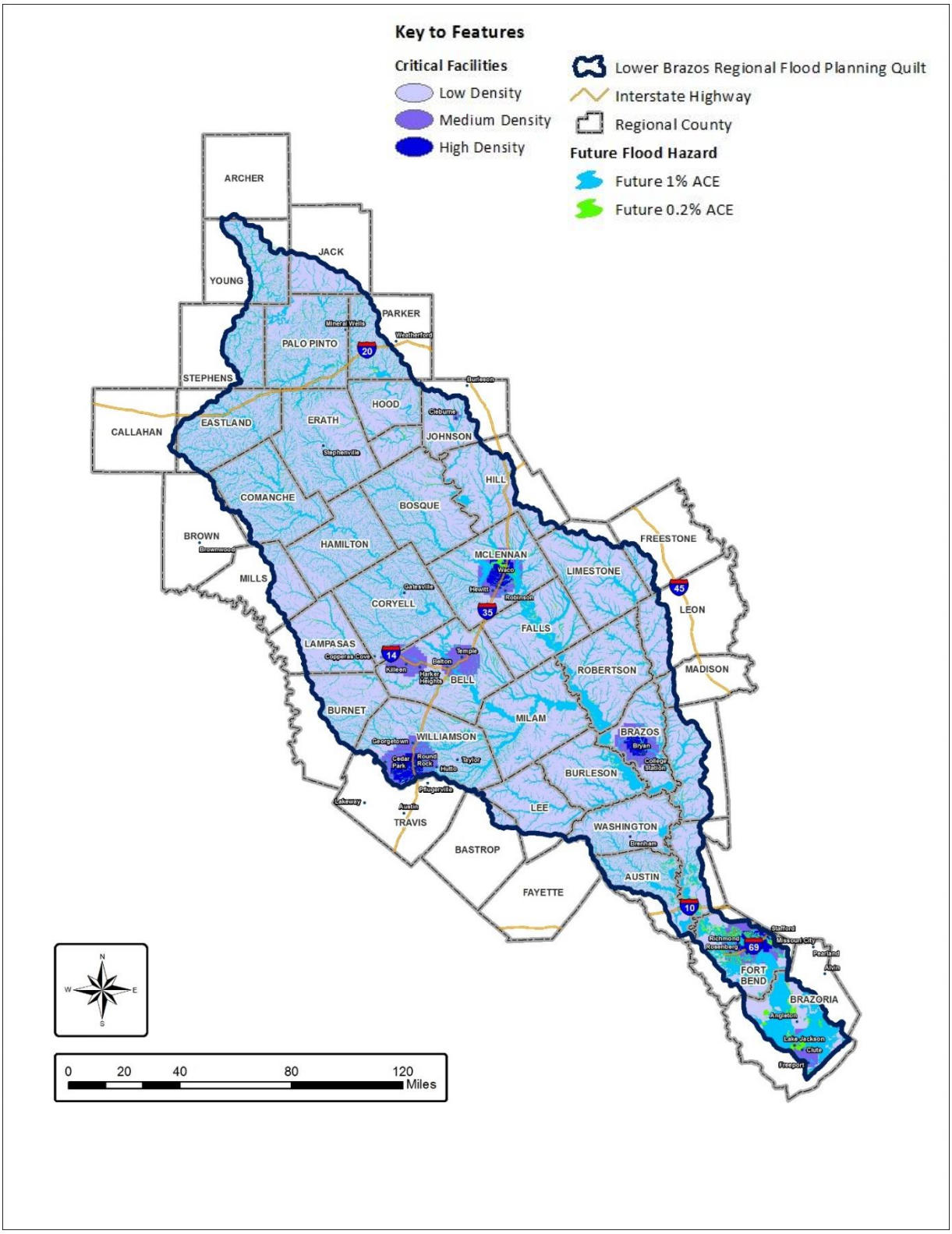
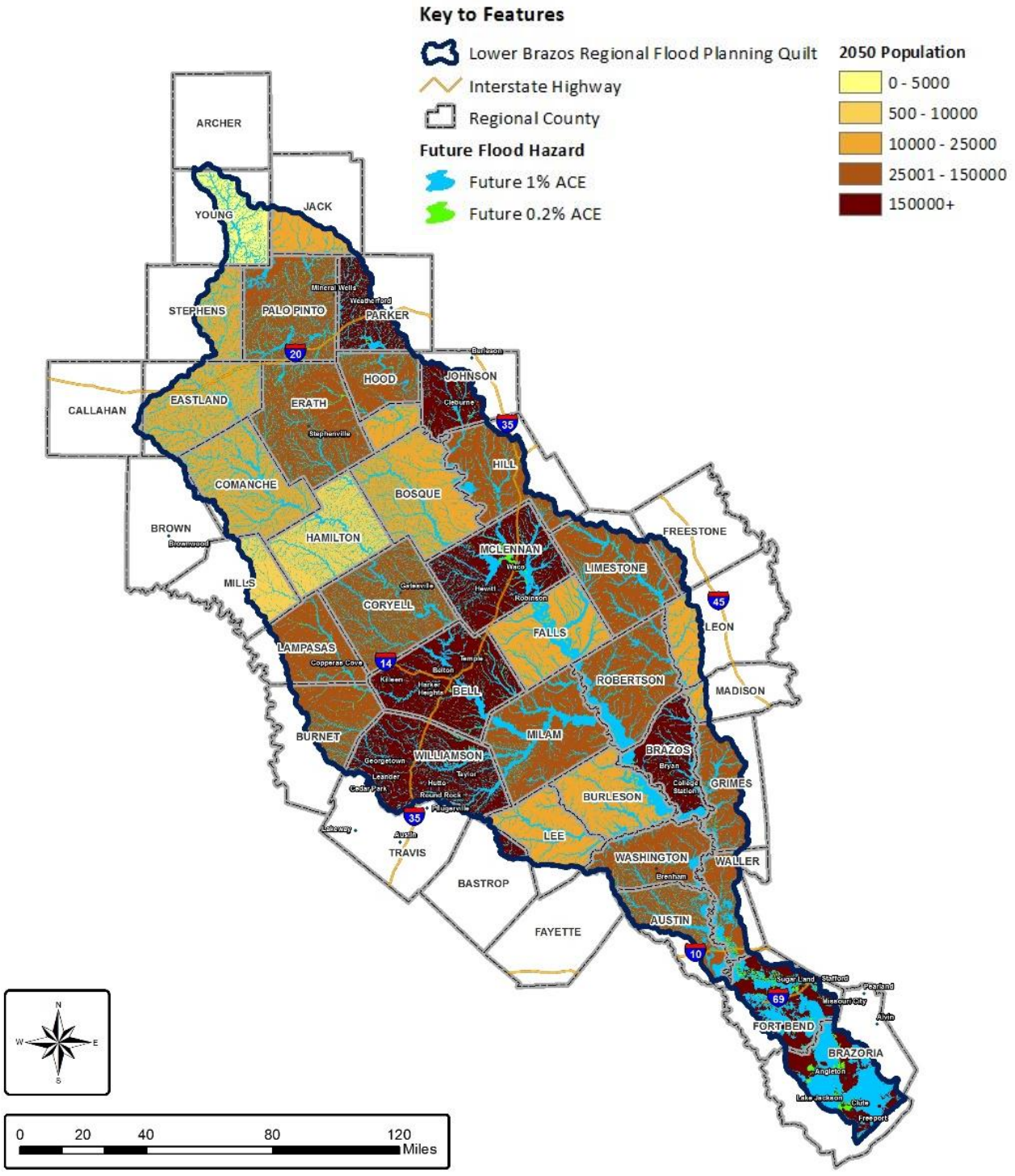


Figure 1.15: Floodplain Quilt (1% ACE) and 2050 Population



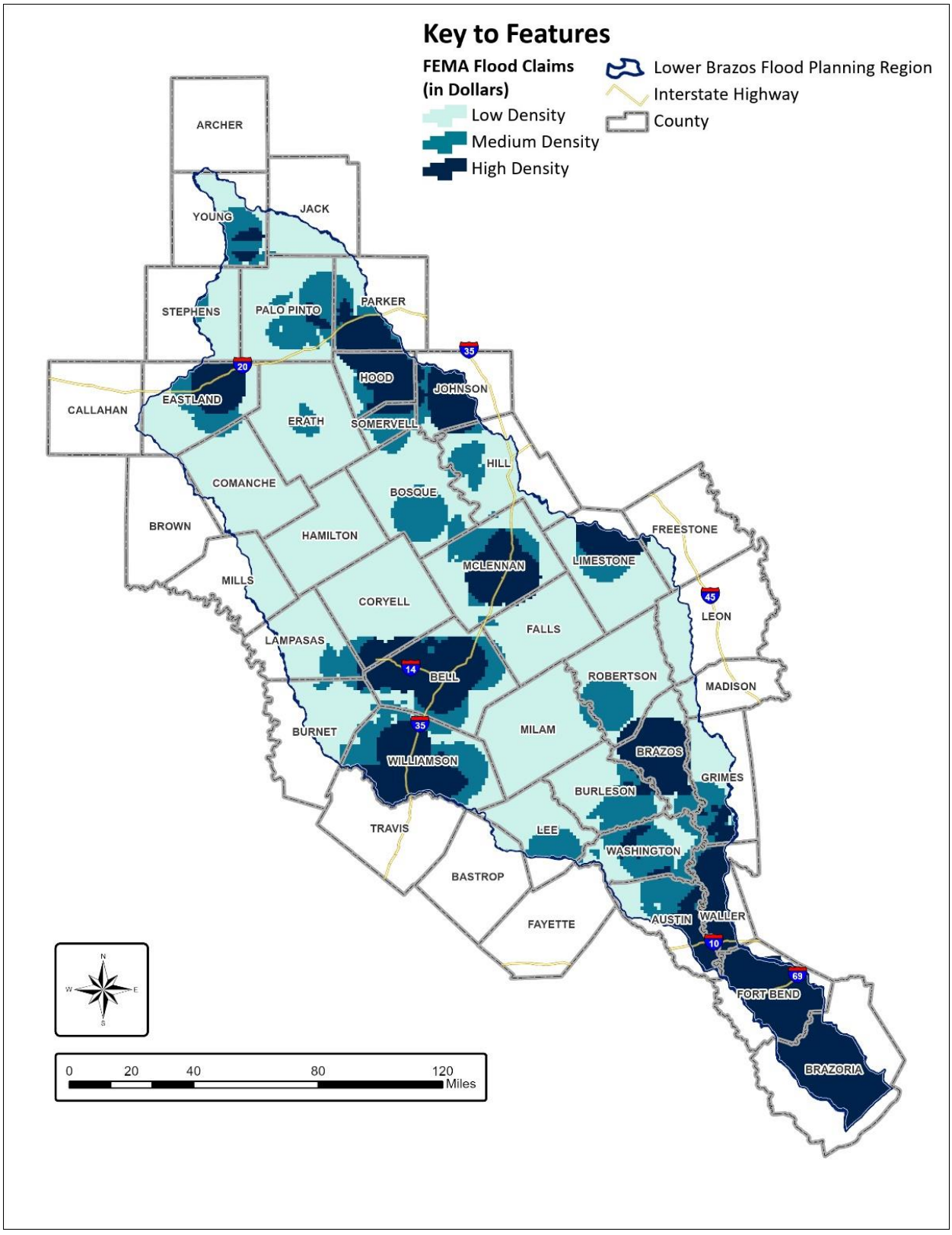
Existing Flood Risk

Figure 1.16 illustrates the distribution of flood claims filed with FEMA in the Lower Brazos Planning Region. These flood claims indicate areas that currently have a flood risk and that will continue to suffer from flooding until flood reduction measures are put in place.

The highest density of FEMA flood claims is in Brazoria, Waller, and Fort Bend counties in the most southern portion of the region where the Brazos River and its distributaries are a significant source of flood and where topography is flat. This region presently has a high population density and is expected to experience continued high growth in the future.

The areas around the major metropolitan areas (Killeen-Temple, Waco, North-Austin, and Bryan-College Station) also have a high density of flood claims primarily due to the density of the population in these areas.

Figure 1.16: FEMA Flood Claim Density



(Federal Emergency Management Agency)

Agricultural and Natural Resources Most Impacted by Flooding

Region 8 is comprised of five main land-use types including farming, forestry, ranching, urban areas, and open water. *Table 1.6* provides the acreage for each land use in the region. The following section discusses the detrimental impact of flood events on the agricultural and natural resources of the Lower Brazos Planning Region.

Table 1.6: Lower Brazos Planning Region Land Use Summary

Land Use	Total Area in Lower Brazos Region (acres)	Total Area in Lower Brazos Region within the 1 percent ACE Floodplain (acres)	% of Area at 1 percent ACE Flood Risk
Farming	2,325,760	535,424	23%
Forestry	9,732,480	933,057	10%
Ranching	8,783,360	683,035	8%
Urban Development	1,699,840	135,680	8%
Total	22,541,440	2,184,981	10%

(Texas Water Development Board and United States Department of Agriculture)

Farming

Flooding or excess precipitation can wash nutrients downstream or result in complete or partial loss of crops. The severity of impact flooding has on farming depends on many factors, including what is planted, what time of year the flood event occurs, and the wind speed of the storm. Additionally, a crop's growth stage influences the susceptibility to damage or loss due to excess water. Different crops have different resilience to excess precipitation and prolonged standing water. Permanent crops, such as fruit trees tend to be more resilient to excess precipitation and standing water than row crops, such as cotton. Heavy rain before planting could delay planting or prevent planting entirely. Damage can also occur after a crop has been harvested. Crops, such as hay or cotton, which have been harvested but not bailed or processed can be degraded by heavy rainfall in the Lower Brazos Planning Region. According to the United States Department of Agriculture Risk Management Agency, Region 8 experienced over $140 Million in crop losses due to flooding, hurricanes, and tropical storms from 1989-2020, the years for which records are available for review.

Flooded fields in rural agricultural lands. Source: Halff

Forestry

Forestry impacts due to flooding are also multifaceted. Flash flooding can bring swift-moving debris that could physically wound a tree creating the conditions for contaminated flood water to introduce diseases to the tree. Sustained flood conditions can deplete the oxygen supply and cause root damage to trees. Floods that occur during the growing season can kill trees much faster than similar conditions during the dormant season, according to the Texas A&M Forest Service, an agency chartered by the Texas Legislature to manage the interests of forests in Texas. Furthermore, as described in research conducted by the University of Arkansas Agriculture Research and Extension, flooding can positively impact forests by clearing weaker trees, spreading seeds, and stimulating the growth of surviving trees.

Ranching

Information from Texas A&M AgriLife Extension illustrates how ranching activities in Region 8 are also impacted by flooding. Livestock can be swept away, drowned, or injured by flash floods. Livestock exposed to contaminated flood waters can experience health issues such as

pneumonia or foot rot. Livestock could also be exposed to disease-carrying mosquitoes during flooding events. Flood events can cause delays in building back livestock herds. Damages to feed crops can also reduce ranching capabilities.

Natural Resources

Region 8 contains many natural resources that flood events can negatively impact. As with livestock, wildlife can be injured or killed by flash floods. Severe flood conditions can degrade stream health and impact ecosystems in the region. Flooding can cause an imbalance in the ecosystem of the Brazos River Estuary. Oil and gas extraction can also be interrupted by flood conditions.

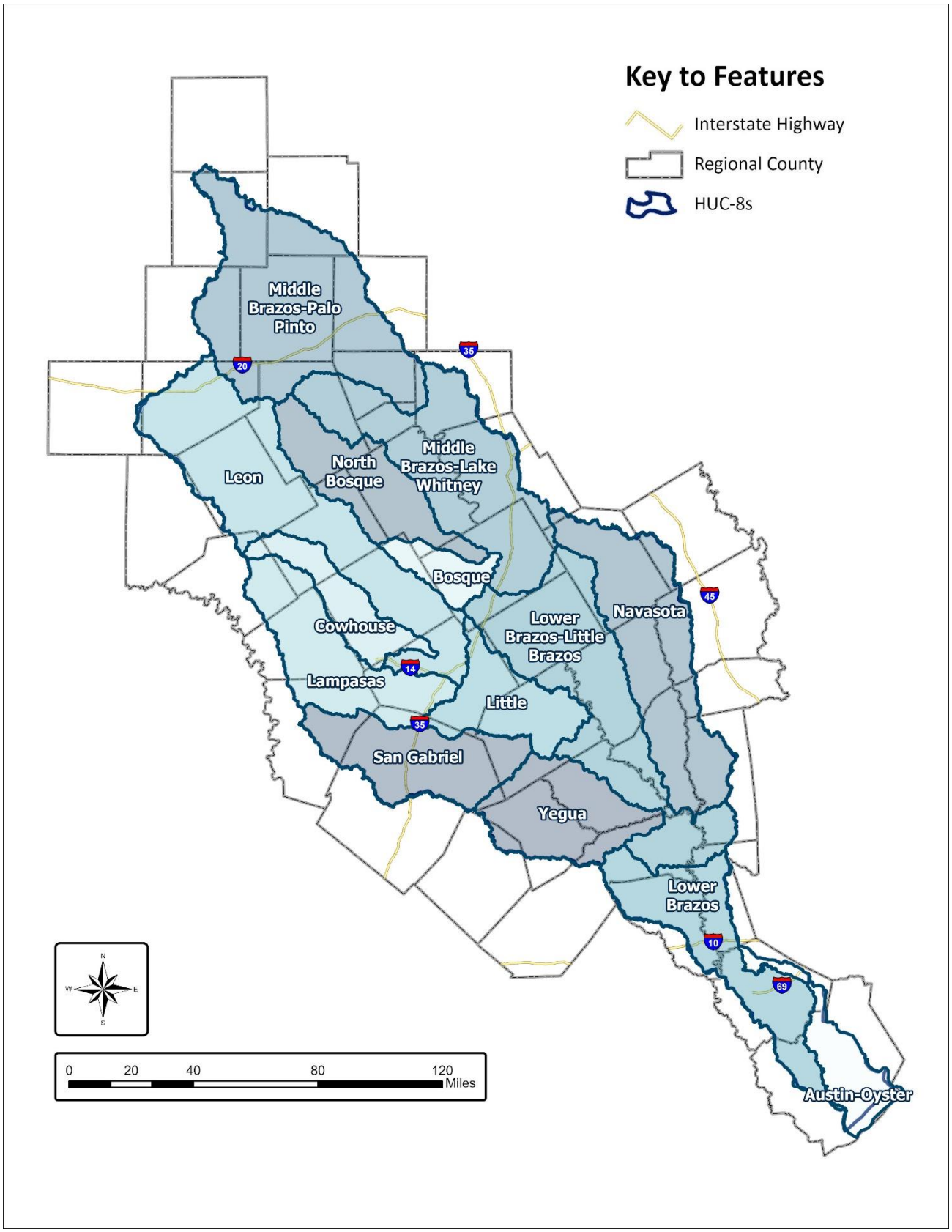
The agricultural land use in the Lower Brazos region that has the largest acreage within the 1 percent ACE floodplain is forestry, with over 930,000 acres in the 1 percent ACE floodplain. In other words, 10 percent of the entire land area used for forestry is in the 1 percent ACE floodplain. The total acreage of land used for ranching in the Lower Brazos region in the 1 percent ACE floodplain is over 683,000 acres, which is 8 percent of the entire land area used for ranching in the region. While the total acreage of land used for farming in the 1 percent ACE floodplain, approximately 433,200 acres, is less than the forestry or ranching land acreage in the 1 percent ACE floodplain, the percentage of the total farming land in the 1 percent ACE floodplain is the highest, at 19 percent, compared to other agricultural uses.

A HUC is a United States Geological Survey watershed delineation or boundary based on surface hydrologic features. Each hydrologic unit is assigned a 2 to 12-digit number that uniquely identifies the unit within a classification system that consists of the following:

- 21 regions (2-digit)
- 222 subregions (4-digit)
- 370 basins (6-digit)
- 2,270 subbasins (8-digit)
- approximately 20,000 watersheds (10-digit)
- approximately 100,000 sub watersheds (12-digit)

A HUC-8 represents the subbasin level analogous to medium-sized river basins. There are 14 HUC-8s in the Lower Brazos Planning Region as shown in *Figure 1.17*.

Figure 1.17: HUC-8s in the Lower Brazos Planning Region



The HUC-8s with the most significant amount of agricultural land area in the 1 percent ACE floodplain are Lower Brazos – Little Brazos and Middle Brazos – Lake Whitney in the northeastern area of the Lower Brazos Planning Region, as detailed in *Table 1.7*.

Table 1.7: Land Use Acreage Within the 1 percent ACE Floodplain by HUC-8

HUC-8	Farming (acres)	Forestry (acres)	Ranching (acres)	Total (acres)	HUC Total Acreage
Austin Oyster	33,552	108,738	36,500	178,790	446,059
Bosque	4,308	9,680	9,545	23,533	269,796
Cowhouse	2,045	15,478	6,950	24,473	465,569
Lampasas	6,293	41,903	13,772	61,968	967,883
Leon	16,825	52,134	22,995	91,954	1,933,332
Little	55,422	34,092	37,372	126,887	642,122
Lower Brazos	38,561	136,259	130,776	305,597	1,051,241
Lower Brazos - Little Brazos	182,840	101,918	131,001	415,759	1,726,263
Middle Brazos - Lake Whitney	39,848	74,575	69,915	184,339	1,598,530
Middle Brazos Palo Pinto	7,954	95,477	59,037	162,468	2,017,175
Navasota	11,466	122,840	76,874	211,181	1,437,563
North Bosque	8,454	31,576	24,562	64,592	795,789
San Gabriel	18,383	34,170	20,870	73,423	874,721
Yegua	7,257	74,217	42,866	124,339	845,755
Total	433,209	933,057	683,035	2,049,302	15,071,798

(Texas Water Development Board and United States Department of Agriculture)

1.2.4 Key Historical Flood Events

Historic Flood Events Before Current Level of Regulation

In December 1913, a notable record flood occurred across the Lower Brazos River Watershed (Ellsworth, 1923). After a very wet autumn which led to high stages, the watershed received about 3 inches of rainfall on average over 10 days, and many levees were damaged. As a result, the confluence of the Brazos River and the major tributary Little River at Valley Junction reached a record stage of 55.0 feet on Dec 4, 1913. Four days later, a record stage of 61.2 feet was recorded at the Richmond gage in Fort Bend County, according to the United States Geological Society and firsthand accounts, which notes that the floodplains of the Colorado and Brazos rivers merged with each other. At least 174 people were killed due to flooding along the Brazos River (Sawyer, 2021).

September 1921 brought heavy rainfall and flooding to central Texas (Ellsworth, 1923). The United States Weather Bureau recorded 16 inches of rainfall in Williamson County on September 9, 1921. As a result, the Little River near Cameron crested at a record gage height of 49.50 feet, and the gage height for the Brazos River at Jones Bridge, near Bryan, Texas, rose to 47.90 feet between September 8-12. The Little River basin, particularly in Williamson and Milam counties, suffered 159 fatalities, the most significant loss of life across the Lower Brazos Planning Region. Collectively, $4,000,000 in damages and 224 fatalities were recorded in the Lower Brazos watershed, as reported by the United States Geological Society.

The floods of April to June 1957 followed a period of severe drought in Texas (State of Texas Board of Water Engineers). Palo Pinto County recorded 19 inches of rainfall in May 1957, resulting in the downstream gage at the Brazos River near Glen Rose, Texas, reaching 33.89 feet, the fifth-highest record. Little River near Cameron reached a gage height of 39.56 feet with a stream flow of 116,000 cubic feet per second (cfs), the third-highest record. The long-duration event generated extensive runoff; 9.3 million acre-feet of total volume passed the Richmond gage. United States Army Corps of Engineers estimated statewide flood damages totaling $100,000,000.

These major flood events, amongst others, led to the construction of multiple flood control reservoirs to regulate the flow of the Brazos River. While major flooding in recent years has resulted in significant loss of life and property, gages with long periods of record throughout the watershed show that flooding was more severe in the region before regulation.

Historic Tropical Flooding Events

Tropical Storm Frances

Tropical Storm Frances made landfall on September 13, 1998, between Corpus Christi and Victoria. While Harris County was among the hardest hit in the Coastal Region, Brazoria

County averaged 10 inches of rainfall in 24 hours. According to the National Hurricane Center, West Columbia received more than 16 inches of rainfall in 24 hours. A major disaster declaration was issued for Brazoria County due to inland flooding. One direct fatality connected to flood conditions was reported in Brazoria County, as reported by the National Oceanic and Atmospheric Association's (NOAA) Storm Event Database.

Hurricane Ike

Hurricane Ike made landfall on September 13, 2008, near Galveston as a Category 2 hurricane, bringing strong wind and rain to Texas and Louisiana. The National Hurricane Center (NHC) reported wind gusts of 80 mph in Rosharon and 83 mph in Danbury, making Hurricane Ike one of the most destructive weather events on record for the Lower Brazos Planning Region. While Hurricane Ike did not bring record-setting rainfall to the region, the storm's wind field stretched 400 miles wide and produced severe storm surges ranging from 5 to 10 feet along the coast of Brazoria County, as reported by NHC's Tropical Cyclone Report for Hurricane Ike. As a result, Ike is the second most severe flooding event in the region's history by a number of flood claims.

Tropical Storm Hermine

Tropical Storm Hermine made landfall on September 5, 2010, in northeast Mexico before turning towards central Texas. The storm developed into a band of intense rainfall along I-35. The NHC reported 16 inches of total rainfall for Lake Georgetown between September 7th to 9th, 2010, of which 15 inches fell in 24 hours. As a result, Little River, near the City of Little River, reached a gage height of 40.58 feet, the second highest on record. As reported by NOAA's Storm Event Database, flash flooding in Bell, Johnson, and Williamson counties resulted in three direct fatalities.

Hurricane Harvey

Hurricane Harvey made landfall near Rockport, Texas, on August 25, 2017, as a Category 4 hurricane. Brazos River recorded the highest gage height since regulation of flows began, with 55.19 feet and 52.65 feet at Richmond and Rosharon, respectively. Rainfall within the Brazos River watershed between August 25 and September 1 ranged from 13 to 39 inches, the highest of which is comparable to the average annual precipitation for the watershed, according to NOAA. This extreme rainfall resulted in Harvey being the most damaging storm in Region 8 since the NFIP launched in 1968. As reported by NOAA's Storm Event Database, flash floods in Fort Bend County resulted in three direct fatalities.

Tropical Storm Imelda

Tropical Storm Imelda made landfall on September 17, 2019, near Freeport, Texas. The storm developed in the Gulf, strengthening just before its landfall where it traveled along the Texas coast towards Louisianna battering communities with heavy rainfall and winds for 2 days. While the heaviest damage and even fatalities from the storm occurred outside of the Lower

Brazos Planning Region, the NHC reported that portions of Brazoria and Fort Bend County experienced up to 15 inches of rainfall.

Hurricane Beryl

Hurricane Beryl made landfall in Texas on July 8, 2024, near Matagorda and Lake Jackson, Texas. The combination of the tide and storm surge caused surges of 5-7 ft near Freeport, Texas with water level sensors measuring 6.35 ft above the Mean Higher High Water as reported by the NHC. In addition to the storm surge, rainfalls of up to 15 inches were experienced throughout Fort Bend and Brazoria Counties with substantial rainfall and winds reaching up through Milam and Lee Counties.

Historic Flooding of Non-Tropical Origin

Winter 1991-1992

Winter 1991-1992 brought heavy rainfall and flash flooding to most of Region 8 (Halff Associates, 2019). According to the United States Geological Survey, the heaviest rain fell in Coryell County, which received an average depth of 7 inches in 12 hours. Little River reached a stage of 38.95 feet at Cameron, which remains the highest stage after the 1957 flood at this location. The Brazos River floodplain reached five miles width near Bryan and merged with Oyster Creek downstream of Rosenberg.

Spring 2007

Spring 2007 brought heavy rainfall to the Lower Brazos Planning Region (Region 8) after 18 months of drought (Halff Associates, 2019). The Brazos River watershed upstream of Whitney Reservoir received 13 inches of rainfall in May 2007, raising the Brazos River near Aquilla to a stage of 23.28 feet. The Brazos River reached 46.45 feet with 85,900 cfs streamflow near Bryan, the highest stage recorded since the gage began collecting data in 1994. Flash floods in the Leon and Little River watersheds resulted in at least eight direct flood fatalities, as reported by the NOAA Storm Event Database.

Memorial Day 2015

At the end of an above-normal month of rainfall in central Texas, an intense storm produced flash flooding in the Lower Brazos Planning Region (Region 8) on May 23, 2015 (Halff Associates, 2019). The Brazos River near Hempstead reached a stage of 49.97 feet on July 18, its third-highest stage since flood control reservoirs were implemented in the upper watershed. On May 25, 2015, as the system approached Harris County, it merged with a smaller cell in Fort Bend County, resulting in widespread flooding along the lower reach of the Brazos River. Maximum rainfall was recorded at 12 inches over two days near Richmond. Brazos River near Rosharon reached a stage of 51.46 feet on June 5, the sixth-highest recorded stage. Flash floods

in the Leon River watershed and Fort Bend County resulted in at least five direct flood fatalities, as reported by the NOAA Storm Event Database.

Spring 2016

Widespread heavy rain during Spring 2016 led to elevated stages along the Brazos River and wet antecedent conditions for a higher intensity storm that produced 17 inches of rainfall in 24 hours on May 26 in Brenham. This translated to river stages of 54.89 feet at Hempstead and 54.74 feet at Richmond. These gages recorded stages not seen since the flood of 1913, but the stage at the Richmond gage would be surpassed the following year during Hurricane Harvey in 2017. Flash flooding resulted in at least 15 deaths in the Brazos River watershed. Among the fatalities of the Spring 2016 floods were nine soldiers from Fort Hood, as reported by the NOAA Storm Event Database.

FEMA Flood Claims for Historic Flood Events

The FEMA flood claim data began with the establishment of the NFIP in 1968. Total NFIP flood claims connected to each major historical flood event are summarized in *Table 1.8* for significant historical flood events within the Lower Brazos watershed.

Table 1.8: FEMA Flood Claims for Significant Historical Flood Events within the Lower Brazos watershed

Flood Event	Year	Number of Flood Claims	Flood Claims Paid
Hurricane Beryl	2024	N/A[1]	N/A[1]
Hurricane Imelda	2019	2,644	$33,734,675
Hurricane Harvey	2017	44,323	$311,463,534
Spring 2016	2016	8,816	$47,200,156
Hurricane Ike	2008	12,750	$22,477,298
Tropical Storm Hermine	2010	3,363	$20,035,360
Memorial Day 2015	2015	3,815	$8,270,617
Tropical Storm Frances	1998	7,621	$6,061,991
May-June 2007	2007	2,362	$5,502,155
September 1979	1979	602	$3,060,896
Winter 91-92	1992	208	$2,622,179

[1]Flood claims data is not yet published for Hurricane Beryl

(Lower Brazos Flood Claims, Federal Emergency Management Agency)

1.2.5 Political Entities with Flood-Related Authority

The Technical Consultant Team has identified all political subdivisions with flood-related authority as interest groups in the Lower Brazos Planning Region. These entities include cities, counties, river authorities, soil and water conservation districts, water control and improvement districts, flood control and improvement districts, municipal utility districts, and levee improvement districts, among others. Flood-related authority includes a range of actionable powers, from enforcing ordinances to the ability to raise money to execute flood mitigation projects. The publication and enforcement of flood ordinances and regulations are primarily left to the cities, counties, and drainage districts.

Table 1.9 lists the number of entities with various levels of flood-related regulatory authority in the Lower Brazos region.

Table 1.9: Political Entities with Flood-Related Authority

Entity	Number
Cities	193
Counties	43
Municipal Utility District	253
Municipal Water District	2
Water Control and Improvement District	21
Management District	18
Drainage District	8
Levee Improvement District	15
Special Utility District	7
Improvement District	6
Fresh Water Supply District	13
Council of Government	7
Water Authority	10
Other	9
Total	**605**

(Population Estimates, Texas Water Development Board)

Fort Bend and Brazoria counties at the southern tip of the Lower Brazos region contain the largest number of water and flood-related entities functioning within the Lower Brazos Planning Region, including drainage districts, fresh water supply districts, and municipal utility districts. In addition to these entities, Fort Bend County has 13 levee improvement districts. Entities in Fort Bend County, such as Fulshear and Sienna, also operate several additional utility districts. The area comprising Williamson County at the western boundary of the region and nearby communities such as Leander and Round Rock has the next highest number of political

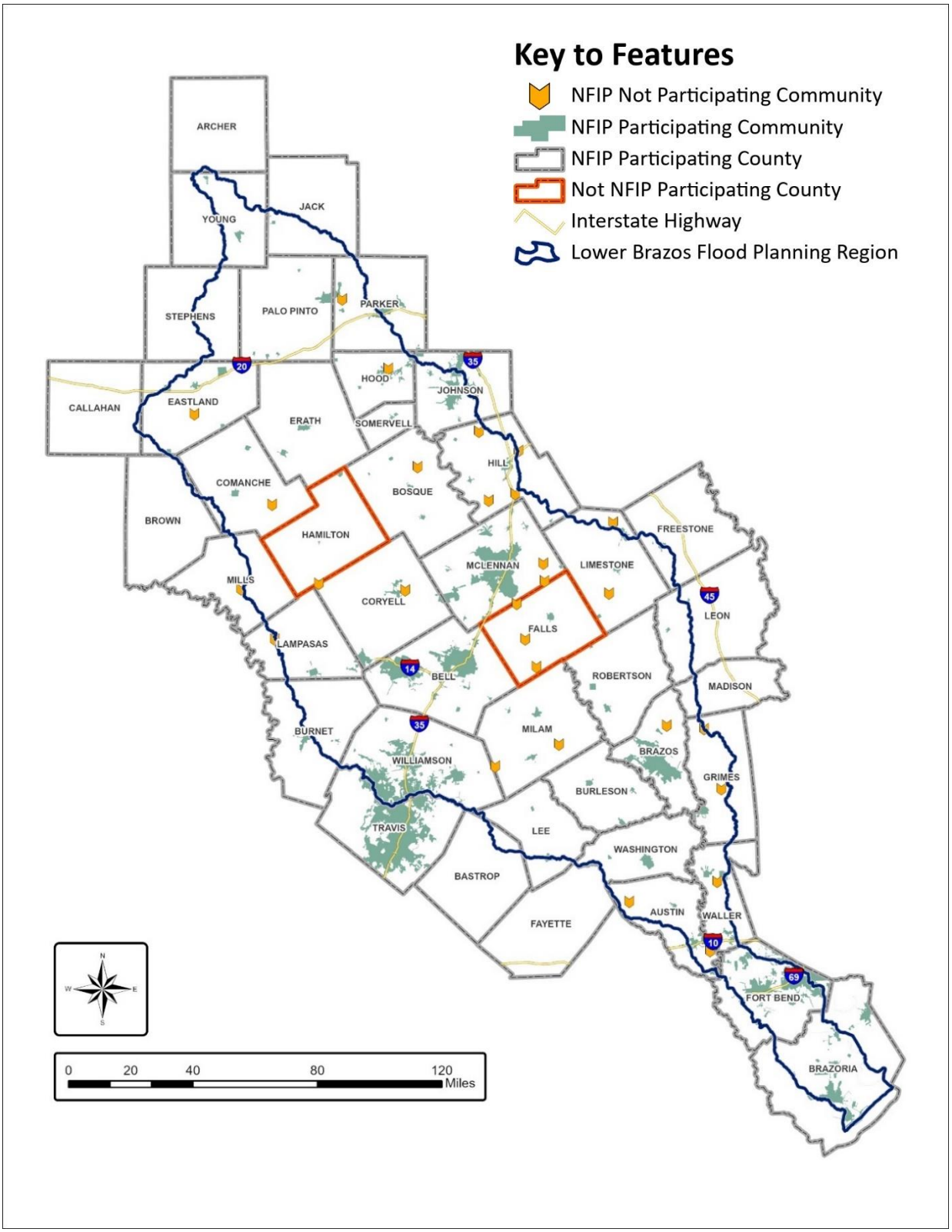
entities with several municipal utility districts, water control and improvement districts, and water, sewer, irrigation, and drainage districts. Counties north of the Lower Brazos region have relatively fewer flood-related political entities responsible for flood planning, management, and mitigation.

Rates of National Flood Insurance Program Participation

The National Flood Insurance Program (NFIP) is administered by the Federal Emergency Management Agency (FEMA) and is a program that assists communities with regulating development in the floodplain and helps communities and individual residents recover from the impact of flood damage.

Twenty-eight cities or towns and two counties within Region 8 do not participate in the NFIP (see *Figure 1.18*). Communities that do not participate have residents who may experience life and property loss during flood events but are not eligible for coverage or assistance under the NFIP. Region Flood planning efforts in Region 8 should consider the increased vulnerability of communities within the 1 percent ACE floodplain that do not participate in the NFIP.

Figure 1.18: NFIP Participation



(Federal Emergency Management Agency)

Summary of Existing Floodplain Management

This section summarizes the regulatory and policy environment governing floodplain management in the various jurisdictions of the Lower Brazos Planning Region. Chapter 3 includes a review of existing floodplain management standards to inform potential recommendations for improvement. As a part of this review, existing criteria and standards were analyzed for many of the entities within the region. The existing criteria included drainage criteria manuals, engineering standards, master plans, stormwater management programs, subdivision regulations, and ordinances. Cities had a greater variation in existing criteria with many having drainage criteria manuals, master plans, and stormwater management programs. Counties primarily had subdivision regulations and stormwater management programs. The criteria vary over the river basin, however many of the entities have more stringent floodplain management standards than the minimum standards set by the NFIP. Even though there are many entities that have higher standards, only 12 entities participate in the Community Rating System (CRS). The CRS is a program within the NFIP that recognizes communities that implement standards higher than minimum floodplain management standards.

Local and Regional Flood Plans

Several entities provided planning documents critical to their communities through the community questionnaire. Over 30 entities indicated having a Hazard Mitigation Plan that includes their jurisdiction. The two analyses completed by Fort Bend County Drainage District (as described in Section 1.2.2) provide detailed hydrology and hydraulics information for watersheds in the County. Additionally, the City of Sugar Land has overseen the development of several drainage improvement analyses for various locations in the City. Sienna, just southeast of Sugar Land, has created the Sienna South Levee System Mater Drainage Plan and a 2021 emergency action plan.

Additional research was performed to identify Master Drainage Plan documents throughout the region. Fourteen entities were found to have publicly available master plan documents:

- City of Bryan
- City of Cedar Park
- City of Cleburne
- City of Copperas Cove
- City of Gatesville
- City of Georgetown
- City of Harker Heights
- City of Killeen
- City of Lake Jackson
- City of Leander
- Missouri City
- City of Round Rock
- City of Sugar Land
- City of Taylor
- City of Waco

The Master Drainage Plan completion dates range from 2010 to 2024, with a couple still being finalized with expected completion dates in 2025.

1.3 Assessment of Existing Flood Infrastructure

The assessment of existing flood infrastructure provides an overview of existing flood infrastructure and natural areas that contribute to lowering the flood risk of communities in the Lower Brazos Planning Region. This assessment of existing flood infrastructure, both natural and man-made, is based on data provided by the TWDB. Additional information on major public flood infrastructure self-reported by entities who took the Lower Brazos Region Community Survey is also included. Existing flood infrastructure is provided in *Table 1 in Appendix 1.1. Map 1 in Appendix 0* shows an overview of the location of the flood infrastructure.

1.3.1 Natural Features

An inventory of the natural features that perform essential flood-related functions in Region 8 is integral to the flood planning process. This inventory includes wetlands, lakes, reservoirs, parks, and preserves. As detailed in *Table 1.10*, there are over 249,000 acres of wetland in the Lower Brazos region. Over 60 percent of the wetlands in the region are freshwater forested/shrub wetlands, of which the largest freshwater forested/shrub wetland acreage is in the Navasota HUC-8 watershed on the central-eastern boundary of the Lower Brazos Planning Region. The Lower Brazos HUC-8 watershed, which includes mid-sized cities like Sugar Land, Fulshear, and Rosenberg, has 37,340 acres, or 24 percent of the total freshwater forested/shrub wetlands in the region.

Table 1.10: Types of Wetlands by HUC-8

HUC-8 Watershed	Estuarine and Marine Wetland (acres)	Freshwater Emergent Wetland (acres)	Freshwater Forested / Shrub Wetland (acres)	Total Wetland (acres)	Total Wetland (percent)
Austin-Oyster	24,421	23,749	15,773	63,944	26%
Bosque	-	405	922	1,326	1%
Cowhouse	-	260	1,750	2,010	1%
Lampasas	-	623	1,559	2,182	1%
Leon	-	2,812	5,580	8,392	3%
Little	-	929	3,306	4,235	2%
Lower Brazos	384	16,336	37,340	54,060	22%
Lower Brazos-Little Brazos	-	5,571	15,297	20,867	8%
Middle Brazos-Lake Whitney	-	3,989	9,082	13,071	5%
Middle Brazos-Palo Pinto	-	2,477	4,673	7,150	3%
Navasota	-	8,344	40,604	48,948	20%
North Bosque	-	574	1,982	2,546	1%
San Gabriel	-	1,359	5,682	7,041	3%
Yegua	-	2,260	8,426	10,686	4%
Total	24,805	69,689	153,445	249,318	100%

(United States Fish and Wildlife Service)

Overall, the Austin-Oyster HUC-8 watershed at the southern tip of the region comprises over one-fourth of the total wetland in the Lower Brazos Planning Region, performing critical flood-related functions. Approximately 14 percent of the entire Austin-Oyster HUC-8 watershed land area is covered with wetlands. While Lower Brazos and Navasota HUC-8 watersheds contain over 20 percent each of the total wetland acreage of the Lower Brazos region, only 5 and 3 percent of their land area, respectively, is comprised of wetland. HUC-8 watersheds in central and northern areas of the region stretching from Graham and Stephenville in the north to Killeen and Bryan in the south comprise of less than 5 percent of the total wetland acreage of the region, and less than 1 percent of their land area has wetland coverage. These HUC-8 watersheds, therefore, lack the relative protection and flood mitigation functions performed by natural features, such as wetlands.

Wetlands perform essential flood-related functions. Source: Brazos River Authority

Lakes, reservoirs, parks, and preserves are critical natural infrastructure performing mitigating functions during flood events.

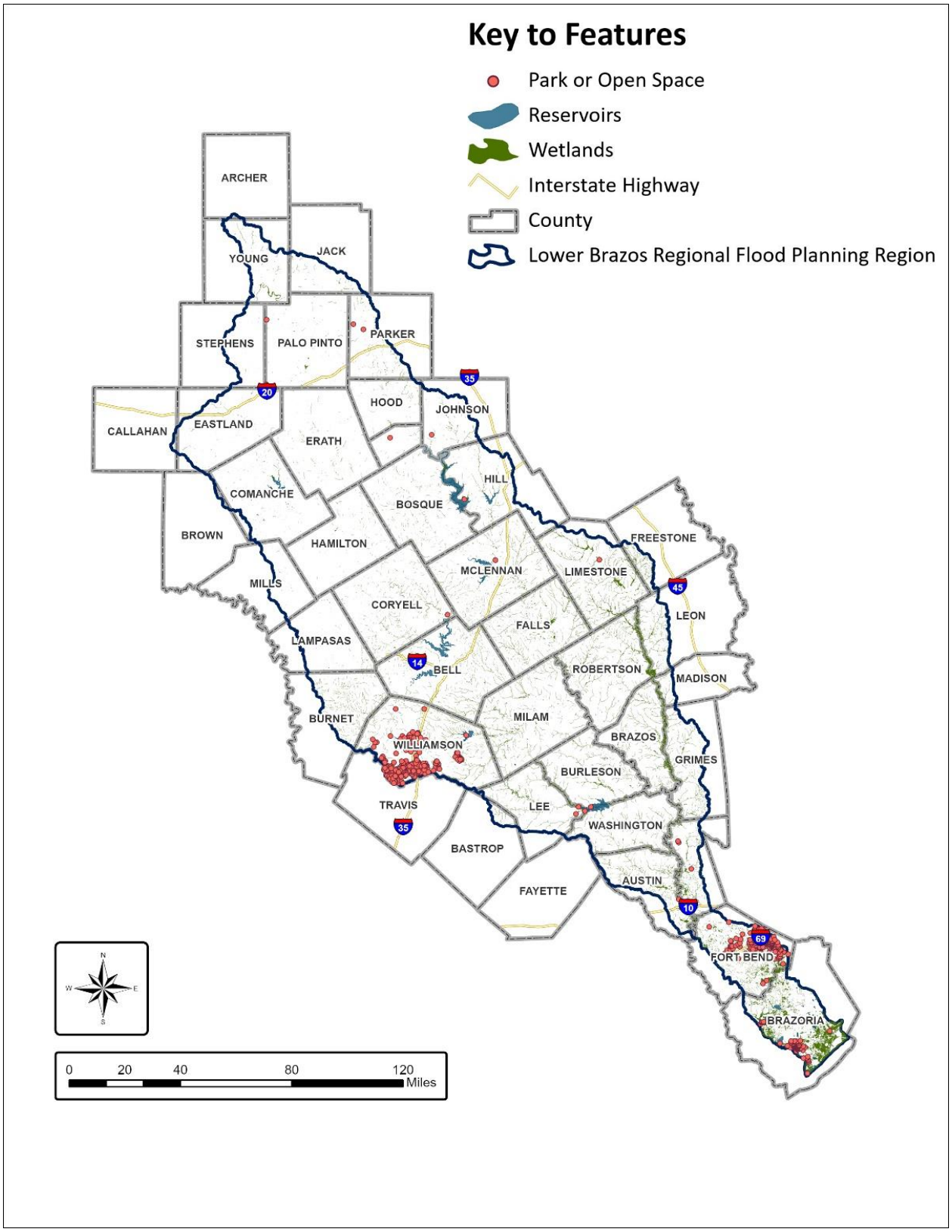
Table 1.11 details the acreage of each of these natural features and the total land area in the HUC-8 watersheds covered by these natural features. The Austin-Oyster HUC-8 watershed at the southern tip of the region has approximately ten percent of Region 8 HUC-8 watershed's total land area covered with lakes, reservoirs, parks, and preserves. The San Gabriel watershed, at the southwestern boundary of the Lower Brazos Planning Region, has approximately four percent of the Region's total HUC-8 land area covered with lakes, reservoirs, parks, and preserves. Other HUC-8 watersheds in Region 8 that have approximately two percent of the total watershed land area covered with lakes, reservoirs, parks, and preserves are Bosque and Middle Brazos – Lake Whitney HUC-8 watersheds in the north and northeastern portion of Region 8 and the Lower Brazos and Yegua HUC-8 watersheds in the south of Region 8. HUC-8 watersheds in the central and central northern region area have less than 2 percent of total land area comprising of flood mitigating natural features. *Figure 1.19* illustrates the location of parks, lakes, preserves, and wetlands in Region 8.

Table 1.11: Lakes, Reservoirs, Parks, and Preserves by HUC- 8

HUC-8 Watershed	Reservoirs (acres)	Parks or Open Space (acres)	Total Reservoirs & Parks or Open Space (acres)	HUC-8 Total Land (acres)	Percent of Total HUC-8 Watershed Land Area
Austin-Oyster	3388	39177	42,565	445,809	9.55%
Bosque	6218	107	6,325	269,796	2.34%
Cowhouse	3328	-	3,328	465,569	0.71%
Lampasas	6364	18	6,382	967,886	0.66%
Leon	14139	381	14,521	1,933,335	0.75%
Little	101	-	101	642,12	0.02%
Lower Brazos	5837	13466	19,302	1,051,476	1.84%
Lower Brazos-Little Brazos	210	-	210	1,726,270	0.01%
Middle Brazos-Lake Whitney	26598	2883	29,480	1,598,523	1.84%
Middle Brazos-Palo Pinto	-	9017	9,017	2,017,196	0.45%
Navasota	213	1468	1,681	1,437,551	0.12%
North Bosque	2338	529	2,867	795,790.	0.36%
San Gabriel	5583	26745	32,327	874,721	3.70%
Yegua	11707	7256	18,964	845,669	2.24%
Total	86022	101046	187,068	15,071,713	24.6%

(United States Fish and Wildlife Service, United States Army Corp of Engineers, Texas Parks and Wildlife Department)

Figure 1.19: Natural Features in Lower Brazos Planning Region



1.3.2 Constructed Flood Infrastructure/Structural Protections

The existing major infrastructure features in Region 8 include publicly owned dams, levees, and weirs. In total, there are 1,066 public dams in the region, of which the largest percentage are in the Leon HUC-8 watershed with 176 dams or 17 percent of all dams in the region.

Lake Whitney Dam in Hill County. Source: Brazos River Authority

The HUC-8 watersheds with less than 5% of the region's dams are Bosque, Lower Brazos, Lampasas, and Austin-Oyster. However, the Lower Brazos and Austin-Oyster watersheds have a relatively large number of levees, accounting for 86 percent of the total levees in the Lower Brazos Planning Region.

Table 1.12 details the dams, levees, and weirs in Region 8. *Figure 1.20* illustrates the location of dams and levees in Region 8.

Table 1.12: Dams, Levees, and Weirs by HUC- 8

HUC-8 Watershed	No. of Publicly owned Dam	No. of Levee	No. of Weir	Total Number
Austin-Oyster	19	23	3	45
Bosque	5	-	5	10
Cowhouse	50	-	-	50
Lampasas	39	1	8	48
Leon	176	4	12	192
Little	66	1	6	73

HUC-8 Watershed	No. of Publicly owned Dam	No. of Levee	No. of Weir	Total Number
Lower Brazos	35	28	2	65
Lower Brazos-Little Brazos	104	7	2	113
Middle Brazos-Lake Whitney	162	4	4	170
Middle Brazos-Palo Pinto	120	1	12	133
Navasota	103	1	2	106
North Bosque	76	1	3	80
San Gabriel	58	-	50	108
Yegua	53	-	-	53
Total	1,066	59*	109	1,234

*12 Levees extend through both the Austin-Oyster and Lower Brazos HUC-8 watersheds.
(United States Army Corps of Engineers)

The two HUC-8 watersheds that abut the Gulf Coast have coastal barriers and revetments that provide structural protection against coastal flooding, as summarized in *Table 1.13*.

Table 1.13: Coastal Infrastructure in Austin-Oyster and Lower Brazos HUC-8

HUC-8 Watershed	No. of Coastal Barrier	No. of Sea Wall	No. of Coastal Revetment
Austin-Oyster	29	8	9
Lower Brazos	4	-	-
Total	32*	8	9

*One coastal barrier extends through both the Austin-Oyster and Lower Brazos HUC-8 watersheds.
(United States Fish and Wildlife Service and General Land Office)

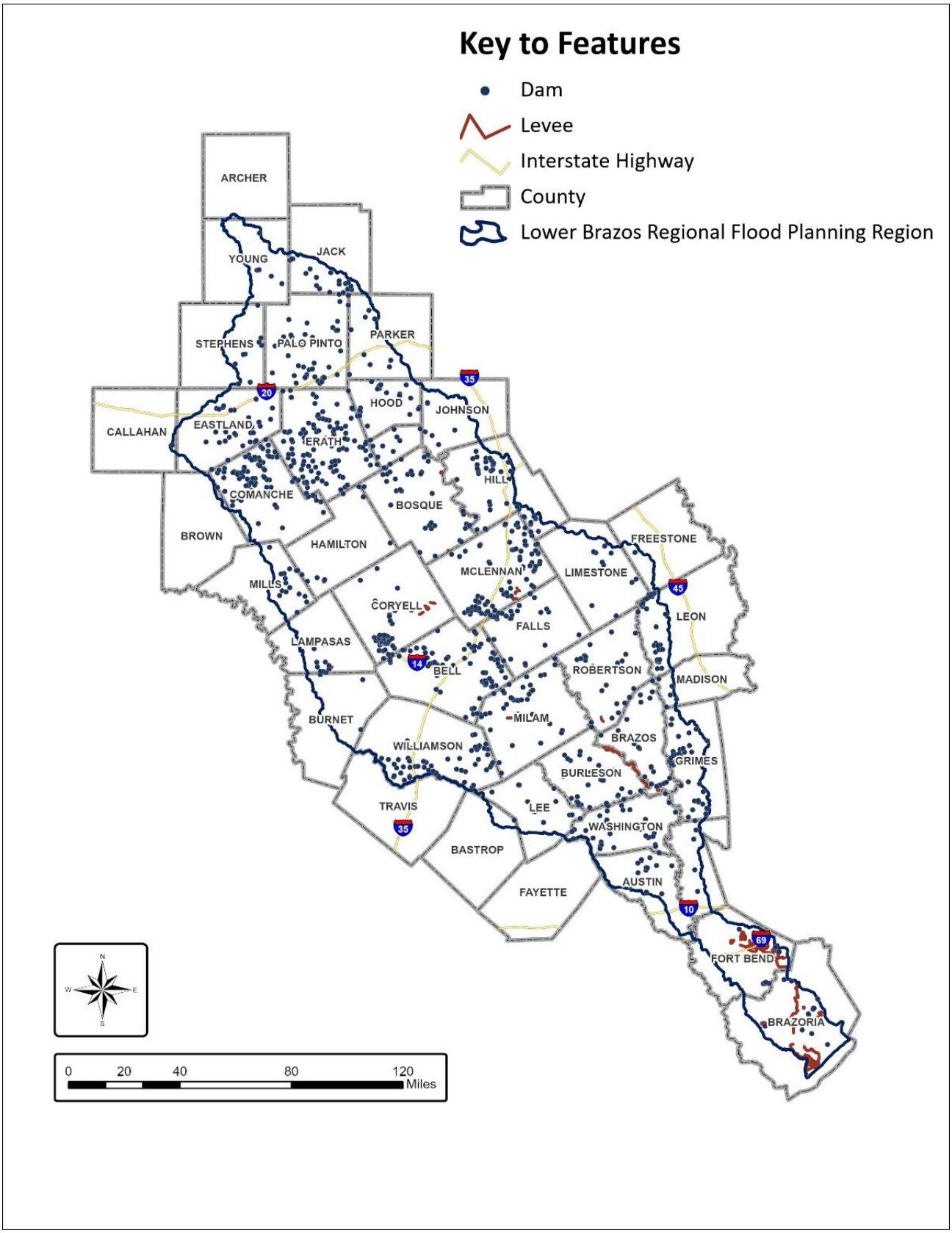
There are 1,149 high water marks in the Lower Brazos Planning Region. As detailed in *Table 1.14*, the San Gabriel HUC-8 watershed in the southwestern area and the Austin-Oyster HUC-8 watershed in the southern area have the highest percentage of high water marks in Region 8, at 27 percent and 25 percent, respectively.

Table 1.14: High Water Marks by HUC-8

HUC-8 Watershed	No. of High-Water Mark	Percent
Austin-Oyster	292	25%
Bosque	4	< 1%
Cowhouse	6	< 1%
Lampasas	47	4%
Leon	41	4%
Little	139	12%
Lower Brazos	77	7%
Lower Brazos-Little Brazos	88	8%
Middle Brazos-Lake Whitney	82	7%
Middle Brazos-Palo Pinto	21	2%
Navasota	20	2%
North Bosque	17	1%
San Gabriel	307	27%
Yegua	8	1%

(Texas Water Development Board)

Figure 1.20: Constructed Flood Infrastructure in the Lower Brazos Planning Region



1.3.3 Non-Functional or Deficient Flood Mitigation Features

This section summarizes the Lower Brazos Planning Region's non-functional or deficient flood mitigation infrastructure. This information is based on self-reported data from communities that have responded to the Lower Brazos Region Interest Group Survey and have self-assessed the condition of their infrastructure as Functional, Non-Functional, or Deficient. This self-reported data has been augmented by information obtained from Levee Safety Assessments by the Levee Improvement Commission in the Texas Commission on Environmental Quality and the Soil and Water Conservation Society's (SWCS) Levee Program and Small Watershed Programs to indicate areas where the existing infrastructure is failing to do its job of protecting the population or is at risk of failure.

The following tables provide information on the level of service (LOS) and functional classification of the dams and levees in the Lower Brazos Planning Region. The LOS is dependent on the assumption that regular maintenance has been performed.

Table 1.15 describes the functional classification of levees by HUC-8. Twenty-one levees extend into both the Austin-Oyster and Lower Brazos HUC-8s and are shown in both categories. *Table 1.16* provides the total number of levees in each classification.

Table 1.15: Functional Classification of Levees by HUC-8

HUC-8 Watershed	Levees 100-Year LOS	Levees Not Assessed	Levees In Progress	Levees Functional
Austin-Oyster	10	20	1	3
Bosque	-	-	-	-
Cowhouse	-	-	-	-
Lampasas	-	1	-	-
Leon	-	4	-	-
Little	-	1	-	-
Lower Brazos	17	21	1	7
Lower Brazos-Little Brazos	-	7	-	-
Middle Brazos-Lake Whitney	-	4	-	-
Middle Brazos-Palo Pinto	-	1	-	-
Navasota	-	1	-	-
North Bosque	-	1	-	-
San Gabriel	-	-	-	-
Yegua	-	-	-	-

(United States Army Corps of Engineers)

Table 1.16: Functional Classification of Levees in the Lower Brazos Planning Region

Functional Classification	Number of Levees
Total Count	59
With 100-Year LOS	21
Levees with 100-Year LOS with an overlap in Austin-Oyster and Lower Brazos HUC-8s	6
Functional	7
In Progress	1
Not Assessed	52
Deficient	1
Non-Deficient	4

(United States Army Corps of Engineers)

Table 1.17: Functional Classification of Dams by HUC-8

HUC-8	Deficient	Non-Deficient	Not Assessed (Unknown)	Total
Austin-Oyster	4	12	3	19
Bosque	-	5	0	5
Cowhouse	-	18	32	50
Lampasas	1	33	5	39
Leon	7	148	21	176
Little	2	64	-	66
Lower Brazos	2	30	3	35
Lower Brazos-Little Brazos	5	82	17	104
Middle Brazos-Lake Whitney	7	139	16	162
Middle Brazos-Palo Pinto	6	94	20	120
Navasota	6	74	23	103
North Bosque	5	55	16	76
San Gabriel	1	55	2	58
Yegua	4	37	12	53
Total	50	846	170	1,066

(United States Army Corps of Engineers)

Of the 1,066 dams in the Lower Brazos Planning Region, the deficiency classification is available for 50 dams and is detailed in *Table 1.17*. Less than 10% of dams that have deficiency data available from the State Regulated Dams TCEQ 2021 Report are classified as deficient or in need of replacement.

1.4 Proposed or Ongoing Flood Mitigation Projects

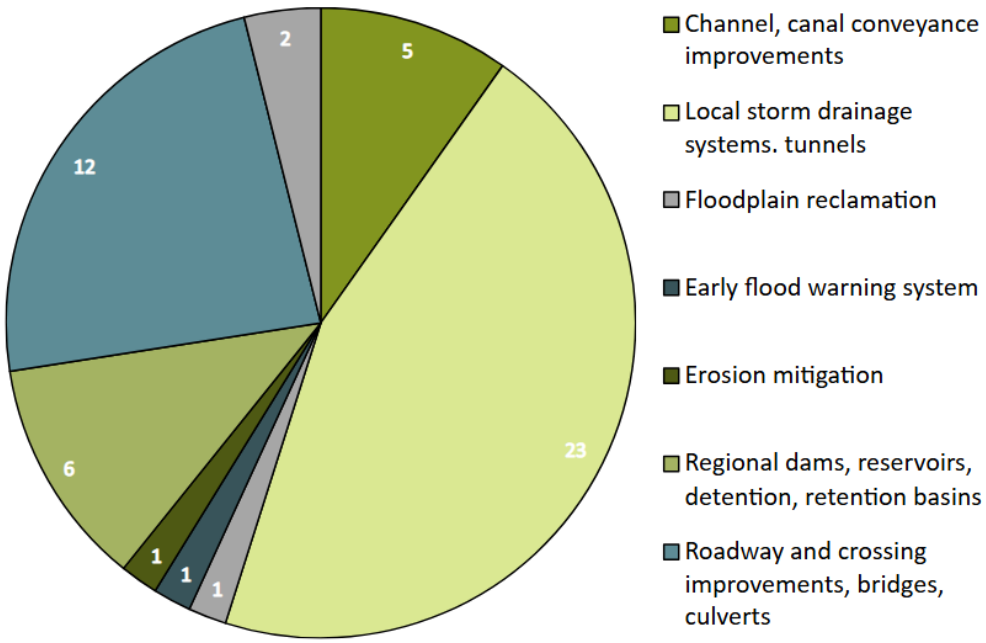
For a thorough flood planning process that considers the flood protection policy and regulatory framework at the local level, it was essential to document the proposed and ongoing flood mitigation projects in the Lower Brazos Planning Region. The data for this section is derived from research into projects awarded funding through the Flood Infrastructure Fund (FIF) and Capital Improvement Program (CIP) projects. Data on FIF projects was obtained from the Texas Water Development Board's Flood Infrastructure Fund (FIF) Project Reporting Dashboard, which details proposed and ongoing projects being funded by the FIF. Information on CIP projects was obtained through research into CIP projects being done in cities within the region.

Cities often publish information on proposed and ongoing CIP projects online, and this publicly available information was used to research and compile information on FMPs. More detailed results are available in the Summary *of* Proposed or Ongoing Flood Mitigation Projects in *Appendix 1.2* and *Map 2* in *Appendix 0*.

1.4.1 Ongoing or Proposed Projects Identified in the Lower Brazos Planning Region's Data Collection

Over 50 ongoing or proposed flood mitigation projects were identified within the Lower Brazos Planning Region. However, there are several gaps in this data set as little data was provided for some of these projects. There are 25 major cities within the region with populations of over 25,000. Almost all of these cities, along with several other small communities, intend to pursue a variety of FMPs in the coming years. These include projects related to local storm drainage systems, roadway improvements, regional dam improvements, reservoirs and detention areas improvements, erosion control, and floodplain reclamation. *Figure 1.21* details the distribution of the types of intended flood mitigation projects.

Figure 1.21: Intended Number of Flood Mitigation Projects



(FIF dashboard and various publicly available CIP sources)

Table 1.18 details the frequency with which communities plan on implementing a particular type of flood mitigation. While several project types, like local storm drainage systems and roadway improvements, may be local in nature, many other solutions are more regional in nature, such as regional dams and retention.

Table 1.18: Number of Flood Mitigation Projects

Type of Flood Mitigation Project	Number
Channel, canal conveyance improvements	5
Local storm drainage systems, tunnels	23
Floodplain reclamation	1
Early flood warning system	1
Erosion mitigation	1
Regional dams, reservoirs, detention, retention basins	6
Roadway and crossing improvements, bridges, culverts	12
Pump station improvements	2
Total	51

(FIF dashboard and various publicly available CIP sources)

These proposed or ongoing flood mitigation projects are derived from research into communities throughout the region, including cities, counties, and additional political entities. The predominant types of projects being pursued are:

- local storm drainage systems and tunnels
- roadway and crossing improvements, bridges, culverts
- regional dams, reservoirs, detention, retention basins
- channel, canal conveyance improvements

The projects with no interest were nature-based projects, property floodproofing, and sea barriers, walls, and revetments. It is important to note that there may be more ongoing projects than identified within this report. Information was sourced from publicly available sites which may not be comprehensive or contain the most up to date information.

Potential funding sources identified for these projects as part of the RFPG effort include federal and state sources, such as the Flood Infrastructure Fund, as well as local funding sources.

Structural Projects under Construction

Information collected during research is insufficient to provide a complete understanding of structural projects under construction across Lower Brazos. Some ongoing structural projects may not have been identified during research. However, 48 out of the 51 identified flood mitigation projects are structural, and 30 of these 48 projects are either currently under construction or recently completed. The majority of proposed or ongoing structural projects concern local storm drainage systems or roadway improvements.

Non-Structural Flood Mitigation Projects Being Implemented

Information collected during research is insufficient to provide a complete understanding of the non-structural flood mitigation projects being implemented within the various entities. Only three of the 51 identified projects were non-structural, including floodplain reclamation, early flood warning system, and erosion management projects. There may be more non-structural projects being implemented within the area that were not identified.

Structural and Non-Structural Flood Mitigation Projects with Dedicated Funding and Year

Information found during research efforts is insufficient to describe all structural and non-structural flood mitigation projects with dedicated funding. Entities with the Lower Brazos utilize both local sources of funding and outside funding, such as the Flood Infrastructure Fund (FIF). Dedicated local funding includes sources such as general obligation bonds, general funds, and CIP bonds. Some entities do not publicly publish funding sources or an estimated year of completion.

Potential Benefits of Planned Mitigation Projects

Although some communities did not provide detailed information about their intended projects, there does appear to be substantial awareness of the value of preparing for future flood events. Research into proposed and ongoing flood mitigation projects indicates that substantial investment is being made in local drainage, roadway, and flood control infrastructure. Without greater detail regarding the scale, complexity, and location of these projects, it is difficult to quantify the benefit received.

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